BC Water Symposium Proceedings

February 2011

Prepared for the BC Ministry of Environment

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TABLE OF CONTENTS

LIST OF APPENDICES

1. Executive Summary

The BC Water Symposium was an opportunity for members of the BC water community to discuss current and emergent issues, to develop new relationships and to work together to build the foundations for a BC Water Science Strategy. The theme for the Water Symposium was improving the flow of information and knowledge among groups working and living in watersheds. The Symposium was held in three locations concurrently: Prince George, Kelowna and Victoria, at the end of August 2010, and included plenary speakers, panel sessions, a poster session, networking breaks, and four breakout discussions. Plenary presentations were simulcast across all three locations but other sessions were held locally. The main purpose of these proceedings is to document and summarize the input received during the Symposium and to provide some initial directions for the Water Science Strategy.

Participants' input was collected mainly through the four facilitated breakout discussions that were held over the second and third days. The breakout discussions focused on the symposium theme of improving knowledge translation and exchange, as well as gathering input for the Water Science Strategy. The first two breakout sessions concentrated on identifying the key issues pertinent to the sustainable management of water resources and aquatic ecosystems and identifying communication methods used by groups (scientists, policy-makers, end-users, stakeholders and First Nations) within a watershed. The third and fourth breakout sessions were devoted to identifying key elements that must be in place to support the translation and exchange of information and knowledge as well as those that should be included in a Water Science Strategy.

Improving collaboration and breaking down divisions among government agencies, disciplines and sectors were repeatedly suggested as necessary steps to improving the flow of information and knowledge. This included the need to recognize the importance of building trusting, open and honest relationships and to respect all types of knowledge, and especially First Nations' knowledge, when working together. Communication pathways within groups (e.g. scientists, stakeholders) are generally stronger than those among groups and therefore new communication pathways that link groups together need to be forged to facilitate the flow of information. Suggested tools to build these new pathways included regular multi-disciplinary and multi-sector events such as the Water Symposium held at both the regional and provincial scale; a living database of water experts and water practitioners; and Listservs or social networking tools that facilitate online communication and community building.

In addition to increasing interpersonal communication, participants also identified the need to increase access to water data and water knowledge. In some cases, participants felt that there is generally insufficient information to inform water allocation planning and decision-making. Participants suggested that mandatory reporting of groundwater and surface water extraction could be implemented. Water extraction data were seen as essential to creating water balance models for watersheds to inform water allocation decisions. In addition to data collection, the participants identified the need to improve data standardization. It was suggested that better access to water data could be achieved through the creation of an information-clearing house.

Many participants commented on the need to improve communication, education and outreach of water science as well as to increase training and mentoring opportunities. In general, there was a feeling that better public outreach would improve engagement (both public and political) around water issues and could help to improve water conservation. Mentoring young professionals and educating youth could also improve engagement in water issues.

Participants were eager to see the development of a Water Science Strategy move forward and were hopeful that dedicated leadership in water science, through the Water Science Strategy, could improve coordination, the integration of water science into decision-making, and help to secure resources to support water science. A wealth of input was captured at the Water Symposium that will be used to inform the development of the Water Science Strategy including principles to guide the development of a strategy, a suggested governance model, and specific recommendations to improve the flow and application of water science in the province. As a next step, the Ministry of Environment will use the information from the Symposium to guide the development of a draft Water Science Strategy framework.

Acknowledgements

The following sponsors and partners made the BC Water Symposium possible:

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2. Introduction

Living Water Smart, BC's Water Plan[1]*, outlines* government's commitments to safeguarding our water. One of the commitments made by government in this plan is the creation of a Water Science[2] Strategy (WSS) to improve access and availability of water science to aid in decision-making. Developing a WSS for the province is a complex task, especially as many different groups within a watershed hold water information and knowledge. The BC Water Symposium was a chance to bring together the different knowledge creators, holders and users of water knowledge to exchange information on water issues and to think of ways to improve the flow of information and knowledge.

The BC Water Symposium was held concurrently in Prince George, Kelowna and Victoria on August 30,31 and September 1st, 2010. The objectives of the Symposium included:

- discuss current and emerging water issues;
- develop new collaborative relationships; and
- work together to build the foundations for a BC Water Science Strategy (WSS).

The Symposium brought together over 200 participants from government, academia, First Nations, non-governmental organizations and industry. The Symposium was a mix of plenary speakers, panel sessions, breakout discussions, a poster session and also included time for informal dialogue through networking breaks and lunches.

The theme for the Water Symposium was knowledge translation. The WSS Advisory Committee[3] determined that one of the first obstacles that must be overcome to apply water knowledge to planning and decision-making was access to this knowledge by improving knowledge translation. Knowledge translation is the process of communicating knowledge to another party with different training and perspectives, and knowledge exchange, the process of co-developing knowledge across disciplinary or sector boundaries. The BC Water Symposium Discussion Paper, available on the Water Science Strategy website[4], was circulated to participants before the Symposium and gave an overview of the Symposium theme as well as a description of active watershed groups.

The sessions of the Symposium were designed to stimulate discussion, build relationships and initiate discussions to inform a WSS. The complete program for the Water Symposium can be found in **Appendix B.** The first evening was open to non-registered participants and included two public lectures: Dr. Hans Schreier gave an overview of watershed management innovations, and Chief Keith Matthew spoke of the inclusion of water in Aboriginal Rights and Title and the importance of water from a First Nations' perspective. A list of plenary speakers and abstracts can be found in **Appendix C.** The plenary presentations were followed by a public panel that discussed either what a Water Science Strategy might look like, or in the case of Prince George, the impacts of climate change on northern watersheds. A public reception that included poster viewing capped the first night of the Symposium.

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[1] See www.livingwatersmart.ca for more information

[2] For the WSS, science is defined broadly to include all empirically based information, which includes First Nations' knowledge.

[3] See **Appendix A** for Advisory Committee membership

[4] www.livingwatersmart.ca/watersciencestrategy/

On the second day, plenary speakers presented their work and recent successes and described challenges of applying their research. A panel discussion tackled the question of how different types of information and knowledge are used to develop policy (a list of all panelists for both panels in all locations can be found in **Appendix D).** Two breakout discussions on the second day were targeted towards summarizing the main water issues in BC (breakout session I) and understanding the means by which different groups within a watershed communicate (breakout session II). The final session of the second day was a poster reception. Abstracts for all posters can be found in **Appendix E.**

Ken Matthews, CEO of the Australian National Water Commission, gave the keynote address on the third day and spoke of the efforts to create a national water strategy in Australia. Following this there were two more breakout sessions, to identify the key elements necessary to facilitate the creation, translation and exchange of water information and knowledge (breakout session III) and an afternoon session devoted to determining the key elements that should form the basis of a WSS (breakout session IV).

The Symposium included both provincial and local sessions. Welcome remarks, plenary speakers and the final recap were simulcast via webinar technology. The plenary speakers were distributed among the locations and participants were able to ask questions either verbally via the web link or by typing the message out and sending it to the host location. Poster, panel and breakout sessions were all held independently at each location. The breakout sessions were facilitated by government staff and followed a Symposium facilitation guide that gave instructions for the breakout process.

2.1. About the Water Symposium Proceedings

This main document presents an overview of the methods used in each breakout session as well as a summary of participants' input. More detailed summary of the information collected by facilitators on flip charts and written comments collected from participants can be found in the accompanying appendices. Regional summaries are also provided within the appendices along with a more complete description of the activities that took place within each breakout session.

The intention in producing these proceedings was to capture and summarize participants' input provided in the breakout sessions. In this way all the material will be available for later analysis once more progress has been made on developing the WSS.

3. Breakout Discussions

3.1. Breakout Session I – What are the key issues pertinent to the sustainable management of water resources and aquatic ecosystems?

Description of Facilitated Break-out Session

There were two guiding questions for this breakout session:

- What are the key issues pertinent to the sustainable management of water resources and aquatic ecosystems?
- Where are the knowledge gaps?

Three rooms were used within each location to target discussions on one of three topic areas: water governance (social, policy, and regulatory tools to better conserve and manage water), surface and groundwater hydrology; and watershed health (people and aquatic ecosystems). To address the first question, participants wrote issues on sticky notes and then posted and grouped these issues. A full summary of all input received through this process can be found in **Appendix F. A** summary of the main themes is described below.

