ADVANCING WATER RESOURCES PLANNING, EDUCATION AND OUTREACH
THROUGH COLLABORATIVE MODELING AND
STAKEHOLDER ENGAGEMENT METHODS

By
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School of the Environment

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To the Faculty of Washington State University:

The members of the Committee appointed to examine the dissertation of MELANIE R. THORNTON find it satisfactory and recommend that it be accepted.

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ADVANCING WATER RESOURCES PLANNING, EDUCATION AND OUTREACH THROUGH COLLABORATIVE MODELING AND STAKEHOLDER ENGAGEMENT METHODS

Abstract

by Melanie R. Thornton, Ph.D.
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Water resource issues are inherently challenging due to the diversity of stakeholder perspectives and values and because of the inherent and fundamental complexities of socio-ecological systems. These complexities necessitate that water resource planning processes utilize collaboration and adaptive governance principles, as well as highly iterative, participatory techniques that promote social learning and trust. Collaborative modeling and systems thinking are effective participatory techniques for addressing such challenges. This research utilized a collaborative modeling process to engage water resource stakeholders over the course of four years in the Spokane River Basin located in northeast Washington and northern Idaho. In doing so it met the call for universities to be increasingly involved as bridging organizations that engage regional stakeholders as they address societal problems. In this role, university research teams help bridge the gaps between science, society and decision-making entities.

This research advances understanding of the strategies, methods and processes that university-affiliated bridging organizations use to enhance long term water resource planning,
education, and outreach. This research improves understanding of the role collaborative
modeling and stakeholder engagement provides to water resource stakeholders. It supports the
body of literature that communicates the importance of building relationships, social capacity
and trust, and that learning is an essential component to effective participatory processes. This
research demonstrates the necessity of facilitation skills, and the importance of designing an
iterative, flexible approach that meets the changing priorities of stakeholders. It concludes with
best practices for supporting long-term stakeholder engagement in water resources.
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<td>WISDM</td>
<td>Watershed Integrated System Dynamics Modeling</td>
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<td>CM</td>
<td>Collaborative Modeling</td>
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<td>SRB</td>
<td>Spokane River Basin</td>
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<td>SVRP</td>
<td>Spokane Valley Rathdrum Prairie Aquifer</td>
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<td>WRRIA</td>
<td>Washington Watershed Resource Inventory Area</td>
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<td>CAMP</td>
<td>Idaho Comprehensive Aquifer Management Plan</td>
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DEDICATION

To my Grandparents:

Without your love, support and passion for education I would not have made it this far.
CHAPTER ONE: INTRODUCTION

1.1. Problem Context: Stakeholder Engagement in Water Resources Research

Water issues are among the most controversial, crucial and sensitive issues that face communities and governments today. Water resources planning, management and education are inherently challenging due to the uncertain and intricate nature of human and natural resource systems and conflicting interests of regional stakeholders (Dörendahl, 2013; Global Water Partnership, 2000). To be effective in addressing these challenges it requires significant collaboration across multiple jurisdictions and competing value systems. In the field of water resources planning, this requires adaptive governance principles that utilize highly iterative and participatory processes that promote social learning, increase understanding of complex issues and build personal relationships, trust and respect among stakeholders.

Participatory processes engage stakeholders and communities in the process of addressing problems, developing plans or making decisions about water resource management (Reed, 2008). Often times, these processes are critical for finding consensus-based solutions to complex water resources challenges. Research and case studies support that these processes must employ an approach that is both iterative and flexible to build a comprehensive understanding of water management systems, develop solutions to complex water challenges and meet the evolving priorities of stakeholders (Kallis, Videira, Antunes, & Pereira, 2006; Langsdale et al., 2013; Mott Lacroix & Megdal, 2016). Collaborative modeling is an approach that integrates the principles of water resource modeling with stakeholder engagement (Langsdale et al., 2013). It provides communities with the opportunity to foster informed, meaningful dialogue about integrated planning, management and education of shared water resources (Beall King &
Thornton, 2016; Bourget, 2011; van den Belt, 2004). Participatory processes that utilize collaborative modeling have the greatest potential to develop robust recommendations for water planning, management and education that engage stakeholders, advance social learning and address the needs and interests of regional water resource stakeholders. Universities serve a unique role in the long-term engagement of stakeholders by facilitating participatory processes that advance stakeholder collaboration and promote adaptive governance of water resources.

Universities are being called upon to address societal problems, bring practical information and support to their region and engage with stakeholders from government, industry, special interest groups and communities (Allen, Kruger, Leung, & Stephens, 2013; Shapiro, 2009). Recent research supports that engaging stakeholders to address complex human-environmental systems challenges is a new, important function of universities (Allen et al., 2013; Trencher, Yarime, & Kharrazi, 2013). Universities and university research teams serve a unique role in bridging the gap between society and decision-making agencies and facilitate collaboration and stakeholder engagement to address challenges to regional water resource planning, management and education. Universities commonly participate in stakeholder engagement serving as bridging organizations. Bridging organizations primarily function as collaborative organizations that engage stakeholders and facilitate solving complex human-environmental problems (Crona & Parker, 2012). Research on how universities, university research teams and bridging organizations support long-term stakeholder engagement processes in water resources is needed.

1.2. PURPOSE AND OBJECTIVES

The Spokane River and the Spokane Valley Rathdrum Prairie (SVRP) aquifer are a tightly coupled hydrologic system on the border of Washington and Idaho. This bi-state, multi-
jurisdictional system is made more complex by the dynamic interaction between groundwater and surface water and a climate change signature that is not clearly visible. As with many other complex systems the complexities within the Spokane Basin cannot be understood from a single disciplinary perspective. Therefore collaboration among water resource decision makers, stakeholders with a vested interest in water resources, and scientists is essential for addressing regional water resource management alternatives. Furthermore, this collaboration must endure over time and changing political regimes. Investing in the process of long-term stakeholder engagement provides an opportunity for university research teams to work iteratively with stakeholders, to discuss problems and challenges, to assist with the development of strategies and solutions, and to better understand how water resource decisions change over time. It also assists with the identification of mutually beneficial and acceptable water management, education and outreach strategies.

This dissertation focuses on connections between university research teams, bridging organizations and long-term stakeholder engagement processes to address water resource sustainability. The primary purpose of this study is to investigate the role of collaborative modeling and university research teams in the long-term engagement of water resource stakeholders in an urban watershed. Key research questions include the following:

1. How do university research teams engage stakeholders in participatory water processes over time?

2. What does long-term stakeholder engagement and collaborative modeling bring to a group of water resource professionals in a bi-state watershed?
3. Can university research teams function as bridging organizations to support long-term stakeholder engagement and facilitate addressing and solving complex water resource problems?

This research improves understanding of the contributions that collaborative modeling and university-affiliated bridging organizations provide in long-term stakeholder engagement and participatory processes. This project included a stakeholder engagement process spanning four years that utilized many stakeholder engagement activities and approaches to support regional stakeholders in addressing water resource sustainability in the Spokane River Basin. Early components of a collaborative modeling approach to engage stakeholders was utilized to develop a tool, the Spokane River Basin (SRB) OASIS model, and discuss important issues related to water resources. This ongoing participatory process allowed stakeholders to explore and develop basin-wide planning, management and education strategies to address regional water resource challenges. An in-depth case study of a stakeholder engagement process in the Spokane River Basin was the focus of this research.

It is important to note that this research project’s objectives changed overtime in an evolving effort to meet the changing needs of regional water resource professionals in the Spokane River Basin. Early stages of this project included an objective to utilize a collaborative modeling process to develop the Spokane River Basin OASIS model to explore basin-wide management strategies with stakeholders in the region. The initial objectives of the collaborative modeling project included: a) developing future scenarios with stakeholders to ensure that information is relevant to specific stakeholder needs; and b) exploring and evaluating different water management strategies that help facilitate adaptation to a changing climate. This participatory process aimed to explicitly understand how water resource decisions may be
affected by climate change impacts in the region. Mid-way through the research project, it was clear that stakeholders shifted their priorities from collaboratively building a new hydrologic model to prioritizing the need for education, outreach and preliminary regional water planning. Thus, the core research objectives of the research were modified to understand the role of both collaborative modeling and university research teams in the long-term engagement of water resource stakeholders.

1.3. Stakeholder Engagement Narrative

The Spokane River Basin from many perspectives has an abundance of water. Water resource leaders value collaboration and understand the importance of institutionalizing adaptive management in advance of a potential water management crisis. These water resource stakeholders encouraged university researchers to utilize a participatory process to work with diverse, regional stakeholders in addressing challenges to bi-state water planning, education and outreach. This narrative describes my experience collaborating with local water resource professionals over the course of four years. It illustrates a process that supports the changing priorities and needs of stakeholders over time.

This stakeholder engagement project was a part of a larger interdisciplinary research project to address water resources sustainability in the Pacific Northwest. It met the call for universities and university researchers to increasingly engage stakeholders as they address complex socio-ecological challenges. This research project began by employing a collaborative modeling process to allow scientists and stakeholders to jointly ask key issues related to their regional water resource system. The collaborative modeling method builds from principles of system dynamics, facilitation and planning. This approach emphasizes the importance of the
process, where stakeholders come together to deepen their understanding of the system, build trust, and learn.

This project began with the intent to build a model to be used to bring stakeholders together, prompt discussion, and facilitate a process where stakeholders would work together on developing bi-state water management strategies. The stakeholder engagement team met individually with stakeholders to establish common ground, and provide an environment for individuals to share their knowledge about the water system and discuss pressing issues related to water planning. Many stakeholders shared their concerns about low streamflows in the Spokane River, groundwater pumping impacts to Spokane River streamflows, complexities of interstate responsibilities and jurisdiction, and the relatively separate approaches to water resources planning, education and outreach. Overtime, relationships and trust forged between the regional stakeholders and the university research team, including myself.

Trust and knowledge of the regional water resource system developed with active, ongoing involvement in the basin, by attending monthly meetings, giving presentations at meetings, workshops and conferences, and assisting with meeting facilitation. Over a two year period, a hydrologic model of the Spokane River Basin and Spokane Valley Rathdrum Prairie aquifer was developed. The model development process included many individual and group meetings, phone conservations, emails and presentations with a wide variety of hydrologic experts in the basin. This model was tested and vetted by hydrogeologic experts at Washington State University, Washington Department of Ecology, Idaho Department of Water Resources and regional consulting firms.

Many water resource stakeholder were interested in exploring future scenarios that included water conservation, population growth and prolonged drought. Throughout the ongoing
engagement of stakeholders, many water resource leaders believed that there was a “silver bullet” solution to solving most of their water resource challenges. During this time, I was invited to plan and facilitate an interactive future scenarios session using the OASIS Spokane River Basin model at the regional water conference, the Spokane River Forum. The goal was to facilitate discussion about climate change and future water demand, and the subsequent impacts on the Spokane River. This session simulated model outputs on the fly and allowed stakeholders to see the impact of various scenarios.

At this particular Spokane River Forum, participants heard plenary presentations on: a) importance of collaboration, b) impacts of groundwater pumping on Spokane River streamflows and c) the future impacts of climate change on the Spokane River Basin hydrologic system. Following these presentations, my interactive session provided stakeholders the opportunity to discuss these future scenarios and the impact it has on streamflows and water resources in the basin. During this session, many participants confirmed what I had come to understand that conservation and reduced water use would not solve the low streamflow problem in the Spokane River. There was no “silver bullet” solution to the regional water challenges. To summarize this shift, one participant expressed their concern: “we thought we had time….we have to do something now.”

Stakeholder priorities and needs were shifting. It became clear to many people that it would be challenging to design and implement a bi-state water management plan that included streamflow mitigation without education, outreach and public buy-in. Many stakeholders realized that it was too early in the process to use a modeling tool to work with the public in addressing water planning and management in the basin. These professionals realized that there was sufficient understanding of the water resource science in the basin, and the focus needed to
be on education, and the importance of collaborative water governance. I made a conscious choice to shift with the changing stakeholder objectives, and assisted in designing and facilitating a process to develop an education and outreach plan for the basin, which is now in the process of being executed.

I have found that stakeholder engagement research projects do not always follow the original plan, as stakeholder priorities and requirements shift over time. Through this process, I recognized that it is not always about developing one final plan, it is ultimately the process of working together that makes the outcome stronger. In the end, there will never be just a single plan or solution, but ongoing and continual adaptation.

1.4. Dissertation Outline

The dissertation is structured in a traditional thesis format (Figure 1.1). Chapter two serves as a literature review and includes an overview of the theoretical concepts, history and definitions of stakeholder engagement and participatory processes. A framework for a discrete participatory process that includes important design, implementation and evaluation components is described. An overview of the participatory methods used in this research project is provided. Finally, information on the role universities, university research teams and bridging organizations play in water resource stakeholder engagement projects are included. Chapter three includes background information on the Spokane River Basin. This chapter includes an overview of water planning, education and outreach in the basin and an overview of the watershed characteristics. Chapter four and five describe this research project’s methodology.

Chapter four provides an overview of stakeholder engagement in the basin and describes the engagement process in four parts: 1) collaborative modeling; 2) engaging stakeholders at the Spokane River Forum; 3) developing an education and outreach campaign for water stewardship;
and 4) preliminary water resources planning workshops. Chapter five describes methods used to evaluate the participatory process and gather perspectives on understanding the role university researchers play in long-term engagement processes. This chapter details the interview methods use to gather and analyze data for this research. Chapter six describes the results of this long-term stakeholder engagement research project. This chapter is separated into three components: 1) outcomes from the WISDM-related stakeholder engagement activities; 2) outcomes from the stakeholder requested engagement activities; and 3) evaluation and interview results.

Chapter seven discusses the analysis and the findings. A set of best practices for stakeholder engagement was developed to show how bridging organizations can design participatory processes that engage stakeholders to advance social learning and strategies that support improved collaboration for water resources management. This chapter describes the proposed framework of best practices for long-term stakeholder engagement. Recommendations and challenges of long-term stakeholder engagement by bridging organizations are discussed. This chapter concludes by outlining potential areas for future study.
Figure 1.1 Roadmap of this dissertation.
CHAPTER TWO: LITERATURE REVIEW

2.1 INTRODUCTION

This chapter provides an overview on stakeholder engagement and participatory processes in water and natural resource decision making. This chapter details principles of effective stakeholder engagement processes. This literature review reviews the framework for stakeholder engagement for a discrete participatory process, which includes design, implementation and evaluation of the participatory process. This chapter includes an overview of the participatory methods used in this research project. Finally, this chapter synthesizes the role of universities, university research teams and bridging organizations play in stakeholder engagement initiatives.

2.2 WHAT IS PARTICIPATION, COLLABORATION, STAKEHOLDERS AND PARTICIPATORY PROCESSES?

This section provides an overview of key terms used in this literature review and in this research project. This section defines participation, collaboration and participatory processes. This section provides a brief history of the different definitions of the term stakeholder. Finally, the terminology used in this research project is detailed.

Participation is defined as “the involvement of individuals and groups [i.e., the public or stakeholders] that are positively or negatively affected by or are interested in a proposed intervention” (Enserink, Patel, & Kranz, 2007). In the management of natural resources, participation is usually defined as an approach to consult and involve relevant stakeholders in a participatory process where stakeholder perspectives and insights are addressed in the development, management and implementation of plans and policies (Koontz, 2004). Defining stakeholder participation is multifaceted, and incorporates multiple social, political, ideological
and methodological meanings that may change as it is applied across a variety of contexts (Reed, 2008). Additionally, participation can vary depending on the level of engagement and the objectives of the participation; different typologies of participation are further explored in Section 2.4 (Reed, 2008). This broad definition of stakeholder participation is an indication that participation is wide-ranging and it is as much of an abstract concept as it is a practical tool.

Collaboration is a process in which a diverse group of stakeholders, those with an interest or stake in a particular issue, work together to resolve a conflict or create and develop a shared vision (Gray, 1989; Koontz & Johnson, 2004). In natural resources planning and decision making, participatory processes are defined as collaboration between diverse stakeholder groups that generate information, build networks and trust, and strive for consensus based decisions that address complex environmental problems (Ananda & Proctor, 2013; Bourget, Langsdale, & van den Belt, 2013; Koontz, 2004). Participatory approaches have become a pillar in the management of natural resources (Armitage, Plummer, & Berkes, 2009). Participatory processes or approaches are ways to involve different stakeholders and communities in the process of developing plans or making decisions about natural resource management (Reed, 2008). Whereas, traditional processes are those where stakeholder participation is not clearly defined or incorporated into the process. Participatory processes usually result in the collaboration of diverse stakeholders in many sectors that convene either periodically or indefinitely in an effort to work together to develop and implement a plan or public policy (Reed, 2008).

The term stakeholder dates back to the 17th century where it was primarily used to describe an individual or third party who had been responsible with a stake in a bet (Ramirez, 1999). In the business management field, there have been more recent and commonly cited definitions of the term stakeholder. The term stakeholder is defined as “any group or individual
who can affect or is affected by the achievement of the organization’s objectives” (Freeman, 1984). In the field of natural resources, more recent definitions build on Freeview’s perspective and try to differentiate between those who affect or are affected by an action or decision (Grimble & Wellard, 1997). Other authors and researchers from both non-profit organizations and the public sector have attempted to define the term stakeholder (Table 2.1).

**Table 2.1 Different definitions of the term stakeholder. Sources listed in table.**

<table>
<thead>
<tr>
<th>Definition</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>“All parties who will be affected by or will affect [the organization’s] strategy”</td>
<td>(Nutt &amp; Backoff, 1992)</td>
</tr>
<tr>
<td>“Any person, group or organization that can place a claim on the organization’s attention, resources or output, or is affected by that output”</td>
<td>(Bryson, 1995)</td>
</tr>
<tr>
<td>“People or small groups with the power to respond to, negotiate with, and change the strategic future of the organization”</td>
<td>(Eden &amp; Ackermann, 1998)</td>
</tr>
<tr>
<td>“Those individuals or groups who depend on the organization to fulfill their own goals and on whom, in turn, the organization depends”</td>
<td>(Johnson, Scholes, &amp; Whittington, 2008)</td>
</tr>
</tbody>
</table>

For the purposes of this research project, it is important to define who should participate in a participatory process in water resources. In this thesis, the term stakeholder is defined broadly. Participants in this research project include water resource professionals involved in decision-making, local and state agency personnel, water purveyors, consultants, industry personnel, individuals in nongovernmental organizations, academic researchers and self-selected members of the general public who are interested in water resource management. For this thesis, the term participation will be used broadly to describe the various approaches to engage stakeholders into water resources planning, education and outreach. Participatory processes will be used to refer to the engagement of stakeholders. Other terms that have similar meanings include participatory processes, engagement processes, stakeholder engagement and stakeholder participation.
2.3. Stakeholder Engagement & Participatory Processes Background

This section provides an overview of the role stakeholder engagement and participation plays in water and natural resource decision making. The benefits and challenges of stakeholder engagement are detailed. This section also provides an overview of general principles of effective stakeholder engagement processes. Applications of participatory processes in the field of water resources are described.

2.3.1 The Role of Stakeholder Engagement in Water and Natural Resources Decision Making

By the mid-20th century, the recognition that environmental problems were becoming increasingly complex resulted in a plethora of legislation within the United States that calls for increased stakeholder involvement in decision making. The changing regulatory environment and civic activism in the 1960s and 1970s also promoted collaboration. In 1970, the National Environmental Policy Act (NEPA) was passed to provide citizens and non-governmental organizations the opportunity to guide decision making processes and outcomes of federal actions impact the environment (Bourget, 2011; National Environmental Policy Act (NEPA), 1969). The United Nations Conference on the Human Environment in 1972 (also known as the Stockholm conference) marked the beginning of modern environmental diplomacy and prompted public participation at the international scale (Grieger, 2012). In 1987, the World Commission on Environment and Development focused on the role of public and community involvement within environmental decision making (United Nations, 1987). The Dublin Statement on Water and Sustainable Development, adopted in 1992, incorporated participation into its guiding principles (United Nations, 1992b). The Rio Declaration on Environment and Development and Agenda 21 recognized the essential role stakeholder participation plays in natural resources management, including water management (United Nations, 1992a).
Within the water resources community of practice, collaboration and stakeholder participation has grown over the last few decades. In the 1950s, the Harvard Water Program was one of the first times where engineering and economics were deliberately integrated to improve water resources planning (Bourget, 2011). This program marked the start of multi-objective planning processes and impacted water resource planning and decision making in the latter half of the twentieth century (Reuss, 2003). Additionally, this program promoted negotiation and focused attention on the importance of physical, social and political impacts to hydrologic systems, and thus the importance of engaging different stakeholders in the planning process (Reuss, 2003). Key policies, such as the US Clean Water Act in 1972 (http://epw.senate.gov/water.pdf) and the European Water Framework Directive in 2000 (Commission of the European Communities, 2000), emphasize the importance of stakeholder participation and public involvement in water management (Bäckstrand, 2003; McDaniels, Gregory, & Fields, 1999; Reed, 2008). In addition, the World Water Council recognized stakeholder participation as a key element to water resource planning and decision making (World Water Council, 2015).

Since the inception of NEPA in the 1970s, federal agencies in the US have substantially increased public participation in the development of water and environmental policies, regulations and decisions (Conley & Moote, 2003; Koontz & Johnson, 2004; Moore & Koontz, 2003). This involvement has shifted natural resources management from a top-down approach that addressed the public through press releases and hearings, to an integrated, bottom-up approach that fully integrates stakeholders in participatory processes (Koontz, 2004; Koontz & Thomas, 2006). This shift illustrates the importance of participation to improve resource
management and enable individuals and groups to participate in planning and decision making
processes.

2.3.2 **Benefits and Challenges of Stakeholder Engagement**

The literature provides many case studies that illustrate the benefits and challenges of
stakeholder engagement (Table 2.2). The benefits of stakeholder participation and engagement
within natural and water resource decision making are immense, as evident in its prevalent
incorporation into national and international policy. However, there are frustrating and
challenges aspects to stakeholder engagement. Theses aspects of stakeholder engagement are
broadly categorized into benefits and challenges for natural and water resource decision making
(Table 2.2).

<table>
<thead>
<tr>
<th>Benefits of stakeholder engagement</th>
<th>Challenges of stakeholder engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Information Exchange and Learning</td>
<td>• Time consuming process</td>
</tr>
<tr>
<td>• Better understanding of projects, problems and issues</td>
<td>• Expensive process</td>
</tr>
<tr>
<td>• Fostering and improving social learning</td>
<td>• Potential stakeholder frustration</td>
</tr>
<tr>
<td>Integration of Knowledge and Interests</td>
<td>• Identification of new issues and conflicts</td>
</tr>
<tr>
<td>• Improving project design utilizing local knowledge</td>
<td>• Stakeholder participation that is not representative</td>
</tr>
<tr>
<td>• Integration of diverse perspectives and interests</td>
<td>• Empowerment of already important stakeholders</td>
</tr>
<tr>
<td>Acceptance, Trust and Legitimation of the Decision</td>
<td>• Public acceptance of the decision</td>
</tr>
<tr>
<td>• Increased trust in decisions</td>
<td>• Increased ownership</td>
</tr>
</tbody>
</table>

2.3.2.a. **Benefits of Stakeholder Engagement: Information Exchange and Learning**

The communication and exchange of information and social learning are important
components of participation (Beierle, 2002; Luyet et al., 2012; Pahl-Wostl, Craps, & Dewulf,
2007; von Korff, D’Aquino, & Daniell, 2010). Participation approaches bring together a range of
stakeholders with diverse opinions, values and interests, which leads to a more holistic
understanding of the issues (De Marchi, 2003; Hove, 2000; Lynam, Jong, Sheil, Kusumanto, &
Evans, 2007; Newig, 2007; Pahl-Wostl, 2002; Reed, 2008). Stakeholder participation also encourages social learning (Blackstock, Kelly, & Horsey, 2007). This takes place when stakeholders learn from each other through developing new relationships, building on current relationships and transforming challenging relationships (Pahl-Wostl et al., 2007; Reed, 2008). Stakeholders also build trust and learn to appreciate the legitimacy of other stakeholder perspectives (Newig & Fritsch, 2009a). Researchers argue that social learning may be one of the better benefits from participation, as creative solutions and outcomes are developed through thoughtful discussion and deliberation (Newig & Fritsch, 2009a; Reed, 2008). Additionally, case studies demonstrate that participation and participatory processes aid in understanding the issue and defining the problem, which can enrich outcomes and water resource planning strategies (Armitage et al., 2009; Berkes, 2009; Bouwen & Taillieu, 2004; Cormick, 1996; Graffy, 2008; Kallis et al., 2006; Muro & Jeffrey, 2008; Pahl-Wostl et al., 2007; Raymond et al., 2010; van den Belt, 2004).

2.3.2.b. **Benefits of Stakeholder Engagement: Integration of Interests and Knowledge**

The integration of different interests is a crucial component of participation (Luyet et al., 2012). Case studies show that integrating local interests and concerns at an early stage in the process increases the likelihood that the needs and priorities of stakeholders are met (Dougill, Fraser, & Holden, 2006; Stringer, Dougill, & Fraser, 2006). In addition, incorporating different types of knowledge allows for more complete information in the participatory process (Reed, 2008). It is often argued that incorporating diverse interests and knowledge of participants can lead to the ability to anticipate adverse outcomes before they occur (Beierle & Cayford, 2002; Koontz & Thomas, 2006; Newig, 2007; Newig & Fritsch, 2009b; Reed, 2008). In a participatory process, stakeholders can learn to appreciate the knowledge and legitimacy of other stakeholder
perspectives, which have the capacity to build new relationships and transform adversarial ones (Blackstock et al., 2007; Reed, 2008). This relationship building capacity may lead to an increased sense of ownership over both the process and the outcomes, and thus lead to better results. In short, there is overwhelming evidence that stakeholder participation and incorporating different types of interest and knowledge leads to more robust solutions to complex water problems (Beierle & Konisky, 2001; Blackstock & Richards, 2007; Creighton, 2005a; Creighton, Priscoli, Dunning, & Ayres, 1998; D. M. Hall, Gilbertz, Anderson, & Ward, 2016; Koontz & Thomas, 2006; Newig & Fritsch, 2009b; Özerol & Newig, 2008; Reed, 2008; Smith, 2015; Stringer et al., 2006; Susskind, McKearnen, & Thomas-Lamar, 1999).

2.3.2.c. Benefits of Stakeholder Engagement: Acceptance, Trust and Legitimation of the Decision

Stakeholder participation benefits democratic society. In addition, social responsibility and equity, and incorporating public opinions into decision-making are fundamental for democracy and arguably an integral part of democratic efforts to achieve social goals (Bäckstrand, 2003; Beierle & Konisky, 2001; Carr, Blöschl, & Loucks, 2012; Chess & Purcell, 1999; Creighton, 2005b; O’Leary & Bingham, 2003; Pahl-Wostl, 2002; Reed, 2008).

Participation increases public trust in decision making, by increasing transparency and incorporating a variety of perspectives and values (Carr et al., 2012; Creighton et al., 1998; B. Hall, Jackson, & Tandon, 2016; Lynam et al., 2007; Özerol & Newig, 2008; Reed, 2008; Webler, Tuler, & Krueger, 2001; Wesselink, Paavola, & Fritsch, 2011). Stakeholder participation in deliberative discussions about water resource issues is an important component that improves the decision-making process and leads to higher quality decisions (Carr et al., 2012; Dryzek, 2000; Guttman, 2007; Kallis, Videira, & Antunes, 2007; Pahl-Wostl, 2002; Reed, 2008; Tan, Bowmer, & Mackenzie, 2012). Stakeholder participatory processes aim to improve the quality of
decisions, enhance the validity of the decision-making process, and promote active engagement among participants for future decision-making (Beall, 2007; Beierle, 2002; Carr et al., 2012; Palmer, Cardwell, Lorie, & Werick, 2013).

2.3.2.d. Chalanges of Stakeholder Engagement

Participatory processes have many benefits that engage stakeholders, however it is often challenging to continuously encourage stakeholder participation, manage expectations of stakeholders and scientists, and effectively communicate among stakeholders (Bourget, 2011; Creighton, 2005a; Reed, 2008; von Korff et al., 2012). Stakeholder participation is often time consuming, and it is difficult to encourage stakeholders to actively participate and maintain interest throughout the timespan of the project (Reed, 2008). An absence of mutual trust among stakeholders and a lack of interest among stakeholders can hinder effective participation during the participatory process (Ananda & Proctor, 2013; Bourget, 2011; Chess & Purcell, 1999; Kallis et al., 2006; Newig, 2007; Priscoli, 2004; Reed, 2008; Stringer et al., 2006; von Korff et al., 2012). Therefore, it is critical to build trusting relationships, clearly communicate the benefits of participation, and create commitment by establishing responsibility among stakeholders.

2.3.3 Principles of Stakeholder Engagement

Participatory processes have a variety of different approaches, and how to best design and implement stakeholder engagement in water resources participatory processes is not usually straightforward (Bryson, Quick, & Slotterback, 2013; Carr et al., 2012; Dietz & Stern, 2008; Espeland, 1998). Best practices within the stakeholder participation and engagement field are widely debated, as most researchers and practitioners emphasize selecting relevant tools and approaches depending on the situation (Reed, 2008). It is important to understand the main factors that impact designing and implementing a participatory process in order to improve the
stakeholder engagement and participatory process. Based on a comprehensive review of key participation research, three studies were identified that reviewed and developed a set of principles or best practices specifically related to stakeholder participation and participatory processes in natural resources (Table 2.3) (Luyet et al., 2012; Reed, 2008; von Korff et al., 2010). Reed conducted a Grounded Theory Analysis of the literature and identified eight key features for best practice of participation (Reed, 2008). Luyet et al. conducted a literature review of case studies that illustrate clear principles for successful participation (Luyet et al., 2012). Von Korff et al. developed key participatory process design principles resulting from a comparative analysis of five different design guides of participatory processes (Beierle & Cayford, 2002; Daquino, 2007; Enserink et al., 2007; Mazri, 2007; Stern & Fineberg, 1996; von Korff et al., 2010). It is important to note that each study incorporated key aspects of participatory processes, specifically related to natural and water resources.
2.4. Framework for Stakeholder Engagement in Participatory Processes

This section reviews the stakeholder engagement and participatory processes literature, highlights discussions related to water resource projects and their participation techniques. It includes a methodologic basis for practical guidelines for researchers involved in the design of participatory processes. This section investigates a stakeholder participation framework to design, implement and evaluate a discrete participatory process (Figure 2.1). This section details research describing the importance of selecting a participatory technique that best supports the needs and objectives of the project. It is important to note that stakeholder participation can apply to many fields, but for the purposes of this research project this review focuses on participatory processes in the field of water resources.
This section aims to focus on literature and case studies where university research teams are involved in stakeholder engagement and participatory processes. Researchers responsible for executing a participatory process should have the experience and theoretical knowledge of how to design participatory processes, and the skillset to implement and evaluate the selected approach. The theoretical knowledge about how to design a participatory process includes stakeholder identification, the degree and type of stakeholder engagement and choice of participatory techniques and approaches. The facilitation skills and experience of the researcher responsible for leading and implementing the participatory process are also crucial. The researcher should also have experience and knowledge about participation evaluation methodologies. Evaluation techniques can include quantitative and/or qualitative methods, although there is no standardized approach for participation evaluation. In summary, this section will included detailed information and important elements to effectively design, implement and evaluate a participatory process that engages stakeholders in the water resources field.

*Figure 2.1* Framework for stakeholder engagement for one participatory process. Modified from Luyet et al., 2012.
2.4.1 Design of Participatory Processes

Research shows that the many benefits of stakeholder engagement do not necessarily occur without skillful and knowledgeable design and implementation of a participatory process (von Korff et al., 2012). Current advice, guidelines, case studies and research on best practices of effective participatory processes exist in the practitioner and research arena (Arnstein, 1969; Beierle & Cayford, 2002; Creighton, 2005a; von Korff et al., 2012, 2010). Despite a wealth of guidelines and successful stakeholder engagement processes, selecting a participatory process approach that meets the needs of the stakeholders and objectives of the process is still a necessary, difficult task (Rowe & Frewer, 2000; von Korff et al., 2012). Often times, the individuals responsible for designing and implementing a participatory process lack experience or do not feel comfortable with the task (Pahl-Wostl, Newig, & Ridder, 2008; von Korff et al., 2012). Therefore, the design and implementation of a participatory process are essential to achieve effective and successful outcomes.

Comprehensive research on the design of participatory processes is an emerging research field. In the field of natural and water resources, practical methodologies on how to design a participatory process are limited. Current research and methodologies typically integrate evaluation research and design practice. Predominant design principles focus on effective evaluation criteria of participatory processes (Table 2.8) (Luyet et al., 2012; Pahl-Wostl et al., 2008; Rowe & Frewer, 2000; von Korff et al., 2012; Webler et al., 2001). In addition, work by participation practitioners, not researchers, has been done to develop design guidelines of participatory processes (Creighton, 2005a; von Korff et al., 2012). In recent years, water resource case studies discussing participatory process design have integrated guidance and techniques from both practice and research (D. M. Hall et al., 2016; Mott Lacroix & Megdal, 2016; von
Korff et al., 2012).

2.4.1.a. **Stakeholder Identification**

Participatory processes engage a variety of stakeholders and depending on the participation and project objectives, stakeholders must first be identified. Stakeholder identification techniques vary depending on the project context, project phase and the availability of resources (Luyet et al., 2012). Stakeholders can be identified by using a set of criteria, such as proximity, legitimacy, urgency, economy and social values (Creighton, 1986; Mitchell, Agle, & Wood, 1997). Stakeholders can also be identified by using the snowball technique, which allows for stakeholders to identify and recommend additional stakeholders to participate in the process (King, Feltey, & Susel, 1998). Stakeholder identification is sometimes based on stakeholder analysis (von Korff et al., 2010). Stakeholders can also be identified in an informal manner, where researchers involved in the design of participatory processes collaborate with key stakeholders to identify individual stakeholders based on project objectives and contexts. The challenge of stakeholder identification is finding the optimum balance that integrates all stakeholders to achieve successful participation.

2.4.1.b. **Typologies: Degree, Nature and Objectives of Stakeholder Participation**

This section discusses the basis of typologies for stakeholder participation. Typologies of participation are based on three areas: degrees to which stakeholders participate in the process, the nature of participation defined by the direction that communication flows between parties, and the objectives for including participation in a process (Beierle, 2002; Reed, 2008; Rowe & Frewer, 2000; Thomas, 1993).