To address the second question, the identification of knowledge gaps, participants were asked to first vote on those issues they thought were most urgent, and from those issues identified as most urgent, vote again on the issues that had the least amount of available information. The intention of the voting was to identify urgent issues that were information poor, however participants in all locations expressed concern over the voting process as a means to identify priority issues. For this reason the results of the voting are not presented in the main proceedings but are listed in **Appendix G**. In general, the voting results showed that there was no clear agreement among participants of the most urgent or information poor issues. A different process will need to be developed to determine knowledge gap priorities.

Summary of Key Issues

Water Governance – Inclusivity and transparency in water governance was an interwoven theme throughout much of the discussion on water governance. Participants perceived a lack of trust in current decision making processes and a concern that political processes will trump scientific advice. A multi-stakeholder governance model, including the involvement of First Nations, was suggested as a means to increase transparency and provide a process to discuss and make trade-offs on the multiple values (social, ecological, economic) when making land and water decisions.

Across all locations there was general recognition that current water legislation is fragmented: the complex nature of the legislation and overlaps amongst jurisdictions has lead to a lack of comprehensive watershed management. New legislation will need to be flexible, create jurisdictional clarity, (including First Nations rights to wate)r, and establish measurable targets and thresholds that can be enforced. Participants felt that compliance and enforcement are necessary tools for managers to complete the adaptive management cycle by enforcing behavior changes. New legislation should also clearly assign responsibilities and provide the resources to carry through on these responsibilities.

Surface and groundwater hydrology - Insufficiencies in data and monitoring necessary to inform watershed planning and decision-making were mentioned in every breakout room in every location but

were a major theme in the hydrology groups. Participants pointed to a lack of high quality, basin specific, current data on groundwater and surface water quality and quantity and aquifer characterization. The lack of water quality data on emerging contaminants such as pharmaceuticals, was also a concern. Participants commented on the need to record the amount of water extracted from surface and groundwater sources for domestic, commercial and industrial activities to better inform allocation decisions. Mandatory reporting of water use and submissions of well records were common suggestions to increase incoming data. Long term funding for monitoring programs was repeatedly mentioned as a major hurdle to improving monitoring. Another was the management of the information and data currently available to ensure its accessibility to all potential users.

Watershed health - There was general agreement that water management and planning needs to be done at the watershed scale and follow watershed boundaries rather than political boundaries. Watershed health, referring to the health of aquatic ecosystems and people, was mentioned repeatedly as a management objective though it was also mentioned that this term is without a clear and measurable definition. There was recognition of the link between land and water and concern for the impacts of current land use activities on water in general. Three management concerns that were commonly mentioned were the need for riparian protection, the protection of ecological flows, and the management of cumulative impacts.

The need for more education, communication and engagement was also mentioned repeatedly as a means to increase awareness and understanding of water issues by the public and stakeholders and to cultivate a stewardship ethic. There was a suggestion that community engagement efforts can empower local communities and increase the political mandate to conserve and protect water.

3.2. Breakout Session II – Communication methods of groups within watersheds

Description of Facilitated Break-out Session

The purpose of the second breakout session was to explore the information needs and communication methods of different groups of water practitioners. For the Water Symposium, the groups refer to the five groups described in the Water Symposium Discussion Paper. A brief description for each group is given below:

- Scientist - a social or natural science researcher, technical person (such as someone who collects data in a monitoring program), a technical specialist or other person who provides scientific expertise on water science and issues.
- Policy-Maker - An elected official, a political advisor or policy analyst within government or within another organization.
- End-User - A person who implements policy by carrying out operational procedures and making site-specific decisions. For example, a person who works in the natural resource sector, local government or as a water purveyor.

- First Nations - Descendents of the first peoples of Canada who have a unique relationship and interest in water based on Aboriginal title, rights, and treaty. First Nations knowledge of water is rooted in traditional water management uses and practices.
- Stakeholder – A group that shares specific concerns about water and takes action regarding this concern with other members of society. Examples include groups representing the water interests of agriculture, tourism or power production, as well as those groups, such as NGOs and local stewardship groups, who work to protect, conserve and restore freshwater systems.

To begin, participants worked in small groups on a chosen issue to identify specific information needs of each group and the general characteristics of the information needed by each group. Information needs tables were too detailed to summarize but the characteristics of information are summarized in **Appendix H** and the tables are presented in their entirety in **Appendix I**.

In the second part of breakout session II, facilitators asked participants to reconvene to discuss communication methods within and among groups. The specific questions asked were:

- How do individuals communicate within each group?
- What are some of the ways these groups communicate with each other?
- What are some different ways that they could communicate in the future?

Summary of Main Themes

Group information needs - Input collected from participants confirmed that all groups need information to take action in watersheds but the characteristics of this information differ. For example, where scientists need good quality data in a raw format, other groups need this information interpreted and contextualized in a user-friendly format that uses common language, is brief, and makes use of visuals. Policy-makers need specific information to support decision-making such as environmental triggers, ecological thresholds and links between cause and effect. End-users, stakeholder and First Nations need practicable, neutral information. Written information for First Nations needs to honour different perspectives and make room for oral information.

Contextual information is also of value to all groups. For example: scientists may need more information on links to policy and policy constraints; policy-makers and First Nations' need holistic information to inform trade-offs; end-users need background information that will inform a site-specific decision; and stakeholders could use new ideas for mitigation.

A comparison of communication methods within each group reveals differences in, and dependence upon, the various formats (written, person-to-person, group meetings) as well as formal versus informal forms of communication. For example, in written form, communication methods range from the codified journal format of scientists to the oral traditions used in many First Nations' cultures. Policy-makers also lack a comprehensive written source that summarizes policy initiatives. This can pose a challenge for those who want to contribute to policy development. Collaboration and partnerships are formal ways for person-to-person communication and are used predominantly by end-users and scientists. Other groups work person-to-person in less formal ways or in culturally specific ways. All groups come together in meetings but the accessibility to these meetings by outsiders varies. For example, it may not be possible for individuals outside the policy development process to attend working group meetings.

Communication methods across groups - The main method for across group communication appears to be through multi-disciplinary meetings, forums, workshops, and symposia. These venues usually provide both formal activities as well as informal breaks where individuals can network with other participants outside their peer group. Other methods include participatory research and field sampling. This "learning-by-doing" may be especially useful for overcoming sector, cultural and disciplinary divisions.

3.3. Breakout Session III – How can knowledge creation, translation and exchange be better supported?

Description of Facilitated Break-out Session

In this break-out session, participants worked in groups of four and asked each other one of four questions:

a. What do you see as the most important elements that must be in place to support the creation of information and knowledge?
b. What do you see as the most important elements that must be in place to support knowledge translation?
c. What do you see as the most important elements that must be in place to support effective knowledge exchange?
d. What are some key opportunities or new ideas that would improve information and knowledge creation, knowledge translation and/or knowledge exchange?

Following this first exercise, facilitators lead a group discussion around the question, "What are some of the major challenges and constraints to implementing these new ideas?" A detailed summary of participants' input can be found in **Appendix J**.

Summary of Main Themes From Questions A to C

Similar themes re-occurred throughout the first three questions of the interview matrix, suggesting that the process for creating information and knowledge and the translation and exchange of this information and knowledge are inextricably linked. Four overarching themes emerged from the responses: leadership, collaboration, infrastructure, and outreach.

Leadership – Leadership is needed to support the creation, translation and exchange of information and knowledge. Leadership is needed to gain buy-in from politicians and government officials, as well as setting clear goals and responsibilities for developing and implementing a strategy. When considering the creation of new information and knowledge, many participants commented on the need to first conduct a knowledge inventory. Next, stakeholder and community priorities and provincial water goals and objectives could be determined to both identify and to prioritize knowledge gaps.

Leadership is also needed to improve adaptive management of watersheds, or to close the loop from action to monitoring to reassessment and back to action. The need to build in feedback mechanisms was suggested to ensure that: 1) knowledge providers receive feedback on the utility of the information they produce; 2) to make sure that the knowledge produced is applied; and 3) to assess if the application of the knowledge was effective.

Collaboration - There were many references of the need to pay more attention to building trusting relationships that allow us to work together in an open and honest way that includes: sharing, a willingness to learn and listen, to providing feedback, to exchanging knowledge, and a willingness to work with and understand different forms of knowledge. Respect for and inclusion of First Nations' knowledge was mentioned repeatedly as was the need to take the time and effort to build cultural understanding and relationships, listen to Elder's stories, learn from the land, and remove language barriers. The need to work inclusively to include all stakeholders and to work across silos were also repeatedly mentioned.

Infrastructure - Dedicated social infrastructure is needed to facilitate the ongoing exchange of information. Specific suggestions include creating knowledge broker positions and creating an information and knowledge clearing-house. Designing this clearinghouse will need to be a multi-stakeholder effort to ensure that all users will adopt it. Specific suggestions for the characteristics of the clearinghouse included:

- A common web portal that is easy to access and supports a searchable database
- One set of common standards for data and information
- Peer reviewed data, information, and conclusions
- Incentives to include proprietary information in the clearinghouse

Long-term stable funding was consistently stated, in reply to every question, as a basic need to support these initiatives. Funding is needed to allow dedicated staff time for knowledge translation and exchange and to cover capital expenses. Providing opportunities to continue the multi-disciplinary and multi-sector exchange of information, similar to the Water Symposium, was suggested as a means to encourage knowledge exchange. Participants suggested that a directory that lists experts and organizations working on specific water issues would be a useful tool to facilitate knowledge translation and exchange. It was also commonly mentioned that knowledge translation could become a larger part of everyone's job but that this will require time to commit to knowledge exchange activities such as building relationships.

Outreach - Outreach including communication, engagement, education and training is needed to improve communication among groups as well as to increase public awareness of water issues. Improving communication among groups can begin by using common and consistent language when communicating scientific findings across disciplines and to non-technical audiences. On a larger scale, mass communication and education were suggested as a means to inform the public about water issues so the public can partake in meaningful engagement on watershed planning; delivering water education in schools to increase awareness of water issues amongst children and youth; and the availability of mentoring opportunities for young professionals to support knowledge transfer across the generations divide.

Summary of Main Themes from Question D

When asked for new ideas to improve the creation, translation and exchange of information and knowledge, participants gave practical suggestions. For example: leveraging opportunities for knowledge exchange at meetings, using electronic media for communication, and providing a list of water contacts. Easier access to data was also suggested as was increased opportunities for face-to-face communication with First Nations and opportunities for intergenerational communication. Although

more costly, knowledge brokers and local watershed coordinators were seen as a practical way to improve the flow of information and knowledge.

The following were commonly mentioned as constraints and challenges to implementing the new ideas:

- Political will
- Leadership
- Funding
- Uncertainty around roles and responsibilities
- Capacity of First Nations to engage (e.g., adequate resources)
- No local champions
- No dedicated, neutral position for knowledge translation

3.4. Breakout Session IV – What should the WSS include?

Description of Facilitated Break-out Session

The purpose of the fourth breakout session was to get specific input into what a Water Science Strategy should include. Participants were asked to identify critical elements for the Water Science Strategy in three main categories: social/institutional arrangements (governance), tools, and actions. This was followed by a general discussion to identify next steps in creating a WSS. A detailed summary of participants input can be found in **Appendix K.**

Summary of Main Themes

Social/Institutional Arrangements – Critical elements in this category focused on the governance model by which the WSS will be developed and implemented. Overall, participants felt that a governance model should be inclusive, multi-stakeholder, and multi-sector. There were a number of suggestions that a WSS governing body could be created to oversee decision-making and to secure the long-term continuation of a WSS. Key elements for the development of the WSS included multi-sector champions and a dedicated WSS coordinator.

Multiple suggestions relate to the development of a WSS framework to clarify the scope, problem statement, goals, objectives, timelines, and performance measures for the WSS. Further, the WSS should be informed by past conditions and examples of a water science strategy from other jurisdictions, especially Australia. Creating cross government and cross sector links were also suggested. Leadership and funding were seen as critical elements necessary to support the success of a WSS.

Tools and Actions - Some of the potential action items for a WSS were similar to those suggested in breakout session III for the creation, translation and exchange of information and knowledge. These include creating knowledge broker positions, searchable information clearinghouse, outreach strategy, and regular opportunities for knowledge exchange. Other critical elements related to specific issues such as water conservation and the need for metering. Conducting gap analyses on institutions, water science capacity and knowledge were also suggested as critical elements necessary to support priority setting.

Suggestions for continuing the development of a WSS over the coming year concentrated on developing a WSS framework and committing to ongoing communication. Clarification of the WSS vision and ownership were also seen as critical next steps. Suggestions for ongoing communication to continue the WSS process included: circulation of the Water Symposium proceedings, regular updates, and online discussion forums. Regular regional round table discussions may also provide a means to continue the dialogue.

4. Next steps

The BC Water Symposium, captured through these proceedings, provided a wealth of information that will be useful in the development of the Water Science Strategy; however, specific directions will depend upon the scope of the Water Science Strategy. Indeed the need to define the scope, vision, and goals of the Water Science Strategy (WSS) was a common comment made by participants. As a result, the next step will be to develop a WSS framework. This will be facilitated by the BC Ministry of Environment as part of the next phase in creating a WSS.

Though participants were not specifically asked for the principles that should guide the development of a framework, the responses collected speak of the values and principles that participants thought were important to improve the flow of information. These include: inclusivity, respect for other's knowledge (especially First Nations), collaboration, effectiveness, action oriented, and integration across government silos, sectors and disciplines. The principle of adhering to adaptive management by building in feedback loops within the WSS was also a common theme in the responses. Another suggestion was that a multi-disciplinary and multi-sector council should oversee the WSS.

A number of actionable items suggested throughout the breakout sessions could be adopted as objectives for a WSS. These ranged from discrete actions, such as increasing the availability of venues for multi-sector and multi-discipline discussion, to overarching strategic initiatives that would require a collaborative effort across government, sectors and stakeholders.

In addition to the wealth of input collected at the Water Symposium, the event began the process of bringing together a multi-disciplinary and multi-sector community to discuss water science. Participants expressed the value of this event and many commented on the need for other similar events. In general, participants realized that the Symposium was the first step in creating a WSS. When asked about next steps, participants commented on the need to improve the clarity around the WSS and were eager to help. Participants suggested electronic tools such as a Listservs and a wiki site to aid in the continuation of the discussion.

The BC Ministry of Environment will continue to lead the development of the Water Science Strategy but the complexity of the task, and the success of the strategy, will require the continued cross sector and cross disciplinary involvement and collaboration that was initiated at the Symposium. With the completion and publication of these proceedings, the Ministry will move into Phase II of creating a WSS. Phase II will be guided by a new WSS Advisory Committee which will be assembled to represent a diversity of sectors, stakeholders, disciplines and governments. The purpose of this next phase is to create a framework for the WSS, using these proceedings as guidance, and to present a draft of the framework to Symposium participants as well as other interested parties for feedback.

APPENDIX A: WSS PHASE I ADVISORY COMMITTEE MEMBERS

Dr. Angeline Tillmanns, Unity Head, MOE
Dr. Bernie Bauer, Director, Okanagan Sustainability Institute, UBC Okanagan
Oliver Brandes, Associate Director and WSP Leader, POLIS Water Sustainability Project
Sheila Creighton, Fraser Basin
Celine Davis, Manager, Science and Adaptation, MOE
Liam Edwards, Director, Local government infrastructure, MCD
Heather English, Scientific and Technical Officer, HLS
Leon Gaber, Provincial Bio-Monitoring Science Specialist, MOE
Elizabeth Hendricks, Outreach Coordinator, POLIS Water Sustainability Project
Steve Litke, Senior Manager, FBC
Michele MacIntyre, Unit Head, Environmental Economics, MOE
Dr. Margot Parkes, CRC in Health, Ecosystems and Society, CRC Research Chair, UNBC
Robin Pike, Watershed Research Hydrologist, MOF
Esther Parker, Ministry of Healthy Living and Sport
Dr. Todd Redding, Okanagan College and FORREX
Dr. Valentin Schaefer, Faculty Coordinator for the School of Environmental Studies, UVic
Samina Tajwar, MITACS
Ted Van der Gulik, Ministry of Agriculture

APPENDIX B: BC WATER SYMPOSIUM PROGRAM

Day One - August 30th, 2010

Time	Session	Linked/Independent
3:00-5:00 pm	Poster set-up	Independent
4:15-5:00 pm	Registration opens	Independent
5:00-5:10 pm	BC Welcome – MLA John Slater, Parliamentary Secretary for Water Supply and Allocation	Linked via webinars (Speaker in Kelowna)
5:10-5:20	BC Welcome – Grand Chief Stewart Phillip	Linked via webinars (Speaker in Kelowna)
5:20-6:00 pm	Public lecture – Hans Schreier, UBC Title: *Examples of Innovative water protection and conservation methods for B.C.*	Linked via webinars (Speaker in Kelowna)
6:00-6:40 pm	Public address – Chief Keith Matthew	Linked via webinars (Speaker in Kelowna)
6:40-7:10 pm	Break (cold buffet and cash bar)	Independent
7:10 -7:30 pm	Local welcomes	Independent
7:30-8:30 pm	Locally organised panel discussions	Independent
8:30-9:30 pm	Reception (cold buffet and cash bar)	Independent