The degree of stakeholder participation is one of the most researched and addressed topics in the stakeholder literature. The degree of stakeholder participation was first
differentiated between the level that stakeholders were engaged (Arnstein, 1969). This ladder of participation, defined by Arnstein (Figure 2.2), describes a range of participation from being receivers of information to having decision-making power (Arnstein, 1969). The three general groups of decision makers’ use of stakeholder participation in planning processes are categorized by ‘nonparticipation’, ‘tokenism’ and ‘citizen power’. It is important to note that different levels of engagement may be appropriate in different contexts. This will depend on the nature of the stakeholder engagement work and the individual stakeholders who participate (Reed, Graves, & Dandy, 2009).

![Figure 2.2 The ladder of citizen participation. Source: Arnstein, 1969.](image)

The nature of stakeholder participation focuses on the direction that communication and information flows between parties (Rowe & Frewer, 2000). The lowest level of engagement includes top-down communication and one-way flow of information, whereas the highest level is categorized by dialogue and two-way communication (Rowe & Frewer, 2000). For example, the
lowest level may involve communications between scientists and the public, such as statements about risk and hazards. Higher levels may engage individuals in the decision-making process, such as soliciting public comments or involving stakeholders in a participatory process (Rowe & Frewer, 2000). Once again, the most appropriate method of stakeholder engagement will depend on the situation and the objectives of the participation.

Typologies based on the objectives of stakeholder engagement have also been developed. These objective based typologies include research-driven, development-driven, planner-centered, people-centered, and consensus-driven participation (Michener, 1998; Reed, 2008; Sumberg, Okali, & Reece, 2003; Warner, 1997). Research-driven participation focuses on producing effective scientific results and is primarily used by researchers to collect information from stakeholders (Okali, Sumberg, & Farrington, 1994). Development-driven participation is often associated with projects and community organization efforts and focuses on the process, capacity building and self-organization of stakeholders (Okali et al., 1994). Planner-centered participation focuses on process and project efficiency, whereas people-centered participation focuses on respecting the rights and needs of the stakeholders and public (Michener, 1998). Finally, consensus-driven participation was created based on achieving sustainability objectives and focuses on a process with a mutually agreed upon outcome (Warner, 1997). Each of these typologies allow for individuals involved in the design of participatory processes to distinguish between the numerous available methodologies and approaches, and provide a basis for selecting the method that is most appropriate for the objectives of the project (Reed, 2008). In short, these typologies provide a foundation for selecting a participatory process approach that is most appropriate.

In water planning and management, a five-step classification of stakeholder participation
has been developed based on revisions and adaptations of Arnstein’s ladder (Creighton, 2000; Davidson, 1998; Mostert, 2003; Vroom, 2003). The five levels of participation include information, consultation, collaboration, co-decision making and decision-making/empowerment. The *information* level includes one-way communication and the stakeholders are given an explanation and information about the project. The *consultation* level allows for stakeholders to provide input and suggestions about a project, but ultimately the decision may be made with or without taking into account stakeholder input. The *collaboration* level includes engaging stakeholders to elicit feedback and suggestions and stakeholder input is usually taken into account when a decision is made. The *co-decision* level allows for stakeholders to jointly make a decision with the decision-making authority. The *decision-making* level delegates the decision-making to the stakeholders. Table 2.4 includes an overview of this classification system with different levels of participation, expected outcomes and methods used at each level (Mostert, 2003).

**Table 2.4** Five-step classification of public participation in water management and planning. Source: Mostert, 2003.

<table>
<thead>
<tr>
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<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Outcomes</td>
<td>The public is provided with or has access to information</td>
<td>The views of the public are sought</td>
<td>Real interaction takes place between the public and government/decision making authority</td>
<td>The public shares decision making powers with the government/decision making authority</td>
<td>The public performs public tasks independently</td>
</tr>
<tr>
<td>Approach</td>
<td>Leaflets, brochures, mailings, briefings, use of media, Internet, etc.</td>
<td>Reply forms, opportunity to comment in writing, hearings, meetings, interviews, opinion polls, stakeholder analysis, internet discussions</td>
<td>Small or large group meetings, workshops, roundtables, brainstorming sessions, internet discussions</td>
<td>Negotiation, i.e. resulting voluntary agreement, stakeholders represented in decision making/government bodies, small or large group meetings</td>
<td>Waste use association and other NGOs performing public functions, popular initiative, small or large group meetings</td>
</tr>
</tbody>
</table>
2.4.1.c. **Choice of Participatory Techniques**

There have been many studies that provide guidance on the available approaches and methodologies toward stakeholder engagement. The type of participatory method is usually selected once the objectives have been decided. In addition to the objectives of the process, the participatory method should also consider the available resources and decision-making phase in which the methods are applied. Table 2.5 summarizes potential objectives, resources available to support the participatory process and the phase of the decision-making process (Daniell, 2011; Reed, 2008).

**Table 2.5** Potential objectives, resources and planning/decision-making phases that can influence the appropriate choice of methods and participants. Source: Daniell, 2012.

<table>
<thead>
<tr>
<th>Objectives</th>
<th>Resources</th>
<th>Decision-making phases</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Information provision</td>
<td>• Time and finance</td>
<td>• Identifying and structuring issues and values</td>
</tr>
<tr>
<td>• Education</td>
<td>• Skills in designing and using methods</td>
<td>• Situation analysis</td>
</tr>
<tr>
<td>• Improving two-way communication</td>
<td>• Organizational will and leadership</td>
<td>• Visioning for the future</td>
</tr>
<tr>
<td>• Social learning</td>
<td>• Existing trust levels and relationships</td>
<td>• Eliciting preferences</td>
</tr>
<tr>
<td>• Enhancing legitimacy of decisions</td>
<td>• Power to make and implement decisions</td>
<td>• Developing and assessing management options</td>
</tr>
<tr>
<td>• Enabling democratic governance</td>
<td>• Knowledge of the subject/policy/decision-making area</td>
<td>• Negotiating choices</td>
</tr>
<tr>
<td>• Conflict resolution</td>
<td>• Stakeholder interest and capacity in engaging</td>
<td>• Implementation planning</td>
</tr>
<tr>
<td>• Legal or organizational requirements</td>
<td></td>
<td>• Monitoring and evaluation</td>
</tr>
<tr>
<td>• Building personal relations and social capacity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>• Achieving an improved water management outcome</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The objectives, resources available and decision making phase targeted are important to inform the design of a participatory process. The level of engagement can also be a crucial factor in deciding what participatory method should be utilized within the process (Arnstein, 1969).

There is no one size fits all method to participatory processes, and deciding what participatory strategies to implement, largely depends on the issues, level of engagement and objectives of the group. The degree of involvement is a critical component in stakeholder participation, as it tends
to influence the entire process and particularly in the selection of an appropriate technique. There is a variety of different techniques that can be classified based on the level of stakeholder participation (Table 2.6). However, participatory techniques should also be selected based on their ideal use, challenges of the method and the number of people that can participate (Table 2.7) (Daniell, 2011). Further discussion of participatory techniques can be found in a range of publications (Creighton, 2005a; Forester, 1999; Luyet et al., 2012; Mostert, 2003; Reed, 2008; Rowe & Frewer, 2000).

Table 2.6 Select participatory techniques with the related level of involvement, modified from Daniell, 2012 and Luyet et al., 2012.

<table>
<thead>
<tr>
<th>Participation Technique</th>
<th>Information</th>
<th>Consultation</th>
<th>Collaboration</th>
<th>Co-decision making</th>
<th>Decision making</th>
</tr>
</thead>
<tbody>
<tr>
<td>Newsletter</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reports/Press release</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Presentations</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Town hall</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Internet webpage</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Interviews, surveys</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cognitive map</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Workshop</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Collaborative modeling</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Role playing</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Problem structuring</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Visioning, scenarios</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Participatory evaluation</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Discussion forums</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
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<tr>
<td>Negotiations</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
</tr>
<tr>
<td>World café</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Advisory panel</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Multi-criteria analysis</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Consensus conference</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>
### Table 2.7 Common methods for stakeholder engagement with some of their proprieties, in two categories: less interactive and more interactive. Source: Daniell, 2012.

<table>
<thead>
<tr>
<th>Methods</th>
<th>Ideal use</th>
<th>Key challenges</th>
<th>Participant numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Less Interactive</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mail-outs, press releases, broadcasts</td>
<td>Broad scale information distribution, awareness raising</td>
<td>Tailoring information to audience, finding attractive format</td>
<td>Few to very large numbers</td>
</tr>
<tr>
<td>Town hall, public meetings</td>
<td>Providing overview information, providing people to explain information</td>
<td>Can heighten conflict if information is contentious or disputed, difficult to hear many voices</td>
<td>Depend on size of meeting hall. Typically &lt; 200</td>
</tr>
<tr>
<td>Public presentations, Q&amp;A sessions</td>
<td>Providing information of interest and encouraging some debate</td>
<td>Requires a good facilitator to maintain a positive Q&amp;A</td>
<td>Depend on room size unless televised/streamed. Typically &lt; 200</td>
</tr>
<tr>
<td>Mail, phone and in-person surveys</td>
<td>Eliciting information from a targeted population</td>
<td>Obtaining expertise to develop and administer a useful and well-constructed survey</td>
<td>Dependent on survey design and resources to carry it out. Potentially large numbers</td>
</tr>
<tr>
<td>Delphi analysis (usually experts)</td>
<td>Developing a structured expert view on an issue</td>
<td>Facilitation of method use and choice of experts</td>
<td>Three to many</td>
</tr>
<tr>
<td><strong>More interactive</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Citizens’ juries, consensus conferences</td>
<td>Developing judgements on controversial or little publicly examined topics</td>
<td>Organization of the events, having political buy-in to considering decisions, recommendations</td>
<td>Approx. 10-150</td>
</tr>
<tr>
<td>Collaborative modeling</td>
<td>Developing shared representations as a basis for joint investigations and informing decisions</td>
<td>Managing modeling team and participant dynamics, effectively structuring complex information</td>
<td>Approx. 5-50</td>
</tr>
<tr>
<td>Facilitated workshops, focus groups</td>
<td>Encouraging dialogue and collaborative work, including making trade-offs through use of techniques such as multi-criteria decision analysis</td>
<td>Establishing agree workshop aims and finding effective facilitators who can work with participants to achieve theme</td>
<td>Approx. 10-30 per workshop. More can be handled in parallel by multiple facilitators</td>
</tr>
<tr>
<td>Games (role-playing, simulation, online..)</td>
<td>Developing understanding of a specific situation and impacts of actions</td>
<td>Finding resources for game development, having access to appropriate props, technology</td>
<td>Variable depending on game and platform</td>
</tr>
<tr>
<td>Problem-structuring methods</td>
<td>Aiding decision making in complex,</td>
<td>Finding facilitators with a working</td>
<td>Approx. 5-50</td>
</tr>
</tbody>
</table>

30
The choice of the participatory technique depends on the type of stakeholders, their knowledge, prior experience, time available and interest, local and social norms, past events and history, and knowledge and experience of the project manager and facilitator (Luyet et al., 2012; Mostert, 2003; Reed, 2008). It is important to consider the historical, cultural and political context in which the process takes places, as it may not yield the intended outcomes (Luyet et al., 2012; von Korff et al., 2010). Determining an inappropriate level of participation can lead to the uncertainty and conflict-ridden situations.
incorrect engagement of stakeholders or selecting an inadequate participatory approach. One way to avoid this risk is to apply multiple, two or more, participation techniques to a participatory process.

2.4.2 Implementation of Participatory Processes

Implementation of a single project commences once the design phase is complete, which includes stakeholder identification, level of participation and selection of participation techniques. Principles of effective stakeholder engagement (Section 2.3.3) should be incorporated as the participatory process is executed. This implies that the researcher involved clearly understands and has the knowledge and skillset to carry out the participatory techniques. Improper implementation of the participatory technique can lead to stakeholder frustration and mistrust, and subsequently the process could fail.

2.4.3 Evaluation of Participatory Processes

The evaluation of a participatory process is critical to improve future stakeholder engagement and participatory applications, understand the impacts, benefits and challenges of the process, assess effectiveness and success and to report the experiences and outcomes. The evaluation of such processes has been described in a variety of case studies (Blackstock et al., 2007; Carr et al., 2012; Luyet et al., 2012; Mott Lacroix & Megdal, 2016; Rowe & Frewer, 2000; von Korff et al., 2012). Evaluation criteria is generally divided into two categories: 1) related to the process; and 2) related to the outcomes (Table 2.8) (Blackstock & Richards, 2007; Blackstock, Waylen, & Dunglinson, 2012; Luyet et al., 2012).
Table 2.8 Participatory Processes Evaluation Criteria (adopted from Blackstock, Waylen, & Dunglinson, 2012).

<table>
<thead>
<tr>
<th>Process</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Access to information</td>
<td>Accountability</td>
</tr>
<tr>
<td>Connectivity, coherence</td>
<td>Capacity building</td>
</tr>
<tr>
<td>Fairness</td>
<td>Effectiveness of outcomes</td>
</tr>
<tr>
<td>Flexible and iterative process; two-way dialogue</td>
<td>Shared understanding and consensus</td>
</tr>
<tr>
<td>Communication: the quality and flow of information to participants</td>
<td>Transparency</td>
</tr>
<tr>
<td>Leadership/champions for the process</td>
<td>Trust and social capital</td>
</tr>
<tr>
<td>Problem framing</td>
<td>Using information gained in future policy (or management strategies)</td>
</tr>
<tr>
<td>Social learning</td>
<td></td>
</tr>
<tr>
<td>Shared decision making authority</td>
<td></td>
</tr>
<tr>
<td>Systemic perspective</td>
<td></td>
</tr>
</tbody>
</table>

Quantitative and qualitative methodologies are used to evaluate participatory processes. Information from surveys, interviews, observation, and group facilitation recordings are used to assess the effectiveness of a participatory process (Blackstock & Richards, 2007; Carr et al., 2012). Research shows that interviews or analyzing reports and minutes increases the possibility of fully understanding impacts of the process (Blackstock et al., 2007). There is no standard method of evaluating a participatory process. Criteria should be selected based on objectives of the process (Blackstock et al., 2012). A comprehensive evaluation should be well organized and planned at an early stage. Evaluation criteria should consider aspects related to the purpose and timing of the evaluation and integrate both process and outcome measures. In short, developing an evaluation framework is important to understand the effectiveness, impacts and success of a participatory process.

2.5. Participatory Methods in this Research Project

This section provides background information on the participatory techniques used in this research project. This section is split into two categories: 1) collaborative modeling; 2) interactive workshops that used Liberating Structures, systems thinking, water café, futures, scenarios and facilitated discussion.
In order to execute a stakeholder engagement process, targeted participatory methodologies must be determined. As previously mentioned, the approach must be chosen once the objectives of a particular process and the level of involvement of stakeholders have been identified (Luyet et al., 2012; Reed, 2008). The literature reveals that there is an immense number of different techniques for engaging stakeholders in a participatory process (Daniell, 2012; Luyet et al., 2012). However, individual experience, background and familiarity to particular methods may also impact the chosen approach. It is important for the individuals involved in the design of the participatory process to use a participatory method that is appropriate and useful to the purpose of the project.

2.5.1 Collaborative Modeling

Models have been recognized as useful tools for integrating social, economic and environmental systems in a way that facilitates management decisions (Bourget, 2011; Langsdale et al., 2013; Palmer et al., 2013; Tidwell, Passell, Conrad, & Thomas, 2004; van den Belt, 2004). There are many names for the process of using computer models to facilitate group learning and solutions to water resource problems, for example: Mediated modeling (van den Belt, 2004), Participatory modeling (Langsdale et al., 2009; Voinov & Gaddis, 2008), Collaborative Modeling for Decision Support (Cardwell & Langsdale, 2011), Computer-aided Dispute Resolution (Bourget, 2011), Shared Vision Planning (Cardwell, Langsdale, & Stephenson, 2008; Creighton, 2010), and Computer-aided Negotiation (Rivera, Sheer, & Miller, 2013). For this project the term Collaborative Modeling (CM) will be used to describe a processes that integrates the disciplines of water resource modeling, stakeholder engagement and water resources planning methodologies to inform water resource management decisions.
Collaborative modeling is effective at creating a nexus of local and scientific knowledge that fosters discussions, problem identification and consensus-based strategies and solutions to current environmental issues. Eight key principles of Collaborative Modeling are identified in the literature (Table 2.9) (Langsdale et al., 2013). In a collaborative modeling process, models are used to facilitate dialogue, build discussion and discover what issues and needs are important to stakeholders (Bourget, 2011). Collaborative modeling is an effective methodology based on developing a common language to integrate technical scientific information with local knowledge and expertise in simulation models (Beall & Ford, 2007; van den Belt, 2004). The process of building a collaborative model helps stakeholders clarify their own mental models and gain a better understanding of relationships and interconnections in a system (van den Belt, 2004). Participatory processes rely upon shared information for the purposes of problem identification, education, increased trust and buy-in from local stakeholders (Beall & Ford, 2007; Beierle & Cayford, 2002; Cormick, 1996; van den Belt, 2004).

**Table 2.9 Best Practices for Collaborative Modeling** (Langsdale et al., 2013)

<table>
<thead>
<tr>
<th>Practice</th>
</tr>
</thead>
<tbody>
<tr>
<td>CM is appropriate for complex, conflict-laden, decision-making processes where stakeholders are willing to work together</td>
</tr>
<tr>
<td>All stakeholder representatives participate early and often to ensure that all their relevant interests are included</td>
</tr>
<tr>
<td>Both the model and the process remain accessible and transparent to all participants</td>
</tr>
<tr>
<td>CM builds trust and respect among parties</td>
</tr>
<tr>
<td>The model supports the decision process by easily accommodating new information and quickly simulating alternatives</td>
</tr>
<tr>
<td>The model addresses questions that are important to decision makers and stakeholders</td>
</tr>
<tr>
<td>Parties share interests and clarify the facts before negotiating alternatives</td>
</tr>
<tr>
<td>Collaborative modeling requires both modeling and facilitation skills</td>
</tr>
</tbody>
</table>

Collaborative modeling provides the opportunity for model building and facilitated group problem solving to take place simultaneously. Model building creates a simulation of the environmental problem and enables stakeholders to share insights into to potential solutions to
problems through management and policy simulations (Lund & Palmer, 1997; Tidwell & Brink, 2008; Tidwell et al., 2004; Voinov & Gaddis, 2008). Collaborative modeling processes are often used only for learning and to assist stakeholders with problem identification and definition (van den Belt, 2004; Vennix, 1996). This is important because to incorporate a variety of stakeholder’s interests into the model, the parameters of the problem must be clarified (Beall & Ford, 2007). This motivates stakeholders to evaluate and clearly communicate their own knowledge that they wish to share (Langsdale et al., 2013; Voinov & Bousquet, 2010). Participants often begin to realize that their knowledge and perspectives may be similar to others involved in the process, which builds trust. Model building can provide an opportunity for participants to learn how to prioritize and sometimes compromise, because models have limitations and cannot incorporate all variables at a time (Beall & Ford, 2010; van den Belt, 2004). Participatory processes encourage group learning, and often times during these discussions a new and better understanding of the problem may occur.

2.5.1.a. Collaborative Modeling Process

Collaborative modeling can facilitate dialogue among stakeholders, which provides the ability to identify acceptable alternatives of managing a water resource system. Collaborative modeling is best understood as an iterative cycle whereby this process will often return to previous steps until mutually satisfactory outcomes are achieved (Figure 2.3) (Bourget, 2011). The first step in a collaborative modeling process is identifying the issues and defining the problem (Figure 2.3) (Langsdale et al., 2013). At this point, stakeholder identification and engagement is crucial, as stakeholders are instrumental in defining their own local water resources challenges (Reed et al., 2009). Developing performance measures allows stakeholders to take a step back from the problem and think about what is really important (Michaud &
Langsdale, 2009). These measures are a way to assess how well the system is doing and responding, and they are also used to compare alternatives for one or more management objectives (Michaud & Langsdale, 2009).

Collaborative modeling essential builds a model with stakeholders, rather than for stakeholders. Through model development, stakeholders can provide information about data needed to effectively model the problem (Beall & Ford, 2007; Lund & Palmer, 1997). By engaging stakeholders and discussing issues related to their water resource systems, the modeler can then create a relevant model that addresses issues important to stakeholders and decision makers (Palmer et al., 2013; Voinov & Bousquet, 2010). It is important to remain transparent about model assumptions, relationships, input and output, especially during the model development phase (Langsdale et al., 2013; Sandoval-Solis, Teasley, McKinney, Thomas, & Patiño-Gomez, 2013). The joint development and evaluation of management strategies is the next component of the CM process. And finally, the CM process should provide stakeholders the insight to a preferred management or policy alternative, and then they would implement that preferred management strategy (Langsdale et al., 2013; Rivera et al., 2013).
2.5.1.b. **Challenges in Collaborative Modeling**

Conducting a collaborative modeling process to find mutually beneficial solutions has great benefits, but also comes with a number of challenges. Collaborative modeling is time consuming and the quality of work will be dependent on the quality of available data, the techniques and skills of the modelers and facilitators, and the willingness of the stakeholders to work together to find mutually beneficial solutions (Bourget, 2011; Liu, Gupta, Springer, & Wagener, 2008). Stakeholders are often volunteers, so attendance may be inconsistent and the composition of the group may change (Videira, Antunes, & Santos, 2009). In addition, an important stakeholder may not be at the table. The political and public context tends to force a short time period for the work, and this sometimes creates a solution or strategy that is not mutually beneficial to all participants (Ingram, 2008; Lund & Palmer, 1997). Participants may
also not be willing to change their mental models, and they may have personal objectives that reduce their willingness to change their opinions (Floress, Akamani, Halvorsen, Kozich, & Davenport, 2015; Langsdale, 2007).

Beyond the complexities of stakeholder engagement, environmental problems are regulated by a variety of local, state and federal laws that may impede the implementation process. However, even when implementation does not exist, collaborative modeling stakeholders may still benefit from the process (van den Belt, 2004). Collaborative modeling can improve understanding of the problem, and can facilitate group dynamics and group learning (Beall, Fiedler, Boll, & Cosens, 2011). It can also be used to integrate scientific and local knowledge, which is essential for finding consensus-based solution to environmental problems (Bourget, 2011). Success comes from long term commitment to interpersonal work and skills, and an understanding of the structure and relationships that are intrinsic to the environmental system of concern (Langsdale et al., 2013).

2.5.2 Interactive Workshops

This section provides an overview of the other core participation techniques used at workshops and other stakeholder engagement activities throughout this research project. The participation tools and techniques utilized in this research study were chosen based on the design framework for stakeholder engagement, as detailed previously, and the knowledge and expertise of the researcher. Practitioners and facilitation handbooks were used extensively in the selection of participation techniques (Bens, Picard, & Tornatore, 2012; Creighton, 2005b; Lipmanowicz & McCandless, 2013). This section details the following participation and facilitated discussion techniques employed at various workshops and stakeholder engagement activities: Liberating
Structures, systems thinking, mental models and futures thinking. Detailed descriptions of how these participation techniques and tools were utilized are detailed in chapter four.

2.5.2.a. **Liberating Structures**

Liberating structures is a facilitation tool that can provide participants with an opportunity to play a transformative role in group discussion and decision making (Lipmanowicz & McCandless, 2013). Liberating structures (LS) is a form of participatory communication and has the capability to engage all participants throughout all phases of the participatory process (Lipmanowicz & McCandless, 2013). This level of engagement is important as shared meaning and knowledge is created by all of the participants involved. There are 33 microstructures within LS that can complement traditional practices and foster lively participation in groups (Lipmanowicz & McCandless, 2013).

Liberating Structures provides detailed instructions, examples and steps needed to utilize specific microstructures (Lipmanowicz & McCandless, 2013, 2016). LS improves meeting structures and has easy to use facilitation techniques that involve all participants in a meeting or workshop. For the purposes of this stakeholder engagement project, **Crowd Sourcing, 1-2-4-All, Open Space Technology, Critical Uncertainties, Conversation Café and What Debrief** were used in different stakeholder engagement activities. **Crowd Sourcing** is used to create an environment in which good, out-of-the-box ideas are generated and spark synergy among participants (Lipmanowicz & McCandless, 2013). **1-2-4-All** is a technique that engages every individual, creates an inclusive space for discussion, diminishes power asymmetries, and enriches the quality of observations and insights before discussion (Lipmanowicz & McCandless, 2013). **Open Space Technology** addresses complex problems, generates action and builds energy, responsibility and shared leadership (Lipmanowicz & McCandless, 2013). **Critical Uncertainties**
focuses on testing the adaptability of current strategies by exposing uncertainties, developing priorities in the context of robust strategies and making an effort to improve confidence in managing an uncertain future (Lipmanowicz & McCandless, 2013). *Conversation Café*, also known as world café, provide a space to generate new ideas, build a shared understanding of different perspectives and ideas, and make sense of complex water resource systems (Lipmanowicz & McCandless, 2013). *What Debrief* provides a space for participants to reflect, make observations, and clarify facts of their interpretation; it also ensures that learning is generated from shared experiences (Lipmanowicz & McCandless, 2013).

2.5.2.b. *Systems Thinking, Mental Models and Futures Thinking*

Systems thinking essentially means thinking about systems. Systems thinking exercises can be useful in water resource issues in assisting stakeholders with problem identification and problem definition. Systems thinking is commonly used within CM processes to help assess perceptions of issues and identify gaps in understanding (Voinov & Bousquet, 2010). These exercises help establish variables that are important to a particular system. It helps individuals understand existing patterns of behavior, focusing on the connections and relationships between the variables, rather than the individual connections within the system (Forrester, 1994). Causal loop diagrams are one way to explore casual effects within a system. These diagrams map the variables characterizing a dynamic problem within a system of study and the causal effects and relationships established between them (Videira et al., 2009). Although these are diagrams may not be used to accurately infer dynamic behavior, they are useful for understanding complicated issues and behavior within a system (Videira et al., 2009). In water resources, it is useful for improving understanding of complex water resource systems and making long-term water resource management decisions (Beall et al., 2011).
Mental models have been utilized in stakeholder engagement processes to assess knowledge of complex water resource systems and improve understanding of stakeholder values and interests within a particular water resource system (Beall King & Thornton, 2016). Mental models are conceptual representations that characterize how individuals or groups of individuals construct their understanding and thinking about a particular issue, how they initially obtain these perceptions, and how these perceptions influence behaviors (Johnson-Laird, 1980). However, the small size and simplicity of mental models compared to the complexity of real-world systems often limits the ability to see and understand the entire system. In the field of water resources, the elicitation and analyzation of mental models has been used within CM processes to explore individual and group mental models and identify gaps of knowledge within the system (Tillotson, 2015). The elicitation of mental models enables exploration of the “cognitive dimensions” of perceptions on local water resources in order to better understand the shared vision of stakeholders involved (Jones, Ross, Lynam, & Perez, 2014).

Futures thinking is a participation technique, similar to systems thinking, that is used to bring people together that share a common interest in a problem or issue. It is used to explore and map how individuals come to think and know their own ideas and images that define their interpretation of the future (Inayatullah, 2008). These images and ideas are used to create how an individual views future alternatives and scenarios (Inayatullah, 2008). Similar to some of the Liberating Structures and systems thinking techniques, futures thinking is a tool that focuses on solving problems by working together and giving individuals the opportunity to provide input on future decisions or management strategies of an issue (Lauttamäki, 2014). Futures workshops promote collaborative problem solving and creating future alternatives, which are important
components of participatory processes that advance social learning and water resource planning (Lauttamäki, 2014).

2.6. **THE ROLE OF THE UNIVERSITY RESEARCHERS IN STAKEHOLDER ENGAGEMENT PROJECTS**

This section focuses on the role of universities and university research teams in stakeholder engagement initiatives and participatory processes. This section provides an overview of bridging organizations and how they function to support stakeholder engagement initiatives to address water resource management challenges.

Universities are nonprofit institutions, often have a public service oriented mission and are committed to address societal problems and bring vital, practical information to their region (Shapiro, 2009). Researchers and scholars acknowledge that traditional research approaches are not able to capture the dynamic, uncertain and complex nature of many water resources problems. Recently, there has been a shift in research toward interdisciplinary collaboration, systems thinking and co-production of knowledge between researchers and stakeholders to address water resource management challenges (Allen et al., 2013; Dentoni & Bitzer, 2015). This shift is also evident as funding agencies have been increasingly supporting and encouraging large collaborative research projects that address complex human-environmental systems and engage both academic and non-academic stakeholders (Allen et al., 2013; Lukman, Krajnc, & Glavič, 2009). Thus, stakeholder engagement within academic research projects are particularly common in large, interdisciplinary research projects that are associated with high levels of complexity and uncertainty (Carney & Whitmarsh, 2009).

Universities are being called upon to actively network, exchange information and engage with stakeholders from government, industry, special interest groups and communities (Allen et al., 2013; Bäckstrand, 2003; Lukman et al., 2009; Mader, Mader, & Zimmermann, 2013; Peer &
Stoeglehner, 2013; Trencher et al., 2013). Research supports that engaging stakeholders to address societal challenges to complex human-environmental systems is a new, important academic function of universities (Allen et al., 2013; Trencher et al., 2013). In the field of water resources management, social learning and adaptive management have increasingly become important priorities (Keen, Brown, & Dyball, 2005). Universities can provide a unique role in bridging the gap between society and decision-making agencies and can facilitate collaboration and stakeholder engagement to address and improve natural resources management (Keen et al., 2005; Sedlacek, 2013). Research supports that universities can serve as bridging organizations to support sustainable water resource management (Sedlacek, 2013).

2.6.1 Bridging Organizations: The Role of Universities and University Researcher Teams

Universities most commonly participate in stakeholder engagement serving as bridging or boundary organizations. Bridging and boundary organizations primarily function as collaborative organizations that engage diverse stakeholders to facilitate solving complex human-environmental problems (Crona & Parker, 2012). Examples include Regional Integrated Science Assessments, Climate Hubs, state-funded conservation districts, National Institutes or Centers for Water Resources and extension programs at land-grant universities (Allen, 2016; Sternlieb, Bixler, & Huber-Stearns, 2013). Extension programs are a long-standing, established example that were established to provide engagement between the scientific and agricultural community for knowledge and information exchange, mutual learning and decision-making support (Ramussen, 2002).

Bridging and boundary organizations differ in scope and formal organization. Boundary organizations traditionally are more formal institutions with clearly defined organizational arrangements that have focused on engaging individuals at the intersection of science and policy
Boundary organizations have three distinct functions: 1) mediate between the science and policy sectors; 2) exist between two distinct fields with well-defined responsibility; and 3) use boundary objects, i.e. reports, conceptual models, or visualization tools (Guston, 2001; Sternlieb et al., 2013). Bridging organizations provide “an arena for knowledge coproduction, trust building, sense making, learning, vertical and horizontal collaboration, and conflict resolution” (Berkes, 2009, p. 1695). Bridging organizations have a broader scope and serve as an entity that engages and connects diverse constituencies in an effort to assist in solving complex human-environmental problems that would not be able to solve if acting independently (Biggs, Westley, & Carpenter, 2010; Brown, 1991).

Bridging organizations typically have a flexible organizational approach to facilitate discussions and governance surrounding complex human-environmental systems (Sternlieb et al., 2013). Recent literature of bridging organizations in natural resources focus on adaptive management and social learning (Berkes, 2009; Crona & Parker, 2012). These organizations may also assist collaborative initiatives by providing and communicating technical information or providing legal or financial resources (Schultz, 2009). In water resources, bridging organizations can balance power asymmetries that are commonly present in participatory processes (Sternlieb et al., 2013). In summary, bridging organizations are widely cited as promoting learning, building trust and relationships, mediating conflict and solving problems (Berkes, 2009). These are necessary components to engage diverse stakeholders in a participatory process that addresses regional water resources.

University affiliated organizations, such as Extension Programs and National Institutes for Water Resources, are uniquely situated to serve as bridging organizations to address and facilitate solving complex water resource problems. These university affiliated organizations
usually do not have water rights, decision-making authority or stake in protecting a particular water interest, but are recognized by local communities as providing neutral expertise (Mott Lacroix & Megdal, 2016). Furthermore, the definition of bridging organization fits best with the scope of this research project and research done in conjunction with Washington State University Water Resource Center.

The advantages to having university researchers as designers and facilitators of participatory processes include longevity of appointments and perceived neutrality. Most researchers and faculty serve teaching, research and/or service roles over the course of many years. This longevity allow faculty members to concurrently access and develop interpersonal relationships with key stakeholders, and became entrenched in the social, economic and environmental aspects of a particular region over time. This knowledge and long-term engagement with stakeholders is crucial to designing a participatory process that is relevant to stakeholder needs (Hall et. al., 2013). University-based researchers can have a unique third party role that spans boundaries between agencies, water managers and citizens (Cash, Clark, & Alcock, 2003; Edelenbos & Meerkerk, 2015). Furthermore, researchers can serve as a liaison and potential buffer between state agencies and pertinent stakeholder groups and the public (D. M. Hall et al., 2016).

### 2.6.2 Bridging Organizations in Water Resources Stakeholder Engagement Projects

Research on the role bridging organizations play in water resource stakeholder engagement processes is still a relatively new field. Most recently, researchers at the University of Arizona developed a framework, the Stakeholder Engagement Wheel, that is centered on the role bridging organizations plays in stakeholder engagement activities (Figure 2.4) (Mott Lacroix & Megdal, 2016). This framework highlights that engagement processes are necessary to
understand and manage complex water resources (Mott Lacroix & Megdal, 2016). This approach recommends that an engagement process be iterative and provide a space for personal relationships, trust and respect to be developed among stakeholders (Mott Lacroix & Megdal, 2016). Processes that aim to promote social learning should be inclusive, interactive and flexible (Mott Lacroix & Megdal, 2016). This case study illustrates the importance of multiple iterations of problem-solving throughout the process to ensure the problem, objectives and goals are robust and that actions and plans are developed to meet stakeholder needs (Mott Lacroix & Megdal, 2016).

Figure 2.4 Stakeholder Engagement Wheel. Source: (Mott Lacroix & Megdal, 2016)
2.7. **Chapter Summary**

Stakeholder engagement and participatory processes in natural resource and water resource decision-making have long been recognized as important components to the decision-making process. There are numerous case studies and examples about the benefits, and sometimes challenges, that stakeholder participation provides. Research studies cite that stakeholder engagement promotes social learning, better understanding of problems and issues, and increased trust in decisions (Reed, 2008). It also highlights that it leads to high quality, more robust decisions and often stakeholder groups generate a sense of ownership of the outcome (Reed, 2008). Challenges include that these processes are time-consuming and expensive, and lead to the identification of new issues and conflicts and empowerment of already important stakeholders (Reed, 2008).

Many resources, guidebooks, manuals and case studies exist for how to convene and design a discrete stakeholder engagement process. Participatory processes have three common phases: design, implement and evaluate. The design phase requires immense planning to ensure appropriate stakeholders are identified, the proper type of stakeholder engagement is determined and the appropriate and relevant participatory method is selected. The implementation phase executes the plans from the design phase and is somewhat straightforward. The evaluation phase is important to determine if the process and project was effective and successful. It is also important to evaluate a participatory process to make recommendations for future processes.

Finally, university-affiliated organizations and research teams serve a unique role in taking lead to convene, design and implement participatory processes that promote social learning and solving complex water resource problems. The role of bridging organizations in
water resource engagement processes is useful to facilitate understanding and managing complex water resource systems.
CHAPTER THREE: SPOKANE RIVER BASIN BACKGROUND

3.1. INTRODUCTION

This section includes background information on the Spokane River Basin and the Spokane Valley Rathdrum Prairie (SVRP) aquifer. This section provides an overview of water planning, management education and outreach in the Spokane River Basin.

3.2. OVERVIEW OF THE SPOKANE RIVER BASIN AND SPOKANE VALLEY RATHDRUM PRAIRIE AQUIFER

The Spokane River is part of the SVRP aquifer system that spans the state line in northwestern Idaho and northeastern Washington. The Spokane River Basin, roughly 2,400 square miles, is bordered by the Upper Columbia sub-basin to the north, the Pend Oreille sub-basin to the northeast, and the Coeur d’Alene sub-basin to the east. The Spokane River’s headwaters are formed by the outlet of Coeur d’Alene Lake in Idaho and flow westward for almost 112 miles to its confluence with the Columbia River on Lake Roosevelt in Washington (Figure 3.1). The river is used for fishing, swimming, boating and hydropower (the river has seven dams that generate electricity). The Spokane River also provides aquatic, riparian and upland habitat for an assortment of species. The Spokane River interacts with the Spokane Valley Rathdrum Prairie (SVRP) aquifer, as evident by the multiple gaining and losing reaches between Coeur d’Alene and Spokane (Kahle & Bartolino, 2007).
The SVRP aquifer underlies about 370 square miles of a relatively flat, alluvial valley surrounded by bedrock highlands (Kahle & Bartolino, 2007). The SVRP aquifer extends south from Lake Pend Oreille to Coeur d’Alene Lake and west across the Washington-Idaho stateline to near Long Lake, northwest of Spokane (Figure 3.2). Land elevations in the basin range from about 1,500 ft to nearly 2,600 ft (Kahle & Bartolino, 2007). Several lakes, the largest of which are Coeur d’Alene and Lake Pend Oreille in Idaho, are located on the perimeter of the aquifer, and the only surface drainage in the valley includes Spokane and Little Spokane Rivers.
3.2.1 Water Supply, Land Use and Climate

The Spokane River interacts with the Spokane Valley Rathdrum Prairie (SVRP) aquifer, which is a Sole Source Aquifer for over 600,000 people in the basin (Kahle & Bartolino, 2007). Groundwater is the primary source for public-supply, domestic, irrigation, and industrial water use. Estimated groundwater use in 2010 for Spokane, Bonner, and Kootenai Counties was more than 141 million gallons per day (mgd) (Maupin, Kenny, Hutson, Nancy Barber, & Linsey, 2014), which is less than the estimated groundwater use of 188 mgd in 2000. In Spokane County alone, estimated groundwater use in 2010 was about 118 mgd for public supply, 12 mgd for domestic, 14 mgd for irrigation and 7 mgd for industrial (Maupin et al., 2014). Peak summer daily ground-water withdrawals from the SVRP aquifer are roughly about 450 mgd (MacInnis et al., 2009). Figure 3 shows a snapshot of total aquifer withdrawal rate for municipalities only.

Primary land uses in the study area include urban and agricultural. Agricultural land is used primarily for pasture or the production of hay, wheat, grass seed, barley and oats (Kahle &
Bartolino, 2007). Urban areas supplied by the SVRP aquifer include the Spokane metropolitan area in Washington and Coeur d’Alene and Post Falls in Idaho. Residential and commercial development is increasing in the region, for example Spokane County, Washington saw a 12% percent increase in population, while Kootenai County, Idaho saw a 27% percent increase from 2000 to 2010 (US Census Bureau).

Climate varies from semiarid to sub-humid throughout the region, and is typically characterized by warm, dry summers and cool, wet winters (Molenaar, 1988). Precipitation mostly falls in the form of snow in the winter time (November through March), and varies considerably across the aquifer, increasing from west to east. The average annual precipitation in Spokane is about 16 inches, while the average annual precipitation in Coeur d’Alene is over 25 inches (MacInnis et al., 2009).

3.2.2 Geology

The Spokane River basin is represented by the Okanogan Highlands to the north and the Columbia Basin, also known as the Columbia Plateau, to the south. The SVRP valley is bounded by the Selkirk Mountains on the western border and the Bitterroot Mountains to east of the prairie. A series of geologic events have defined the surface and subsurface geologic framework of the SVRP aquifer and Spokane River Basin system. The mountain highlands and the basement of the aquifer are composed of Precambrian igneous and metamorphic rocks (Molenaar, 1988).

During the Miocene epoch of the Tertiary period, around 20 million years ago, huge basalt flows of the Columbia River Basalt Group flooded into parts of Washington, Idaho and Oregon. These basalt flows occurred as separate events over millions of years and covered the valleys and foothills of the SVRP, blocking stream drainages and creating small lakes that left behind sediment deposits known as the Latah Formation. Following the basalt lava flows, the
ancestral Spokane River eroded much of the exposed Latah Formation sediments forming a deep valley, which followed a course similar to that of today’s Spokane River, near the southern border of the aquifer (Molenaar, 1988).

From two million to 10,000 years ago, during the Pleistocene, the earth was characterized by cold climates in which large continental ice sheets formed and extended from Canada into the northern United States. The Cordilleran ice sheet greatly impacted the Pacific Northwest and the SVRP region geology. Lobes of the Cordilleran ice sheet extended down into the margins of the Columbia Plateau, where meltwater streams contributed vast quantities of sediment from these glacial lobes (Kahle & Bartolino, 2007). One lobe of the Cordilleran ice sheet blocked the drainage of the Clark Fork River northeast of the SVRP region, which led to the formation of Glacial Lake Missoula in western Montana (Kahle & Bartolino, 2007). There were multiple cycles of flooding associated with the buildup and breaching of the ice dam, as evident from various geomorphic features in the vicinity. As floodwaters flowed toward the Pacific Ocean, large quantities of debris were transported and deposited. Large, coarse-grained sediment deposits accumulated in the northern Rathdrum Prairie, whereas finer materials were scattered in the western arm (Kahle & Bartolino, 2007).

3.2.3 Hydrology and Hydrogeology

The SVRP region has an ample supply of water from the Spokane River and from the region’s highly permeable aquifer. Water enters the region via precipitation, runoff from adjacent highland areas, inflow from the Spokane River and subsurface groundwater inflow near Hoodoo Valley in northern Idaho. Water leaves the region below Nine Mile Falls as discharge of the Spokane River and as subsurface groundwater outflow, by evapotranspiration, and by groundwater pumping. However, some of the pumped water either is eventually returned to the
groundwater system by percolation, is lost by evapotranspiration or returned to the Spokane River via a wastewater treatment plant.

The Spokane River is an important because of the hydraulic connection between the river and the aquifer. The river has seasonal and annual variations in discharge that directly influence the storage and flow of water in the aquifer. The Spokane River begins at the outlet of Coeur d’Alene Lake, where inflow to the lake is primarily from Coeur d’Alene, St. Joe, and St. Maries Rivers, which drain parts of the Bitterroot Mountains in Idaho. Coeur d’Alene Lake is a natural lake with a natural outlet to the Spokane River. However, the lake elevation is regulated by Avista, who operates Post Falls Dam, a hydroelectric project that is located approximately nine miles downstream from the outlet at Coeur d’Alene Lake. The hydroelectric operations at Post Falls regulate the lake level for about half of any given year, and the remainder of the time, primarily during winter and spring, Coeur d’Alene lake water elevations and outflow are controlled entirely by the natural outlet restriction.

Major tributaries to the Spokane River, from upstream to downstream, include Latah Creek, also known as Hangman Creek, Little Spokane River, and Chamokane Creek, also known as Tshimikain Creek. Streamflow along the Spokane River has been measured at several gaging stations for many years, dating back as far as 1891 at the Spokane gage and 1912 at the gage near Post Falls, Idaho (Hsieh et al., 2007; Kahle & Bartolino, 2007). Flow conditions on the Spokane River fluctuate greatly between peak flow and base flows according to USGS records between 1891 and 2013. Historically, peak flows occur between December and June, with the majority occurring in May, but it depends largely on the timing of rain and snow events. Peak discharge ranges between 7,500 and 49,000 cfs, while base flow during August and September averages around 1,759 (cfs) (GEI Consultants Inc., 2003).
River terrain consists mainly of fine to medium grained sand beaches, gravel beaches or cobble beaches. Portions of the riverbank are steep, completely inaccessible steep vegetated banks or unvegetated banks (Kahle & Bartolino, 2007). There are some reaches that have areas of exposed rock shores, while other reaches are relatively flat sandy beaches. The upper Spokane River is a fairly low gradient river characterized by a wide valley and minimal channel entrenchment, and stable banks and unembedded boulder substrate characterize the channel (Kahle & Bartolino, 2007). Spokane Falls, near downtown Spokane, mark a change in stream gradient. The falls are composed of Miocene basalt flows, and the channel is highly entrenched and bedrock is the primary substrate (Kahle & Bartolino, 2007). Downstream of the falls, the channel is highly entrenched with a relatively narrow valley floor with unembedded cobble to boulder substrate in areas not affected by the reservoir (Kahle & Bartolino, 2007).

The SVRP aquifer is an unconfined aquifer composed of unconsolidated coarse-grained sand, gravel, cobbles and boulders deposited by the series of catastrophic Missoula glacial floods (Kahle & Bartolino, 2007). An unconfined aquifer means that the water table forms its upper boundary, and the aquifer is open to the unsaturated soils, atmospheric pressure changes and water seepage from above. The aquifer is coarser and contains more boulders near the center of the valley, where as there is finer material found in the western arm of the aquifer (Kahle & Bartolino, 2007). This is one of the most productive aquifers in the world, because the material deposited in the environment is more coarse-grained than a typical basin filled with deposits (Kahle & Bartolino, 2007). The aquifer contains large amounts of stored water that are free to flow through openings between grains of coarse sand, cobbles and boulders. The open, highly permeable material allows the percolation of precipitation and snowmelt through the unsaturated
zone to the water table, and rapid lateral movement of water through the aquifer (Kahle & Bartolino, 2007).

Hydraulic conductivity values are high in the SVRP aquifer with estimates ranging from 100 to 6,200 ft/day, with most values larger than 1,000 ft/day (Hsieh et al., 2007). SVRP aquifer thickness is generally uncertain, but ranges from 150 to more than 600 ft deep, for example in the northern Rathdrum Prairie, the aquifer is more than 800 ft thick, while it is roughly 400-600 ft thick near the Washington Idaho state-line (Kahle & Bartolino, 2007). Completed wells in the aquifer rarely extend more than 100 ft into the saturated zone, but often yield several thousand gallons per minute (Hsieh et al., 2007; Kahle & Bartolino, 2007). General groundwater flow direction within the SVRP is from the north to south between the northern boundary and Coeur d’Alene Lake, and then westward toward Spokane (Hsieh et al., 2007; Kahle & Bartolino, 2007). The generalized hydraulic gradient of the SVRP aquifer is relatively flat in the central SVRP aquifer areas and steeper along the aquifer boundaries. For example, the hydraulic gradient in the northern arm of the aquifer is approximately 22ft/mi, whereas the gradient in the western arm is around 8 ft/mi (Hsieh et al., 2007). Steeper gradients occur along the aquifer margins, with approximately 69 to 96 ft/mi reported near Newman, Hayden, and Hauser Lakes (Hsieh et al., 2007).

3.3. AN OVERVIEW OF WATER RESOURCE PLANNING, EDUCATION AND OUTREACH IN THE SPOKANE RIVER BASIN

The water management structure in the Spokane River Basin involves a complex assortment of interstate, multi-jurisdictional laws and responsibilities, planning units, federal licenses, private agreements, court rulings, infrastructure, cultural traditions and physical limitations of the water system. The states of Idaho and Washington have the primary responsibility for water allocation. River and aquifer management plans in both states aim to
address water availability, water quality and demand issues in the future, however each state has
different planning strategies. To date, there is not an interstate compact agreement or integrated
water resource management strategy between the two states that manages water resources in the
region. In the region, there are three watershed plans, at the sub-watershed level, and one aquifer
management plan of the SVRP (Table 3.1). The aquifer plan occurs in Idaho and is called the
Rathdrum Prairie Comprehensive Aquifer Management Plan (Whitman, 2013). In Washington,
the three sub-watershed plans include: a) joint Little Spokane River and Middle Spokane River
Watershed Management Plan; b) Lower Spokane River Watershed Management Plan; and c)
Hangman (Latah) Creek Water Resource Management Plan (Whitman, 2013). A summary of the
plans, purpose and vision is detailed in Table 3.1.

Table 3.1 Spokane River Basin watershed and aquifer plans, including purpose and vision.
Source: Whitman, 2013

<table>
<thead>
<tr>
<th>Watershed/Aquifer Planning Area</th>
<th>Purpose, Vision/Mission of Plan</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rathdrum Prairie Comprehensive Aquifer Management Plan</td>
<td>To provide a &quot;framework for long-range management of the aquifer.&quot; The vision of this plan is to &quot;Provide a sustainable source of high-quality groundwater for current and future economic, social, and environmental benefits, and preserve the exceptional quality and reliability of the Rathdrum Prairie Aquifer.&quot;</td>
</tr>
<tr>
<td>Hangman (Latah) Creek Water Resources Management plan</td>
<td>“[A]ssess and evaluate the water resources in Hangman Creek watershed” and to give “recommendations for future water use and instream needs.” The vision for this plan is “Preserving, managing, and enhancing the water resources of Hangman (Latah) Creek for the Benefit of humans, wildlife, and fisheries.”</td>
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<tr>
<td>Little Spokane and Middle Spokane River Watershed Management Plan</td>
<td>This plan had 4 main objectives including “[G]ather information” “address water resource issues” “provide local management of water resources”, and “coordinate and consolidate water management practices.” No stated vision or mission statement was in the plan.</td>
</tr>
<tr>
<td>Lower Spokane River Watershed Plan</td>
<td>Assess the status of the watershed and its resources as well as develop an action and implementation plan. The mission of this plan is “The WRIA 54 Planning Unit will create a living watershed management plan providing implementation strategies to manage water resources while improving water quality. The plan will support economic well-being, and protect and enhance the environment through collaborative citizen, business and government partnerships.”</td>
</tr>
</tbody>
</table>
3.3.1 Education and Outreach in the Spokane River Basin

Education and outreach strategies throughout Washington and Idaho in the basin vary in content, target audience and delivery. The National Water Institutes, Idaho Water Resources Research Institute and the State of Washington Water Research Center, both provide education and outreach in the basin. Education and outreach also occurs at the K-12 level, although detailed information about the various water resources education curriculums and projects in the classroom is beyond the scope of this project. This section describes outreach at a regional conference and commonly cited outreach campaigns about water resources in the Spokane River Basin.

The largest education and outreach effort is the Spokane River Forum. The Spokane River Forum brings together 200-350 individuals from local, state and federal agencies, industry, special interest groups, and the public to share relevant water resource science and projects, and to discuss pertinent regional water resource issues (Beall King & Thornton, 2016). This regional water conference is hosted by the Spokane River Forum, a nonprofit organization founded to improve education and outreach efforts, and to communicate pertinent water resource science, to the regional community in order to improve water resource planning and management in the Spokane River Basin (“Spokane River Forum,” 2016).

There are many education and outreach programs that focus on water quality and water quantity issues in the basin. The Spokane Aquifer Joint Board developed a series of messages using the “Aqua Duck – Defender of the Aquifer” cartoon character to protect the aquifer and raise awareness of the public’s impact on water quality (“Aqua Duck,” 2015). The Aqua Duck campaign had billboards, coloring books and information online about how to use water wisely. Education and outreach are also a component to the National Pollutant Discharge Elimination
System, and entities must have an education and outreach component targeted at knowledge and awareness of stormwater and water quality (Arnold, 2014). Outreach on water quantity focuses on instream flows and water conservation. For example, the City of Spokane developed “Slow the Flow” campaign with advertisements, short videos and online educational tips about water conservation (“Slow the Flow,” 2017). The Center for Environmental Law and Policy created “Our River is Low, H2KNOW” campaign to conserve water and mitigate impacts to the Spokane River (Osborn & Hedemark, 2015). These are a few examples of the many education and outreach initiatives and strategies that currently exist in the basin.

3.3.2 Collaboration and Stakeholder Engagement Background in the Spokane River Basin

Collaboration among water resource professionals in the basin occurs voluntarily. Currently, there is no legal mandate or management plan that requires stakeholders from both Washington and Idaho to collaborate. Among leaders in the water resources community, there is an expressed interest in collaboration to meet future water demands, improve aquifer and ecosystem health, decrease conflict and improve sustainability efforts.

The Idaho Washington Aquifer Collaborative (IWAC) is the only nonprofit group that currently exists in the basin and includes public water purveyors and educators in both Washington and Idaho. The purpose of IWAC is to work together to maintain and enhance water quality and quantity for present and future generations by developing management strategies which benefit the SVRP Aquifer and the Spokane River region (“Idaho Washington Aquifer Collaborative,” 2017). The organization has an objective of developing management strategies to address regional water supply and demand needs over the next 50 to 100 years (“Idaho Washington Aquifer Collaborative,” 2017). The Idaho Washington Aquifer Collaborative has
goals related to five themes: organization strategies, water quantity, water conservation, water quality, and public awareness and education (“Idaho Washington Aquifer Collaborative,” 2017). This research project works closely with leaders and members of IWAC, since they want to work on water resources issues as a basin, instead of separately as individual states.
CHAPTER FOUR: TECHNIQUES: STAKEHOLDER ENGAGEMENT IN THE SPOKANE RIVER BASIN

4.1. INTRODUCTION

This chapter describes techniques used to engage stakeholders and evaluate the impacts of long-term stakeholder engagement. The structure of stakeholder engagement and the initial approach to engaging stakeholders within a collaborative modeling framework is explained. In addition, facilitation techniques, methods used in the education and outreach participatory process, and the preliminary water resources participatory process are detailed. Chapter 5 describes the interview and data analysis methodology.

4.2. STAKEHOLDER ENGAGEMENT IN THE SPOKANE RIVER BASIN

This research project focused on the stakeholder engagement and collaborative modeling process that took place from January 2013 to December 2016 in the Spokane River Basin (SRB). The stakeholder engagement process was initiated as part of an interdisciplinary research project conducted at Washington State University called Watershed Integrated System Dynamics Modeling (WISDM). The WISDM research effort was funded in 2012 by the U.S. Department of Agriculture, National Institute of Food and Agriculture under project number WNP00804. WISDM aimed to integrate process-based hydrological models into a collaborative modeling (CM) framework to address relevant stakeholder needs in the Columbia River Basin. The CM process worked iteratively with diverse stakeholders including government agency representatives, policy decision-makers and biophysical scientists, to understand and address issues relevant to urban and agricultural water resource systems. The WISDM team included 10 faculty, two regional experts, and six graduate students from Washington State University. Team
members represented diverse academic disciplines including atmospheric chemistry, biological systems engineering, ecology, economics, environmental engineering, environmental science, hydrogeology, hydrology, and law.

Initial stages of the stakeholder engagement activities were based largely on collaborative modeling best practices (Langsdale et al., 2013). Rather than a linear process, the process used an iterative and flexible approach to stakeholder engagement (Table 4.1) (Beall King & Thornton, 2016; Mott Lacroix & Megdal, 2016). The WISDM stakeholder engagement team (SET) consisted of Dr. Allyson Beall King and Melanie Thornton who were responsible for designing the stakeholder engagement and collaborative modeling processes, facilitating key meetings and workshops, and writing reports and documentation for assorted meetings and workshops. For purposes of this research project, stakeholders are defined broadly, and included water resource professionals involved in decision-making, water purveyors, local and state agency personnel, industry professionals, nonprofit organizations, academic researchers and self-selected members of the public with a vested interest in water resources in the Spokane River Basin (Beall King & Thornton, 2016). The stakeholder engagement process involving these people spanned almost 4 years.
Table 4.1 An Overview of Stakeholder Engagement Activities over time in the Spokane River Basin (2010-2016), modified from (Beall King & Thornton, 2016).

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<td><strong>Ongoing Stakeholder Engagement Activities</strong></td>
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<td><strong>Spokane River Forum</strong></td>
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<tr>
<td><strong>Collaborative Modeling Process</strong></td>
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<tr>
<td><strong>Education &amp; Outreach Planning</strong></td>
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<tr>
<td><strong>Pre-Planning Regional Workshops</strong></td>
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</table>

The stakeholder engagement process was designed to be flexible enough to support the evolving needs of stakeholders, and to facilitate and support regional water resource planning efforts in the Spokane River Basin. The latter goal was furthered by the participation of stakeholders from the nonprofit Idaho Washington Aquifer Collaborative (IWAC). IWAC is the only bi-state organization addressing present and future water quantity and quality needs in the region (“Idaho Washington Aquifer Collaborative,” 2017). IWAC was included in the project because it involved stakeholders from both Washington and Idaho, prioritized collaboration, and was willing to re-think the way water resources were managed in the region (Table 4.2). Although participatory water planning processes usually do not include volunteering participants or organizations, including IWAC was a unique opportunity to include an organization striving to be forward thinking related to water planning in the inland northwest. Thus, including IWAC was beneficial in ensuring the participation of willing stakeholders in discussions surrounding regional water resources planning.
Table 4.2 Regular participants in the Idaho Washington Aquifer Collaborative, included members and non-members.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Organization</th>
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</thead>
<tbody>
<tr>
<td>Water Purveyors</td>
<td>Consolidated Irrigation District, East Greenacres Irrigation District, Hayden Lake Irrigation District, Model Irrigation District, North Kootenai Water &amp; Sewer District, Spokane County Water District, Vera Water and Power</td>
</tr>
<tr>
<td>Municipal</td>
<td>City of Spokane Valley, City of Spokane, City of Coeur d’Alene, City of Post Falls, Spokane County Water Resources</td>
</tr>
<tr>
<td>Tribal</td>
<td>Coeur d’Alene Tribe of Indians, Spokane Tribe of Indians</td>
</tr>
<tr>
<td>Industry</td>
<td>Avista, Idaho Water Engineering</td>
</tr>
<tr>
<td>Academic</td>
<td>Washington State University, University of Idaho-Education &amp; Extension</td>
</tr>
<tr>
<td>Other</td>
<td>Spokane Aquifer Joint Board</td>
</tr>
</tbody>
</table>

4.2.1 An Overview of Stakeholder Engagement Activities

Stakeholder activities included problem scoping, systems thinking exercises, model development, meeting participation, education and outreach activities, planning, and facilitated workshops. The initial part of stakeholder engagement included the first stages of CM, including becoming acquainted with the system; problem scoping; and model conceptualization, formulation, and simulation. Prior to model development, the SET met individually with water resource professionals in the Spokane River Basin to learn about the regional surface and groundwater system. During model development, ongoing stakeholder engagement involved attending monthly IWAC meetings, meeting individually with hydrological and hydrogeological experts in the region, and making presentations about model development at water planning groups including IWAC, Washington Watershed Resource Inventory Area (WRIA) and Idaho Comprehensive Aquifer Management Plan (CAMP). It is important to note that IWAC, CAMP and WRIA are the key water planning groups in the SRB.

The next part of stakeholder engagement included designing and facilitating interactive stakeholder engagement activities with the biennial regional water conference, the Spokane River Forum. The SET designed sessions to include broader stakeholder participation at this reoccuring conference in March 2013, November 2014 and March 2016. The next part of the
stakeholder engagement activities included addressing an education and outreach goal prioritized by IWAC. The SET helped design and plan a facilitated process to develop education and outreach strategies for IWAC. The final phase of stakeholder engagement was developing the initial planning workshops for regional water resources. Shortly after the planning workshops, individual semi-structured interviews were conducted to evaluate the stakeholder engagement activities and to obtain information about stakeholder perceptions about roles university researchers can play as members and as facilitators of participatory water planning processes. The interviews also addressed future stakeholder needs that related to water resources planning in the bi-state Spokane River basin. Please reference Section 5.2 for details outlining the interview process.

4.2.1.a. **Stakeholder Engagement Structure**

In this collaborative modeling project, the structure of stakeholder engagement is modified from the Shared Vision Planning Circles of Influence approach, which provides a formal structure for engaging different stakeholders in a collaborative modeling process (Cardwell et al., 2008; Creighton, 2010; Palmer et al., 2013). The Circles of Influence approach organizes stakeholder participation based on level of interest and ability to engage. This approach structures collaboration through concentric circles (Figure 4.1) with the innermost circle encompassing the “support team” (Figure 4.1, Circle A) (Cardwell et al., 2008; Creighton, 2010; Palmer et al., 2013). For this research project, the support team refers to the stakeholder engagement team, including King and Thornton, and consists of the individuals responsible for constructing the model, process facilitation and project management. The next larger circle includes the most interested stakeholders who through a combination of time, energy and capability are involved in the technical modeling work. This “cooperative modeling team”
directly engages in the development and/or application of the model, and thus develops a detailed knowledge of the technical process (Figure 4.1, Circle B). Agency representatives and consultants with extensive hydrologic modeling expertise in the Spokane River Basin were a part of this “cooperative modeling team.” The third outer circle is drawn to encompass all other stakeholders who desire only a nonessential, participatory role in the process (Figure 4.1, Circle C). The outermost circle contains the decision makers that provide direction to the effort. This circle overlay the three concentric circles, with information and dialogue occurring directly with each (Figure 4.1). This approach allows stakeholders with differing levels of involvement to contribute to collaborative modeling process and build trust and understanding (Palmer et al., 2013).

![Figure 4.1](image)

**Figure 4.1** Circles of Influence approach developed by Shared Vision Planning.

### 4.3. Part 1: Collaborative Modeling Process

#### 4.3.1 Get Acquainted with the System and Problem Scoping

Early stages of the stakeholder engagement and CM process included clarifying issues and defining problems related to stakeholders’ regional water resources. Trust and rapport developed by King during a previous collaborative modeling project in the Palouse Basin during...
2008-2010 was essential in encouraging regional stakeholders to engage the SET in a CM process in the Spokane River Basin (Beall et al., 2011). The stakeholder engagement team approached stakeholders with the concept of creating a dynamically integrated surface water and groundwater model for the Spokane basin that could be used as a tool in a mock water-planning process. SET met with individuals that King had previously developed a relationship with through a previous stakeholder engagement project (Table 4.3). These initial informational meetings were conducted over a six month period, October 2012 – March 2013. At each meeting, the SET provided a brief overview of the WISDM project and asked individual stakeholders to share information about the regional water resource system, including current planning and management strategies, challenges and barriers to the current system, and ideas for the future. These meetings were essential beginning phases of model development, enabling the modeling team to become acquainted with the water resource system and to understand more clearly stakeholder issues and concerns that could be addressed and incorporated into the Spokane River Basin modeling framework (Ford, 2009).

### Table 4.3 Informational Meetings by Sector and Organization from October 2012 – March 2013

<table>
<thead>
<tr>
<th>Sector</th>
<th>Organization</th>
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<tbody>
<tr>
<td>Agency/Municipality</td>
<td>Idaho Department of Water Resources, Washington Department of Ecology</td>
</tr>
<tr>
<td>Industry</td>
<td>Avista, J-U-B Engineers, Idaho Water Engineering</td>
</tr>
<tr>
<td>Non-Profit</td>
<td>Spokane Aquifer Joint Board, Spokane River Forum</td>
</tr>
<tr>
<td>Tribal</td>
<td>Coeur d’Alene Tribe of Indians</td>
</tr>
<tr>
<td>Water Purveyor</td>
<td>City of Coeur d’Alene, City of Post Falls, City of Spokane, Hayden Lake</td>
</tr>
<tr>
<td></td>
<td>Irrigation District, North Kootenai Water and Sewer District, Spokane County</td>
</tr>
<tr>
<td></td>
<td>Water Resources</td>
</tr>
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</table>

### 4.3.2 Hydrologic Model Conceptualization and Development and Ongoing Stakeholder Engagement

During monthly stakeholder engagement activities, SET began to work with stakeholders with expertise in the hydrology and hydrogeology of the SRB to conceptualize the hydrologic...
model. Research suggests that a modeler’s perception of a particular hydrologic system impacts the level of conceptualization that must be translated into the model structure (Wagener, Boyle, & Lees, 2001). Therefore, these meetings with hydrological experts were essential in developing the SET’s understanding of the SRB hydrologic system. In addition, these meetings were important for receiving stakeholder input, and to understand stakeholder issues and concerns that could be addressed and incorporated into the SRB modeling framework. In short, during these meetings regional stakeholders shared knowledge, expertise, and data relevant to developing a hydrologic model that would integrate surface water and groundwater components for the SRB and SVRP aquifer (See Appendix A).

SET chose to build the collaborative model of the Spokane Valley Rathdrum Prairie aquifer and Spokane River Basin with OASIS with OCL™ (OASIS) modeling software (Hydrologics Inc., 2009). The OASIS modeling software includes the capability for real-time simulations. This feature makes it useful in collaborative modeling sessions when simulating various “what-if” scenarios designed by stakeholders. Exploring various scenarios with stakeholders in this fashion allows the stakeholders to go through a decision-making process without actually having to go through the real experience. Utilizing OASIS in this way creates a powerful experience allowing diverse stakeholders, with differing management objectives or conflicting goals, to work together to develop mutually agreed-upon water management scenarios and strategies.

During model development, monthly meetings with individual stakeholders and small groups occurred over the course of two years, including SET and experts from Washington State University, Washington Department of Ecology, Idaho Department of Water Resources, IWAC, and individuals from both Spokane and Kootenai County (Beall King & Thornton, 2016). These
meetings were important to address model assumptions and parameters, and also functioned as a way to build trust with hydrologic experts in the region. In addition to these meetings, SET presented model progress at various IWAC, CAMP and WRIA meetings as a way to obtain stakeholder input and feedback, and to understand more completely stakeholder issues and concerns within the SRB modeling framework.

4.3.3 Spokane River Basin OASIS Model

OASIS is a surface water resource-specific software package designed to optimize system performance based on user-defined goals and constraints. It uses a fully-configurable linear programming solver to simulate water routing and to optimize system operations for each time step in the simulation period. The routing of water accounts both for human control and for physical constraints on the system. This linear programming technique has been used widely to study the optimization of water resource systems (Labadie et al., 2004; Randall, Cleland, Kuehne, Link, & Sheer, 1997). Mathematical details of linear programming, in particular specific information of the mixed-integer linear programming method applied in OASIS, can be found from the User Manual for OASIS with OCL™ (Hydrologics Inc., 2009).

Critically, OASIS software was not modeled on systems with a coupled groundwater and surface water system, and thus it was necessary to develop a new feature within OASIS to model groundwater. Accordingly, the Spokane River Basin (SRB) OASIS model was constructed to simulate groundwater and the movement of water within a coupled groundwater and surface water system. In addition, this model was designed to address relevant stakeholder issues such as future population growth, water demand, conservation and climate change impacts. Details regarding OASIS modeling software and the Spokane river basin OASIS model structure can be found in Appendix A.
4.4. PART 2: ENGAGING STAKEHOLDERS AT THE SPOKANE RIVER FORUM

In addition to engaging stakeholders in individual and group meetings, SET utilized the Spokane River Forum, a regional water conference, to engage a broader audience of individuals interested in regional water resources. SET developed stakeholder engagement activities for the March 2013, November 2014 and March 2016 Spokane River Forums.

During the past few years, the Spokane River Forum planning team asked SET to design different stakeholder engagement activities at the Forum. Specifically, at the 2013, 2014 and 2016 Forums SET designed clicker sessions to engage conference participants by answering a series of multiple choice questions. At the March 2013 Forum, SET helped develop and plan a world café session. And at the March 2016 Forum, SET planned and implemented an interactive future water scenarios session. Since 2011, King has given plenary presentations highlighting the importance of collaboration and engagement in participatory water planning processes within the basin. Each stakeholder engagement activity at the Forum served as an opportunity to learn about evolving needs of regional stakeholders, and to facilitate communication with key stakeholders in order to learn about new projects, programs and pressing issues in the Spokane basin.

4.4.1 World Café Session

A world café session is a way to engage stakeholders in an open and interactive way on a topic of mutual interest in order to share knowledge, ideas and insights, and to gain a deeper understanding of the topics discussed (Lipmanowicz & McCandless, 2013). The world café session held at the Spokane River Forum in 2013 included 35 stakeholder participants. There were five different tables where discussions took place, and each table focused on a specific topic. Topics included water demand, water supply, nutrient dynamics (water quality), urban development, and collaboration and sustainability. SET and three other Environmental Science
graduate students facilitated conversation at each table. Each facilitator also took notes during the group discussion. Each table had available poster boards and paper where stakeholders recorded important concepts within each topic. In order to facilitate conversations with multiple stakeholders, the world café session occurred in three rounds, during which stakeholders would move to a new table with a different topic. The world café session was designed to listen to multiple stakeholders about major concerns for the region, and to gain information about needs and future scenarios that participants were interested in exploring, specifically those related to regional water resources planning, education and management.

4.4.2 **Clicker Session: Online Multiple Choice Question Series**

At the Spokane River Forum in 2013, 2014 and 2016, SET and the Forum planning team designed a clicker session to involve conference participants in the completion of a series of multiple choice questions regarding water science, values and preferences, and planning and management challenges (Beall King & Thornton, 2016). This stakeholder engagement activity aimed to understand the individual and group mental models of Forum attendees. Participants in this activity were conference attendees who attended the plenary session, which included the clicker session activity. Prior to each conference, SET worked with key stakeholders and the Forum planning team to develop a series of multiple-choice questions that would be asked at the Forum (Beall King & Thornton, 2016). The group vetted all questions to ensure they were clear and accurate and to reduce the likelihood of controversial meaning. The development of these questions was used as a transparent, trust-building process (Beall King & Thornton, 2016).