Day Two - August 31th, 2010

Time	Session	Linked/Independent
8:00-8:30	Registration	Independent
8:30-8:40	Local welcomes	Independent
8:40-8:50	Ministry of Environment Welcome Celine Davis, MOE	Linked via webinars (Speaker in Victoria)
8:50-9:15	Introduction to Water Science Strategy Angeline Tillmanns, MOE	Linked via webinars (Speaker in Prince George)
9:15-10:00	Plenary Speaker: Diana Allen, SFU Title: *Water Science Research: Challenges and Success Stories in Knowledge Translation*	Linked via webinars (Speaker in Prince George)
10:00-10:30	Break	Independent
10:30-10:50	Plenary Speaker: Markus Schnorbus, PCIC Title: *Impacts of Future Climate Change in Selected Watersheds of British Columbia*	Linked via webinars (Speaker in Victoria)
10:50-11:10	Plenary Speaker: Trevor Murdock, PCIC Title: *Historical and Future Climate in BC: Informing Decision-Making*	Linked via webinars (Speaker in Victoria)
11:15 -12:00	Plenary Speaker: John Richardson, UBC Title: *Learning how to protect water for environmental and human needs in a variable world*	Linked via webinars (Speaker in Kelowna)
12:00-1:00	Lunch	Independent

1:00-2:00	Breakout discussions I • What are the most urgent current and emerging issues pertinent to the sustainable management of water resources and aquatic ecosystems? Where are the knowledge gaps?	Independent
2:00-2:50	Panel Discussion – How are different types of information (e.g. research, TEK, monitoring) used to inform policy and procedures and make decisions?	Independent
2:50-3:20	Break	Independent
3:20-4:30	Breakout discussions II • What are the information needs of water scientists, policy-makers, end users, stakeholders, and First Nations?	Independent
4:30-6:00	Poster session & reception	Independent

Day Three – September 1st, 2010

Time	Session	Linked/Independent
8:00-8:30	Registration	Independent
8:30-9:00	Recap of yesterday's activities and discussions	Independent
9:00-10:00	Plenary speaker: Ken Matthews, Chair of Australian National Water Commission	Linked via webinars (Speaker in Victoria)
10:00-10:30	Break	Independent
10:30-12:00	Breakout discussions III • How can we support information and knowledge creation? Where are the opportunities?	Independent
12:00-1:00	Lunch	Independent
1:00-1:30	Facilitator re-cap of morning discussion groups	Independent
1:30-3:00	Breakout discussions IV • What will the WSS look like? How can we continue to work together to create and implement a WSS?	Independent
3:00-3:30	Break	Independent
3:30-4:30	Plenary discussion on Water Science Strategy & Next Steps	Linked via webinars and/or online blogging

APPENDIX C – PLENARY SPEAKER ABSTRACTS

TABLE OF CONTENTS

C.Plenary Speaker Abstracts

Full presentations for plenary speakers can be found on the Water Science Strategy website:

http://www.livingwatersmart.ca/watersciencestrategy/

C.1. Hans Schreier, University of British Columbia, Vancouver

Innovative Approaches to Water Conservation, Source Water Protection and Storm Water Management

Increased climatic variability, greater demand for water from urban and agricultural land use activities and the requirement for leaving sufficient water in our rivers for aquatic ecosystems requires a rethinking of the way we manage water in B.C. British Columbians are among the largest water consumers in the world so reducing our water footprint should be a relatively easy challenge. Effective water conservation is the most cost effective strategy in the short run and this will give us time to put in place a more comprehensive strategy to arrive at managing and protecting water for all uses in new and innovative ways.

The presentation will first focus on positive examples of how to best conserve water in the urban and rural environment. Then the effort needed to create a viable source water protection strategy that assures that land use activities, such as agriculture, urban development and forestry, do not impair the integrity of freshwater sources through non-point sources of pollution and cumulative effects. Finally, improving rivers to maintain a healthy ecosystem needs to be addressed in a watershed context.

Examples will be presented to show what individuals can do at their property level to reduce their water footprint and to minimize water quality impairments. This will then be scaled up to the neighborhood level to show what we need to do to detain and clean runoff from transportation systems and other land use activities. Finally, successful approaches that deal with flooding and environmental degradation at the watershed scale will be presented. Moving from innovative ideas to action is the main theme of the presentation.

C.2. Chief Keith Matthew, Simpcw First Nation

"Water is the lifeblood of the land": action upon Indigenous water knowledge and rights to water

An abstract for Chief Keith Matthew's presentation is not available, but his presentation can be viewed at:

http://www.slideshare.net/BCWaterScienceSymposium/chief-keith-matthew

C.3. Diana M. Allen, Simon Fraser University, Vancouver

Water Science Research: Challenges and Success Stories in Knowledge Translation

Groundwater is becoming an attractive resource to meet the growing water needs in many regions of British Columbia. As the demand for groundwater increases, it will become increasingly important to consider the threats to this resource in terms of sustainability and vulnerability to contamination; conflict between water users, including ecosystems; and potential impacts of climate change. As water scientists, we need to communicate these risks to decision makers more effectively than we have done in the past. This presentation will show examples, through a series of case studies conducted in British Columbia, where we have had some successes and have met challenges in knowledge translation. The case study areas include Grand Forks, the Gulf Islands and Okanagan Basin. The focus will be on groundwater resources assessment and aquifer vulnerability mapping in these complex mountain and coastal settings, and knowledge translation to decision-makers through partnership with federal and provincial agencies. In addition, some thoughts on stream low flows, groundwater and climate change will be shared.

C.4. Markus Schnorbus, Pacific Climate Impacts Consortium, Victoria

Impacts of Future Climate Change in Select Watersheds of British Columbia

The aim of the hydrologic impacts program at PCIC is to quantify the hydrologic effects of climate change and climate variability on water resources. The presentation will provide examples of this work using three watersheds: the Peace, the Mica and the Campbell. Projections of future climate (as temperature and precipitation anomalies) are derived from several different Global Climate Models (GCMs) which are driven by several emissions scenarios representing alternative trajectories of greenhouse gas emissions. Consequently, projections of future climate have uncertainties associated with inter-scenario and inter-GCM variability. Regardless, all climate projections indicate increased warming for all three study watersheds by the 2050s, both annually and four all four seasons. Precipitation projections show that the response (i.e. increase or decrease) is variable both geographically and seasonally. These changes in precipitation and temperature can lead to changes in annual and seasonal runoff. It

will be shown that hydrologic impacts will vary both seasonally and regionally, and different watersheds exhibit different sensitivities to projected temperature and precipitation changes.

C.5. Trevor Q. Murdock, Pacific Climate Impacts Consortium, Victoria

Historical and Future Climate in BC: Informing Decision-Making

The difficulty of translating scientific results into useful information defines the *abyss* that is addressed by the Pacific Climate Impacts Consortium of academics-government-industry. The scope of the consortium is research applications of climate variability and change, including extreme weather events, for climate impacts and adaptation in Pacific North America.

Analysis of regional historical climate demands consideration of year-to-year variability, as well as decadal oscillations and long term trends. All trends are not created equal; the large influence of length of climate record on resulting trend in BC will be shown.

Adaptation requires planning and decision making at local and regional scales. Scenarios from multiple Global Climate Model projections may be used to indicate a range of future climate change for a large region. High resolution in space (and time) requires downscaling. Techniques for downscaling will be introduced. Finally, examples will be presented of going beyond projected future temperature and precipitation to impacts that are more directly relevant to decision-making.