Materials used at each clicker session consisted of 20-30 PowerPoint slides, with each slide containing a multiple choice question decided upon by the Forum planning team (Stowell & Nelson, 2007). Additional materials included the TurningPoint Technology personal response
system, which included 200 individual audience response transmitters (clickers), a receiver connected to a computer, and a laptop computer running TurningPoint and PowerPoint software (“Turning Technologies,” 2016). The TurningPoint Technology records all answers within the PowerPoint software, which can then be exported to Excel software. Descriptive statistics of questions asked at the 2013, 2014 and 2016 Forums were summarized (Beall King & Thornton, 2016). Additional statistical analysis is ongoing with Environmental Science student collaborators (Thornton, Gray & King, *in press*).

SET led and facilitated the clicker session at each Forum. During the Forum, all conference participants were given a clicker to answer each question anonymously. At the beginning of each session, participants were asked one question about demographic representation. Each individual was asked to select one of the following groups: local agency, state agency, federal agency, tribal, non-governmental organization, interested public, academic, or other. After the responses to subsequent questions were received, participants viewed the distribution of answers of participants, along with the correct answer for the question, and then were provided with an explanation of the correct answer. The responses to questions related to water resource science helped SET and conference attendees assess the level of general knowledge on a particular topic. Questions associated with values and preferences helped participants understand diverse attitudes and preferences about water resources in the region. In addition, responses to questions about planning and management challenges helped SET and conference participants gauge the level of interest for collaboration and collaborative bi-state water resource management.
4.4.3 Interactive Future Scenarios Session

SET was approached by the Forum planning team to organize and design an interactive session for the 2016 Spokane River Forum. SET therefore designed a session with the objective of allowing audience participants to help develop future scenarios that were related to different projections for growth in demand or conservation, climate change, and subsequent impacts on the river and aquifer levels. The various scenarios, including combinations of different parameters, were chosen by participants and simulated on-the-fly with the SRB OASIS model. The session included approximately 25 audience members. The session was facilitated by SET and notes were taken by Environmental Science graduate and undergraduate students.

This session was designed to include live model simulation and the ability to change scenarios and certain parameters on-the-fly. Because of limitations in OASIS software, this activity employed R software and R packages to improve the functionality and usability of the SRB OASIS data, graphics and interface (Appendix B). R is an open-source programming language and environment used for statistical computing, data analysis and graphics (Adler, 2010). The R packages ggplot (version 2.2.1) and Shiny (version 2.2.1) were used; ggplot was used to produce data and graphics, and Shiny was used to build interactive applications and graphics directly from R (Beeley, 2016; Wickham, 2009). A user friendly interface was developed that to simplify changing parameters and simulating new scenarios on-the-fly (Figure 4.2).
This user-friendly interface enables the user to select variable, scenario and the type of plot (graph). A specified number of variables and plot types were given, based on initial feedback from stakeholders. The choice of variables included two streamflow gages (cubic feet per second), the Spokane gage and the Post Falls gage, at the Spokane River, the elevation (feet) at Coeur d’Alene Lake, and total water demand (million gallons per day) for municipalities. The scenarios included a business-as-usual scenario as well as self-selected scenarios based on decisions made by the session participants. The plot type included a daily time series plot from 1990 – 2005, and the average monthly plot (January – December) for the entire time series.

4.5. PART 3: DEVELOPING AN EDUCATION AND OUTREACH CAMPAIGN FOR WATER STEWARDSHIP

As part of the ongoing and iterative stakeholder engagement activities, Thornton regularly attended the monthly IWAC meetings. IWAC has a goal related to public awareness and education of the regional water resources that states “develop a coordinated public
awareness and education campaign for the aquifer system” (“Idaho Washington Aquifer Collaborative,” 2017). IWAC members gave a high priority to developing a single regional, bi-state water resources message. SET was approached by leaders of the IWAC to help the organization reach their education and outreach goals. She worked with leaders of IWAC to design a five-month process to develop content and concepts for an education and outreach campaign. Thornton was lead facilitator for all of the meetings during this process, and three Environmental Science graduate students recorded notes at each meeting held from October 2015 to February 2016. The number of IWAC meeting attendees varied at each meeting (Table 4.4). This process included designing workshop meetings that included a variety of facilitation techniques, including a mental models exercise and utilizing Liberating Structures. The intended outcome was to develop a visionary executive summary for an education campaign, to identify theme(s) and content for the messaging campaign, and to generate ideas and concepts for various messaging materials.

<table>
<thead>
<tr>
<th>IWAC Meeting</th>
<th>Number of IWAC participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>October 2015</td>
<td>13</td>
</tr>
<tr>
<td>November 2015</td>
<td>21</td>
</tr>
<tr>
<td>December 2015</td>
<td>15</td>
</tr>
<tr>
<td>January 2016</td>
<td>16</td>
</tr>
<tr>
<td>February 2016</td>
<td>12</td>
</tr>
</tbody>
</table>

4.5.1 Mental Models Mapping Exercise

To initiate the process, Thornton facilitated a mental models exercise with the IWAC participants. Mental models can be used to design more targeted and effective messaging techniques (Zaksek & Arvai, 2004). The mental models mapping exercise was based on the
Conceptual Content Cognitive Map method (3CM), used to gain an understanding of individual and group mental models (Kearney & Kaplan, 1997). The 3CM is a methodology for understanding and measuring individual’s perspectives on complex systems (Kearney & Kaplan, 1997). There were 13 individuals present at the IWAC meeting when this method was conducted. Participants were prompted with a scenario and asked to identify important and relevant items based on the prompt. The scenario prompt used with the IWAC participants was the following:

*I want you to think for a moment about your own perspective on the entire water resource system in the Spokane River Basin region. Now, imagine that you are going to explain your perspective as you presently understand with water resource concepts, issues, challenges, etc. What are some of the things you would talk about? In other words, in your opinion, what things are important to consider when understanding the water resource system in the region? How else would you describe and characterize the region’s water resources? What elements would you contain? What is valuable to you?*

Each participant was asked to write each important, relevant item on an index card. Participants were encouraged to identify discrete things, rather than lengthy explanations or emotions. Next, participants were prompted to organize and group cards into categories, according to their individual preference. Participants then circled and labeled each category on a new index card. Finally, participants were asked to rank their individual cards based on importance, and then indicate if the item is positive or negative relative to their own opinion.

Following the mapping method exercise, each group of cards from an individual was transcribed electronically. Based on analysis of the resulting data, stakeholders’ mental models of the SRB region were depicted using concept map diagrams. These concept maps were used as
a tool to organize and represent stakeholder perceptions and knowledge graphically. Thematic analysis of the mental models data was conducted using QSR International’s NVivo 11 qualitative data analysis software, version 11.3.2.779 (Richards, 1999). Thematic analysis and qualitative data analysis are outlined in Chapter 5.

4.5.2 Developing a Water Stewardship Education and Outreach Plan

The first phases of the participatory process on education and outreach began with informal discussion at an IWAC meeting in August 2015 about education and outreach initiatives in the Spokane River Basin. During the initial meeting of this collaborative education and outreach process, the lead facilitator gave a presentation on the components of developing an education and outreach campaign and provided examples for current water messaging campaigns in the Pacific Northwest and in the United States. The group then held a brief, preliminary discussion on possible features of an IWAC education and outreach campaign. The next phase of this process focused on brainstorming and developing an education and outreach plan for IWAC.

4.5.2.a. Developing Sub-Themes, Issues and Objectives

Given the facilitation experience and techniques of SET, Thornton used Liberating Structures methods (Lipmanowicz & McCandless, 2013) in designing an approach and method for organizing and structuring the meetings, and as a way to include all IWAC members and meeting participants in the process. There were three different facilitation techniques from Liberating Structures that were used during this participatory process. The techniques included Crowd Sourcing, Open Source Technology, and What Debrief (Lipmanowicz & McCandless, 2013). In addition to the Liberating Structures techniques, Thornton also led an open discussion about the education and outreach messaging campaign outcomes and next steps. IWAC participants developed a story board that included content and ideas for specific categories.
IWAC leaders and SET decided that this messaging campaign would be focused on water stewardship as a central theme. The first step of this process was to identify several key sub-themes of the water stewardship education and outreach campaign. The lead facilitator designed the workshop to include 25/10 Crowd Sourcing, Open Space Technology and a What Debrief (Lipmanowicz & McCandless, 2013). 25/10 Crowd Sourcing is a technique from Liberating Structures that can help a group quickly generate and rank ideas (Lipmanowicz & McCandless, 2013). Open Space Technology is a technique that allows groups to identify issues and co-create plans and recommendations (Lipmanowicz & McCandless, 2013). What Debrief, also called “What, So What, Now What”, is a technique that allows groups to reflect on progress to date in a way that builds understanding and make adjustments as necessary (Lipmanowicz & McCandless, 2013).

Crowd Sourcing was used to generate and prioritize ideas quickly to help identify sub-themes. Chairs were arranged in a single large circle. Each participant was given two index cards. The lead facilitator posed a question and prompted participants to think silently about their response, and to write two responses, one on each index card. The prompting question for the group was “What are your big ideas related to important ‘topic areas’ for developing a regional water stewardship message.” Once all participants completed writing on their cards, there were rounds swapping cards repeatedly until each participant did not have their own cards. In each round, participants were asked to rate the idea on the card on a scale of 1-5, with 5 being the highest and 1 being the lowest. The process of swapping and rating cards was repeated five times. At the end of the exercise, each card contained five different ratings. Individuals then were asked to sum the rating scores for the card in their hand. The facilitator collected the cards with a score of 25, then 24, 23, etc. and then wrote the eight top-ranked ideas on a white board. The
facilitator ended this session by asking the group members to describe what caught their attention during it. Four key sub-themes were determined using the crowd sourcing technique.

The next part of the meeting used the open source technology technique to develop objectives, recommendations and action plans for each of the sub-themes of the messaging campaign. Open source technology was used to invite and include IWAC participants to address the education and outreach priorities established in the previous exercise. Chairs were arranged in four concentric circles for the approximately 20 participants. A group was organized for each of the four pre-determined sub-themes. Participants self-selected for each group, based on the theme that interested them the most. The prompt developed by SET for this exercise was: “What are important issues to this topic area? What is the overall messaging objective for this topic area? And, what next steps would you take?” Each group used large flip charts to take notes during the discussion. SET and Environmental Science graduate students helped facilitate the individual groups. Each group developed objectives and draft action plans for their water stewardship theme.

The meeting ended with a debrief session called What Debrief, and also referred to as “What, So What, Now What”. SET prompted IWAC participants to think about the discussion and experience and consider adjustments or needed next steps. The What Debrief was organized according to three stages. During each stage, participants were asked to think silently about the prompting questions before sharing their thoughts and perspectives with the group. The first stage was “What?” and the prompting questions were: “What happened? What did you notice, what factors or observations stood out?” The second stage was “So what?” and the prompting questions were: “Why is that important? What patterns or conclusions are emerging?” The final,
third stage was “Now what?” and the prompting questions were: “Now what? What actions make sense?”

4.5.2.b. *Developing a Vision and Content for Educational Videos*

It is important to note that a majority of the IWAC participants wanted to develop short educational videos for each sub-theme. To develop content involving various sub-themes for the education and outreach campaign, SET designed the next meeting based on components of the digital storytelling process. It included planning, research, writing a script and developing a storyboard and plan. This meeting ended with a What Debrief discussion.

At the next meeting, Thornton gave a short presentation about the different components of the digital storytelling process. The IWAC participants then broke into four different groups, one for each sub-theme: water preservation, water quality, water quantity and stormwater. IWAC participants designed content for educational videos reflecting each sub-theme. Each group was prompted with questions to identify the audience, define the message, establish the purpose, and engage the audience. Most of the time in this meeting was spent working on creating a storyboard. The storyboard development process helped individuals and groups synthesize the many steps and components necessary to organize the sequence of a video, and to achieve the overall purpose and vision. Each individual was given a storyboard table sheet that included two columns; one column was used to write the relevant script text and the other column was used to include relevant images and graphics coordinated with the script language. Individuals within each group identified key scenes that they wanted to include in the educational video. Individuals shared their key scenes with the sub-theme group members. The subgroups then collaborated to develop one storyboard for their sub-theme. Each subgroup presented their storyboard to the
entire group. The meeting ended with a What Debrief discussion to talk about next steps in the campaign design process.

4.5.2.c. **Eliciting Feedback**

SET worked with the IWAC leaders to rank sub-themes according to priority. IWAC leaders decided that the stormwater and water quantity sub-themes were of highest priority. SET and three Environmental Science graduate students prepared for the next meeting by developing a series of animation sketches for the water quantity sub-theme and the first phase of a video for the stormwater sub-theme. At the next meeting, the IWAC members finalized the objectives and content of each sub-theme. SET then presented the initial draft sketches and video to the IWAC stakeholders. Participants provided feedback on the sketches and video. SET and IWAC leaders then facilitated a group discussion about the collaborative education and outreach campaign process, along with next steps for developing a plan to implement and execute the vision of the education and outreach campaign; topics included finding collaborative partners and raising funds.

After each workshop meeting, SET transcribed all notes and drafted an executive summary document that was used for the official IWAC meeting minutes. In addition, Thornton drafted a report that was utilized by IWAC leaders to find collaborative partners and solicit funding.

**4.6. PART 4: PRELIMINARY WATER RESOURCES PLANNING WORKSHOPS**

IWAC members recognized the importance of expanding the regional discussion on future water resources planning. After reflecting on both the participatory process to develop an education and outreach campaign, and the interactive discussions at the 2016 Spokane River Forum, IWAC members asked SET to assist the group in thinking about next steps related to
regional water resources management. Leaders of IWAC and SET planned two summer workshops in 2016 to begin a preliminary discussion related to regional water resources planning and management. SET were the primary facilitators at each of the workshops. An Environmental Science graduate student assisted SET by serving as an observer and record keeper. Each workshop was three hours in length. There were 12 participants at the first workshop and 19 participants at the second workshop, representing a variety of organizations in the basin (Table 4.5).

Table 4.5 Workshop participants by sector and organization for workshop one and workshop two.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Workshop One: July 12, 2016</th>
<th>Workshop Two: August 9, 2016</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Managers/Purveyors</td>
<td>City of Spokane Valley, Hayden Lake Irrigation District, Liberty Lake Sewer and Water District, Model Irrigation District, North Kootenai Water and Sewer District, Spokane County Water District, Spokane County Water Resources</td>
<td>Municipalities / Water Purveyors City of Post Falls, City of Spokane, City of Spokane Valley, East Greenacres Irrigation District, Hayden Lake Irrigation District, Liberty Lake Sewer and Water District, Model Irrigation District, North Kootenai Water and Sewer District, Spokane County Water District, Spokane County Water Resources</td>
</tr>
<tr>
<td>Academic</td>
<td>Washington State University; University of Idaho-Education and Extension</td>
<td>Academic Washington State University; University of Idaho-Education and Extension</td>
</tr>
<tr>
<td>Agency</td>
<td>Spokane County Water Resources, Washington Department of Health</td>
<td>Tribal Spokane Tribe of Indians</td>
</tr>
<tr>
<td>Other</td>
<td>Spokane Aquifer Joint Board, Idaho Water Engineering</td>
<td>Agency Idaho Department of Environmental Quality, Idaho Department of Water Resources, Idaho Panhandle Health District, Spokane County Conservation District, Spokane County Water Resources, Washington Department of Health</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Other Spokane Aquifer Joint Board, Idaho Water Engineering</td>
</tr>
</tbody>
</table>
4.6.1 Workshop One

Workshop One included a facilitated discussion, establishing objectives and a systems thinking, causal mapping exercise on: problems and issues, barriers, and potential solutions to regional water resource management problems in the Spokane River Basin. The workshop agenda included a futures triangle exercise, a causal loop diagramming exercise, and ended with a discussion about next steps.

The July workshop began with an IWAC leader providing an overview and explanation of the purpose of the workshop. This overview included descriptions of challenges and problems related to regional water resources, and the opportunity to develop solutions and recommendations for bi-state water planning. SET provided additional background on brainstorming ideas and potential solutions for these issues. Thornton led the group in the first activity called Futures Triangle. Futures Triangle is a technique where participants map the past, present and future in an effort to explore plausible futures (Inayatullah, 2008). It uses a triangle with three dimensions to help participants explore the past, present and future. Each participant worked individually to answer the following questions: “What are five problems related to water resources in the region? What are five barriers to fixing the issues you previously mentioned? And, what are five hopes and fears for the future?” Each participant wrote their responses on a piece of paper and also wrote individual responses on post it notes. Next, participants split into two groups, discussed items from the first activity, and translated them into causal loop diagrams for the Spokane River Basin water resource system. The causal loop diagram is a map that helps individuals visualize how different variables are interrelated within a system (Forrester, 1994; Winz, Brierley, & Trowsdale, 2009). The workshop concluded with a roundtable debrief and discussion about next steps. In addition, the participants discussed potential attendees for the
next workshop to be held in August. After Workshop One, SET transcribed all notes, drafted a summary document and digitized the casual loop diagram that was used for the workshop minutes.

4.6.2 Workshop Two

Workshop Two included a facilitated discussion on potential solutions to, and action items for, regional water resource management issues that were identified and described within the integrated causal map. The agenda of the second workshop included a Critical Uncertainties and Scenarios Matrix technique from Liberating Structures, updates on the causal loop diagram, and ended with a What Debrief to reflect on progress and discuss next steps.

SET began the meeting by providing background and an overview of the first workshop; the introduction included themes of expanding the conversation and moving from challenges and barriers to strategies and actions. Thornton led the Critical Uncertainties and Scenario Matrix session. This first session aimed to facilitate conservation and to help develop strategies and build capacity to respond to future challenges. King led the next part of the workshop, prompting the group to translate scenarios and strategies developed in the previous exercise into a draft version of the causal loop diagram. During this portion of the workshop, participants had the opportunity to revise and edit the current draft version of the causal loop diagram. The workshop ended with a What Debrief, the same Liberating Structures technique used in the education and outreach process.

The Critical Uncertainties and Scenario Matrix session began with the following prompting question: “In the context of regional water planning, what factors are the most challenging to predict or control?” Each individual was asked to make a list of five uncertainties related to the question. Then, the individuals were asked to choose two of the most critical
factors in answer to this question: “Which factors create the biggest challenge to develop and implement a regional water plan?” Individuals gathered in groups of four or five people and selected the two most common factors identified by all individuals. Each group created a grid with two axes with a negative/less to positive/more continuum. The two most common factors that the group decided were then transferred to the grid. Each group developed a scenario matrix with four quadrants. Each group then wrote a brief scenario for the preferred quadrant, and brainstormed three strategies that would help the group successfully develop and implement a regional water plan. Each group briefly shared their scenario story with the entire group.

The last part of the workshop was the debrief portion. Thornton facilitated the group using the What Debrief technique, as described in Section 3.5b. The workshop concluded with a roundtable discussion about next steps for workshops and future action items. After Workshop Two, SET transcribed all notes and drafted an executive summary report that was used for the official IWAC meeting minutes.
CHAPTER 5: INTERVIEW AND DATA ANALYSIS METHODOLOGY

5.1 INTRODUCTION

This chapter describes the methods used to gather data for the analysis, including individual interviews with stakeholders actively engaged in IWAC. This chapter also includes the approaches used to analyze the data. Additionally, potential limitations of the research approach are discussed. Appendix D includes the interview protocol, interview questions and interview consent form.

5.2 INTERVIEW METHODOLOGY

Interviews are an effective method and a powerful way to gain insight through understanding the perspectives and experiences of the participants involved in a participatory process (Seidman, 2013). This section describes the interview protocol and provides a description of participants.

5.2.1 Overview of Interviews

Interviews were conducted with 20 IWAC participants in the fourth year of the project, from November – December 2016. Interview participants included individuals from local, state and tribal agencies, water managers and purveyors, academia, non-governmental organizations and industry in the Spokane River Basin (Table 5.1). Interviews followed a semi-structured format consisting of 20-25 questions. Semi-structured interviews were intended to be flexible to enable interviewees to develop ideas and speak widely on the issues raised by SET (Denscombe, 2014; Seidman, 2013). All interviews were audio recorded and conducted via telephone. Each interview lasted 30-75 minutes. Interviews were transcribed by a third party transcription service prior to analysis.
Table 5.1 Interview participants by sector and organization.

<table>
<thead>
<tr>
<th>Sector</th>
<th>Organization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water Managers/Purveyors</td>
<td>City of Post Falls, City of Spokane, City of Spokane Valley, Consolidated</td>
</tr>
<tr>
<td></td>
<td>Irrigation District, Hayden Lake Irrigation District, Liberty Lake Sewer and</td>
</tr>
<tr>
<td></td>
<td>Water District, Model Irrigation District, North Kootenai Water &amp; Sewer</td>
</tr>
<tr>
<td></td>
<td>District, Spokane County Water District, Spokane County Water Resources</td>
</tr>
<tr>
<td>Tribal</td>
<td>Coeur d’Alene Tribe of Indians</td>
</tr>
<tr>
<td>Academic</td>
<td>University of Idaho-Education &amp; Extension</td>
</tr>
<tr>
<td>State</td>
<td>Washington Department of Ecology, Washington Department of Health</td>
</tr>
<tr>
<td>Other</td>
<td>Spokane Aquifer Joint Board, Idaho Water Engineering</td>
</tr>
</tbody>
</table>

Interview questions explored stakeholders’ perspectives on the Idaho Washington Aquifer Collaborative organization, the role university researchers can play in participatory processes, the perceived impacts of the individual and the group from participating in the participatory process, and the benefits and challenges of the participatory process. In addition, interviewees were asked to share their perspectives on the future of regional water resource management in the Spokane River Basin. Some interview questions were designed to incorporate the evaluation of key criteria that were important in evaluating participatory processes in natural resources (Blackstock & Richards, 2007; Carr et al., 2012). The criteria included important evaluation categories related to the process and the outcomes of the participatory process (Table 5.2).

Table 5.2 Interview criteria used for evaluating a participatory process related to the process and outcome, adopted from (Blackstock & Richards, 2007).

<table>
<thead>
<tr>
<th>Process</th>
<th>Outcomes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fairness</td>
<td>Accountability</td>
</tr>
<tr>
<td>Flexible and iterative process</td>
<td>Capacity building</td>
</tr>
<tr>
<td>Communication: quality and flow of information</td>
<td>Shared understanding and consensus</td>
</tr>
<tr>
<td>to participants (two-way)</td>
<td></td>
</tr>
<tr>
<td>Leadership</td>
<td>Transparency</td>
</tr>
<tr>
<td>Problem framing and social learning</td>
<td>Trust and social capital</td>
</tr>
<tr>
<td>Systemic perspective</td>
<td>Effectiveness of outcomes</td>
</tr>
</tbody>
</table>

5.3. Data Analysis

Interview data were analyzed using thematic analysis techniques based on utilizing a Grounded Theory Analysis approach (Braun & Clarke, 2006; Charmaz, 2006). Thematic analysis
Thematic analysis is a form of qualitative research analysis used widely in social sciences research (Charmaz, 2006). It is a methodology for identifying, analyzing, and reporting themes and patterns within data (Braun & Clarke, 2006). It searches for themes that emerge from data; these emerging themes then become categories for analysis, rather than using categories of analysis defined prior to transcribing data (Charmaz, 2006). Thematic analysis is useful for distilling and summarizing information from a large body of data to inform planning and management strategies (Charmaz & McMullen, 2011).

Interview questions covered both the process and outcome criteria, and were open-ended to allow data to be analyzed for emerging themes that were not necessarily related to the pre-defined criteria. This framework allowed themes to emerge to reflect different values and perspectives held by the participants rather than mechanically applying criteria to interview data. Thus, the analysis process for this project identified themes by allowing them to emerge naturally from the data, and also explored the pre-determined evaluation criteria themes.

NVivo 11 Qualitative Analysis software was used to code interview transcripts and mental model data. The analysis consisted of examining, categorizing, and tabulating data to search for emerging themes and empirically based conclusions. Initial exploration of data involved reading each interview in its entirety several times. Memos were created to include notes on key concepts, ideas, and short phrases revealed in the data. Memos also were used to keep notes on comparing codes and emerging categories. The analysis included free line-by-line coding of the interviews (without a hierarchical structure), organizing these codes into related areas to develop descriptive themes, and the developing analytical themes. The interview coding process began by coding transcripts at the sentence and paragraph level. Line-by-line coding is useful in identifying and translating key concepts from one interview to another (Seidman,
2013). Codes were used to capture the meaning and content of sentences and paragraphs. Initially, codes were structured with or without a hierarchical structure. Codes then were organized into a hierarchical tree structure. New codes were created to group codes into thematic categories for analysis. In addition, the analysis included running query relationships among descriptive codes. Occurrence of common descriptive codes across multiple interviews suggested common and core themes within the data.

5.4. **Verifying Initial Codes and Categories**

Verification of major categories and themes was achieved by having a fellow Environmental Science graduate student (Johnson) analyze the interview transcripts using the thematic analysis approach. In multiple feedback sessions, codes were discussed, vetted and confirmed.

It is important to note that this analysis was primarily conducted independently. In addition, since this analysis was conducted by a researcher, researchers play an active role in identifying, selecting and reporting themes that are of interest to the individual and to the scope of the project.

5.5. **Potential Limitations of the Research Approach**

A potential shortcoming of utilizing a thematic analysis approach to analyze the interview and mental models data is that it is often perceived to be less theoretically driven and less arduous than grounded theory analysis or other qualitative research methods (Braun & Clarke, 2006). The graduate student researcher on the stakeholder engagement team was the primary interviewer, coder, and analyst of the semi-structured interviews. Therefore, it is possible that additional or different themes could be identified in the data. The interviewer and analyst in this research project also was engaged in designing and planning the participatory process, including
stakeholder engagement workshops. It is possible that this dual role influenced the analysis and interpretation of the interview data. It is also possible that the stakeholders were selective in sharing their perspectives because of the interviewer’s role as a graduate student who was the primary individual that engaged with the IWAC stakeholder group.
CHAPTER SIX: RESULTS

6.1. INTRODUCTION

This chapter includes an overview of all the stakeholder engagement activities for this research project. The results presented here are separated in three parts that focus on: 1) WISDM related stakeholder engagement activities and objectives; 2) activities and objectives requested by the stakeholders; and 3) interview results and evaluation of the participatory processes included in this research project (Table 6.1). The primary objectives of long-term stakeholder engagement in the Spokane River Basin include: 1) advance strategies that support improved collaboration with the long-term goal of collaborative, bi-state water resources management; 2) social learning; 3) build personal relationships and social capacity; 3) improve two-way communication; 4) achieve an improved water management outcome; 5) achieve improved education and outreach approaches; and 5) understand the role of collaborative modeling and university research teams in long-term stakeholder engagement processes. This chapter details each stakeholder engagement activity, key discussion items and outcomes. The last part of this chapter is of utmost importance, as it examines stakeholder perceptions of the role university researchers play in participatory water planning processes and evaluates the participatory process and outcomes over the course of this research project.
Table 6.1 This table summarizes all engagement activities described in this research project. It is separated in three different sections: 1) primary objectives of long-term stakeholder engagement in the Spokane River Basin; 2) WISDM related activities and objectives; and 3) stakeholder requested activities and objectives.

<table>
<thead>
<tr>
<th>Technique</th>
<th>Objective</th>
<th>Time Frame</th>
</tr>
</thead>
</table>
| **Long-term Stakeholder Engagement Process** | Primary objectives:  
- Advance strategies that support improved collaboration with the long-term goal of collaborative, bi-state water resources management  
- Social learning  
- Build personal relations and social capacity  
- Improve two-way communication  
- Achieve an improved water management outcome  
- Achieve improved education and outreach approaches  
- Understand the role of collaborative modeling and university research teams in long-term stakeholder engagement processes | 4 years, on-going |
| **WISDM Related Activities and Objectives** |  
- Collaborative Modeling  
- Develop improved strategies for regional water management  
- Understand how managers would change management strategies in the context of climate change  
- Build relations, trust  
- Social learning  
- Improve communication | 3 years: January 2013 – March 2016 |
|  
Spokane River Forum: World Café  
- Develop conversations and collective understandings about concerns in the region related to: water demand, water supply, water quality (nutrient dynamics), urban development, collaboration and sustainability | March 2013 |
|  
Spokane River Forum: Future Scenarios Workshop  
- Develop and assess potential water demand and supply scenarios | March 2016 |
| **Stakeholder Requested Activities and Objectives** |  
- Understand perspectives, values and understanding of water resource system  
- Social learning  
- Improve two-way communication  
- Education/Outreach component  
- Elicit group mental models | Every 18 months: March 2013, November 2014, March 2016 |
|  
IWAC Workshop Series: Education and Outreach  
- Crowd Sourcing  
- Open Source Technology  
- Storyboarding | 6 months: October 2015 – March 2016 |
### What Debriefs

**IWAC Workshop Series: Pre-Planning**
- Futures: Futures Triangle
- Causal Loop Diagram
- Critical Uncertainties/Scenarios Matrix
- What Debrief

- Develop plan and next steps for regional water planning
- Brainstorm strategies for operating in a range of potential futures

| 3 months: May – August 2016 |

**Evaluating Stakeholder Engagement and Participatory Processes in this Research Project**

| Interviews and Participatory Evaluation | - Assess participatory process: social learning, communication, capacity building  
- Encourage participant reflection and feedback to make recommendations for improvements in the future  
- Gather feedback on IWAC and next steps for regional water resources planning and management | 2 months: November – December 2016 |

### 6.2. WISDM-related Stakeholder Engagement Activities

This section describes three stakeholder engagement activities that were employed as components to the interdisciplinary research project WISDM. First, this section describes the collaborative modeling process, specifically focusing on getting acquainted with the system, model conceptualization, initial model development and preliminary scenario development. The other two engagement activities were designed as interactive workshops, world café and interactive future scenarios, that occurred concurrently with the collaborative modeling process. Lastly, this section describes outcomes of the world café workshop and the interactive future scenarios workshop that occurred at the Spokane River Forum at different years. A summary of all stakeholder engagement activities is detailed in Table 6.1.

#### 6.2.1 Collaborative Modeling Process and Preliminary Outcomes

The collaborative modeling and stakeholder engagement process in the Spokane River Basin commenced as part of a large interdisciplinary project that aimed to address water resource sustainability in the Pacific Northwest. This project in particular was the stakeholder engagement component that worked with key water resource stakeholders to advance strategies that support
improved collaboration, communication and social learning with the long-term goal of collaborative, bi-state water resources management. In addition, the original project objective was to understand how water resources managers would change their management strategies in the context of climate change.

It is important to note that the Spokane River Basin is not short of hydrologic models. Within the last 10 years, two predominant models were developed: 1) a USGS MODFLOW model that was used to better characterize and simulate groundwater flow and was primarily developed by academic researchers and agency scientists (Hsieh et al., 2007); and 2) a three-dimensional finite-element groundwater model that explored water pumping impacts of specific wells and the subsequent impacts on streamflow in the Spokane River Basin and was developed by a consulting firm (Porccello & Gorski, 2016). Thus, the initial purpose of the CM process and developing another model was to explore strategies that addressed bi-state water management.

This stakeholder engagement process followed traditional collaborative modeling stages: a) get acquainted with the system and stakeholders; b) identify key issues and performance measures; c) model conceptualization and development; and d) scenario development. Later stages of CM processes, including scenario evaluation, developing a water management plan and implementing the plan, were not completed during this process. These latter stages of CM were uncompleted because stakeholder needs and priorities shifted part-way through this process.

The first stage of a CM process include getting acquainted with the system and engaging key stakeholders. These stakeholders assist with identifying pressing issues and important model conceptualization components. Components of the stakeholder engagement and CM process included: a) individual and group meetings with water resource stakeholders; b) presentations and workshops to share research updates and progress; and c) attending regional water resources
meetings (Table 6.2). The table includes the number of individual and group in-person meetings/phone calls, presentations and workshops given related to this research project, and attending meetings related to water resources in the basin.

**Table 6.2 Stakeholder Engagement in the Spokane River Basin Overview from 2012 – 2016.**

<table>
<thead>
<tr>
<th>Year</th>
<th>Individual/Group Meetings and Phone Calls</th>
<th>Presentations/Workshops</th>
<th>Meeting Attendance</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>2012</td>
<td>6</td>
<td>0</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>15</td>
<td>3</td>
<td>4</td>
<td>22</td>
</tr>
<tr>
<td>2014</td>
<td>12</td>
<td>6</td>
<td>15</td>
<td>33</td>
</tr>
<tr>
<td>2015</td>
<td>10</td>
<td>5</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td>2016</td>
<td>12</td>
<td>6</td>
<td>10</td>
<td>28</td>
</tr>
<tr>
<td>Total</td>
<td>55</td>
<td>20</td>
<td>38</td>
<td>113</td>
</tr>
</tbody>
</table>

These introductory meetings allowed the stakeholder engagement team to get acquainted with the Spokane River Basin system. Stakeholders taught and shared their knowledge and history of the basin. The SET met with 14 individual stakeholders and heard an assortment of information about the SRB (Table 6.3). Stakeholders shared their expertise and knowledge related to hydrologic and hydrogeologic challenges of the Spokane River Basin and Spokane Valley Rathdrum Prairie Aquifer, the complexity of water use in the basin, the political, social and historical aspects of water resource management in the basin, and some ideas about future scenarios that could be explored in the model. All stakeholders shared the complexity of a dynamically integrated surface and groundwater system. The differences in water law, rights and management approaches in both Washington and Idaho were also mentioned frequently. Many stakeholders wanted to know what the impacts of climate change and prolonged drought would be on both streamflow and groundwater levels. These meetings marked the beginning of the relationship and trust building process, which is crucial to working with stakeholders.
Table 6.3 Overview of key concepts, issues, and concerns related to water resources in the Spokane River Basin.

<table>
<thead>
<tr>
<th>Hydrology/ Hydrogeology Challenges</th>
<th>Water Use</th>
<th>Political, Social, Historical Context</th>
<th>Future Scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dynamic surface-groundwater system</td>
<td>Municipal water use patterns (consumptive and non-consumptive)</td>
<td>Current water law &amp; water rights</td>
<td>Prolonged Drought</td>
</tr>
<tr>
<td>Variable hydraulic conductivity</td>
<td>Variable water costs</td>
<td>Politics and Bureaucracy</td>
<td>Large population increase</td>
</tr>
<tr>
<td>Variable streambed conductance</td>
<td>Unknown water use: permit exempt wells</td>
<td>Differences between Idaho and Washington</td>
<td>Land use change: agricultural to municipal</td>
</tr>
<tr>
<td>Uncertain lake inputs</td>
<td>Wastewater</td>
<td>Instream flow rule</td>
<td>Water demand forecasts</td>
</tr>
<tr>
<td>Uncertain Storativity</td>
<td>Industry &amp; Agricultural water use</td>
<td>Post Falls Dam FERC license</td>
<td>Augmentation of low flows in the Spokane River</td>
</tr>
<tr>
<td>Variable Recharge: areal and tributary</td>
<td>Tribal rights &amp; history</td>
<td>Modified Dam operations</td>
<td></td>
</tr>
<tr>
<td>Hydrologic response effects of pumping</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

6.2.1.a. **Model Conceptualization, Development and ongoing Stakeholder Engagement**

The next stage of CM is model conceptualization and initial development. During the model conceptualization phases, model structure and potential outputs of the model were shared at various meetings with individuals with hydrogeologic expertise, small groups and at different water organization meetings in the region. At this time, the model conceptualization was really used as a platform for dialogue to allow stakeholders to discuss pressing issues and potential components that they would like to see in the model. As time progressed, research progress and model updates were intermittently shared with key stakeholders.

Between meetings, presentations and phone calls, extensive research about the basin’s water budget, hydrologic and hydrogeologic characteristics, and groundwater model reports was reviewed. In an effort to improve understanding of the SRB and SVRP aquifer system, various spreadsheet models, including a response effects model and a water demand forecast model, were extensively explored. This model conceptualization phase also included personal data analysis to better understand trends in precipitation, water demand, and streamflow. During this
learning phase, communication with stakeholders was ongoing to assist with clarifying information and understanding of the regional water resource system.

Data gathering and continuous fine tuning of the model, as well as engagement with individual and groups of stakeholders, was planned for time between giving presentations of research and model progress. The engagement of stakeholders during this time was to provide a time for interested stakeholder to familiarize themselves with the model and to allow for in-depth discussion and engagement to occur.

Data used in the model came from a few different sources, including USGS Reports, USGS Water Data and MODFLOW model data. Streamflow data came from the USGS streamflow gages. Water demand data including municipal, industrial and agricultural use was taken from the MODFLOW model. Most of the other data inputs, including lake inputs, areal recharge and tributary recharge, came from the MODFLOW model. More information about the data used and key model assumptions and equations used to calculate the routing of water are detailed in Appendix A.

6.2.2 Interactive Workshop: World Cafe

The World Café workshop occurred as a session at the March 2013 Spokane River Forum. This workshop occurred during the initial stages of model conceptualization and development. The interactive workshop provided a unique opportunity to engage a broader audience to discuss regional water resource issues. Individuals that self-selected to participate in this session were not the usual stakeholders that were engaged in this research project. This workshop served as another engagement and learning opportunity to identify pertinent and pressing issues to participants at the Spokane River Forum (Figure 6.1). The café was designed in two rounds, where the first round focused on stakeholders sharing concerns, ideas and
anything related to the pre-determined theme at each table. The second round specifically focused on scenario development, where stakeholders were encouraged to think of future scenarios that they would want the collaborative model to address. The first round of discussion at the world café is reported in Table 6.4 and is organized into three categories. The second round of discussion on potential future scenarios was summarized in Table 6.5 and is categorized in four themes. For the purposes of this research project, discussions regarding water quality and nutrient management were not included. Following the workshop and conference, findings from the café were compiled into a report and shared with key stakeholders.

Figure 6.1 Picture taken at the World Café workshop at the Spokane River Forum, March 2013 by graduate student researcher Elizabeth Allen.
Table 6.4 Key issues, concerns and concepts discussed during round one at the world café workshop at the Spokane River Forum, March 2013.

<table>
<thead>
<tr>
<th>Key Issues, Concerns and Concepts</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Physical factors that determine water demand (irrigable area, housing lot size, soil type)</td>
<td>Water Demand</td>
</tr>
<tr>
<td>• Sprinkler system efficiency</td>
<td></td>
</tr>
<tr>
<td>• Infrastructure factors (wastewater treatment, septic) impacts to water demand</td>
<td></td>
</tr>
<tr>
<td>• Differences in water bills and how individuals are billed for water</td>
<td></td>
</tr>
<tr>
<td>• Individuals proximity to parks or golf courses</td>
<td></td>
</tr>
<tr>
<td>• Social factors and the effects of neighbors on outdoor water use</td>
<td></td>
</tr>
<tr>
<td>• Different water restrictions for outdoor water use throughout the region</td>
<td></td>
</tr>
<tr>
<td>• New developments should require xeriscaping</td>
<td>Urban Development</td>
</tr>
<tr>
<td>• Impacts of new development on water efficiency</td>
<td></td>
</tr>
<tr>
<td>• There are limitations of services, sewer, water and electric, that impact where new development occurs</td>
<td></td>
</tr>
<tr>
<td>• Quality of life is important</td>
<td></td>
</tr>
<tr>
<td>• Differences in how residential areas are classified, urban or rural</td>
<td></td>
</tr>
<tr>
<td>• Water purveyors and municipalities have long-term operation and maintenance costs that need to be considered</td>
<td></td>
</tr>
<tr>
<td>• Concerns about industry uses of water and the possibility for conservation</td>
<td></td>
</tr>
<tr>
<td>• Changing soil requirements for new development, to install something that is more porous than clay materials</td>
<td></td>
</tr>
<tr>
<td>• Need to develop and agree on commonly established management goals</td>
<td>Collaboration and Sustainability</td>
</tr>
<tr>
<td>• All regional decision-making entities need to be brought together to think about collaborative management between different levels of government</td>
<td></td>
</tr>
<tr>
<td>• Water management should follow adaptive management principles</td>
<td></td>
</tr>
<tr>
<td>• Participatory process that allows for relationship building, developing trust and respect are needed</td>
<td></td>
</tr>
<tr>
<td>• Increased transparency in decision-making should be a priority</td>
<td></td>
</tr>
<tr>
<td>• What does successful collaboration look like?</td>
<td></td>
</tr>
<tr>
<td>• What does successful bi-state water management look like?</td>
<td></td>
</tr>
</tbody>
</table>
Table 6.5 Potential future scenarios participants desired to be incorporated in the collaboratively development model discussed during round two at the World Cafe workshop at the Spokane River Forum, March 2013.

<table>
<thead>
<tr>
<th>Potential Future Scenarios</th>
<th>Theme</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Potential policy impacts of water reduction practices targeted at reducing peak demand in large water districts</td>
<td>Water Demand</td>
</tr>
<tr>
<td>• Potential impacts if the region used grey water or implemented purple pipe practices</td>
<td></td>
</tr>
<tr>
<td>• Economic impacts on water demand (different economic futures and subsequent impacts)</td>
<td></td>
</tr>
<tr>
<td>• Potential policy of steep, strict rate increases</td>
<td></td>
</tr>
<tr>
<td>• Potential policy/practice that focuses on incentives to reduce water use: smart irrigation systems, mandatory watering day restrictions, and rebates for water efficient appliances</td>
<td></td>
</tr>
<tr>
<td>• New developments impact on water demand</td>
<td>Urban Development</td>
</tr>
<tr>
<td>• Different patterns of land use and subsequent water use</td>
<td></td>
</tr>
<tr>
<td>• Joint, bi-state decision-making related water management – what would the impacts to the water resources be?</td>
<td>Collaboration and Sustainability</td>
</tr>
<tr>
<td>• Impacts on the Columbia River Basin Treaty and how it will impact the large basin</td>
<td></td>
</tr>
<tr>
<td>• Exploring climate change impacts on river and aquifer and the gaining and losing reaches of the river</td>
<td>Water Supply</td>
</tr>
<tr>
<td>• Exploring augmentation scenarios to address instream flow needs</td>
<td></td>
</tr>
<tr>
<td>• Exploring the restoration of wetlands and impacts on river flows</td>
<td></td>
</tr>
<tr>
<td>• Impact of moving wells to mitigate effect on river flows</td>
<td></td>
</tr>
</tbody>
</table>

6.2.3 Interactive Workshop: Future Scenarios

The interactive future scenarios workshop occurred at the 2016 Spokane River Forum. The workshop was designed to focus on future water demand, future water supply (i.e. climate change impacts) scenarios and the subsequent impacts it would have on streamflows at the Spokane gage and Post Falls gage. This session was designed to stimulate dialogue about the future of water demand, supply and management in the region. The format of the workshop followed a semi-structured presentation with four pre-determined scenarios. The scenarios were pre-determined to show what kind of on-the-fly simulations could occur during the workshop. For simplicity purposes, SET chose to only show two outputs: monthly average streamflows at the Spokane gage and at the Post Falls gage.

The workshop was loosely designed in four stages: a) overview of WISDM and the CM process; b) presentation and discussion of the four pre-determined scenarios; c) on-the-fly
simulation of scenarios determined by workshop participants; d) open discussion and reflection on the simulation of different future scenarios. The first part of the workshop briefly discussed the goal of the WISDM research project, the role of CM in the SRB and the overall goal to explore long-term strategies and scenarios in the region. This part of the workshop also discussed the preliminary water planning workshops that were going to occur over the next few months.

The second part of the workshop included presenting the four scenarios. Prior to the scenario simulation part, participants were asked to draw the reference mode of a monthly hydrograph for the Spokane River. And, prior to showing the impacts of the proposed scenario on streamflow in the Spokane River, participants were asked to draw the impact of the scenario. This was done to prompt discussion among participants and explore participant’s expectations of future behavior. The first scenario (Figure 6.2) simulated the impact of reducing outdoor water demand by 50% every year over a 15 year period. The second scenario (Figure 6.3) simulated a population increase of 100,000 people over a 15 year period, a population increase rate of ~1.2% per year, and kept the water use per person the same. The third scenario (Figure 6.4) simulated the percentage decrease in outdoor water use needed to offset the addition of 100,000 as simulated in scenario two. This scenario asked participants to provide estimates of what the percent decrease would need to be and the answer was a 40% decrease in outdoor water use. The fourth scenario simulated one climate change scenario (Figure 6.5). The climate change scenario used data from the CanESM2 with a Representative Concentration Pathway 8.5, which is a scenario of relatively high greenhouse gas emissions (Government of Canada, 2016). This climate change scenario was selected to show extreme impacts on the water resources in the region. For a full list of all figures used in this workshop, see Appendix B.
Scenario 1: Outdoor Demand 50% decrease every year for 15 years

RESULTS

Figure 6.2 Scenario 1: The simulated results of monthly average streamflow at the Spokane gage (left) and the monthly average streamflow for summer months: June – September (right). Red lines depict the business-as-usual scenario and blue lines depict the simulated future scenario. This scenario simulated the impact of reducing outdoor water demand by 50% every year over a 15 year period.

Scenario 2: +100,000 people, keep water use per person the same

RESULTS

Figure 6.3 Scenario 2: The simulated results of monthly average streamflow at the Spokane gage (left) and the monthly average streamflow for summer months: June – September (right). Red lines depict the business-as-usual scenario and blue lines depict the simulated future scenario. This scenario simulated a population increase of 100,000 people over a 15 year period, a population increase rate of ~1.2% per year and kept water use per person at the same rate.
Scenario 3: What % decrease in outdoor water use will offset the +100,000 people?

**RESULTS:**

40% decrease in outdoor water use

*Figure 6.4* Scenario 3: The simulated results of monthly average public supply water use (million gallons per day) for the entire basin. The figure on the left shows the public water use figure from scenario 2 and the figure on the right shows the results of scenario 3. Red components depict indoor water use, whereas blue components depict outdoor water use. The simulated results of monthly average streamflow at the Spokane gage were the same as the business-as-usual scenario and thus not shown. This scenario simulated a 40% decrease in outdoor water use that was needed to mitigate the impacts of population growth simulation in scenario 2 (Figure 6.3).

Scenario 4: Climate Scenario (CAN_ESM2_RCP 8.5)

**RESULTS**

*Figure 6.5* Scenario 4: The simulated results of monthly average streamflow at the Spokane gage (left) and at the Post Falls gage (right). Red lines depict the business-as-usual scenario and blue lines depict the simulated future scenario. This scenario simulated one climate change scenario using data from the CANESM2, Representative Concentration Pathway 8.5 scenario (Government of Canada, 2016).

The scenario presentation and simulation part of the workshop prompted lots of discussion about future scenarios in the basin. It also prompted questions about model
assumptions and how water was routed. Participants discussed the minimal impact municipal water use has on streamflows and how it is not practical for this basin to conserve their way out of the low streamflow problem. There was discussion about the importance of having coordinated messages and communication about water conservation strategies. Participants discussed the impacts of the different gaining and losing reaches of the Spokane River and how impacts to streamflow are more concerning in WA than in ID, as the river is primarily perched in ID. There was also discussion about different ways to best communicate information and model outputs.

The third part of this interactive session allowed workshop participants to propose future scenarios to be simulated on-the-fly. Participants wanted to see the impacts of different population increases, for example double and triple the population over the 15 year period. Participants also wanted to simulate the impacts of no pumping, however with the current model capabilities, this scenario was could not be simulated. Finally, participants asked that the model simulate the range of climate change impacts on streamflow. This part of the session naturally transitioned to the final discussion part of the workshop.

The final part of this workshop allowed stakeholders to converse and reflect on initial thoughts, ideas and concerns. Participants had a lengthy discussion about the best way to communicate and visualize data and model outputs. Participants also discussed what model outputs would be most useful in beginning to start the process to develop a bi-state water management plan. This discussion also talked the importance of educating the public about the source of their water, the cost of having drinking water and the current water management challenges in both WA and ID. The discussion also included general comments about the model time-step and the simulation time period. Participants also discussed the diverse values of
stakeholders and how 30 ft³/s of water in the river has varying priorities and importance to
different water users and stakeholders. Participants concluded the discussion with wanted to have
future workshops targeted at simulating climate change impacts and developing water
management plans that address future climate uncertainty.

6.3. Stakeholder Requested Engagement and Activities

This section describes three stakeholder engagement activities that were conducted at the
request by leaders within the collaborative water resource stakeholder community. First, this
section briefly describes the clicker survey sessions at the Spokane River Forum in 2013, 2014
and 2016. Second, this section describes outcomes of the participatory process employed to
develop an education and outreach campaign and plan. Lastly, this section describes the
outcomes of the two workshops designed to serve as a preliminary water resource planning
process. Again, a summary of all stakeholder engagement activities is detailed in Table 6.1.

6.3.1 Clicker Sessions at the Spokane River Forum

The clicker sessions at the Spokane River Forum have been incorporated into the
conference program since 2011. The clicker session was another opportunity for SET to engage
with more stakeholders. The Forum planning team wanted to use the clicker session as a way to
gauge the conference participants on a variety of topics, including education, perceptions, values
and preferences in priorities (Beall King & Thornton, 2016). This session provided the
opportunity for participants to have informal discussions with other participants at their table.
Summary statistics of clicker questions asked at the Forum were summarized in King &
Thornton (2016). Further exploratory and in-depth analysis was beyond the scope of this
research project. However, additional statistical analysis of this data is ongoing with
Environmental Science student collaborators (Thornton, Gray & King, in press).
6.3.2 Mental Models and an Education and Outreach Campaign

This section has broken into two components, mental models and the education and outreach campaign. First, this section preliminarily analyzes individual and group mental models of IWAC participants related to the Spokane River Basin water resource system. Second, this section details outcomes of the planning process to develop a bi-state education and outreach campaign focusing on communication and messaging. Common concepts of mental models and priorities for the education and outreach campaign are identified.

6.3.2.a. Eliciting Mental Models

This section examines the mental models of individual IWAC members related to the regional water resource system in the Pacific Northwest. Thirteen individuals participated in the 3CM exercises.

The mental models data went through several phases of organization and categorization in an effort to simplify the results. During the first phase of organizing the mental models data, 42 categories were identified by the participants. Similar categories were grouped together to form nine common themes (Table 6.6). These ten themes were used to code the mental models data in NVivo. The second phase of organization helped to group and categorize the initial set of codes in NVivo. Each theme was analyzed to compare and contrast the different concepts detailed by the participants. Initial analysis from this exercise was used to develop a survey to better understand stakeholder priorities and values related to key concepts identified during this mental models exercise. The survey was distributed to approximately 100 conference attendees at the 2016 Spokane River Forum. Further analysis of this survey is ongoing with Environmental Science student collaborators (Thornton, Gray & King, in press). Further mental models analysis of this data is beyond the scope of this research project.
Table 6.6 Nine common themes identified by the participants in the mental models elicitation exercise.

<table>
<thead>
<tr>
<th>Themes</th>
<th>Initial Coding Categories Identified by Participants</th>
</tr>
</thead>
<tbody>
<tr>
<td>Protection</td>
<td>Aquifer/Source Protection; How to Protect; Connection to a Treasure; Senses; Societal Challenges</td>
</tr>
<tr>
<td>Regulations, Rules and Politics</td>
<td>Political; Policy Drivers; Regulation; Challenge; The rules</td>
</tr>
<tr>
<td>Water Quantity</td>
<td>Usage; Quantity; Conservation; Resource; Usage above SVRP; Competing Priorities</td>
</tr>
<tr>
<td>Water Quality</td>
<td>Water Quality Issues; Legacy- It affects us all; Stormwater; Wastewater; Issues; Human creations; Impacts</td>
</tr>
<tr>
<td>Education</td>
<td>Education; Youth (K-12) Education and Outreach; Citizen Understanding; Perception; Adult/community Education and Outreach; Societal Challenges; Concepts; Challenge</td>
</tr>
<tr>
<td>Physical/Natural System</td>
<td>Nature - All naturally created; Physical; Natural systems; Movement - Modes of water transport; Technical/physical/chemical aspects of the water system; Concepts; Facts</td>
</tr>
<tr>
<td>Engineered System</td>
<td>Engineered Systems: These items involve human intervention; Human creations</td>
</tr>
<tr>
<td>Future Scenarios</td>
<td>Impacts; Macro Drivers of Change; Land use; Science &amp; Tech</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Organizational Connectedness; Collaboration</td>
</tr>
</tbody>
</table>

6.3.2.b. Developing an Education and Outreach Campaign for Water Stewardship: Vision and Content

This section describes the process and outcomes of developing a regional education and outreach campaign for water resources in the Spokane River Basin. The SET designed, planned and developed a campaign process that was modified from the communication campaign planning process literature (Nitsch, 1999). This process occurred over the course of six months with monthly two hour workshops. This process included identifying the problem, determining campaign goals and objectives, determining target audiences, developing content and formulating messages, determining campaign budget, and developing a plan to deliver the messages. For the purposes of this research project, SET developed a participatory process with the objective to develop content and a plan for an education and outreach campaign. IWAC
leaders and SET mutually agreed that IWAC would be responsible for securing money and developing the plan to implement and deliver the messages.

6.3.2.b.i  Problem identification

This process began by first discussing and identifying the education and public awareness challenges in the region. IWAC leaders and SET had multiple meetings and discussions to discuss the public’s lack of knowledge, understanding and concern for water resources. At meetings, IWAC members also had lengthy discussions about their perception of the public’s lack of awareness and knowledge of the surface and groundwater resources in the region. It is important to note that there has not been any recent research to assess the public’s knowledge and attitudes of water resources in the region.

IWAC participants recognized that there were no currently existing bi-state communication, education and outreach messages for water resources. There were various organizations in the region that developed their own messages and campaigns for water resources (see Chapter 3). Participants felt it was important to coordinate messages between the two states in an effort to minimize confusion or conflicting information. Stakeholders identified that there were two overarching problems: 1) different, inconsistent messages coming from entities in both states; and 2) the public’s lack of knowledge and understanding of their regional water resources.

6.3.2.b.ii  Determining Campaign Goals and Objectives

IWAC members prioritized a need to focus on IWAC’s education and public awareness goal and work on developing one collaborative, bi-state water stewardship message. Through a series of facilitated exercises, the members identified one major theme, water stewardship, and four subthemes, water quantity, water quality, stormwater and preservation (Figure 6.6). The
central goal of the messaging campaign is to promote water stewardship to the public. Water stewardship is a broad theme that encompasses responsible water use, and the enhancement and protection of the regional water resource for both humans and the environment.

Figure 6.6 Water Stewardship Campaign with four subthemes.

The stakeholders then created goals and objectives for each subtheme to address the overarching campaign purpose. The water quantity subtheme aimed to communicate the key components of the water cycle, promote water conservation and highlight the public’s role in ensuring that the region has adequate supplies of drinking water. The water quality subtheme was designed to address the importance of maintaining high quality surface and groundwater now and into the future, communicate the impacts that individuals have on water quality and share ideas about what the public can do to improve the quality of the regional water resources. The stormwater subtheme aimed to provide tips to prevent debris and pollutants from entering the storm drain and thus protect the surface and groundwater resources. The preservation subtheme intended to provide compelling information about the importance of preserving and protecting the aquifer, lakes and rivers in the region.
6.3.2.b.iii Target Audience

The target audience for this campaign is individuals who consume and use water resources in the Spokane River Basin. IWAC acknowledged that there were ongoing efforts to educate K-12 students about the surface and groundwater resources in the classroom. Thus, IWAC wanted to focus the messaging of this campaign on the public. The general public is a broad term and it is not practical to create one education campaign for the public. IWAC wanted to use a variety of messaging techniques to target a wide range of ages and demographics in the region. The participants wanted to use online advertisements, infographics, social media, short videos, handouts, billboards, public service announcements, and television commercials.

6.3.2.b.iv Developing Content and Formulating Messages

The SET facilitated two workshops that focused on developing content and materials for each subtheme. IWAC participants worked in four groups, each group working on a specific subtheme. The first phase of content development included creating storyboards and information for the production of a video or video series. The second phase of content development included developing ideas and information, prioritizing communication objectives and formulating messages. Stakeholders wanted to make sure that the communication materials developed would be meaningful to different audiences and discussed how to address the question “how do we get people to care?” In this campaign planning process, SET and stakeholders emphasized that the campaign objectives must provide the public with opportunities to engage with information and discover new understandings, rather than having facts and information forced upon them. Stakeholders prioritized the water quantity and stormwater subthemes for the first stage of implementation. For a full list of content, ideas and storyboards for each subtheme please see Appendix C.
6.3.2.b.v Water Quantity Subtheme

The water quantity subtheme’s central concept is “we are all in this together.” Stakeholders intended the messaging to include educational elements about the drinking water resource, the Spokane Valley Rathdrum Prairie Aquifer. It is important that the messages include content and information about the shared aquifer resource that spans the Washington-Idaho border. Elements of intergenerational equity and water conservation were also important to stakeholders, and thus communicating that the regional water resources are for current and future generations. The subtheme goals also include sharing information about the Spokane River Basin’s unique water cycle. For example, communicating the following components of the water cycle were important to IWAC participants: how precipitation moves through the system, showing the interaction between the groundwater and surface water system, how water pumping and use impact flows in the river, spatial and temporal delays in aquifer pumping and subsequent impacts to the river, outdoor water use and returns to a wastewater treatment plant. This subtheme also wanted to include easy and simple tips on ways individuals can conserve water, both inside and outside the home or business.

6.3.2.b.vi Water Quality Subtheme

The water quality subtheme’s central concept is “what you do matters” and “if you do not want to drink it, do not put it in the ground or down the drain.” The goal was to provide tips and actions about how individuals impact water quality. The subtheme should provide information on: how fertilizer treatment plans in yards impact water quality, agriculture impacts, fertilizer alternatives, where to recycle or get rid of unusual waste types (car batteries, oil, paint, antifreeze, etc.), how to appropriately water your yard to reduce runoff, how to minimize
wastewater costs, and tips to prevent water pollutants from entering the drain. This subtheme aims to incentive action from individuals to responsibly protect water quality.

6.3.2.b.vii Stormwater Subtheme

The stormwater subtheme’s central concept is “you dump it, you drink it.” The goal is to communicate how stormwater impacts water quality. In addition, the subtheme should include information and content that describes what happens to stormwater, since it eventually flows into the aquifer and into the river. Similar to the water quality theme, this subtheme wants to include information about how fertilizers, dog waste and lawn watering all contribute to overall water quality impairments.

6.3.2.b.viii Preservation Subtheme

The preservation subtheme’s central concept is to include photographs comparing the historic water resource landscapes with the current landscape of water resources. This strategy has been shown to be a powerful tool that encourages individuals to learn more about what they are seeing with their current landscape. The goal is to protect and preserve the regional water resources, which includes the Spokane Valley Rathdrum Prairie aquifer, Spokane River, tributary rivers and the nine regional lakes (Coeur d’Alene, Pend Oreille, Liberty, Fernan, Hayden, Spirit, Twin, Hauser and Newman). This subtheme wants to include photographs and imagery of the water resources and educational tips and aspects about what individuals can do to preserve their local water resources. The goal is to ensure that this message effectively communicates concepts that matter to the individual and general public.

6.3.2.b.ix Determining Campaign Budget & Developing a Plan to Deliver the Messages

A successful communication and education campaign includes collaboration, partnerships, and financial resources. For the purposes of this research project, SET supported
this stakeholder initiative through the development of content and concluded by writing a report to summarize the campaign planning process. Thornton and Johnson wrote an executive summary report that included the current challenges to public awareness and education, campaign goals and objectives, target audience and content for each subtheme (Thornton & Johnson, 2016). The next steps in a campaign process include determining the budget and developing a plan to deliver the messages.

IWAC leaders developed a plan to solicit money from local and state agencies in both Idaho and Washington. IWAC leaders shared the report with potential financial sponsors to demonstrate IWAC’s commitment to implementing the education and outreach campaign. In summer 2016, IWAC secured roughly $40,000 for the education and outreach campaign (“Idaho Washington Aquifer Collaborative,” 2017). The next step in this process was to develop a plan to create the campaign materials and deliver the messages. IWAC leaders began communicating with various businesses about creating videos and developing digital marketing materials. IWAC contracted Friends of KSPS, a local public television station, to produce four 30-second videos, one 3-5 minute video and digital marketing materials (“Idaho Washington Aquifer Collaborative,” 2017). This stage of the campaign process is still ongoing, as of January 2017. Updated information on the IWAC education and outreach campaign can be found on their webpage (www.iwac.us) (“Idaho Washington Aquifer Collaborative,” 2017).

6.3.3 Preliminary Water Resources Planning Workshops

This section is describes outcomes from the two interactive workshops that occurred during summer 2016. The objective of these workshops were to begin a preliminary planning process to develop a plan and next steps for regional water planning and to brainstorm strategies
for operating in range of different potential futures. This section includes discussion items and key takeaways from these workshops.

The two workshops included brainstorming, interactive exercises about futures thinking, systems thinking causal loop diagram, developing scenarios and debrief discussions to discuss next steps. The workshop started with an exercise that worked on re-framing the problem. This was important because it allowed the stakeholders to think about the problem and challenges in a bi-state water planning and management lens. At the beginning of any participatory process that re-prioritizes objectives, it is important to re-frame the problem as it relates to the updated objectives and decision-making context.

6.3.3.a. *Futures Triangle*

The facilitation techniques and activities planned at these workshops were designed to allow stakeholders to think about the future so that the group could work on developing improved strategies in water management. The futures triangle exercise prompted participants to think about the problems, barriers, hopes/fears and potential actions/solutions to their regional water resource system. Participants worked individually and then shared with a partner some of the pertinent items that they included in their triangle. Table 6.7 summarizes the results from activity. This activity segued into a systems thinking exercise where stakeholders worked to develop a SRB causal loop diagram.
Table 6.7 Summary of key items discussed in the Futures Triangle exercise. This table is separated into three categories: problems, barriers and hopes or fears and potential actions or solutions.

<table>
<thead>
<tr>
<th>Problems</th>
<th>Barriers</th>
<th>Potential Actions/Solutions</th>
</tr>
</thead>
</table>
| • Population  
• Low flow in river  
• Excessive outdoor water use during summer months  
• Climate Change  
• Heavy metals  
• Stormwater quality impacts  
• Regulatory enforcement  
• Lack of state involvement in IWAC  
• Public perception: unlimited supply & unchanging quality  
• Increased development adjacent to surface water  
• Political inconsistency  
• Water right availability  
• Exporting water out of the watershed  
• Fair ownership of pollution sources | • Poor/inconsistent messaging of water resource issues by utilities  
• Heavy metals into CDA Lake  
• Unrealistic expectations: river flows and river quality  
• Public Perceptions  
• Value of Water  
• Cost of Water  
• Cooperation: politics & power  
• Emotions and political power over logic  
• Political will  
• Political leadership  
• Complexity drive by: scale, intensity, toxicity  
• FERC regulations  
• Recreation needs  
• Tribal needs  
• Finances & Costs  
• Social acceptance of potential solutions & change  
• Different goals & objectives | • Conservation  
• Water education (outdoor water use)  
• Aquifer degradation  
• IWAC creates a water use plan that influences policy in both WA & ID  
• Regional communication  
• Science based policy  
• Improved monitoring of natural system  
• Improved Economy  
• Climate resilient policies  
• Regional water collaborative  
• Common methodology for demand projections  
• User behaviors  
• Regional/Consistent education and outreach  
• More stringent regulation on pollution |

6.3.3.b. Causal Loop Diagram

A causal loop diagram was developed to characterize important components and linkages within the regional water resource system. These diagrams aim to describe relationships and causation and to prompt participants to discuss the various relationships within the Spokane River Basin and SVRP aquifer system. The key concepts developed in the futures triangle exercise were used to begin building the diagram. Both individuals from the SET facilitated dialogue for the two groups of participants and encouraged participants to begin drawing out the relationships of the physical hydrologic system. Group members discussed how aquifer quantity, river flows and demand were related. In addition, participants discussed how population impacts water use, both indoor and outdoor use. The relationships between river quality, aquifer quality,
storm water, wastewater and point and nonpoint sources were discussed. These conversations about somewhat straightforward relationships prompted even more dialogue about the human complexities to the regional water system.

Participants discussed the challenges related to public perceptions, social acceptance of potential solutions and change, politics and power and education. Workshop participants discussed in detail the importance of education, and how it could be beneficial to begin conversations of more consistent and regional education of the water resources to the general public, but also to decision and policy makers. There was extensive discussion about inconsistent state policies, regulations and enforcement, in the context of both water quality and water quantity. Workshop participants were concerned about varying perceptions of the water supply. Public perception about aquifer quality and river quality were also a concern. Conservation of water resources was discussed and debated among workshop participants. The group discussed the motivation and sustainability of conservation strategies to reduce water use, and the challenges with developing a consistent conservation message to the general public. Participants also talked about the cost and value of water. All of these aspects were incorporated into the causal loop diagram, and each facilitator challenged the participants to describe how these items were related.

The second workshop allowed time for participants to provide feedback on the causal loop diagram draft that was created in the first workshop. In between workshops, the large poster board hand-drawn spaghetti diagrams were converted to an electronic version using VenSim PLE Software (Figure 6.7) (Ventana Systems Inc., 2006). There was a great deal of dialogue about the challenges and barriers to the regional water resource system, however workshop participants also informally discussed potential actions and solutions. There were different ideas
and innovative solutions discussed, including: irrigation design standards, regional education, regional water messaging and communication, a regional water demand model, regional water collaborative, lining the river (to prevent seepage to the aquifer), restoring various wetlands, pumping storage into smaller lakes, and impounding smaller lakes. Additionally, participants discussed the impacts a crisis or catastrophic event could have on water management in the region. Participants also discussed the role IWAC could play in developing recommendations related to regional water planning and management.

Figure 6.7 Causal Loop Diagram created at the preliminary workshop series. The red loop highlights climate change impacts to the system, whereas the bold navy loop highlights the development of innovative solutions to water management for the basin.
6.3.3.c. **Critical Uncertainties and Scenarios Matrix**

The SET emphasized the importance to expand the conversation beyond discussing the problems and barriers to discussion potential strategies and action steps. Two Liberating Structures facilitation techniques were used for this portion of the workshop, *Critical Uncertainties and Scenarios Matrix* (Lipmanowicz & McCandless, 2013). Participants worked in groups to develop 4 future scenarios or strategies to address factors that pose challenges to develop and implement a regional, bi-state water plan. This particular exercise asked groups to think about the uncertain future, and question assumptions, drivers and forcers for these potential future scenarios. Results from this particular exercise varied by group, but discussed a variety of factors that would be challenging to developing and implementing a regional water plan. This included political will, public perceptions, water demand for resource conflict, collaboration, conflict, water availability, conservation and education.

Each group created a scenario matrix (Figure 6.8) based on determining two most critical and challenging factors to bi-state water management. Group A approached the scenarios from a regional water demand and political will point of view; this group’s ideal scenario within the matrix was effective conservation, low demand and high political will, which would ideally be achieved through regional education, shared values, and clear and consistent bi-state regional planning or policies. Group B discussed the conflict-collaboration continuum and growth; the preferred scenario was low conflict, high collaboration and low growth, which would be achieved through developing a bi-state water management plan. Group C approached the scenario matrix with supply and demand, more specifically with water availability and water needs; the ideal scenario includes enough water to meet future water needs, but this also includes
responsible use of the water that is not limited by water availability. Finally, Group D incorporated aspects of public perception and the concerns of water professionals in the region, however this group did not discuss what would the preferred scenario would be.

Strategies needed to attain the preferred scenario within each group were developed. Group A discussed the possibility of creating a regional water collaborative that could develop strategies to: create regional awareness of the water resource, develop standards and conservation ideas, and coordinate policies and standards so that everyone is working together to achieve one common goal, conservation. Group B discussed unifying the demand models and creating one regional water demand model. This group also discussed the importance of having one consistent education plan and strategy, and recommendations could be given to policy makers. Group C aimed to address low water needs through conservation, improving efficiency and design standards, water recycling, and creating surface water storage system to augment in-stream flow. Group D discussed the importance of education from kindergarten through high school and the general public. Workshop participants great ideas of potential strategies needed to begin the process to develop a bi-state water management plan. However, participants also recognized that these strategies would not be possible without buy-in and support from many stakeholder groups and the public. Thus, developing a plan to engage more diverse stakeholders, including state and tribal agencies with decision-making authority in the basin, was a crucial next step to bi-state water management.
Figure 6.8 This figure is a result of the Liberating Structures scenario matrix and critical uncertainties exercise (Lipmanowicz & McCandless, 2013). See text for more information on the scenario matrices for the four different groups. Preferred scenarios are indicated by labeling the quadrant with a star, group D did not specify which quadrant was the most ideal scenario.

6.3.3.d. **What Debrief: What, So What, Now What?**

Each workshop planned for time to have a structured debrief discussion to allow participants to share their thoughts, reflect on the experience and talk about next steps. These discussions used a Liberating Structures facilitation technique called What Debrief (Lipmanowicz & McCandless, 2013). Participants discussed about who was attending the workshops and who should be attending the workshops. There was general agreement that
inviting personnel from state agencies to the conversation would be necessary, as there were mostly water purveyors and municipalities in the room. Participants also discussed the importance of tribal representation and participation from environmental nongovernmental organizations. Participants also addressed the importance about the levels of trust and respect among current IWAC members which a crucial aspect to successful participatory processes. Participants raised concerns about the challenges of developing new relationships, trust and respect by engaging new, diverse participants in a planning process. Participants also discussed the role IWAC, the only bi-state water organization in the basin, should play in convening and engaging stakeholders beyond their current membership.