C.6. John S. Richardson, University of British Columbia, Vancouver

Learning How to Protect Water for Environmental and Human Needs in a Variable World

Water can become a limiting resource to many organisms at some times. Reserving water for "environmental flows" has developed around reservoir management, and primarily for salmonids. However, water management could be more strategic in its geographic and temporal scope, rather than a site-by-site approach. Experiments conducted in the past several years have demonstrated some of the short-term and persistent effects of low flows, and there are examples of large-scale loss of biodiversity and ecosystem services from reduced flows. One could realize that short-term bottlenecks in the habitat available may be sufficient to lead to local extinction of species, or at least local populations. Extreme (or even annual) low flow periods (or extreme floods) can create conditions that some species will not persist through. These crunches are likely to be region-wide, meaning that there are unlikely to be refuge populations for some of these organisms and they could disappear from the landscape. The concept of "environmental flows" does not take into account this broader spatial scaling or the need for safety factors, for instance, if low flows are accompanied by warm temperatures, as they are likely to be. Our expectation of leaving the minimum possible for aquatic ecosystems does not allow for safety factors for the variations that occur in the environment or for the variation in the sensitivity of some organisms to compression of their habitats. It will require strategic planning at larger spatial (and temporal) scales to ensure that needs for water by

aquatic ecosystems and humans can be accommodated. In the absence of planning we will react without options that could have been available with a bit of foresight.

C.7. Ken Matthews, Chair of Australian National Water Commission

Managing the National Water Science Effort in Australia

The presentation describes the Australian approach to managing the national water science effort. It positions water science as an important element of a wider national water reform process in Australia. Deficiencies of the current system for planning and implementing water science in Australia are described and suggestions are made about improvements for the future.

Much of the critique of the Australian water science system would have general application in other countries. Aspects of the proposed solutions may also be of interest outside Australia.

APPENDIX D – PANELISTS

TABLE OF CONTENTS

D. Panelists

Two panel discussions were held to share differing points of view and to stimulate thought and dialogue within the participants. The public panel was held the first evening and panelists representing a broad cross section of water interested were asked to addressed either what a Water Science Strategy might look like or, in the case of Prince George, the impacts of climate change on northern watersheds. In all cases, panelists shared their views on the topic and then took questions from the audience.

The second panel was held on the afternoon of the second day. Panelists addressed the question, "How are different types of information and knowledge used to inform decision-making and policy formulation, and to develop robust procedures that lead to wise and sustainable water resources management practices?" Panelists in this session were selected for their vast knowledge and experience in connecting robust information and knowledge to daily practice.

Panelists and moderators are given below for each location. Unfortunately, the recording devices in all locations malfunctioned so there are no transcripts to summarize these discussions.

D.1. Prince George

Public Panel

Panel Moderator: Charles Jago, Board Chair, Fraser Basin Council and Northern Health. Past President, UNBC

Panelists:

- Laura Grafton, Prince George Cattleman's Association
- Larry Joseph, Extension Specialist - Aboriginal Forestry and Indigenous Knowledge (FORREX)
- Margot Parkes, Canada Research Chair, Health, Ecosystems, and Society, UNBC
- John Rex, BC Ministry of Forests and Range

Symposium Panel

Moderator: Margot Parkes, University of Northern BC

Panelists:

- Sharolise Baker, Stellat'en First Nation
- Lucy Beck, Northern Health Authority
- Ellen Pettigrew, UNBC
- Terry Robert, Fraser Basin Council
- Chelton van Geloven, Ministry of Environment

D.2. Kelowna

Public Panel

Moderator: Robert Birtles (Interior Health Authority)

Panelists:

- Ron Mattiussi (City Manager, City of Kelowna)
- Michael Mercer (Director, BC Water Supply Association and Director of Engineering, District of Lake Country) – too be confirmed
- Lee Hesketh (Program Manager, FRISP, BC Cattlemen's Association)
- Howie Wright (Program Manager/Senior Fisheries Biologist, Okanagan Nation Alliance)
- John Slater (BC Liberal MLA Boundary-Similkameen and Parliamentary Secretary for Water Supply & Allocation, BC MoE)

Symposium Panel

Moderator: John Wagner (UBC Okanagan)

Panelists:

- Brian Symonds (Director, Regional Operations, Water Stewardship Division, BC MoE)
- Al Cotsworth (Water Manager, Greater Vernon Water)
- Rick Simpson (Volunteer Director, Oceola Fish & Game Club; Volunteer Co-Chair, BC Wildlife Federation – Region 8)
- Marlowe Sam (Water Scholar, En'owkin Centre and UBC Okanagan)
- Kindy Gosal (Director of Water & Environment, Columbia Basin Trust)
- Gerry Tonn (Senior Associate, Urban Systems Ltd.)
- Theresa Ann Terbasket (Elder, Okanagan Nation Alliance)
- Anna Warwick Sears (Executive Director, Okanagan Basin Water Board)

D.3. Victoria

Public Panel

Moderator: Rachel Boston (BC Ministry of Environment)

Panelists:

- Jody Watson (Harbours and Watershed Coordinator for the Capital Regional District)
- Dr. Judith Sayers (past Chief of Hupacasath First Nation, Entrepreneur in Residence at the Faculty of Business and Adjunct Professor of Law with the Faculty of Law)
- James Mattison (former Director of the Ministry of Environment's Resource Inventory Branch, former Administrator for the Canada-BC Hydrometric Agreement, and former Assistant Deputy Minister in the Ministry of Environment)
- Dr. Stewart Cohen (Senior researcher with the Adaptation and Impacts Research Section of Environment Canada, and Adjunct Professor with the Department of Forest Resources Management, University of British Columbia).
- STOLCEL John Elliott (member of the Saanich Nation on Vancouver Island, Chairman of the Saanich Native Heritage Society and language and culture teacher at the LAU,WELNEW Tribal School).

Symposium Panel

Moderator: Celine Davis (BC Ministry of Environment)

Panelists:

- Thomas White (Manager of Water Air Monitoring and Reporting, B.C. Ministry of Environment)
- Elizabeth Hendricks (Water Governance and Policy Coordinator, POLIS Project on Ecological Governance)
- Craig Wightman (Senior Fisheries Biologist, BC Conservation Foundation, Nanaimo)
- Eli Enns (BA JSC, Eli is the great grandson of Now-waas-suum (Harold Charlie mitt) who was the historian and public speaker for Wickaninnish - head chief of the Tla-o-qui-aht confederation.)
- Dr. Darlene Sanderson Centre for Aboriginal Health Research (CAHR) at the University of Victoria

APPENDIX E – POSTER ABSTRACTS

TABLE OF CONTENTS

E. Poster Abstracts

Posters presenting scientific research and industry, community and NGO initiatives were displayed in each location. The intention of the poster session was to share knowledge related to the sustainable management of water resources and aquatic ecosystems in the region. All forms of knowledge (e.g. research, case studies, and stories) were encouraged. The posters were available for viewing throughout the symposium and the public reception on the first evening and the poster reception on the second day provided a chance for participants to meet the authors and discuss their work. Abstracts are presented by location.

E.1. Prince George

Salmon spawning effects on riverbed biofilm abundance: Evidence from chlorophyll a and stable isotope analysis

Sam Albers
University of Northern British Columbia

Each year millions of Pacific salmon return to their natal streams, significantly influencing these aquatic systems. This impact is both physical and biological. Salmon physically disturb the streambed creating nests which resuspends sediment and nutrients. Salmon also provide biologically valuable nutrients to the aquatic systems as they die-off and decay within streams. The interaction between these two processes forms a crucial delivery mechanism that may ensure nutrients are retained in a nearfield environment. The opportunity to use a salmon spawning channel in an interior BC river system provided an opportunity to test this phenomenon. We evaluated benthic biofilm abundance as a response of the aquatic systems to salmon nest construction and die-off. Additionally, we used stable isotope tracers to monitor the incorporation of salmon nutrients into benthic biofilms. Salmon spawning reduced benthic biofilms via nest construction. Biofilm abundance, however, increased in the post-spawn period and stable isotope analysis suggests that this increase was due to salmon. This increase in biofilm abundance in the nearfield environment suggests that nutrients are being delivered to the streambed over a small spatial scale. This work represents a portion of a larger project that is attempting to determine the mechanisms behind salmon nutrient delivery and the interaction between physical and biological parameters in aquatic systems.

Changes in the sediment buffering function of wetlands over the last century

Katrina Caley
University of Northern British Columbia

The role of wetlands in regulating the flow of sediment through a wetland-lake system and the influence of natural and anthropogenic factors on wetland sediment retention remain poorly understood issues. To explore these knowledge gaps, two wetlands in the Quesnel River Basin (central Interior BC), whose surrounding catchment areas were significantly logged, were studied in 2009-2010. Historical forestry practices were examined as a potential mechanism for increasing sediment transport through these wetlands. Sediment cores were collected from both wetlands as well as their adjacent lakes to determine the relative proportion of sediment retained by each feature in years prior to, during and following forestry practices. Proxy indicators (bulk physical parameters, magnetic susceptibility, particle size, carbon-to-nitrogen ratio) were used to assess wetland buffering over time, and to trace the movement of allochthonous material through the catchment. Preliminary results indicate that under natural conditions wetlands have provided their adjacent lakes with a consistent buffering function. Responses to forestry practices varied between the two sites with a noticeable increase in the proportion of minerogenic material in one lake indicating that the buffering function may have been compromised. The presence of a channel crossing by a road and the installation of a culvert may be responsible for the change in sedimentation pattern as they have been known to increase sediment delivery to downstream aquatic environments.