Beyond discussing which stakeholders would be most appropriate to engage in a bi-state water planning process, SET challenged the current workshop participants to think about short-term, attainable action items in goals. The participants primarily discussed three concepts: lawn watering/irrigation design standards, education and creating a regional water collaborative. Participants proposed working on developing 1) irrigation design standards and 2) a voluntary standard lawn watering ordinance, i.e. no lawn watering from 9am – 5pm. Education was a central theme to the discussion about potential action items and next steps. Developing an effective, consistent and sustainable message was important to participants. A potential action step would be to create a tailored K-12 regional water resources curriculum and implement in both states. Participants discussed developing an educational curriculum or guidance of water resources management for decision makers, policymakers and lobbyists. The group discussed developing an education committee within IWAC to develop recommendations for K-12 education and for decision-makers. These recommendations would include current knowledge, information they should know, and information necessary to make informed decisions. Finally,
the idea of creating a regional water collaborative was discussed. Participants discussed the potential for a regional water collaborative and how it could develop educational recommendations, coordinate communication and outreach, and develop regional recommendations related to regional water planning. However, the participants agreed that there needs to be more research on what this entails, how they are created, who would be the stakeholders, where would the funding come from, and how would it work in a bi-state basin.

The workshop series concluded with a roundtable discussion about next steps. Workshop participants agreed it would be most appropriate to continue these conversations and develop next steps in the regularly scheduled IWAC meetings.

6.3.3.e. **Next Steps**

Following the two workshops, IWAC leaders and SET agreed that it was an appropriate time to pause, evaluate the engagement process to date and thoroughly think about next steps for both IWAC and the broader water resource planning community. A report detailing outcomes from both workshops was created and distributed to all IWAC members (Thornton, 2016). The next component of this research project included interviewing IWAC members to evaluate the participatory process, share their perspectives on the role of university researchers in stakeholder engagement processes and reflect on next steps; see the next section for more details.

**6.4. Evaluation and Interview Results**

This section details the analysis of the interviews conducted with stakeholders involved in the participatory process of this research project. This section is organized into two parts: role of university researchers in a participatory process and evaluation of the participatory process. Within each of these sections, responses are described and summarized. Further reflection and discussion of major themes are detailed in Chapter 7.
The objectives of the interviews and evaluation were to: understand stakeholders' perceptions about the role a university researcher plays as a participant, facilitator and neutral, third party in a participatory planning process, review the participatory process of developing an education and outreach campaign and exploring next steps for a bi-state water planning process, review the perceived outcomes of being involved in the participatory processes, and develop a framework of best practices for long-term stakeholder engagement by university research teams. Since the interviews took place as the project took a natural break, the evaluation is best described as a summative evaluation. The purpose of the evaluation was to reflect on the benefits and challenges of participatory research processes and to reflect on what could be done different to inform future research and engagement processes. Thus, the primary purpose of the evaluation was centered on learning and improving.

The reported data in this section came from the semi-structured interviews (see Appendix D). This format allowed interviewees to discuss topics not specifically related to the questions, as a result not all participants completely answered the questions asked. This open-ended interview approach enabled the data to be analyzed for emerging and repeated themes not necessarily related to the selected criteria. The credibility of the analysis and evaluation depends on ensuring that the evaluation data incorporates diverse perceptions from multiple stakeholder. Interviewees were selected based on participation in the bi-state organization, IWAC, and throughout the participatory processes led by SET. While the sample selection was not comprehensive due to time and resource constraints, comprehensive sampling techniques were used to seek a variety of demographic and sector characteristics of individuals. Saturation in terms of themes emerging from answers was achieved after about 12 interviews, which provides confidence in the robustness of the interview data despite a small sample size (N=20).
Of the 20 stakeholders were interviewed, 12 individuals have been involved with the bi-state organization IWAC for over 3 years, 12 individuals attended more than half of the workshops for the education and outreach process and 13 people attended at least one of the two preliminary water planning workshops. All interview files were assigned a code and removed names to provide anonymity. Direct quotes from the interviews used in this dissertation are labeled with a code, for example, P20 is a quote from participant number 20 in this study.

6.4.1 Role of University Researcher in a Participatory Process

Participants were asked four questions to better understand perceptions of the role university researchers can play in a participatory water planning process: 1) what do you think of the role a university researcher plays as a participant in a water planning process; 2) what do you think of the role a university researcher plays as a facilitator in a water planning process; 3) do you think a university researcher can serve as a neutral facilitator in a water planning process with multiple stakeholder groups; and 4) do you have any suggestions or general comments about how university researchers and or facilitators can help regional stakeholders with water planning processes in the future. Results from these four interview questions are summarized in Table 6.8.
Table 6.8 Stakeholder Feedback on the Role of a University Researcher in a Participatory Process (from qualitative interview; N=20)

<table>
<thead>
<tr>
<th>Question</th>
<th>Summarized Responses</th>
</tr>
</thead>
</table>
| What do you think of the role a university researcher plays as a participant in a water planning processes? | • Bring knowledge and expertise x9  
• Generate new ideas, advice and knowledge to help solve complex water problems x6  
• Facilitate group discussion x5  
• Provide benefits to the process x4  
• May bring own research agenda |
| What do you think of the role a university researcher plays as a facilitator in a water planning processes? | • Facilitation skills and experience is required x11  
• Understand water resource system in a new, different way x3  
• Not all researchers should be facilitators  
• Fresh perspective  
• Positive energy  
• Potential conflict of interest |
| Do you think a university researcher can serve as a neutral facilitator in a water planning process with multiple stakeholder groups? | • Yes, university researchers can serve as a neutral facilitator x19  
• Yes and no x1 |
| Do you have any suggestions or general comments about how university researchers and/or facilitators can help regional stakeholders with water planning processes in the future? | • Trust and respect between researchers and stakeholders are important x7  
• Help develop vision and goals  
• Key toward scientific understanding of issues  
• Support mid to long-term water planning  
• Support with information and data organization  
• Generate avenues to find innovative solutions to complex problems  
• Can level the playing field and dispute non-factual/scientific information  
• Promote the continuation of long-term participatory processes |

6.4.1.a. **Question 1: Role of University Researcher as Participant in a Participatory Process**

Nine interview participants discussed how university researchers can bring knowledge and expertise to a participatory water planning process. The participants discussed both technical, scientific knowledge but also knowledge regarding the social science impacts to collaborative organizations and decision-making. Six participants discussed the role researchers’ play in bringing new ideas, advice or knowledge to help solve complex water resource problems. Five individuals mentioned the role a university researcher can play as a facilitating group discussion as part of the process. Four participants mentioned the wide range of benefits
involving university research teams in water planning processes. Participants also discussed the importance of trust and respect between university researcher and regional stakeholders was really important. One interview participant mentioned the potential negative impacts of how university researchers may participate in a participatory process with their own research agenda and research questions that may not benefit the region.

6.4.1.b. Question 2: Role of University Researcher as Facilitator in a Participatory Process

The majority of the participants interviewed expressed that facilitation skills and experience are required. Interview participants noted that facilitation is an art and that not everyone would succeed as a facilitator. A few participants mentioned that university researchers can provide a fresh perspective and different energy through a planning process. In addition, three interviewees mentioned that there is the ability to improve and understand the water resource system in a new and different way. The only negative concerns stated were about reservations related to a university researcher as a facilitator. A local municipality member expressed:

“And as long as the facilitation doesn't get mucked up by the research [...] Let's do the right thing for the community, not the right thing for the university or for the individual that's helping with the facilitation. It should always be focused on what's the best thing for the community” (P02).

6.4.1.c. Question 3: Role of University Researcher Serving as Neutral Party in a Participatory Process

All but one individual that was interviewed agreed that university researchers can serve as a neutral facilitator in a water planning process. One interview participant agreed and
disagreed that researchers can be neutral in a water planning process. The following two quotes state the role a university researcher can play as a neutral party:

“I think the university researcher, again, has an unusual position there and it's unusually good. The university people can generally be seen as disinterested third parties” (P07); and “I think they [university researchers] may be able to do that better than anyone else” (P01).

**6.4.1.d. Question 4: General Comments**

Seven people stated that trust and respect between researchers are stakeholders are important for their involvement in a participatory process. Stakeholders also discussed how researchers can assist with information and data organization, mid to long-term water planning and generate ways to find innovative solutions to complex problems. Individuals also discussed how university researchers can level the playing field and can dispute non-factual or non-scientific information. Responses are summarized in Table 6.9 and for a more in-depth discussion, see Chapter 7.

**6.4.2 Evaluating the Participatory Process in the Spokane River Basin**

This section details the results of the evaluation of the participatory process. Participatory processes are evaluated to document participant’s input and assess the impacts and benefits of the process, as well as project outcomes. Evaluation is conducted to provide recommendations to improve participatory processes in the future. There is not a currently accepted framework to evaluate participatory processes, as each process may have different objectives and desired outcomes. Thus, select criteria were used to evaluate this long-term stakeholder engagement participatory process.

This section is separated into five sections: 1) perceived impacts of the process; 2)
relationship and capacity building; 3) benefits and challenges to the process; 4) general impacts of the process; and 5) general evaluation and comments about the engagement process. Based on the objectives of the participatory process and the purpose of the evaluation, select criteria in each section were selected (Table 6.9). However, it is important to note that the open-ended interview approach allowed the data to be analyzed for emerging themes not related to the selected criteria (Table 6.9). Further discussion on emerging and repeated themes is detailed in Chapter 7.

**Table 6.9 Evaluation sections and subsequent pre-selected criteria for initial analysis of interview data.**

<table>
<thead>
<tr>
<th>Evaluation Sections</th>
<th>Pre-selected Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Perceived impacts of the process (Table 6.10)</td>
<td>Social learning; shared understanding; systemic perspective</td>
</tr>
<tr>
<td>Relationship and capacity building (Table 6.11)</td>
<td>Capacity building; Trust and social capital</td>
</tr>
<tr>
<td>Benefits and challenges to the process (Table 6.12)</td>
<td>*open-ended questions, no pre-selected criteria</td>
</tr>
<tr>
<td>General impacts of the process (Table 6.13)</td>
<td>Fairness; Communication; Inclusiveness; Transparency; Representation; Problem framing; leadership; flexible and iterative process</td>
</tr>
<tr>
<td>General evaluation and comments about the engagement process (Table 6.14)</td>
<td>*open-ended questions, no pre-selected criteria</td>
</tr>
</tbody>
</table>

6.4.2.a. *Perceived Impacts of the Process*

Three questions were asked to about perceived impacts of involvement in the participatory process: 1) do you feel you personally learned much from being involved in this collaborative process; 2) do you feel that your contribution to this process was valued; and 3) do you find your involvement in this process changed the way you see the water resource system (Table 6.10). All but two participants stated that they learned from being involved in this participatory process. Nine individuals discussed learning about different perspectives and values of the participants. Interviewees shared that the learned about new ideas and new ways to look at the water resource system and about the knowledge and expertise of other participants involved
in the process. Fourteen individuals shared that they felt valued throughout the process, whereas four individuals were unsure if their contribution to the process as valued. Nine participants stated that they found their involvement in the process changed the way they see water resource system, whereas three people did not agree and four individuals shared mixed responses. Six individuals shared that this process has helped clarify and deepen their understanding of the regional water resource. Four people discussed how it has opened their eyes to new viewpoints. Three people discussed the importance of bi-state communication and two people commented that this process facilitated improved awareness of regional water resource issues.

<table>
<thead>
<tr>
<th>Question</th>
<th>Summarized Responses</th>
</tr>
</thead>
</table>
| Do you feel you personally learned much from being involved in this collaborative process? (N=18) | • Yes x16  
• No x1  
• Mixed response x1  
• Improved understanding of different perspectives x9  
• Improved group dynamics  
• Better appreciation of knowledge and expertise of participants  
• Complexity of managing water resources  
• Developed new ideas |
| Do you feel that your contribution to this process was valued? (N=18)   | • Yes x14  
• Mixed responses x4  
• Participants listened and input was considered x5  
• Stakeholder leadership listens  
• Appreciation of the process |
| Do you find your involvement in this process has changed the way you see the water resource system? (N=17) | • Yes x9  
• No x3  
• Mixed responses x4  
• Clarified and deepened understanding x6  
• Opened eyes to new viewpoints and knowledge x4  
• Learned the importance of bi-state communication x3  
• Raised awareness of issues x2 |

6.4.2.b. **Capacity Building**

Two questions were asked to understand the impact of capacity building: 1) do you think that this process has helped to develop new relationships between different people or
organizations; and 2) do you find your involvement in this process has improved your ability to take part in other collaborative projects (Table 7.1). All 17 participants agreed that this process has helped to develop new relationships between different people and organizations. Three participants discussed the value of trust and respect as an outcome of the process. One participant shared the importance of relationship building, particularly when there is future conflict:

It seems to me that this has built relationships that I think is probably the most important groundwork for if there is a real issue or real crisis (P19).

Twelve participants (all but one) agreed that their involvement in this process improves their ability to take part in other collaborative projects. Three participants shared about how citizen participation is important.

<table>
<thead>
<tr>
<th>Question</th>
<th>Summarized Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Do you think that this process has helped to develop new relationships between different people or organizations? (N=17)</td>
<td>• Yes x17&lt;br&gt;• Trust and respect x3&lt;br&gt;• Relationship building is an outcome&lt;br&gt;• New understanding of participant knowledge</td>
</tr>
<tr>
<td>Do you find your involvement in the process has improved your ability to take part in other collaborative projects? (N=13)</td>
<td>• Yes x12&lt;br&gt;• No impact x1&lt;br&gt;• Importance of citizen participation x3&lt;br&gt;• Deepened understanding about how participatory processes and collaboratives work</td>
</tr>
</tbody>
</table>

6.4.2.c. Benefits and Challenges of the Process

Two questions were asked to discuss the benefits and challenges of the process: 1) what were the positive aspects of the collaborative process; and 2) what were the drawbacks of the collaborative process (Table 6.12). Five participants shared that developing relationships with people was a positive component of the process. Five participants also appreciated that bi-state communication between water professionals in Washington and Idaho was occurring. Three participants specified that the generation of new ideas was a benefit to being involved in the
process. Four participants felt that discussion was inclusive and that all ideas and input shared was respected by the other participants. Two participants stated that trust and respect was improved between participants. Six participants stated the primary drawback was that it was a time-consuming process or participatory processes take time. Five participants did not state any drawback of the process. Four participants commented on the challenges and complexity to bi-state water planning.

<table>
<thead>
<tr>
<th>Question</th>
<th>Summarized Responses</th>
</tr>
</thead>
</table>
| **What were the positive aspects of the collaborative process? (N=18)** | • Developing relationships x5  
• Bi-state communication on water resources x5  
• Inclusive discussion x4  
• New ideas x3  
• Developing trust and respect x2  
• Appreciate and value the process x2  
• Learning  
• Consensus about initiatives  
• Organic progression of the process |
| **What were the drawbacks of the collaborative process? (N=18)**    | • Time-consuming process x6  
• None x5  
• Long-term water planning is challenging and complex x5  
• Need more diverse participants x2  
• Apprehension about interactive discussion x2 |

6.4.2.d. **General Impacts**

Four questions addressed general impacts of the participatory process: 1) have you been involved in a similar collaborative planning process before, and if so how did this process compare with them; 2) with hindsight, what things might you do different if involved in a similar process in the future; 3) do you feel the people in IWAC that participated in the collaborative process were the right ones and were there people or perspectives missing; and 4) what are two of the most useful facilitation tools that were employed in the past year during IWAC (Table 6.13).
<table>
<thead>
<tr>
<th>Question</th>
<th>Summarized Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Have you been involved in similar collaborative planning processes before? (N=15)</td>
<td>• Yes x11&lt;br&gt;• No x4&lt;br&gt;• Exciting to participate in participatory process</td>
</tr>
<tr>
<td>With hindsight, what things might you do differently if involved in similar processes in the future? (N=17)</td>
<td>• Nothing x7&lt;br&gt;• More diverse representation x2&lt;br&gt;• Better informed and knowledgeable as a participant x2&lt;br&gt;• Clearly stated objectives throughout the process x2&lt;br&gt;• Better understand historical and political context of the region as a participant x2&lt;br&gt;• Practice patience as a participant</td>
</tr>
<tr>
<td>Do you feel the people in IWAC that participated in the collaborative process were the right ones? Were there people or perspectives missing? (N=19)</td>
<td>• Unsure x13&lt;br&gt;• State agencies in WA and ID should be involved x8&lt;br&gt;• Tribal representation and participation x5&lt;br&gt;• Environmental nongovernmental organizations x4&lt;br&gt;• Elected officials&lt;br&gt;• Educators&lt;br&gt;• Scientists&lt;br&gt;• Agriculture</td>
</tr>
<tr>
<td>What are two of the most useful facilitation tools that were employed during the past year during IWAC? (N=15)</td>
<td>• Causal Loop Diagram Exercise x6&lt;br&gt;• Crowdsourcing x5&lt;br&gt;• Open Space Technology x5&lt;br&gt;• Hydrologic Model&lt;br&gt;• Futures Triangle</td>
</tr>
</tbody>
</table>

Eleven participants shared that they have been involved in a similar participatory process before, whereas four participants stated that they have not been involved in a similar process. Seven participants did not share anything that they would have done differently if involved in a similar process. Two individuals commented about having more diverse representation within the process. Two people discussed that they wish they were better informed and had more knowledge. Two people reported that objectives, both IWAC’s and the processes, should be clearer and stated throughout the process. Thirteen participants were unsure if the people that participated in the process were the right ones. Eight individuals mentioned that state agencies from both states should be involved. Five people stated that there should be more participation from the tribes. Four people wanted to see participation from environmental nongovernmental organizations. The most important (enjoyed) facilitation techniques were Crowd Sourcing (five
participants stated this), *Open Space Technology* (five individuals mentioned this) and the Causal Loop Diagram (six individuals state this).

6.4.2.e. *General Evaluation and Comments*

One question was asked about evaluating the success of a participatory process: what would you look at in order to judge the success of the overall collaborative water planning process, in terms of its impact: personally, on the group involved and on the Spokane River Basin or region (Table 6.14). One question allowed participants to provide general comments and feedback about the participatory process: do you have any further questions or general comments (Table 6.14). Nine participants stated that the development of a plan or report that had objectives, goals, action items and an implementation plan would be important for determining success. Four individuals talked about trust, respect and relationship building were important components to a successful collaborative process. Three individuals discussed the importance of keeping people engaged throughout and after the process was over. Three individuals commented on tracking progress of the implementation of the plan or outcomes of the process. Three individuals stated that having buy-in from the public in the region was important.
Table 6.14 Stakeholder Feedback on General Evaluation of Participatory Processes (from qualitative interview; N=20)

<table>
<thead>
<tr>
<th>Question</th>
<th>Summarized Responses</th>
</tr>
</thead>
</table>
| What would you look at in order to judge the success of the overall collaborative water planning process, in terms of its impact: Personally? On the group involved? On the Spokane River Basin? | - Development of a plan that has objectives, goals, action items and implementation plan x9  
- Trust, respect and relationship building x4  
- Keeping people engaged in the long-term x3  
- Tracking progress of implementation x3  
- Community buy-in of plan/outcomes x3  
- Financial resources committed x2  
- Measured behavior change (i.e. water savings impact)  
- Development of sustainable strategies  
- Social network analysis                                                                 |
| Do you have any further questions or general comments?                  | - Continued engagement with WSU to address bi-state water planning x4  
- Shared financial resources x2  
- Importance of being prepared for future water management x2  
- Next steps include bringing in more people that represent diverse perspectives  
- Helped participants view issues from different perspectives  
- Appreciate the objective perspective of the university  
- Participatory processes take time  
- Trust is key  
- Successful collaboratives need shared financial resources (i.e. have skin in the game) and shared tasks and action items |

6.5. Chapter Summary

The process of engaging stakeholders in the long-term, as discussed in this chapter, is not always straightforward. Stakeholder engagement processes are complex and time-consuming and need to be designed with a flexible approach. Often, participatory processes that are initiated and supported by university research teams pose challenges to design a process that balances the needs of stakeholders and the skillset and objectives of research teams. Collaborative modeling is an effective methodology that can be used to convene stakeholders, prompt challenging discussion about water resources and develop relationships and trust during the process. Over time, the dialogue generated by regional water resource stakeholders shifted from investing time
in developing another model in the basin to the importance of public awareness, education outreach. Stakeholders at IWAC realized that public awareness and buy-in of managing water resources as a joint bi-state collaboration was deemed more important at the time than working through a CM process. This presented an interested juncture in this research project. Stakeholders knew that eventually they would need to evaluate future scenarios using modeling tools, but it was not the most pressing need among stakeholders. Thus, the stakeholder engagement activities of this project shifted to supporting the changing needs and priorities of the stakeholders.

In this chapter, stakeholders discussed the many benefits and challenges of participatory processes and collaborating with a university research team. Stakeholders recognized that university researchers bring knowledge, expertise and neutrality to a participatory process. However, some stakeholders discussed that university researchers may have a personal, hidden research agenda that may conflict with the needs of the regional stakeholders. Stakeholders also shared that they learned a great deal about the system, developed new relationships and learned about the knowledge and different perspectives of other participants. Finally, many stakeholders emphasized the importance of trust and respect during these processes, especially as it was essential to success of a participatory process.
7.1. INTRODUCTION

This chapter provides a discussion about advancing water resource planning, education and outreach through stakeholder engagement methodologies. It will examine the following original research questions: 1) how do university research teams engage stakeholders in participatory water processes over time; 2) what does long-term stakeholder engagement and collaborative modeling bring to a group of water resource professionals in a bi-state watershed; and 3) can university research teams function as bridging organizations to support long-term stakeholder engagement and facilitate addressing and solving complex water resource problems. Discussion of these participatory processes provides insight to the development of best practices for university-affiliated bridging organizations to engage stakeholders in long-term participatory processes.

The discussion presented in this chapter is broken into three parts. The first part describes a framework of best practices for long-term stakeholder engagement by a university research team. The framework is presented in 3 categories with a total of 9 principles. This framework includes reflections of this long-term participatory process and stakeholder perspectives. Stakeholders shared their perspective about the role university researchers play in a participatory process, and reviewed various components of the participatory processes employed by this research project. This part also incorporates reflection on utilizing collaborative modeling and different participatory techniques throughout this process. The second part provides recommendations for long-term stakeholder engagement. The third and final part of this chapter comments on the challenges of long-term stakeholder engagement by a bridging organization. The discussion closes with concluding statements about how university-affiliated bridging
organizations can support long-term stakeholder engagement to address complex water resource challenges.

7.2. **CONTRIBUTION TO THE FIELD: BEST PRACTICES FOR LONG-TERM STAKEHOLDER ENGAGEMENT**

This section serves this dissertation as a contribution and synthesis of the literature in developing best practices for long-term stakeholder engagement by a university-affiliated bridging organization. This framework was developed based on lessons learned within the different stakeholder engagement activities and an evaluation of the participatory processes to foster flexibility, inclusiveness and capacity building. Key to this process is the role the bridging organization plays as the convener, co-designer and promoter of a process that is iterative, flexible and encourages increased understanding of water resource management issues. The stakeholder engagement team served as the convener and bridging organization responsible for designing, implementing and evaluating the stakeholder engagement processes.

Water resource management and education require adaptive governance principles that utilize highly iterative and participatory processes that promote social learning, increase understanding of complex issues and build personal relationships, trust and respect among stakeholders. Research and case studies support that these processes must employ an approach that is both iterative and flexible to build a comprehensive understanding of water management systems and meet the evolving priorities of stakeholders. University research teams can serve as bridging organizations that can design participatory processes that iteratively engage stakeholders to help them solve complex water resources problems. A set of best practices for stakeholder engagement was developed to show how bridging organizations can design participatory processes that engage stakeholders to advance social learning and strategies that support improved collaboration for water resources management (Table 7.1). The proposed
framework of best practices for long-term stakeholder engagement are separated into three different components: 1) Design Principles (Section 7.3), 2) Evolving Approach (Section 7.4) and 3) Necessary Skills and Resources (Section 7.5). Design Principles recommend consideration of important components to planning and designing a participatory process. Evolving Approach incorporates elements necessary to support long-term engagement, particularly as stakeholder needs and priorities shift over time. Finally, Necessary Skills and Resources are recommended pre-requisites to support long-term stakeholder engagement.

**Table 7.1 Best Practices for long-term stakeholder engagement by a university bridging organization.**

<table>
<thead>
<tr>
<th>Design Principles</th>
<th>Evolving Approach</th>
<th>Necessary Skills and Resources</th>
</tr>
</thead>
<tbody>
<tr>
<td>Principle 1: Create a process that is fair, equal, inclusive and transparent, which emphasizes trust, respect, empowerment, and learning</td>
<td>Principle 4: Design a flexible approach and be able to adapt to changing circumstances</td>
<td>Principle 7: Knowledge of different participation techniques</td>
</tr>
<tr>
<td>Principle 2: Involve stakeholders early and throughout the process, and collaborate with local leaders during the design and implementation</td>
<td>Principle 5: Modify and make adjustments to the participatory process approach as necessary</td>
<td>Principle 8: Adequate resources: personnel, time and financial</td>
</tr>
<tr>
<td>Principle 3: Select and tailor methods to the decision-making context, considering the objectives, steering committee input, type and appropriate level of engagement</td>
<td>Principle 6: Iteratively explore the problem and define objectives</td>
<td>Principle 9: High quality leadership, collaboration and facilitation skills are essential</td>
</tr>
</tbody>
</table>

The best practices framework was designed based on the water resources stakeholder engagement literature and lessons learned from this participatory process. They build on the Stakeholder Engagement Wheel framework and provide strategies for a bridging organization to employ when iteratively designing a participatory process (Mott Lacroix & Megdal, 2016). In any stakeholder engagement and participatory process, research indicates that there are core principles necessary for effective stakeholder engagement (Table 2.3). These include designing a process that is fair, equal, inclusive and transparent that highlights the importance of trust,
respect and learning. Involving stakeholders early and throughout the process is an important best practice stated in many stakeholder engagement projects. In addition, adequate resources, both time, personnel and financial, are central components to ensure project success, as participatory processes are time consuming and often expensive. The skillset and knowledge of both the leaders and the process designers and facilitators are essential to designing an effective and successful engagement process. Finally, comprehensive communication between all parties participating in a participatory process is needed.

7.2.1 University Researcher Teams Serving as Bridging Organizations in Participatory Processes

This research argues that university research teams can serve as bridging organizations in participatory process. This concept is incorporated within the proposed best practices framework for long-term stakeholder engagement. This discussion draws on experience and stakeholder perspectives from this research project and guidance from the field. It is important to mention that the stakeholder engagement team for this research project served as the convener and bridging organization responsible for designing, implementing and evaluating the stakeholder engagement processes in the Spokane River Basin.

Research on the role bridging organizations play in the long-term engagement of stakeholders is still a relatively new research field. However, there are case studies that discuss the beneficial aspects of engaging a university affiliated bridging organization in a regional participatory process that either promotes social learning or aims to develop a water management plan (Berkes, 2009; Crona & Parker, 2012; Floress et al., 2015; Mott Lacroix & Megdal, 2016; Pahl-Wostl et al., 2007). This research project and other case studies support the ability for university-affiliated organizations or research teams to serve as bridging organizations (Mott
Stakeholders in this research project shared their perspectives of the assorted benefits researchers provide in participatory processes. Stakeholders discussed the importance of university researchers providing knowledge and expertise and bringing new ideas and a different perspective to the engagement process. Stakeholders also talked about how researchers were integral toward scientific understanding of issues and providing advice and assistance to solving complex water resource problems. These beneficial aspects align with core functions of bridging organizations.

Bridging organizations are a fundamental aspect of university-stakeholder engagement processes and provide tremendous benefits to the long-term engagement of stakeholders in a particular region. University research teams representing the bridging organization play an important role in ensuring that the engagement process continues to move forward. In this research project, SET was and continues to be crucial to ensure that the engagement process keeps moving forward.

**7.3. BEST PRACTICES: DESIGN PRINCIPLES**

This section discusses three key components that bridging organizations should consider when responsible for convening and designing a participatory process. This section on participatory process design principles is organized in three areas, as bridging organizations should: 1) create a process that is fair, equal, inclusive and transparent, which emphasizes trust, respect, empowerment and learning; 2) involve stakeholders early and throughout the process, and collaborate with local leaders during the design and implementation; and 3) select and tailor methods to the decision-making context, considering objectives, steering committee input, type and appropriate level of engagement.
7.3.1 **Principle 1: Create a process that is fair, equal, inclusive and transparent, which emphasizes trust, respect, empowerment and learning**

Universities play an important role in convening and engaging stakeholders to understand complex water resource issues and promoting social learning through participatory processes (Parker & Crona, 2012). University-affiliated organizations are uniquely suited to serve as a bridging organization in a participatory water process as they are typically recognized by community members as being a neutral, third party and providing expertise. In this research project, 95% of the stakeholders interviewed agreed that university researchers can serve as neutral facilitators in a participatory process.

Bridging organizations engage stakeholders through facilitation to create a space for trust, respect and empowerment among stakeholders. They are responsible for providing a neutral convening space and ensuring that the process is fair, inclusive and transparent. This allows for power asymmetries to be balanced. In this project, this was accomplished by collaborating with local stakeholders and leaders. SET created trust by getting to know water resource stakeholders in the basin, and investing a significant amount of time and energy supporting stakeholders in the bi-state organization, IWAC. In this research project, stakeholders appreciated that their voice and perspectives were heard. They talked about how trust and respect among stakeholders improved throughout the engagement process. The conversation about trust and respect expanded to emphasize its’ importance and that often times processes fail due to lack of trust and respect among stakeholders. This project demonstrates the important role bridging organizations play designing a participatory process that incorporates elements of fairness and trust.
7.3.2 Principle 2: Involve stakeholders early and throughout the process, and collaborate with local leaders during the design and implementation

University-affiliated groups that serve as bridging organizations must collaborate with regional leaders in the water resources community, early and throughout the participatory process. Local water resource stakeholders that are identified as leaders within their community function in some ways as a steering committee (Beall King & Thornton, 2016; Mott Lacroix & Megdal, 2016). The role of the steering committee is to assist in guiding the direction of the participatory process to ensure that stakeholder needs, interests and concerns are well integrated into the process. In this engagement process, IWAC leaders and a few agency scientists informally served as the steering committee. Based on this experience, it is important for the bridging organization, i.e. SET, to frequently engage with this core group of stakeholders.

Collaboration with a steering committee also ensures that participation incorporates individuals with diverse interests, knowledge and perspectives. This is necessary for effective engagement processes that address local issues and develop robust strategies to effectively manage water resources. In a participatory process, diverse knowledge types improve inclusiveness and transparency, particularly in problem solving and decision-making contexts (Luyet et al., 2012). The integration of local and scientific knowledge leads to more robust solutions to water resource problems and empowers communities to better manage their water resource systems (D. M. Hall et al., 2016; Mott Lacroix & Megdal, 2016).

In this project, involving stakeholders was accomplished by collaborating with local water resource stakeholders to ensure a process was designed to meet stakeholder needs. A significant amount of time was spent meeting with individuals to find common ground and learn about the Spokane River Basin system. Over a two year period, a tremendous amount of effort
was invested to develop and vet the OASIS SRB model, which included many individual meetings, phone calls and presentations. In this research project, working with the steering committee was important to ensure there was appropriate representation at different phases of the process. During the preliminary water planning workshops, the bridging organization worked with the steering committee to broaden stakeholder participation and identify individuals needed to begin conversations about bi-state water planning. This project demonstrates the importance of working together with local stakeholders to ensure the participatory process is effective and successful. This research supports that local stakeholders bring tremendous value to the process, as they have local expertise of the water system and maintain a broad network of individuals engaged in water resources. This projects supports the central role bridging organizations play in engaging stakeholders and collaborating with local leaders to ensure a participatory process addressed pressing stakeholder needs in the basin.

7.3.3 Principle 3: Select and tailor methods to the decision-making context, considering objectives, steering committee input, type and appropriate level of engagement

Participatory processes are often utilized in different decision-making contexts. Engagement processes and their objectives and goals vary among stakeholder groups and the water resource issues that need to be addressed. The outcomes of stakeholder participation largely depend on the roles of the participants, circumstances and nature of the process, and the tools, methods and expertise of the process designers (O’Leary & Bingham, 2003; Reed, 2008). Thus, it is necessary for the bridging organization and steering committee to collaboratively determine the most relevant and appropriate participatory approach.

Steering committees function as the fulcrum to participatory processes, because they ensure that the process is driven by the people, organizations and communities that will be
impacted by the outcomes and to address pressing stakeholder needs. Steering committees can also serve as the liaison for initial exploration of the problem, preliminary goal setting and assist in identifying different activities to broaden engagement and individuals and organizations to engage. In this research project, collaborating with local leaders and the steering committee was the fulcrum to design an effective participatory process. Many leaders from IWAC provided advice and input about selecting different participatory techniques. As stakeholder priorities shifted, collaboration with the steering committee in selecting a participatory approach that allowed stakeholders to develop an education and outreach campaign was essential. In the collaborative modeling process, the bridging organization worked with key stakeholders to ensure the model design was relevant to the pressing water resource issues in the basin. Thus, selecting a participatory technique that considers the objectives, decision-making phase and the ideal level of stakeholder participation is imperative to success.

Through each of these three engagement processes, the time invested in developing and maintaining engagement with individuals in the steering committee was crucial to develop successful engagement activities. It also was helpful to make sure the process was relevant to the needs and objectives of stakeholders and to communicate and engage additional stakeholders, as necessary. During the initial stages of the collaborative modeling process, SET made a concerted effort to consistently engage with the steering committee. This frequent interaction enabled our team to quickly get acquainted with the system, obtain data from the USGS groundwater model and connect with hydrologic experts that were not active participants in the process. During the education and outreach engagement activities, this interaction ensured that the process was relevant to the needs of the stakeholders and that the process was designed in a way that had intentional outcomes. This activity was successful, as IWAC leaders were able to obtain over
$30,000 from local and state agencies. These groups felt strongly to support an education and communication initiative that was designed by stakeholders in both states. This collaboration between the bridging organization and the steering committee was instrumental to develop and implement an effective process, particularly as the steering committee provided advice and assistance throughout this research project.

While steering committees are commonly cited in stakeholder engagement case studies and in practitioner guidebooks, they are rarely discussed as being an integral part to stakeholder engagement processes. Little research exists about how bridging organizations and steering committees are key to successful outcomes in a participatory process. Two case studies in water resources have discussed that steering committees are important components of participatory processes, as they are integral to convene, establish and complete the engagement process (Mott Lacroix & Megdal, 2016; Slocum, 2003). In this research project, collaboration between the bridging organization and steering committee was an important component to success, as many stakeholders provided positive commentary about the support, advice and expertise the university researchers provided throughout the process. During interviews, stakeholders also shared that university researchers were useful to ensure the process was designed in a way that reached their objectives.

**7.4. Best Practices: Evolving Approach**

This section discusses three key components that bridging organizations should consider throughout a participatory process. This section on the evolving approach to participatory processes is organized into three areas, as bridging organizations should: 1) design a flexible approach and be able to adapt to changing circumstances; 2) modify and make adjustments to the
participatory process approach as necessary; and 3) iteratively explore the problem and define objectives.

7.4.1 Principle 4: Design a flexible approach and be able to adapt to changing circumstances

The participatory approach must be flexible and adaptable. Given the broad choice of techniques and approaches, it is important for the bridging organization and steering committee to choose an approach that can quickly respond to dynamic environments. Hence, the role of the bridging organization is to facilitate the design of a flexible approach that can adapt to changing situations. When engaging stakeholders in the long-term, it is critically important that the bridging organization and steering committee design an approach that is both iterative and flexible and meets the needs of stakeholders, but is tailored to the desired outcomes. Collaboration between the bridging organization and steering committee is important because it allows for flexibility in the design and evolving engagement process. In this research project, initial engagement was centered on components of the WISDM research project and collaborative modeling, but over time the stakeholder engagement team modified the engagement process to meet shifting stakeholder priorities. This principle supports the core functions of bridging organizations, where incorporating flexibility and modification are crucial to supporting long-term stakeholder engagement.

7.4.2 Principle 5: Modify and make adjustments to the participatory process approach as necessary

During a participatory process, it is important for the engagement approach to evolve over time. Similar to the principle of designing a flexible approach, modifying the engagement method and approach may be necessary. Consistent communication between the bridging
organization and the steering committee is also important for effective engagement processes. Communication about results and outcomes during different stages of the process facilitates decisions between the bridging organization and steering committee about modifications or next steps in the engagement process.

Examples of the evolving engagement approach are seen in throughout this research project. The original WISDM collaborative modeling plan included the development of a decision-support tool to assist stakeholders in bi-state water management. Mid-way through this process, however, it became clear that this new modeling tool was pre-mature to the long-term water planning process. Many water resource professionals realized that they had sufficient understanding of the science in the basin, and the focus needed to be on education and outreach to raise awareness of water resources among the 600,000 individuals in the basin.

The steering committee discussed the importance of buy-in from the water resource community and the public. Buy-in, related to collaborative, bi-state water resources management, was a somewhat new concept and this potential management strategy would completely change the way water resources are currently managed in the basin. Therefore, SET decided to use this opportunity to work with the steering committee to design a process that developed content and a plan to implement an education and outreach campaign for water stewardship. This campaign, since it was developed by bi-state stakeholders, immediately was recognized as a worthwhile investment of time and resources, as the steering committee was able to solicit funding to cosponsor this initiative. This research project demonstrates that effective communication between the bridging organization and steering committee has been shown to enhance the outcomes of the process. In addition, supporting long-term stakeholder engagement
often requires modification to meet shifting stakeholder priorities, as seen throughout this process.

7.4.3 Principle 6: Iteratively explore the problem and define objectives

In any process that includes stakeholder participation, it is important to explore the problem and clarify objectives and expectations throughout the process. In order to ensure a participatory process is relevant to the needs and interests of stakeholders, it is essential to spend time developing clear objectives and goals with the participants. It is equally important to spend time communicating the objectives and goals with the group, so that all participants have a similar understanding of the objectives at the outset of the process (Forester, 1999; Reed, 2008; van den Belt, 2004). In long-term stakeholder engagement processes, it is important that this process is iterative and continues to make progress toward the intended objectives and outcomes.

The bridging organization’s role is to continue engagement by iteratively facilitating discussion and examination of the problem. As part of stakeholder engagement processes, iteratively connecting with stakeholders and revisiting process objectives can enable effective engagement and social learning (Muro & Jeffrey, 2012). This iterative approach to stakeholder engagement is time-consuming and requires immense attention to the design and implementation of the participatory process. This project demonstrates multiple examples of iterative discussion on pressing issues and water resource challenges. For example, this stakeholder engagement process used here facilitated discussion that resulted in the stakeholders re-prioritizing their goals to focus on education and outreach strategies. The stakeholders’ problem statement shifted from improving the understanding of the water resource system to better understanding of how to communicate to a public, where many believe there is an unlimited supply of water. This was an
important aspect of the process, as SET provided time and space for stakeholders to re-examine the problem, which resulted in shifting goals, objectives and outcomes.

7.5. **BEST PRACTICES: NECESSARY SKILLS AND RESOURCES**

This section discusses the necessary skills and resources needed for a participatory process that engages university researchers and local leaders. This section on skills and resources is organized in three areas, as effective participatory processes need: 1) knowledge of different participation techniques; 2) adequate resources, including personnel, time and financial; and 3) high quality leadership, collaboration and facilitation skills.

7.5.1  **Principle 7: Knowledge of different participation techniques**

There are a vast number of different participatory methods and techniques to use in an engagement process (see Chapter 2). It is advantageous to have experience and knowledge of the many different participation techniques. Certainly, practitioner’s manuals and facilitation guidebooks provide an overview of different techniques, but without the experience of using such technique it is often times challenging to select the most appropriate one. In this research project, multiple different participatory techniques, including collaborative modeling, liberating structures and systems thinking, were employed.

This project began utilizing a collaborative modeling approach. Models have long been recognized as a platform for dialogue and a useful way to integrate knowledge and information to address complex human-environmental systems. The approach provided an opportunity to bring stakeholders together to discuss the complexities and uncertainties in the system. Through this process, stakeholders shared their insights about the problems and issues in the basin and potential solutions that may address these challenges. This technique was employed to promote
learning and assist stakeholders with problem examination. It used also helped stakeholders improve their understanding of the regional water resource system.

Liberating Structures is a methodology that has many different facilitation techniques and prompts that can be used in a wide variety of situations. Based on the experience and knowledge of Liberating Structures, this project employed different techniques based on the objectives and the type of engagement that was necessary. Liberating Structures provides tools to promote participation from all individuals in new, innovative ways. During stakeholder interviews, many individuals shared that their voices were heard and their contribution was valued. Stakeholders in this project also enjoyed the Crowd Sourcing technique, as this was a useful methodology for quickly generating ideas and coming to an agreement to prioritize key concepts. The What Debrief technique was useful as it allowed time and space for reflection about what has occurred and what are the next steps of the process. The Futures Triangle, Critical Uncertainties and Scenarios Matrix were useful for stakeholders to think about scenarios in the future and develop various strategies for these future scenarios.

Systems thinking was primarily used in a mental models elicitation exercise and during the development of a causal loop diagram. A causal loop diagram exercise is a useful technique that allows participants to see the water resource system from a 30,000 foot view. It is a way for stakeholders to think critically about the relationships, linkages and causations of many different aspects of a regional water system. In this project, approximately half of the stakeholders mentioned that this was a favorite and very useful participation technique. Stakeholders also shared that while they were frustrated during the process, they really enjoyed having the opportunity to think about the many connections within a water resource system.
It is important for bridging organizations and steering committees to have diverse knowledge and experience of the many different participatory methods and techniques that are available. Lack of knowledge and understanding of these techniques would make it challenging to develop a process that is flexible, iterative and meets the needs of the participants involved in the process. If there are challenges related to lack of knowledge, it is recommended that the conveners and designers of participatory processes work with experienced practitioners to assist in choosing the most appropriate participatory technique.

7.5.2 Principle 8: Adequate resources, including personnel, time and financial

It is important to mention that participatory processes would not be possible without adequate resources. Resources such as personnel, time and money are all integral to successful completion of any stakeholder engagement process. The long-term engagement of stakeholders is immensely time-consuming, both in developing relationships, collaborating, and planning and implementing the process. This research project, which spans just over 4 years, demonstrates the time commitment and dedication to ensure that a participatory process was effective.

Bridging organizations may assist stakeholder engagement initiatives by providing personnel or financial resources. The availability of personnel varies greatly and depends on the individuals in the bridging organization and steering committee. The availability of financial resources largely depends on university research funding or regional grants. For example, in this research project, the collaborative modeling and stakeholder engagement process was funded by a federal research grant. There was also a dedicated graduate student that worked on this project for the entirety of the four year period. It is important that finances, time and personnel be taken into consideration before a participatory process takes place. It is also important to recognize the amount of time stakeholders spend participating in engagement processes over-time. Thus, a
participatory process should be designed in a thoughtful and intentional way that minimizes wasted time of participants and utilizes the limited resources available efficiently.

7.5.3 Principle 9: High quality leadership, collaboration and facilitation skills

The way in which a participatory process is organized and conducted is far more sensitive than the outcome (Chess & Purcell, 1999). Highly skilled facilitators are necessary for participatory processes and discussions that include contentious and polarized issues, such as water management during a drought. The role of the facilitator is to help participants to do their best thinking (Kaner, 2014). A facilitator needs to remain and be perceived as neutral and impartial to the process. It is also important that a facilitator creates a fair, inclusive and open process that balances the diverse perspectives of stakeholders and enhances the productivity and outcomes of participation (Bourget, 2011; Kaner, 2014; Pahl-Wostl, 2009; Rixon, Smith, McKenzie, & Sample, 2007).

Facilitation knowledge, experience and skills are important aspects to designing and leading participatory processes. Researchers may not have the theoretical knowledge and skillset necessary to successfully facilitate participatory processes. Researchers, particularly those with scientific and technical training, may have to learn and adopt soft, facilitation skills in addition to their primary scientific work. Thus, university researchers involved in these engagement processes will need to have strong communication and facilitation skills to lead and facilitate discussion among regional stakeholder groups. Researchers will also have to be willing and interested to initiate, design and execute participatory processes. In this research project, many participants expressed how researchers are uniquely suited to facilitate group discussion to identify the problem(s), establish objectives and goals and develop solutions or strategies to regional problems.
Long-term stakeholder engagement processes need individuals with strong facilitation and leadership skills, as these skills are fundamental to process success. Even in simple settings, such as informal group discussion, it is important for facilitators to have expertise. The expertise among facilitators also varies, as facilitators can use the same tools and have wildly different results (Holtz, Kastens, & Knieper, 2010; Luyet et al., 2012; Reed, 2008). Facilitation skills are often challenging to learn and require intuition, empathy and time to fully develop (Reed, 2008). Facilitators who have been involved in many participatory processes have stated that it is possible to refine personal facilitation practice over time, however usually there is no replacement for experience (Reed, 2008). Over time, I have learned that there are certainly aspects of facilitation skills that individuals develop through experience, including: a) creating clarity through the synthesis of information; b) being a keen observer of the unsaid; c) knowing when to take a leadership role and when to take a back seat; d) drawing out opinions and ideas from participants; e) learning to listen with intent and making individuals feel good about their contribution throughout the process. As a participant stated: “well [through this entire process] you’ve made me feel like we mattered, so thank you….you’ve always been that way with us.” (P13). Thus, bridging organizations that support long-term stakeholder engagement must have individuals with robust facilitation and leadership skills, as it has a tremendous impact on the effectiveness and success of the participatory process.

7.6. CHALLENGES OF LONG-TERM STAKEHOLDER ENGAGEMENT BY BRIDGING ORGANIZATIONS

There are certainly challenges to conducting long-term stakeholder engagement processes that are supported and led by university-affiliated bridging organizations. A recent trend in water resource participatory processes is that researchers are becoming active as change managers and play a more predominant role in facilitating and implementing participatory methods (von Korff
et al., 2012). Individuals within bridging organizations often have a double role as both a researcher and facilitator in participatory processes. In addition, individuals in these bridging organizations are university researchers that have other duties and responsibilities beyond engaging stakeholders. Conducting research that aims to respond and meet the needs of regional stakeholders is challenging for university research teams, as funding is usually finite and available to support a discrete research project.

The double role of researcher and facilitator creates opportunities and poses complex challenges for the university-stakeholder engagement processes. There is conflicting research on whether researchers or local leaders are most suitable and appropriate to facilitate regional water resource participatory processes. Some studies suggest that researchers should be reluctant to facilitate participatory processes because of potential conflicting research objectives and the lack of facilitation experience and skills (Cornwall & Jewkes, 1995). Some research suggests that it would be advantageous to have local leaders facilitate participatory processes because it is assumed they will have the skillset and ability to mobilize resources for implementation (Cornwall & Jewkes, 1995). In addition, local leaders have the potential advantage of already generating trust with the group, which is an important perquisite for successful participation (Hirsch, Abrami, & Giordano, 2010). Although, researchers have the advantage that they are often perceived as impartial.

It is important to consider the process objectives and respective goals of the participatory process when determining who is best suited to facilitate (Daniell, 2012). Some research argues that researchers are best positioned to facilitate a participatory process where advancing and promoting social learning is a key objective (Daniell, 2012). Alternatively, local leaders or practitioners are well suited to facilitate activities where improving management of water
resources is a strategy (Daniell, 2012). These challenges, in the context of the double role of researchers and facilitators, can be avoided by collaborating with key local leaders and participation experts. The stakeholder engagement wheel framework (Mott Lacroix & Megdal, 2016) supports this claim and argues that both a core research team and key local leaders are an important collaboration to successfully design and facilitate participatory processes. The research team, which functioned as a bridging organization, worked to ensure engagement continues overtime. Thus, this research argues that facilitation skills and the collaboration between a bridging organization and steering committee is crucial to long-term stakeholder engagement processes.

Universities or university-affiliated organizations have the ability to provide institutional support for individuals that function as bridging organizations. However, universities do not traditionally function to convene stakeholder groups, mediate conflicts or provide training for individuals to function in this capacity. In order for bridging organizations to support long-term stakeholder engagement initiatives, it is important for universities to provide stakeholder engagement and facilitation training. It is also important for universities to support university researchers that serve within bridging organizations and convene participatory processes that promote social learning, capacity building and development of regional water resource management strategies.

7.7. CONCLUDING STATEMENT AND RECOMMENDATIONS FOR LONG-TERM STAKEHOLDER ENGAGEMENT

Water resource issues are inherently challenging due to the diversity of stakeholder perspectives and values and because of the inherent and fundamental complexities of socio-ecological systems. These complexities necessitate that water resource planning processes utilize
collaboration and adaptive governance principles, as well as highly iterative, participatory
techniques that promote social learning and trust. Collaborative modeling and systems thinking
are effective participatory techniques for addressing such challenges. This research project met
the call for universities to be increasingly involved as bridging organizations that engage
regional stakeholders as they address societal problems. In this role, university research teams
help bridge the gaps between science, society and decision-making entities.

Long-term stakeholder engagement processes are complex, time-consuming processes
that require immense organization, collaboration and planning. Engagement processes supported
by bridging organizations must work with local leaders in the water resources community to
ensure a process is designed intentionally. It is recommended that the steering committee include
local or regional stakeholders that have a vested interest in water resources and in the project’s
outcome. It is also recommended that stakeholder be involved early and throughout the
participatory process, which is an important principle for successful stakeholder engagement.
Participatory processes should collaborate with the steering committee and involve stakeholders
during the design, implementation and evaluation of the project. In short, engaging stakeholders
early in the participatory processes has shown to be essential if the intended outcome is to have
high quality decisions.

Selecting an appropriate engagement approach is also a challenging component to
participatory processes, as it requires knowledge and experience of participatory processes. It is
recommended that bridging organizations and steering committees have knowledge of different
participation techniques. Engagement methods must incorporate input from the steering
committees, consider the objectives of the project and integrate best practices and lessons learned
from previous engagement activities. It is also recommended that the bridging organization and
steering committee determine who would be most appropriate to serve as the facilitator of the process.

Flexibility and iteration are two of the most important practices for engaging stakeholders over the long-run. Often times, university research teams engage stakeholders on a short-term basis, usually based on the length of a research project or grant, with pre-defined research questions and objectives. University researchers have a unique opportunity to engage stakeholders beyond the scope of one project. Therefore, bridging organizations should ensure that the engagement of stakeholders continuously occurs and does not cease when a particular project finishes.

This research advances understanding of the strategies, methods and processes that university-affiliated bridging organizations use to enhance long term water resource planning, education, and outreach. It improves understanding of the role collaborative modeling and stakeholder engagement provides to water resource stakeholders. It supports current research that underlines the importance of building relationships, social capacity and trust, and that learning is an essential component to effective participatory processes. This research demonstrates the necessity of facilitation skills, and the importance of designing an iterative, flexible approach that meets the changing priorities of stakeholders. The best practices framework was developed to incorporate important elements to support long-term stakeholder engagement in water resources.
Water resources management calls on all of us to be adaptive, creative and committed as we search for solutions to complex, socio-ecological challenges. This search will result in not only new solutions and strategies, but it will also reveal new problems and challenges, some unexpected, and others that become important over time. Stakeholder engagement research must be flexible, as the nature of these processes do not always follow the original plan, or develop one final plan or solution that meets both present and future needs. Adaptive, iterative processes that continue to engage stakeholders over time are a necessary component of a sustainable future.
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APPENDICES
APPENDIX A. OASIS SPOKANE RIVER BASIN MODEL

A.1 OASIS Water Resource Modeling Software

A model of the SVRP aquifer and Spokane River Basin utilizes OASIS with OCL™ (OASIS) modeling software (Hydrologics Inc., 2009). OASIS uses a fully configurable linear programming solver to simulate water routing and optimize system operations for each timestep in the simulation period. The routing of water accounts for both human control and physical constraints on the system. Linear programming is “an analytical technique for allocating scarce resources (the exact scarcity of which is represented by mathematical expressions called constraints) so as to maximize or minimize some objective function which in turn is a mathematical statement of the overall system goal” (Drobný, 1971, p.180). This technique has been widely used to study the optimization of water resource systems (Labadie et al., 2004; Randall et al., 1997). The mathematical details of linear programming are beyond the scope of this research project, however more information can be found from the User Manual for OASIS with OCL™ (Hydrologics Inc., 2009) for specific information of the mixed-integer linear programming method applied in OASIS.

OASIS is a surface water resource specific software package designed to optimize system performance based on user-defined goals and constraints. However, OASIS does not perform a single optimization for the entire simulation period, but optimizes system operations for each timestep. A one-year simulation period with a daily timestep would produce 365 separate optimizations with results that vary day to day, depending on the user-defined goals and constraints specified in the model. This is a useful framework for simulating water resource systems, because the optimization of each timestep is similar to how dam operators would operate the system. Critically, OASIS software has not been modeled on systems with a coupled groundwater and surface water system. The Spokane River Basin (SRB) OASIS model is constructed to simulate groundwater, and the movement of water within a coupled groundwater and surface water system.

OASIS models are built using “nodes,” “arcs,” and “inflows.” A node simply represents a point of interest in the system. SRB utilizes three types of nodes: (1) reservoir nodes are used for Coeur d’Alene Lake, and eight sub-regions of the Spokane Valley Rathdrum Prairie Aquifer that have similar hydrogeological properties; (2) junction nodes are used for the Post Falls dam, important gage points, tributary river inputs, lake inputs to the groundwater system, and to identify the point where water leaves the model domain; (3) demand nodes are used to represent the delivery of water, this includes municipal, agricultural and industrial water demand (Figure A.1). Arcs are the features that convey water between nodes, and they may be unidirectional, where water can flow one way between nodes, or bi-directional, where water can flow both ways between connected nodes. In the SRB, arcs are both unidirectional and bi-directional; bi-directional arcs represent the highly interactive groundwater and surface water system, where water can flow both ways between the connected groundwater reservoir nodes and the surface water (river) nodes. Inflows are where a predetermined amount of water enters or exits the system at a node. Finally, the graphical user interface assembles all these components into a graphical, schematic representation of the physical system. The user provides input data that describes the characteristics of the components, and writes rules and constraints that govern how water moves through the system.
A.1.1 Operating Rules: Operational Goals and Constraints

Operating rules are tools that can be used to model the most common, basic features of a water system, and in OASIS they are written in “operations control language”, referred to OCL. There are two kinds of variables in OCL: decision variables and non-decision variables. Decision variables are unknowns that the linear program solves, whereas non-decision (state) variables have a known value at any given time during the simulation period. The primary decision variables in the SRB are flow in the arcs, including streamflow and groundwater flow, and storage and elevation at the surface water and groundwater nodes. Examples of non-decision variables in the SRB include the amount of water entering the model domain and water demand for municipal, agricultural and industrial use.

Water is routed (moved) through the system by calculating: (a) flow through arcs, (b) volume stored in each now, and (c) volume allocated to each demand node. These calculations are made for every time step during a pre-established period of simulation. The linear programming solver is called every time step. OASIS automatically constructs the linear program each time step, solves it, and then turns that mathematical solution into a simulated record of flows and storages. The linear program is internal to OASIS and is hidden, unless the user requests it. Every timestep, flow, storage (elevation), and delivery are the decision variables whose values are solved by the linear program. The user specifies what to do, but the user does not have to tell OASIS how to do it. The user must then define the relationships between the components using operating rules that are expressed as both operating goals and operating constraints. Goals refer to an objective that OASIS attempts to meet, whereas constraints refer to a rule that OASIS must always meet. Thus, with these operating goals and constraints, the user can tell OASIS what to do. These constraints and goals are written into an objective function, which the solver optimizes and determines the decision variables at each timestep by finding a solution that meets all the constraints and maximizes the overall performance of goals.

OASIS includes a few built-in constraints, since the software is tailored to water resource applications. The most important of these constraints is the continuity-of-flow constraint, an adaptation of the general continuity equation that ensures conservation of mass within the system, and thus the model never loses or creates water in its accounting. Listed below are the continuity-of-flow constraints for (a) junction nodes (Equation 1A), (b) reservoir nodes (Equation 1B), and (c) demand nodes (Equation 1C).

\[(\text{sum of arc} - \text{flow in}) + \text{inflow} = (\text{sum of arc} - \text{flow out})\]

Equation 1A. Continuity-of-flow equation at a junction node.
At a junction node (Equation 1A), the arc-flow in and the arc-flow out are the decision variables, but the inflow is a known quantity specified by the user. This constraint assures that if a volume of water flows into a node, the same volume of water flows out of a node, and it cannot leave the system, unless the user specifically creates a negative inflow value at the node. At a reservoir node (Equation 1B), the arc-flow in, the arc-flow out, and the end of period storage are decision variables, however the inflow, evaporation, and beginning of storage variables are known quantities specified by the user. At a groundwater reservoir node, the continuity-of-flow equation excludes the evaporation variable from Equation 1B. At a demand node, the arc-flow in and the delivery are decision variables, but the inflow is a known quantity. The arc-flow out variable is not a part of this equation, because it is assumed that the user will not create arcs that come out of a demand node. At a terminal node, there is no continuity-of-flow constraint, because all water that goes into the terminal node does not stay in the system. In addition, arcs are by default constrained so that water may only pass from the upstream node to the downstream node, with the exception of the bi-directional arcs. These defaults are active in the SRB model and ensure that at each timestep all water added to the system moves downstream through the system in accordance with the solution to the linear program (Hydrologics Inc., 2009).

In order to create a model using OASIS, the user must first construct a schematic representation of the physical system using nodes, arcs, and inflows. In addition there is an Operation Control Language, which is a special language to enter rules and constraints that are specific to the water system being modeled. The modeler expresses all operating rules as operating goals or operating constraints that account for both human control and physical constraints on the system. Operational constraints are used to define physical rules in the system. They include the hydrologic processes that produce runoff, maximum channel capacity, and physical dimensions of the dam and surface water reservoirs in the system. An important constraint on any water resource system is the available supply of water, this includes storage volume available in a reservoir. Human controls (goals) include how water is moved from node to node, according to some “operating criteria,” and how water is allocated to demand nodes that are based on pre-established criteria. The OASIS model developers caution model users with the use of constraints, and advise users to instead treat most constraints as goals in the system with a very high way to ensure goals are met at each timestep. Operating goals are rules that OASIS tries to satisfy. In any time step, OASIS may not be able to satisfy all or any of a given operating goal. The user assigns weights to various goals that allow the linear program to determine the optimal solution.

A typical challenge in managing water resource systems is that it is not possible to meet every goal at all times. OASIS resolves conflicting goals by referring to user assigned weights. The modeler assigns a weight value to every operating goal in the model to construct the objective function. The linear program solution scores points by multiplying the weight value by
the value associated with the decision variable. In every time step, OASIS determines the values of the decision variables by solving the linear program. The solution obeys every constraint, and it is the set of decision variables that gets the maximum number of points from the set of goals. Positive goals encourage actions, while negative weights (penalties) discourage them, and a weight of zero is the same as if the goal did not exist. The weights are assigned from lowest to highest in hierarchical order. Weights do not represent a quantity that one can measure in the real-world system, however they do represent the relative importance of the different priorities of the operators and managers of the real world system.

A.1.2 Rule Logic

A series of rules lie at the heart of the SRB OASIS model. These rules are written in OCL and serve three primary functions: (a) they set variables used in other rules, (b) they establish constraints within which the modeled projects must operate, and (c) they define the goals (or targets as they are called in OCL) that the model attempts to meet. A key advantage of OCL is that it facilitates the creation of conditional rules. Conditions can be constructed from any number of parameters with the most common being the date, a threshold flow, or a storage level threshold. A major benefit of such rules is clarity, as they allow rules to be active or inactive without the confusing series of nested “If/Then/Else” statements that are often used to achieve similar results in other models.

A.2 Spokane River Basin OASIS Model Structure

This section describes how the SRB OASIS was developed and initially calibrated. The OASIS SRB model time period is 1990 – 2005, the same time period as the USGS MODFLOW model of the SVRP (Hsieh et al., 2007). The SRB model utilizes publicly available information on streamflow, groundwater flow, operations and water demand data in the region and combines it with a linear program optimization method to simulate streamflow, groundwater flow, reservoir storage, and the exchange of water between the groundwater system and surface water system. Again, the model is implemented in OASIS (see previous section for more information) and conceptualizes system operations as a collection of competing goals and constraints. The relative weight assigned by the user to each goal defines the objective function, and the optimization routine will determine how to meet the goals at each timestep. The results of the function describe the system state to be optimized in the next time step. Figure A.2 depicts this process (Beaver, 2013).
A.2.1 OASIS SRB Model Domain

The Spokane River Basin encompasses an area of approximately 2,400 square miles, roughly the size of the Los Angeles metropolitan area. The Spokane Valley Rathdrum Prairie aquifer and the main-stem of the Spokane River are the focus of this modeling effort. The three tributaries to the Spokane River were not included in the model domain, and were instead treated as inflows (Figure A.3 and Table A.1). The schematic of the SRB OASIS model is shown in Figure A.3. The numbers of each node serve as a reference for various functions in the model code (Table A.1). The purple triangles are nodes that represent the groundwater reservoirs; the aquifer system is broken into 8 sub-regions that have similar hydrologic properties (Hsieh et al., 2007). The blue triangle is a node that represents Coeur d’Alene Lake. The yellow circles are also nodes, but they represent lake inputs to the groundwater system, points of interest, such as tributary inflows and gage sites. The green squares are demand nodes that represent groundwater withdrawals for municipalities, agriculture, and industry and from domestic wells (Table A.2). The purple arrows represent the water entering the model domain which includes areal and tributary recharge for each groundwater node and lake inputs. The black lines connecting the nodes are arcs, which represent movement of water in the system, this includes: streamflow in the Spokane River, flow from/to the groundwater system to the surface water system, flow
through the groundwater reservoir, flow from lakes to the groundwater system, or flow to meet water demand.

*Figure A.3* Spokane River Basin OASIS Schematic.
Table A.1 Explanation of all the nodes shown in the SRB Schematic in Figure A.3.

<table>
<thead>
<tr>
<th>Node Number</th>
<th>Name</th>
<th>Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>110</td>
<td>Spirit Lake</td>
<td>Junction (lake)</td>
</tr>
<tr>
<td>120</td>
<td>Twin Lake</td>
<td>Junction (lake)</td>
</tr>
<tr>
<td>130</td>
<td>Lake Pend Orielle</td>
<td>Junction (lake)</td>
</tr>
<tr>
<td>140</td>
<td>Hayden Lake</td>
<td>Junction (lake)</td>
</tr>
<tr>
<td>150</td>
<td>Coeur d’Alene Lake</td>
<td>Surface Reservoir</td>
</tr>
<tr>
<td>160</td>
<td>Fernan Lake</td>
<td>Junction (lake)</td>
</tr>
<tr>
<td>170</td>
<td>Liberty Lake</td>
<td>Junction (lake)</td>
</tr>
<tr>
<td>180</td>
<td>Hauser Lake</td>
<td>Junction (lake)</td>
</tr>
<tr>
<td>190</td>
<td>Newman Lake</td>
<td>Junction (lake)</td>
</tr>
<tr>
<td>220</td>
<td>Post Falls gage</td>
<td>Junction (river)</td>
</tr>
<tr>
<td>230</td>
<td>Otis Orchard/Green Acres gage</td>
<td>Junction (river)</td>
</tr>
<tr>
<td>240</td>
<td>Trent Bridge gage</td>
<td>Junction (river)</td>
</tr>
<tr>
<td>250</td>
<td>Spokane gage</td>
<td>Junction (river)</td>
</tr>
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<td>260</td>
<td>Below Nine Mile Dam gage</td>
<td>Junction (river)</td>
</tr>
<tr>
<td>270</td>
<td>Little Spokane + Spokane River confluence</td>
<td>Junction (river)</td>
</tr>
<tr>
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<td>Hangman (Latah) Creek gage</td>
<td>Junction (tributary)</td>
</tr>
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<td>310</td>
<td>Little Spokane River gage</td>
<td>Junction (tributary)</td>
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<td>Groundwater Reservoir</td>
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<td>Southern Rathdrum Prairie (SRP)</td>
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<td>Coeur d’Alene / Post Falls area of SRP</td>
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</tr>
<tr>
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<td>Eastern Spokane Valley</td>
<td>Groundwater Reservoir</td>
</tr>
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<td>Spokane Area</td>
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<td>Western Arm</td>
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<td>Hillyard Trough and Little Spokane River Arm</td>
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<td>Demand</td>
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</tr>
<tr>
<td>860</td>
<td>Western Arm Demand</td>
<td>Demand</td>
</tr>
<tr>
<td>870</td>
<td>Hillyard Trough and Little Spokane River Arm Demand</td>
<td>Demand</td>
</tr>
</tbody>
</table>
Table A.2. Water purveyor groupings by demand node (municipal water use only).

<table>
<thead>
<tr>
<th>Demand Node Number</th>
<th>Water Purveyor</th>
<th>Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>800</td>
<td>Athol, North Kootenai Irrigation District</td>
<td>Northern Rathdrum Prairie (ID)</td>
</tr>
<tr>
<td>810</td>
<td>Avondale, Hayden Lake Irrigation District, North Kootenai Irrigation District, Rathdrum</td>
<td>Southern Rathdrum Prairie (ID)</td>
</tr>
<tr>
<td>820</td>
<td>City of Coeur d’Alene, City of Post Falls, East Green Acres Water District, Green Ferry Water and Sewer District, Hauser Lake Water Association, Post Falls Ponderosa Water Association</td>
<td>Coeur d’Alene &amp; Post Falls (ID)</td>
</tr>
<tr>
<td>830</td>
<td>Consolidated Irrigation District, Green Ridge Estates, Liberty Lake Water and Sewer, Moab Irrigation District, Pioneer Water Company, Trentwood Irrigation District, Timberline, Vera Irrigation District</td>
<td>Eastern Spokane Valley (WA)</td>
</tr>
<tr>
<td>840</td>
<td>Carnhope Irrigation District, East Spokane Water District, Hutchinson Irrigation District, Pinecroft, Hutton Settlement, Irvin Water District, Millwood Water District, Model Irrigation District, Modern Electric, Orchard Ave Irrigation District, Pasadena Park Irrigation District, Spokane County Water District #3-1 West Spokane Valley,</td>
<td>Spokane Valley (WA)</td>
</tr>
<tr>
<td>850</td>
<td>City of Spokane, Spokane Business, Rivervale Water Association</td>
<td>Spokane (WA)</td>
</tr>
<tr>
<td>860</td>
<td>City of Airway Heights, Fairchild Air Field Base, Stevens County Public Utility District</td>
<td>West Spokane (WA)</td>
</tr>
<tr>
<td>870</td>
<td>City of Spokane, North Spokane Irrigation District, Spokane Business, Spokane County Water District #3-4 Mead, Whitworth Water District</td>
<td>Little Spokane (WA)</td>
</tr>
</tbody>
</table>

A.2.2 Overview of Operating Rules in the Spokane River Basin

Current management and operations of the SRB result from a complex mélange of interstate, multi-jurisdictional laws and responsibilities, planning units, federal licenses, private agreements, court rulings, infrastructure, cultural traditions and physical limitations of the water system. Together these components form a mixture of different operating goals and constraints, and some of these components are available via public record, while others are not.

An important constraint on any water resource system is the available supply of water. Water enters the Spokane River from several sources: rain and snow runoff, direct precipitation onto water bodies, groundwater inflow to stream reaches. Water enters the Spokane Valley Rathdrum Prairie aquifer from a number of sources: Spokane River recharge to the groundwater, areal recharge, tributary recharge, lake recharge, and landscape irrigation. Water exits the system through the river’s discharge into the Columbia River, consumptive water uses such as municipal, agricultural and industrial uses, and evaporation from water bodies. Various gages throughout the SRB measure the river’s streamflow and reservoir storage at Coeur d’Alene Lake.
The section on external drivers (Section A.2.3) will explain how water enters the system in the SRB OASIS model.

Post Falls hydroelectric dam, operated by Avista, is on the Spokane River about 9 miles downstream of Coeur d’Alene Lake’s outlet. The dam affects Coeur d’Alene Lake elevation for about half of the year. During the winter and spring, lake levels are controlled entirely by the natural outlet restriction and inflows. The SRB model simulates the operations at Post Falls Dam, as it has the largest storage capacity of the dams on the Spokane River and the only one that must comply with a Federal Energy Regulatory Commission (FERC) license. The FERC license requires that the operations must meet minimum flow requirements, maximize storage capacity at Coeur d’Alene Lake during spring runoff, generate electricity to meet energy demands, and consider the upstream and downstream recreational, residential and commercial needs and interests (GEI Consultants Inc., 2003). All other dams on the river are operated as run-of-river facilities, with the exception of Nine Mile Dam and Long Lake Dam, which at present are excluded from the model domain. The section on operational goals will explain how the dam operations are incorporated into the model (Section A.2.5).