Climate Change and Water Resources: A Focus on Stellat'en First Nation

Stephen Déry
University of Northern British Columbia

Global air temperatures warmed by about 0.6 degrees Celsius over the 20th century and this trend is expected to amplify during the 21st century as greenhouse gas emissions continue to rise. Northern regions are expected to experience the greatest changes in the world as the surface climate is particularly sensitive to modifications in ice and snow covers. Indeed, simulations using global climate models (GCMs) project a rise of several degrees in surface air temperatures by 2100 in northern British Columbia. In anticipation of these changes, it is imperative to better understand past linkages between climate change and water resources, especially at the community level. In this poster, we will present the 1970-2006 climate normals and trends and their impacts on local water resources at the Stellat'en First Nation, situated just west of Fraser Lake, BC. We will then discuss the potential implications of these changes on the Stellat'en First Nation and report on interactions between that community and western scientists. The poster will end with an outline of future collaborative activities between various partners and the Stellat'en First Nation related to climate change and water.

Reconstructing the Natural Streamflow of a Regulated River: A Case Study of La Grande Rivière, Québec, Canada

Marco Hernandez-Henriquez
University of Northern British Columbia

The regulation of rivers by dams, diversions, and reservoirs leads to perturbed streamflow time series, making it difficult for hydrological studies to assess natural trends and variability in runoff. This case study applies a variation of Hirsch's maintenance of variance extension (MOVE) method to reconstruct La Grande Rivière's 1979-2004 natural streamflow. The 1960-2004 hydrometric data for the Eastmain River and Grande Rivière de la Baleine are summed and compared with the 1960-1978 pre-regulated runoff time series of La Grande Rivière. Statistical analyses reveal a high Nash-Sutcliffe efficiency (NSE) index ($Ef = 0.58$, $p < 0.01$) and near 1:1 ratio between the standardized anomalies of the two river combination and La Grande Rivière's 19601978 natural flow records. The accuracy of the proposed method is confirmed by the low error rates and high NSE index ($Ef = 0.64$, $p < 0.01$) exhibited between La Grande Rivière's 1960-1978 observed and reconstructed monthly streamflow time series. Moreover, the reconstructed flows exhibit variability and a natural flow pattern that is indicative of nival rivers, whereas the 1984-2004 regulated flow rates from Hydro Québec show minimal streamflow variability and a flattened annual hydrograph. Trend analyses (1960-2004) in total annual runoff reveal opposite trends from the Eastmain and Grande Rivière de la Baleine that offset each other to yield no trend when these two rivers are used to reconstruct La Grande Rivière's streamflows. The methodology applied in this study is a reliable way to complete the hydrometric record of La Grande Rivière, making it more feasible for future studies to investigate the natural variations and possible effects of climatic forcings on the hydrological cycle of the regulated river.

Murray Creek Rehabilitation Project

Alana Kulchar,
Fraser Basin Council- Youth Intern

Murray Creek is a small stream that runs through Vanderhoof's oldest agriculture land. The development of fields and feeding areas have damaged and eroded the streams banks. Activities such as manure spreading, fertilizing, and cultivating close to the creek have added contaminants and pesticides to the water. Murray Creek enters the Nechako River meters away from where the Nechako White Sturgeon choose to spawn, and adds harmful silt, sediment and nutrients to the spawning grounds.

The Murray Creek Poster focuses on education for the ranching community about work previously completed on the creek as well as future plans. The poster defines riparian areas and explains how they work to filter sediments and produce clean

water. Information is available on best farming practices to promote healthy riparian areas as well as resources and supplies for farmers who want to be involved. The poster also highlights the impact of poor farming practices on the sturgeon population as well as other species of fish. Vibrant photos are scattered throughout the poster as well as "quick facts" about healthy riparian areas. The Murray Creek Poster will also be printed as a newsletter and distributed in the Vanderhoof area. It will be maintained and updated twice a year with issues coming out in the Spring and Fall of each year.

An Evaluation of Hydrometric Monitoring Across the Canadian Pan-Arctic Region, 1950–2008

Theo Mlynowski,
University of Northern British Columbia

This study evaluates the hydrometric monitoring done within the Canadian pan-Arctic and is based on the hydrometric gauges closest to northern seas for 76 river systems throughout 1950–2008. Monitoring is quantified by compiling time series of total gauged area and discharge values from the available hydrometric records. We further evaluate the quality of hydrometric data by examining the availability of hydrometric records, the continuity of individual records, and the influence of water regulation on river systems. The maximum gauged area of the Canadian pan-Arctic was 64% in 1990 before it slowly decreased to 56% in 2008. Larger river systems typically had the most hydrometric data available, though each river system had an average of 46% of their records available. In 1998, a maximum of 22 river systems had more than 30 years of continuous records, which is the maximum attained throughout the study period. For future improvements in hydrometric monitoring, additional gauges on relatively small rivers will need to be deployed. We suggest new gauges should be implemented in the Eastern Hudson Bay, Ungava Bay and Labrador Sea basins in spite of the tremendous need for more in the Arctic Archipelago.

Evaluation of Surface Water Supply at Horn River, B.C.

Brent Moore
Devon Canada Corporation

At the Horn River gas field in NE British Columbia, large volumes of water are needed to hydraulically fracture the shale, and extract the gas. Devon's goal is to ensure that the most environmentally sound and economically viable source of water is used. Devon is considering both fresh water (<4000 ppm TDS) in the short term, and saline water (> 4000 ppm TDS) in the longer term. To date, the main water source has been surface run-off collected in borrow pits. A surface water monitoring program was implemented in 2010 to determine seasonal and long term runoff potential for re-

charging borrow pits and to measure stream flow in local watercourses and a lake. The overall goal is to confirm a sustainable water supply while minimizing environmental impact and providing access to water for future development.

Stream flows are measured using continuous water level pressure transducers combined with periodic manual surveys, including the winter period. Water levels in the lake are also monitored. Water quality is investigated by sampling the lake and streams to establish background chemical characteristics and natural seasonal variability. The poster will present the initial results of the 2010 surface water monitoring program, illustrated with site photographs and a forecast of water demand.

Metal content of road deposited sediment and fluvial channel-bed sediment in the City of Prince George

Phil Owens
University of Northern British Columbia

Over 50% of the global population live in urban centres and, therefore, an understanding of the processes acting upon urban systems is a global issue. The nature of human-made, often impervious, land surfaces and heavily engineered waterways results in hydrological and sedimentological systems in urbanized basins which contrast significantly to those within more natural (i.e. pristine, forested, agricultural) aquatic systems. In addition, the abundance of contamination sources in urban systems results in chemical pressures often manifested as high pollution concentrations or loadings which in turn have detrimental impacts on human and ecosystem health. We collected samples of road deposited sediment (RDS) and fluvial channel-bed sediment within the city of Prince George, British Columbia, in order to determine the metal content of the sediment within the urban landscape, and to investigate the link between the urban road surface and the urban river network, which flows into the Fraser River. Replicate samples of RDS were collected from street surfaces in fall 2008, summer 2009 and fall 2009, air-dried, and sieved into: 500-250 microns, 250-125 microns, 125-63 microns and <63 microns. We are currently undertaking a chemical sequential extraction to give detailed information on the metal speciation within the different size classes. Samples of channel bed sediment have also been analysed for total metal content. This presentation describes this work and presents preliminary results.

The role of environmental stewardship and stakeholder collaboration in sediment management: the example of the Fraser River basin

Phil Owens
University of Northern British Columbia

The management of sediment resources often requires a basin scale approach. In most river basins, this approach requires the inclusion of stakeholders in the consultation and decision making processes. However, there are a variety of different ways in which stakeholders can be engaged in the dialogue and contribute to the decision making process. This paper discusses the role of environmental stewardship within basin-scale sediment management and focuses on initiatives within the Fraser River basin. The Fraser Basin occupies an area of about 220,000 km2 and drains into the city of Vancouver which has a regionally important port. The basin has a range of land uses and environments which result in a variety of different perspectives on what sediment is, what its functions are, and how it should be managed. This makes it difficult to develop broadly acceptable sediment management plans. There are several initiatives within the Fraser Basin which use the concept of environmental stewardship to management the basin in a sustainable way. Central to this, is the development of sustainability indicators and the involvement of stakeholders. The experience in the Fraser basin to date suggests that environmental stewardship offers much potential for evaluating why and how sediment should be managed at the river-basin scale. In particular, this approach provides mechanisms to evaluate and monitor river basin health, and to engage various different stakeholders. It has enabled successful local- and basin-scale sediment management projects in the contributing catchment and in the Port of Vancouver.