The following sections will cover how the model utilizes external datasets (Section A.2.3), what physical properties and relationships govern the way water is routed through the system (Section A.2.4), operational goals that the SRB OASIS model utilizes (Section A.2.5), and finally the outputs that will be generated (Section A.2.6).

A.2.3 External Drivers

The SRB OASIS model utilizes two external datasets: inflows, which include data from a bi-state USGS MODFLOW model, and water demand from the MODFLOW model and the Spokane County Water Demand Forecast model (Hsieh et al., 2007). These datasets serve as time series inputs for the SRB model. All of the time-series data is included in Hydrologic Engineering System Data Storage System (HEC-DSS) in the “Basedata.dss” file (Hydrologics Inc., 2009).

A large-scale, inter-agency hydrologic study and groundwater flow model of the SVRP aquifer, called the bi-state model, that utilized MODFLOW software is now published (Hsieh et al., 2007). An assortment of input data used in this bi-state model was also used in the SRB OASIS model. The nine lakes around the margin of the aquifer boundary contribute recharge to the groundwater (see Table A.1), and the time-series data of all lake inputs was used in the SRB model. Areal recharge, which incorporates direct soil infiltration of precipitation and urban stormwater runoff, and tributary recharge, which is the runoff from the highland areas adjacent to the aquifer and contributes to recharge to the groundwater, was included as inflows to the groundwater sub-regions in the SRB model (purple arrows in Figure A.3). At present, subsurface inflow from Hoodoo and Blanchard Valleys in the northern Rathdrum Prairie area are not incorporated in the model, as there is large uncertainty about how much actually recharges the aquifer in that area.

Inflow data for Coeur d’Alene Lake was back calculated using a linear interpolation routine. The streamflow data for the major rivers flowing into the lake was incomplete for the time period (1990-2005) used in the SRB model simulations, therefore it was necessary to calculate this data. Linear regression has been used to interpolate and extrapolate discharge data at ungaged and gaged sites (Helsel & Hirsch, 1992). Regression can also be used to interpolate missing data from ungaged sites and gaged sites, and is a more accurate method to predict
discharge at ungaged sites (Helsel & Hirsch, 1992). To calculate total discharge to Coeur d’Alene Lake linear interpolation was used based on the storage-elevation rule curve and discharge at the Post Falls gage. A seven-day moving average was then applied to the calculated total discharges. The reason for the smoothing is that inflows computed from outflows is usually noisy resulting in large spikes in the time series data, and the smoothing makes the inflows more realistic (Helsel & Hirsch, 1992).

Water demand in the Spokane River Basin includes municipal (public supply), domestic, agricultural and industrial water withdrawals from the aquifer. Public supply includes withdrawals from the aquifer to provide water to all public water systems, which is approximately 65% of total water withdrawals. Domestic wells includes water withdrawn from the aquifer by private wells for domestic uses including residential and irrigation, this accounts for 16% of total water withdrawals. Agricultural use is water withdrawn from the aquifer and applied to the land for crop and non-residential landscape irrigation, and is about 9% of total withdrawals. And, industrial use includes withdrawals from the aquifer from private wells to provide water for industrial uses in the area, and accounts for about 10% of total withdrawals. The water withdrawal monthly time-series for each of the categories was obtained from MODFLOW.

A.2.4 Physical Properties of the Spokane River Basin and the Spokane Valley Rathdrum Prairie Aquifer System

Aside from the operating constraints and goals (Section A.2.5), the SRB model incorporates physical data and relationships within the model to govern how water is routed through the system. This section includes information for Coeur d’Alene Lake, the Spokane Valley Rathdrum Prairie Aquifer and the surface-groundwater interaction.

Coeur d’Alene Lake

The storage-elevation curve at Coeur d’Alene Lake was obtained from Avista’s Senior Hydro Operations Engineer (Figure A.4). For every reservoir node in the system, there must be a record in the reservoir table, since OASIS computes the storage at the end of every time step. The storage-discharge relationship (also referred to as the maximum channel outlet capacity) was also obtained from Avista as it governs the outflow of the lake as a function of elevation (Figure A.5). This relationship governs the maximum outflow from Coeur d’Alene Lake.
Figure A.4 Coeur d’Alene Lake Storage-Elevation Curve.

Figure A.5 Elevation-discharge relationship that represents the outflow of the lake as a function of elevation at Coeur d’Alene Lake, also known as maximum channel outlet capacity.

Spokane Valley Rathdrum Prairie Aquifer

The storage-elevation curves in the groundwater sub-regions were calculated using fundamental principles of hydrogeology. In an unconfined aquifer, if water is added to the groundwater system, hydraulic head increases and thus water table levels will rise, however if water is removed from the groundwater system, hydraulic head decreases and water table levels in wells fall. In an unconfined aquifer, a change in hydraulic head results in both a change in pressure in the saturated portion of the aquifer, as well as a change in the thickness of the saturated zone. Storativity is the amount of water stored or released per unit area of the aquifer...
given a specific head change, and is calculated for each groundwater sub-region. In the case of the SVRP aquifer, storativity ($S$) equals:

$$S = S_y + S_S h$$

where $S_y$ is specific yield, $S_S$ is specific storage and $b$ is aquifer thickness. Specific yield ($S_y$) is the amount of water per unit volume that will drain from an aquifer under the influence of gravity. In unconfined aquifers, specific yield is usually several orders of magnitude larger than $S_S b$, thus, storativity is considered equivalent to specific yield (Fetter, 2000).

The volume of water that will be drained from or added to an aquifer as the head is raised or lowered is represented by:

$$V = S \cdot A \cdot \Delta h$$

where $A$ is the area overlying the aquifer, $S$ is storativity (specific yield) and $\Delta h$ is the change in hydraulic head. In the SVRP aquifer it ranges between 0.1 and 0.186 (Hsieh et al., 2007; Kahle & Bartolino, 2007). This equation was used to calculate the storage-elevation relationship for each groundwater sub-region, therefore the volume of water changed from a 1 foot change in hydraulic head is shown in Table A.3.

<table>
<thead>
<tr>
<th>Groundwater Sub-region</th>
<th>Volume /1 ft $\Delta h$ (KAF)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Northern Rathdrum</td>
<td>13.50</td>
</tr>
<tr>
<td>Southern Rathdrum</td>
<td>9.00</td>
</tr>
<tr>
<td>CDA/Post Falls</td>
<td>2.25</td>
</tr>
<tr>
<td>Eastern Spokane Valley</td>
<td>1.64</td>
</tr>
<tr>
<td>Spokane Valley</td>
<td>1.64</td>
</tr>
<tr>
<td>Spokane</td>
<td>1.96</td>
</tr>
<tr>
<td>Western Arm</td>
<td>0.98</td>
</tr>
<tr>
<td>Hillyard Trough + Little Spokane River</td>
<td>1.47</td>
</tr>
</tbody>
</table>

Table A.3. The calculated volume change per 1 foot change in head in each of the groundwater sub-regions, units are thousand acre feet (KAF.) See Table A.1 for node number reference.

Surface Water-Groundwater Interaction

The flow from the river to the aquifer is calculated based on MODFLOW’s streamflow packages, and this flow is calculated differently for hydraulically connected and disconnected systems. In MODFLOW terminology, the groundwater is hydraulically connected if the water table is above the elevation of the base of the streambed. In this case, the exchange volumetric flux ($Q_{GW}$) [cfs] between the groundwater and the river is shown in Equation 2A. In Equation 2A, $H_{GW}$ is the head in the groundwater node [ft], $H_{RIV}$ is the stage in the river [ft], $C_{RIV}$ is the conductance of the river bottom sediments [$ft^2/s$], and $Q_{GW}$ is the flow between the groundwater and the river. The hydraulic conductance ($C_{RIV}$) is a lumped parameter that summarizes the geometry of the river and its hydraulic conductivity. If the water table ($H_{GW}$) is below the elevation of the streambed bottom ($R_{BOT}$), the surface water-groundwater system is considered hydraulically disconnected in MODFLOW. In this case, the volumetric infiltration flux ($Q_{RIV}$) from the river to the aquifer is shown in Equation 2B.
\[ Q_{GW} = C_{RIV} \times (H_{GW} - H_{RIV}) \]
Equation 2A. The governing equation for a hydraulically connected groundwater and surface water system.

\[ Q_{RIV} = C_{RIV} \times (H_{RIV} - R_{BOT}) \]
Equation 2B. The governing equation for a hydraulically disconnected groundwater and surface water system.

In the SRB OASIS model, there is only one river reach known to be hydraulically disconnected from the aquifer system, from the outlet at Coeur d’Alene Lake to Post Falls Dam (Groundwater Node 420 to Spokane River Node 220). All other reaches in the SRB model are hydraulically connected to the groundwater system (430 to 230, 440 to 240, 450 to 250, etc.).

In hydrology, a rating curve is a graph of stage (gage height) versus discharge for a given point in the stream, usually at gaging stations. The SRB OASIS model simulates streamflow discharge (cfs), and uses the rating curve to convert the discharge to stage so that it can be utilized to calculate the flow from the river to the groundwater system and vice versa (Equation 2A and 2B). The USGS has streamflow rating curves for both the Spokane gage (node 250) and the Post Falls gage (node 220) (Figure A.6). The rating curves for nodes 230 and 240 were linearly interpolated between the Spokane and Post Falls gages.

![Figure A.6 Rating curves for the gages at Post Falls and Spokane.](image)

A.2.5 Operational Goals in the Spokane River Basin

There are a variety of goals in the SRB model. Rule curves, demand targets, and surface water-groundwater interaction are operational goals implemented in the SRB model. Each of these goals is expressed in the model as a target with weights that define a penalty or an incentive for matching or deviating from the target value. Rule curves (or minimum instream
flow targets) drive hydroelectric dam operations at Post Falls. Demand and surface water-groundwater interaction targets are treated as goals with very high targets to ensure that each goal is met for every timestep. For each timestep in the simulation, the SRB model finds an optimal value for each model output that (a) satisfies all applicable constraints, (b) minimizes applicable target penalties, and (c) maximizes applicable target benefits (Hydrologics Inc., 2009).

Rule curves are one of the most important goals in the model, as they govern the level of Coeur d’Alene Lake. In the SRB model the Upper Rule Curve and the Lower Rule Curve are the same, because Post Falls dam only impacts lake levels for part of the year and thus follows the same general operation pattern every year (Table A.4; Figure A.7). In the summer, Avista holds the elevation of Coeur d’Alene Lake at 2128 ft for recreation and public uses, and because the dam spill gates are closed, the river above the dam looks like a lake. In autumn, Avista begins to let water out of the lake the Tuesday after Labor Day, drawing the lake down about 1-1.5 ft per month until the river is in a natural state, around 2121.5 ft. At some point in December or January, the outlet restriction at the river outlet becomes the determining factor of how much water will flow down the Spokane River. From then until Avista closes the spill gates in June, the Post Falls dam has little or no effect on river flows or lake levels. During spring, the Spokane River behaves like a river, not a lake, above the dam, until the snow has melted and Avista begins to close the spill gates. These operations are incorporated into the SRB via rules (Table A.4).

![Figure A.7](left). Rule Curve for Coeur d’Alene Lake elevation and Post Falls Dam operations.

![Table A.4](right). Rule Curve values shown in figure to the left.

The full delivery of water, and the routing of groundwater to surface water (and vice versa), are treated as goals with high weights. The full delivery of water based on demand is also another important goal in this system. In the SRB OASIS model, the delivery of water has a very high weight associated with each demand node, such that the water demand will be fully delivered. This reflects the fact that there has never been a water demand shortage in the basin; therefore it has a very high goal to ensure that this target is met at each timestep. If stakeholders would like to explore scenarios where demand is not fully met, the user can just adjust the weight of the demand node to change the amount of water delivered at each timestep. The routing of water between the groundwater and surface water systems is also treated as a goal in the model with a very high weight. The equations (2A and 2B) that represent the flux of groundwater to
surface water are computed as targets with a very high weight to ensure that water is routed properly between the two systems.

A.2.6 Outputs

Based on the operating rules, goals and constraints in the SRB OASIS model, it was determined that five primary types of output would be necessary: (1) streamflow at each node in the system, (2) surface water reservoir storage or elevation, (3) groundwater reservoir elevation at each reservoir node, (4) flow of water between each groundwater reservoir node and surface water node, and (5) delivery of water at each demand node. There are the five categories of variables that the linear program optimizes at each timestep, and each one can be used to measure some aspect of system performance. For example, elevation at Coeur d’Alene Lake is necessary to determine whether the operations of Post Falls dam are in compliance with FERC. It is useful to understand that these outputs consist of a value for each of these five parameters each day in the simulation.

A.2.7 OASIS SRB Model Limitations

This research project developed the SRB model with the original goal to develop a decision making tool that could be utilized by water managers in both Washington and Idaho. The version of the SRB model presented here represents a preliminary modeling framework that could be further used in a collaborative modeling process for the Spokane River Basin, although it is important to note three distinct points. First, the model, similar to all models, incorporates assumptions about the system that simplify the complex reality of groundwater properties and integrated surface and groundwater dynamics. Second, it is important to be aware that this iteration of the SRB model has been preliminarily calibrated. Further calibration should include direct comparison and calculating percent bias with the MODFLOW results. Third, hydrologic modeling and collaborative modeling processes are iterative processes. A model with this complexity and scale has triggered, as expected, conversations regarding future and potential refinements. In most CM processes, the purpose is to improve the modeled representation of the system through stakeholder engagement, which can improve stakeholder knowledge and decision-making ability. Thus a CM process should broaden stakeholder participation and evaluation of the model by additional agency scientists, water managers and local stakeholders. This would help both refine the model of the system and improve calibration of the model.
APPENDIX B. R PROGRAMMING LANGUAGE

This section includes all of the R programming language code used for model post-processing purposes.

```r
library(dplyr)
library(data.table)
library(ggplot2)
library(scales)
library(tidyr)
library(plotly)

#LOAD POSTFALL HYDROGRAPH DATA OASIS
pf.flow <- head(read.table("C:/OASIS/OASIS_SVRP/OASIS_SVRP/Runs/Sim/Daily_GW_Route_Nov/PostFalls_Hydrograph.txt", sep="", skip=2, header = T), -3)
pf.flow$DATE <- as.Date(as.character(pf.flow$DATE),format = "%m/%d/%Y")

#LOAD SPOKANE HYDROGRAPH DATA OASIS
spok.flow <- head(read.table("C:/OASIS/OASIS_SVRP/OASIS_SVRP/Runs/Sim/Daily_GW_Route_Nov/Spokane_Hydrograph.txt", sep="", skip=2, header = T), -3)
spok.flow$DATE <- as.Date(as.character(spok.flow$DATE),format = "%m/%d/%Y")

#LOAD SPOKANE DATA - SCENARIO 1
spok2.flow <- head(read.table("C:/OASIS/OASIS_SVRP/OASIS_SVRP/Runs/Sim/Daily_GW_Route_Scenario1/Spokane_Hydrograph.txt", sep="", skip=2, header = T), -3)
spok2.flow$DATE <- as.Date(as.character(spok2.flow$DATE),format = "%m/%d/%Y")

#LOAD POSTFALLS DATA - SCENARIO: DEMAND DECREASE 50%
pf2.flow <- head(read.table("C:/OASIS/OASIS_SVRP/OASIS_SVRP/Runs/Sim/Daily_GW_Route_Scenario1/PostFalls_Hydrograph.txt", sep="", skip=2, header = T), -3)
pf2.flow$DATE <- as.Date(as.character(pf2.flow$DATE),format = "%m/%d/%Y")

#Convert data to a data.table frame (to combine datasets)
pf_tdf <- tbl_df(pf.flow)
pf2_tdf <- tbl_df(pf2.flow)
spok_tdf <- tbl_df(spok.flow)
spok2_tdf <- tbl_df(spok2.flow)

#Combine Datasets
spok_data <- dplyr::inner_join(spok_tdf, spok2_tdf, by = "DATE")  #combined timeseries data
setnames(spok_data, old=c("CFS.x","CFS.y"), new=c("BAU", "Scenario1"))
spok_data$Var <- c("SpokaneGage")
spok_data_long <- gather(spok_data, "Scenario", "Value", BAU:Scenario1)
setnames(pf_data, old=c("CFS.x","CFS.y"), new=c("BAU", "Scenario1"))
pf_data$Var <- c("PostFallsGage")
pf_data_long <- gather(pf_data, "Scenario", "Value", BAU:Scenario1)
pfsf <- bind_rows(spok_data_long, pf_data_long)
OASIS <- pfsf
```

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#Calculating Monthly Means
spokflow.mo <- setDT(spok.flow)[, (MonthlyMeans = mean(CFS)), by = .(month(DATE))]
spokflow2.mo <- setDT(spok2.flow)[, (MonthlyMeans = mean(CFS)), by = .(month(DATE))]
pfflow.mo <- setDT(pf.flow)[, (MonthlyMeans = mean(CFS)), by = .(month(DATE))]
pfflow2.mo <- setDT(pf2.flow)[, (MonthlyMeans = mean(CFS)), by = .(month(DATE))]

# --------- Combine Monthly Mean Datasets - for scenarios ---------
#Spokane
spokmo_tdf <- tbl_df(spokflow.mo)
spokmo2_tdf <- tbl_df(spokflow2.mo)
spok_modata <- dplyr::inner_join(spokmo_tdf, spokmo2_tdf, by = "month") #combined timeseries data
setnames(spok_modata, old=c("MonthlyMeans.x","MonthlyMeans.y"), new=c("SpokaneBAU", "SpokaneDemand"))
spok_modata <- ddply(spok_modata, "month")

#PostFalls
pfmo_tdf <- tbl_df(pfflow.mo)
pfmo2_tdf <- tbl_df(pfflow2.mo)
pf_modata <- dplyr::inner_join(pfmo_tdf, pfmo2_tdf, by = "month") #combined timeseries data
setnames(pf_modata, old=c("MonthlyMeans.x","MonthlyMeans.y"), new=c("PostFallsBAU", "PostFallsDemand"))
pf_modata <- ddply(pf_modata, "month")

# ---------------------- PLOTTING -------------------------
#Re-arrange Data and PLOT both timeseries
#spok_modata is the DF for the plots
#spok_modata is the data with Spokane BAU and Spokane with a 50% decrease in demand
spokscenario <- ggplot(data=spok_modata_long, aes(x=month.abb[month],y=MonthlyMeans, group = Scenario, colour = Scenario))
z <- spokscenario +
  geom_line(size=1) +
  scale_x_discrete(limit=c("Jan","Feb","Mar","Apr","May","Jun","Jul","Aug","Sep","Oct","Nov","Dec"))+xlab("Months") +
  theme_bw() +
  ggtitle("Monthly Average Streamflow at Spokane: \n BAU v. 50% decrease in outdoor demand")
gg2list(z)

#POST FALLS MONTHLY MEAN: SCENARIOS
pfsenario <- ggplot(data=pf_modata_long, aes(x=month.abb[month],y=MonthlyMeans, group = Scenario, colour = Scenario))
bb <- pfsenario +
  geom_line(size=1.5) +
  scale_x_discrete(limit=c("Jan","Feb","Mar","Apr","May","Jun","Jul","Aug","Sep","Oct","Nov","Dec"))+xlab("Months") +
  theme_bw()
gg2list(bb)
APPENDIX C. EDUCATION AND OUTREACH CONTENT

This appendix has materials for the 4 themes of the water stewardship campaign. Section C.1 includes a storyboard and graphic for the water quantity theme. Section C.2 includes the video script and storyboard for the stormwater theme. Section C.3 includes storyboard materials for the water quality theme. Section C.4 includes materials from the preservation theme.

C.1 Water Quantity Storyboard Materials

For this theme, the group has outlined the individual frames of an animated video, see below.

- **EPISODE 1: THE ADVENTURES OF DRIPPY THE WATER DROP**
  - Frames:
    - 1. Title
    - 2. Starting as a cloud
    - 3. Falling as snow onto a tree branch
    - 4. Melts from tree branch and falls onto iceberg n river water
    - 5. Flowing down river on iceberg
    - 6. Melts to merge with river flow
    - 7. Flows from river into lake
      - A. Other flows into lake from other rivers or other lakes
    - 8. Sinks down lake and infiltrates into aquifer with his other water drop buddies (likely multiple frames)
      - A. Bouncing in between rocks (plink sounds), always keep him moving
    - 9. Flows in aquifer between rocks
    - 10. Sucked up through a well
    - 11. Moves from well/storage to underground pipe
    - 12. Moves up pipe towards a neighborhood community
    - 13. Comes out through sprinkler onto the lawn
    - 14. Moving through grass
    - 15. Evaporates into atmosphere
    - 16. Condenses into a cloud
    - 17. Final message and IWAC logo
      - **water works hard to get to you? It’s all connected - precipitation, river, aquifer, lakes & decreased water quantity can impact all of these [its dynamic]. It’s your drinking water, lawn water, etc. use it wisely!**
  - Episode Summary
    - 1. Water Cycle - Drippy the Drop
    - 2. Interaction of ground and surface water
    - 3. Outdoor water use
    - 4. Indoor water use
    - 5. Conservation

Figure C.1 includes a storyboard of sketches of Drippy the drop that were created during an IWAC workshop, with the intent to be used in an animation video. These sketches were created by Kayla Wakulich, School of the Environment graduate student at WSU.
Figure C.1 Water Quantity story board sketches, by Kayla Wakulich.
C.2 Stormwater Video Script and Storyboard

The preliminary version of this video can be found here: https://www.youtube.com/watch?v=MmU-wnKBvhg&feature=youtu.be. This video was created by Korey Woodley, Kayla Wakulich and Jennifer Johnson, all graduate students in the School of the Environment at WSU.

“The Call” Radio/Video Transcript used in the stormwater video was modified with permission from Texas Commission on Environmental Quality and LaPorte County (http://www.laportecounty.org/Environment/MS4/OutreachToolbox/detailspopup.htm#107).

Transcript used in the video:
First Audio:  (Sound of a phone ringing.)

Johnson: Hello?
Storm Drain: Yeah, Johnson. It’s me.
Johnson: Who?
Storm Drain: I’m right in front of the house.
Johnson: Where?
Storm Drain: Right on the street.
Johnson: Well, all I see is a storm drain.
Storm Drain: Yeah, yeah. That’s me.
Johnson: What?!
Storm Drain: Listen, Johnson. You gotta get that car fixed. It’s leaking oil all over the street, ‘ya hear me?

Johnson: My car doesn’t leak… (Storm Drain interrupts)
Storm Drain: Ah, no use denying it, Johnson. Just fix it, all right?
Johnson: Hey, how are you doing that?
Storm Drain: And you’re over-fertilizing your yard.
Johnson: I’m not over-fertilizing… (Storm Drain interrupts)
Storm Drain: They’re called labels, Johnson! What’s the matter with you? They tell you how much fertilizer to use. Read ‘em!

Johnson: But, all I did was… (Storm Drain interrupts again)
Storm Drain: Look, all that stuff washes into us storm drains whenever it rains.
Johnson: Well, I didn’t know that…
Storm Drain: I know you don’t know. That’s why I’m calling you.
Johnson: Well, thanks. I… I didn’t mean any harm.
Storm Drain: Yeah, yeah. Same thing with all that dog waste you have out there, all right? Pick that up!

Johnson: You mean that you eat… (Storm Drain interrupts again)
Storm Drain: Pick it up! I don’t want to talk about it, just pick it up!
Johnson: I understand.
Storm Drain: Listen, listen… All that stuff runs straight into our lakes, Spokane River, and aquifer. The aquifer is the source of your drinking water!

Johnson: Oh, my!
Storm Drain: Exactly. Yeah, so do us both a favor, all right? Please… don’t feed the storm drain!
Johnson: Okay. Thanks mister Storm Drain.

Sponsor Message: A message from the community partners of the Idaho-Washington Aquifer Collaborative. For more information go to the iwac.us. Cause we are all in it together.

C.3 Water Quality Storyboard Materials

Below is the storyboard and ideas developed for the water quality video:

<table>
<thead>
<tr>
<th>Include relevant script text</th>
<th>Include relevant images, graphics, videos, etc. that coordinate with the script language</th>
</tr>
</thead>
<tbody>
<tr>
<td>Birds and summer sounds in the background</td>
<td>This video starts with a nice sunny day image of a house with a green lawn and a car in the driveway</td>
</tr>
<tr>
<td>No audio of faint background music</td>
<td>Show a view inside of house of yellow paint brushes and a roller pan in a sink being cleaned with water only showing hands</td>
</tr>
<tr>
<td>No audio of faint background music</td>
<td>Show view in house of bright medication in toilet being flushed watching it go spinning down.</td>
</tr>
<tr>
<td>No audio of faint background music</td>
<td>Show view of fertilizer being applied to the lawn with bag spilled on driveway</td>
</tr>
<tr>
<td>No audio of faint background music</td>
<td>Show view of car pulling out of driveway leaving behind a large oil spot that has washed away to the nearby drain in street</td>
</tr>
<tr>
<td>Audio of car driving down the road. Advertisement on the radio of annual Spokane River cleanup.</td>
<td>Show view of car driving down the highway with child looking out the window watching cleanup crews cleaning garbage from the river bank.</td>
</tr>
<tr>
<td>Sound of children playing and sounds of waves splashing on beach</td>
<td>End video with mom laying on the beach and children playing.</td>
</tr>
<tr>
<td>No audio of faint background music</td>
<td>Child going to the water that has thick algae scum.</td>
</tr>
<tr>
<td>No audio of faint background music</td>
<td>Display IWAC US website “Find out what you can do at iwac.us”.</td>
</tr>
</tbody>
</table>
C.4 Preservation Storyboard Materials

Below is the storyboard and ideas developed for the preservation video:

<table>
<thead>
<tr>
<th>Include relevant script text</th>
<th>Include relevant images, graphics, videos, etc. that coordinate with the script language</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Narrator:</strong> “music plays”</td>
<td>pristine water images</td>
</tr>
<tr>
<td>- This is where our water comes from, these are our mountains, our lakes our rivers. They are all connected to our aquifer. Preservation, needs to be everyone’s goal. We need your help.</td>
<td>- Fly over or still shots of snow-packed mountains (this is where it starts)</td>
</tr>
<tr>
<td></td>
<td>- Fly over lakes, falls (see the journey of water and what we have)</td>
</tr>
<tr>
<td></td>
<td>- Images of Spokane falls/Post falls, Mt. Spokane, Coeur d’Alene Lake</td>
</tr>
<tr>
<td><strong>Narrator:</strong> Don’t make the same mistakes of past generations. This is what can happen.</td>
<td>Colbert system polluted</td>
</tr>
<tr>
<td></td>
<td>Contamination of public water in Coeur d’Alene</td>
</tr>
<tr>
<td><strong>Narrator:</strong> Here’s what our local citizens are asking for.</td>
<td>Student interviews answering the question “If water is important for your life, what should we be doing to make sure everyone has it?”</td>
</tr>
<tr>
<td><strong>Narrator:</strong> Remember this starts with you. We have to live with our actions. Everyone can do something to preserve our aquifer.</td>
<td>Volunteers doing positive actions</td>
</tr>
<tr>
<td></td>
<td>Kids playing in water, fishing, kayaking</td>
</tr>
<tr>
<td><strong>Narrator:</strong> This message has been brought to you by IWAC. Please go to iwac.us to learn more about what you can do to preserve our waters.</td>
<td>Logo and website on screen (IWAC written out)</td>
</tr>
<tr>
<td></td>
<td>3-4 seconds</td>
</tr>
</tbody>
</table>
APPENDIX D. INTERVIEW PROTOCOL

This appendix has three sections: a) consent form used to interview study participants (Section D.1), b) sample of a stakeholder recruitment letter for interviewing (Section D.2), c) interview protocol and questions asked (Section D.3).

D.1 Consent to Interview Form

CONSENT TO INTERVIEW

Stakeholder Engagement in the Spokane River Basin
Washington State University

Purpose: This research focuses on a collaborative modeling project in the Spokane River Basin that allows stakeholders and scientists to jointly address key issues related to regional water resource decisions and climate change. The goal of this project is to understand how water systems and the relevant stakeholders will adapt their water management strategies to changes in climate and water availability. This purpose of the interviews is to evaluate the stakeholder engagement process and use the information gathered to track opportunities to support stakeholder decision-making related to water resource management. In addition, this research aims to investigate the role a university-based facilitator can play in engaging stakeholders in a participatory water process over time.

The stakeholder engagement study, which is a key component of the WISDM project research, is being conducted by Dr. Allyson Beall King (Clinical Assistant Professor of School of the Environment), and Melanie Thornton (graduate student of School of the Environment). This study, titled "collaborative modeling and stakeholder engagement in the Spokane River Basin" has been deemed exempt from review by the Washington State University Office of Research Assurances (IRB). Any questions about protection of human subjects participating in the study and adherence to ethical standards should be directed to Allyson Beall King, 509-335-4037 or abeall@wsu.edu.

Requirements: The interview will take approximately 30-45 minutes of your time. Participation in this study is completely voluntary. Your decision whether or not to participate will not affect your current or future relationship with any of the organizations involved in this study. If you decide to participate, you are free to refuse to answer any of the questions. You can withdraw at any time. This interview will be audio recorded in order to insure that transcripts of the session are accurate. You may object to being audio recorded. After sessions are transcribed, the audio file or tape will be destroyed. We will stop and/or erase the recording at any point upon request. A copy of this form will be given to you.

Confidentiality: To protect your privacy and that of your colleagues, all transcribing will be done by researchers or professional transcribers. Data will be stored in a locked or password protected storage accessible only to researchers. Presentations, reports, and publications will focus attention on general findings about the stakeholder engagement process. To the extent possible, individuals’ contributions will be reported in ways that avoid identification of those individuals, unless you state your preference that we do so.
Please indicate your choice by checking one statement from the following list:

I prefer that any quotations from my interviews are used in the following way:
  □ quotes attributed to me and my institution
  □ quotes without attribution (research team will use language that does not identify you or your institution)

Statement from the Principal Investigator
I understand the nature of the study and voluntarily agree to participate in an interview about my experience and my perceptions of stakeholder engagement in the Spokane River Basin to be recorded through the use of field notes. I can refuse to be audio-recorded. In addition, I understand that I can stop the interview at any time; I can also request that audio file or tape and field notes be destroyed. I have had enough time to ask questions and have them answered. I have been given a copy of this form whether I agree to participate or not.

SIGNATURE OF PARTICIPANT ___________________________ DATE ___________

PRINTED NAME OF PARTICIPANT _______________________________________

SIGNATURE OF RESEARCHER ___________________________ DATE ___________

PRINTED NAME OF RESEARCHER _______________________________________

D.2 Sample of a stakeholder recruitment letter used for interviews

Dear ____________.

Thank you for your participation in the WSU collaborative modeling exercises in the Spokane River Basin.

I am in the process of setting up interviews with members of the Idaho Washington Aquifer Collaborative (IWAC) to better understand perspectives about the role university researchers play in engaging stakeholders in a collaborative process over time. In addition, I would like to discuss your general experience as a participant in the collaborative modeling process, including the challenges you have faced and lessons you have learned, as well as your goals for the future of IWAC.

I would like to set up a time to interview you on the phone between [insert dates here]. Please reply to this message with a few suggestions of dates and times when you are available.

Thank you for your time.
Sincerely,
Melanie Thornton
PhD Candidate
School of the Environment, Washington State University
melanie.thornton@wsu.edu

D.3 Interview Protocol

Case No. __________

Date ___________________________ Time __________________________

Location ________________________________________________________

Introduction
- Thank you for taking the time to discuss water resources and stakeholder engagement in the Spokane River Basin.
- This purpose of the interviews is to evaluate the long-term stakeholder engagement between WSU and regional water resource stakeholders
- The information gathered will be used to improve stakeholder engagement processes and to track opportunities to support stakeholder decision-making related to water resource management.
- If you consent, I will be taking notes and audio recording our conversation, but if you prefer that I not do one or both of those things, please indicate your preference. We can stop the recording or end the interview at any time.
- In any published discussion of our findings from the interviews, your responses will be anonymous unless you prefer to have quotes attributed to you. You may indicate this preference on the consent form.

Clarifying the nature of the stakeholder’s involvement
1. What connection do you have with the Spokane River Basin region?
2. When did you first become involved in IWAC?

History & future of IWAC
3. I want to ask a few questions about IWAC
   a. When do you think the momentum within IWAC was the highest?
   b. When do you think the momentum within IWAC was the lowest?
   c. What do you think attributes to that change in momentum?
   d. How do you think momentum can be maintained within a group like IWAC?
4. Thinking back to the formation of IWAC, did your perception of this basin’s future changed? If so, when did that happen?
5. Thinking about the mission & goals of IWAC:
   a. What are some issues that IWAC will need to address as immediate or pressing concerns?
   b. What are some issues that IWAC will need to address as long-term concerns?
6. Do you have any other comments about IWAC?

**Role of university researcher**
7. What do you think of the role a university researcher plays as a participant in a water planning processes?
8. What do you think of the role a university researcher plays as a facilitator in a water planning processes?
9. Do you think a university researcher can serve as a neutral facilitator in a water planning process with multiple stakeholder groups?
10. Do you have any suggestions or general comments about how university researchers and/or facilitators can help regional stakeholders with water planning processes in the future?

**Perceived impact of the collaborative process**
11. What was the nature of your involvement in these 2 WSU led collaborative processes?
12. Do you feel you personally learned much from being involved in this collaborative process?
13. Do you feel that your contribution to this process was valued?
14. Do you find your involvement in this process has changed the way you see the water resource system?
15. Do you find your involvement in the process has improved your ability to take part in other collaborative projects or civic actions?

**Benefits and challenges of the process**
16. Have you been involved in similar collaborative planning processes before? If so, how did this process compare with them?
   a. Was the process transparent?
17. What were the positive aspects of the collaborative process?
18. What were the drawbacks of the collaborative process?
19. What are two of the most useful facilitation tools that were employed during the past year during IWAC. Please distinguish between those two.
20. With hindsight, what things might you do differently if involved in similar processes in the future?

**Impact on group involvement - capacity building**
21. Do you feel the people in IWAC that participated in the collaborative process were the right ones? Were there people or perspectives missing?
22. Do you think that this process has helped to develop new relationships between different people or organizations?
23. Do you find your involvement in the process has improved other members in the groups’ ability to take part in other collaborative projects?
**General evaluation question**

24. What would you look at in order to judge the success of the overall collaborative water planning process, in terms of its impact:
   a. Personally?
   b. On the group involved?
   c. On the Spokane River Basin (region)?

25. If you were the water czar of the region? What would be some of the first things you would want to accomplish?

26. Do you have any further questions or general comments?