Anaerobic Co-Digestion of Fruit/Vegetable Waste and Sewer Sludge: A Pilot Scale Study

Nathan Park
University of Northern British Columbia

Anaerobic digestion is a well established technology for the volume reduction and stabilization of sewer sludge. Biogas, a mixture of methane and carbon dioxide, is produced as a useful by-product of the process. At the Lansdowne Wastewater Treatment Plant, the methane gas produced by the digestion process is used for digester heating and electricity production. Current solid waste management in the City of Prince George is focused on disposal and not on energy recovery. Co-digestion of organic waste with sewer sludge has been shown to improve biogas quantity and quality while diverting waste from the landfill. A six week full-scale pilot project, digesting almost 15,000 kilograms of supermarket waste, is near completion. Waste characteristics, biogas quantity, biogas quality, digester

performance, and avoided greenhouse gas emissions are being investigated. Results of our preliminary findings will be discussed and presented

Snowmelt Modeling in the Quesnel Highlands

Kara Przeczek
University of Northern British Columbia

Snowmelt is an important contributor to river discharge in British Columbia. Snowmelt can be modeled using only air temperature (temperature index models) when additional energy balance data is unavailable, but there are some limitations. One approach to improve temperature index models is to consider incoming shortwave radiation (solar) explicitly in the model.

The need for physically based snowmelt models that can be applied in operational runoff models has created a variety of snowmelt models with different complexity and data requirements.

Question: What is the optimal snowmelt model complexity for runoff modeling and does this vary with data availability?

To address this question we compared the ability of a range of snowmelt models to simulate melt on different aspects and under open and forested conditions. We also looked at the benefit of including measured vs. estimated solar radiation data in the models.

Mountain Pine Beetle and Salvage Harvesting Influence on Soil Moisture

John Rex (on behalf of Stephane Dube)
Ministry of Forests & Range

The mountain pine beetle (Dendroctonus ponderosae Hopkins) epidemic is changing British Columbia's forests and watersheds at the landscape scale. Watersheds with pine-leading stands may experience changes in their water balance once the pines die. Forestry stakeholders in the Vanderhoof Forest District have reported an increase in groundwater storage. They report a replacement of summer ground (dry, firm soil) with winter ground (wetter, less firm soil), upon which operation of forestry equipment is difficult or impossible before freeze-up. This project was developed to identify a set of risk indicators to where wet soils may occur at the 3rd and 4th order watershed level within the Vanderhoof Forest District. Risk indicators were selected from available GIS information, aerial photographs, and local knowledge. To make these indicators operationally applicable in forest planning,

general information such as watershed aspect, slope, soil type, and others were used. Indicators were selected during an iterative process that included model refinement, prediction, and field verification over a two-year period and a post-hoc assessment of field information to select the indicators that explain most data variability. The most effective indicators for predicting the risk of wet-ground areas at the watershed level were found to be lodgepole pine content, under storey, drainage density, sensitive soils, and the topographic index, all of whose values are available from provincial GIS databases.

Small Stream Riparian Zone Response to Mountain Pine Beetle and Salvage Harvesting

John Rex
Ministry of Forests & Range

The mountain pine beetle (mpb)infestation and its related salvage harvesting activities adjacent to streams have the potential to influence small stream (< 2 m bankfull width) and riparian zone function by altering and removing riparian vegetation and causing other disturbances. These alterations are a significant management issue because small streams are the most predominant channel type on the landscape, comprising upwards of 80% of a watershed's total channel length. Accordingly, understanding the influence of these changes on small streams and their riparian zones is important to forest management. Findings indicate that salvage harvesting activities reduce shade and stream functioning beyond that of the mpb infestation.

The Compendium of Forest Hydrology and Geomorphology in BC

John Rex (on behalf of Robin Pike),
Ministry of Forests & Range

Over the last two decades, scientists have often discussed the need to document the history, scientific discoveries, and field expertise gained in watershed management in British Columbia. Several years ago, a group of watershed scientists gathered at UBC to discuss the idea of a provincially relevant summary of hydrology, geomorphology, and watershed management. Their main objectives were to bridge the sometimes disparate views in watershed science with an integrated understanding of forest hydrology and geomorphology and to create a "go-to" reference for this information. Through this meeting, the Compendium of Forest Hydrology and Geomorphology was born.

Aquifer Health

Dave Tamblyn
Northern Health

This presentation introduces the concept of 'aquifer health' as an integrative place-based measure of groundwater utility and wellbeing. I begin by critiquing current 'holistic' groundwater approaches, which variously incorporate elements such as quality, safety, productivity, vulnerability, sustainability, stability and resilience, as well as ecological services such as base flow provision, quantity buffering, waste assimilation, and support of groundwater dependent ecosystems. I review the metaphorical application of health to non-organisms, including analogous hydrologic settings (lakes, rivers, watersheds). Grouping key aquifer features into those inherent to the aquifer itself, and those that deal with interactions between the aquifer and its setting, I suggest possible indicators of well-functioning and useful aquifers. I conclude that aquifers can be healthy, in terms of their own productivity, stability and resilience, as well as being healthful, in terms of providing ecosystem services that support the health of dependent ecosystems, including human socio-cultural systems. Future work to apply this framework to in pilot studies is discussed.

Advanced Oxidation Treatment of Wastewater from a Local Oil Refinery

Ronald W. Thring,
Environmental Science & Engineering,
University of Northern British Columbia

Wastewater from a local oil refinery was treated using 2 different advanced oxidation processes, namely, hydrogen peroxide (H2O2) and Fenton's reagent (H2O2/Fe(II)). Treatment was carried out using laboratory-scale reactors and at room temperature for color and phenol (toxicity) removal. The effects of the main operating parameters such as initial pH, oxidant and catalyst concentrations were investigated. Both methods used resulted in some degree of color and toxicity (phenol) reduction. However, the Fenton's reagent using H2O2/Fe(II) resulted in the highest color and phenol removal under the conditions of H2O2 concentration of 50mM, Fe(II) concentration of 5mM and pH value of 6 within 30 minutes of reaction time. This resulted in a color removal of 87% and phenol removal of 67%. Other reaction conditions achieved levels of removal of color in the 80%-85% range and 40%-50% for phenol.

E.2. Kelowna

No meaningful protection for aquatic resources in BC - a case study

Warren Bell
WA:TER (Wetland Alliance: The Ecological Response

In the community of Salmon Arm in South-Central BC, an 8 year process to build a large shopping centre in the floodplain of the Salmon River has been taking place. Despite fierce resistance from leading BC and international scientists, local citizens and First Nations, this project has been approved by the City government, with the blessing of the Ministry of Environment and Fisheries and Oceans Canada. All parties admit that fish habitat will be permanently destroyed by this development, and delta hydrological functions adversely affected, but no mechanism exists whereby science can trump development pressure and stop this from happening. This poster displays the time-line for this still-unfolding failure to protect water resources and fish habitat.

Antibody immobilization and its application to Cryptosporidium detection

Rony Das
University of British Columbia (Okanagan)

Current detection of waterborne pathogens relies on the use of indicators (turbidity, Escherichia coli etc.) or time consuming assays that can only be done in a specialized laboratory. A simple and near real-time assay was developed for rapid, robust, and sensitive detection of pathogens from environmental samples. The assay developed consists of capturing target pathogens onto a capture surface activated with a capture molecule, exposing concentrated pathogens to antibody conjugated micro-retroreflectors (extremely detectable 2-5 micron cubes with 3 mirrored sides, conjugated with capture molecule), and inserting the capture surface into an inexpensive, simple reader to detect the retroreflection signal to confirm the presence of target pathogens. In this research, antibody (capture molecule: IgG and IgM) fragments specific to Cryptosporidium, as a model waterborne pathogen, were immobilized site specifically and randomly onto gold-coated surfaces as well as corner cube micro-retroreflectors (ccμRR). Test to determine the resistance to high shear forces showed that critical shear stress for the antibody-antigen complex was 126 dyne/cm2. Tests designed to determine how well the immobilized antibodies could capture Cryptosporidium revealed that capture efficiencies did not differ significantly within the range of 14 – 42 mL/min but a decrease in cell depth from 250 μm to 125 μm improved the capture efficiency. The IgG-Fab' activated surface showed the best capture efficiency. This assay will allow rapid operations' decision making for drinking water treatment plants.

Human health risk assessment of exposure to THM chlorination by products in drinking water from a public water utility located at the Central Okanagan

Johanna Faccini
UBCO and AF Consulting Ltd

This work presents the findings of the human health risk assessment of exposure to THMs within a Central Okanagan water distribution system. The assessment was based on THMs concentration data obtained from samples taken during 2007, 2008 and 2009. Statistical evaluation of the data helped to identify two periods of annual water usage.

The process focused on assessing the exposure routes, frequency and duration in which the chemicals come in contact and enter the human body. The population was divided in different age groups, because exposure parameters affect differently each age group of the population and provide different risk results. This exposure assessment coupled with a toxicity analysis of the chemicals resulted in two types of human health risk characterization: cancer and non-cancer risk.

Monte Carlo simulation techniques were used due to the nature of the information provided. Uncertainty and variability of the results were discussed and the sensitivity analysis provided information on the parameters that have the highest impact on the results.

The assessment showed that the cancer and non-cancer risks are within the acceptable ranges for all age groups evaluated. The sensitivity analysis showed that chloroform concentration is the parameter that has the higher impact on cancer and non-cancer risk results.

Community Based Haor Management in Bangladesh

Hanna Hamid
Student

Haors are bowl shaped depressions between the natural levees of a river subjected to monsoon flooding every year. The Haors of Bangladesh are rich in biodiversity, having great ecological, economic and commercial values. Some are nationally and internationally important for their rich fauna and flora resources. Tanguar haor, a Ramsar site, is one of the most important mother fisheries and potential wetland for migratory and local birds along with other aquatic wildlife. These wetlands have been highly explored for a long time and during 1990 the nation first realized the needs of resource management. The Community Based Haor Resource Management

Project was implemented by IUCN Bangladesh, with support from the Ministry of Environment and Forest (MoEF) and the UNDP. The major focus of the programme was to involve the community people in planning and implementation of the project activities for the management of natural resources with a view to restoring and maintaining biodiversity as well as human well being in a sustainable manner. In 1998, IUCN Bangladesh along with its partner CNRS (Center for Natural Resource Studies) were able to launch the project in Pagnar and Sanuar-Dakuar haors of Jamalganj Upazilla, two degraded sites of haor ecosystem. Based on the successful initiation and implementation of the project, UNDP and the Ministry of Environment and Forest (MoEF) provided extra funds in October 2000 to extend the project in one more site in Hakaluki haor under Moulvibazar and Sylhet districts. The project was completed in December 2006.

Estimation of Economic Level of Leakage –A Cost Effective Approach

Shafiqul M.Islam
Okanagan School of Engineering, University of British Columbia, Kelowna, BC, Canada

Abstract: Leakage is an important aspect that significantly determines the performance of water utility organization. It is an issue that all the utility organizations need to deal with on daily basis. Whatever might be the reasons of leakage all the utility organizations want to minimize leakage as much as possible within their structural and nonstructural capabilities. To make a balance between their capabilities and level of leakage, they want to know economic level of leakage (ELL) as accurately as possible to ensure minimum water leakage but further reduction of leakage will not increase unit cost for leakage reduction. But estimation of ELL is troublesome task as it is very data intensive. In this study, a set of graphical tools have been developed for quick estimation, without detailed analysis, of active leakage control (ALC) cost and ELL for the study area. In addition, influences of pressure on marginal cost of leakage control and the influence of pressure and marginal cost of water on ELL have been analyzed. The study has been carried out based on data of a district metering area (DMA) of Metropolitan Waterworks Authority, Bangkok water distribution system.

Evaluating source water protection strategies: a decision support tool

Nilufar Islam
Environmental Engineering

Source water protection (SWP) is the most important step in multi-barrier approach that ensures safe supply of drinking water. Protecting water at the source provides a

cost-effective solution as compared to subsequent water treatment technologies. SWP strategies (e.g. vegetated filter strips, storm water management ponds) have been implemented in different jurisdictions around the world. However, the complex regulatory regimes, guidelines and bylaws make the administrative process very challenging and time consuming. For effective implementation of SWP strategies, decision support tools can be very helpful that may lead to saving time and resources. The main objective of this research is to develop a decision support tool to evaluate various available strategies for protecting surface waters against non-point pollution sources (e.g., agricultural runoff, storm water). A quantitative evaluation process requires a simplified index that can be linked to "quality status" of the source water in terms of common water quality issues such as aesthetics, physico-chemical pollution, toxic substances and above all microbial contamination. This index is derived from selected water quality parameters that can be linked to effectiveness and efficiency of SWP strategies. The proposed decision support tool will report overall status of water quality before and after the implementation of selected SWP strategies and help in making informed decisions.

Cumulative Effects Monitoring of Okanagan Streams Using Benthic Invertebrates, 1999 to 2004

Vic Jensen
BC Ministry of Environment

Benthic invertebrate measures were examined by multimetric and multivariate means to determine biological integrity and cumulative anthropogenic effects on 23 streams in the Okanagan Basin. Riffle habitat in low elevation streams, representing a gradient of human impact, were sampled using a Surber net between 1999 and 2004. High and low cumulative stressor categories were estimated using GIS data at the watershed scale, and field surveys at the sampling reach level. A five metric Benthic Index of Biological Integrity (B-IBI) (total taxa, # of plecoptera taxa, # of ephemeroptera taxa, # of intolerant taxa, and # of clinger taxa) was found to consistently distinguish urban and highly altered sites from low impact sites. Water and sediment chemistry at urban streams was somewhat degraded relative to water quality guideline levels but could not consistently distinguish site differences. The same data set was evaluated with Environment Canada's reference condition approach using the multivariate models within CABIN (Canadian Aquatic Biomonitoring Network) and Fraser Basin reference groups. CABIN assigned worse scores in 55% of the cases and better scores in 13% of the cases. CABIN scores were within one category of the B-IBI scores in 81% of the comparisons. Cluster analysis confirmed strong dissimilarity of the low and high stress site groups used to calibrate the Okanagan B-IBI. Subsequent analysis associated highly altered benthic community composition with elevated sediment polycyclic aromatic hydrocarbons found in urban stormwater run-off. Both multimetric and multivariate analyses clearly demonstrated the degraded ecological condition of streams within the rapidly

urbanizing Okanagan landscape. Actions to restore riparian corridors, reduced storm-water and contaminant inputs, are necessary to conserve and protect aquatic ecosystem health of Okanagan streams.

Enhancing institutional arrangements for source water protection in British Columbia

Robert Patrick
University of Saskatchewan

Source water protection gained prominence across Canada after the tragic events of May 2000 in Walkerton, Ontario. While provincial and territorial jurisdictions across Canada have adopted a range of policy and legislation to support source water protection, implementation at the local water operator level remains problematic. This poster describes specific case study research conducted in the Okanagan Basin, BC, between 2004 and 2005.

The research reveals that factors facilitating source protection tend to concentrate at the local scale. Facilitating factors include formation of multi-purveyor joint water committees, relationship building between and among different watershed user groups, broad-based education and dissemination of watershed information to ratepayers, and the appointment of local government staff to assist in coordination of Crown watershed activities.

Factors constraining source protection tend to concentrate at the provincial scale and include lack of local government jurisdictional capacity within community watersheds as well as fragmented roles and responsibility of senior agencies around watershed management generally and source protection specifically. De-regulation and re-regulation tendencies of government respecting broader provincial policy are seen to be contradictory to specific safe drinking water policies, adding to confusion among water purveyors and water resources professionals. In addition, evidence points to provincial inter-agency rivalry that operates to constrain source protection efforts. At both the local and provincial scale there appears to be an incomplete understanding of the meaning of source protection.

While challenges do exist, opportunities for enhancing the institutional arrangements to support source water protection are identified.

Compendium of Forest Hydrology and Geomorphology in BC

Todd Redding
FORREX

The "Compendium" was created to consolidate current scientific knowledge and operational watershed management experience into a readily accessible document. The Compendium consists of 19 chapters that describe specific watershed processes and the effects of disturbances on these processes across different regions of the province. The Compendium is organized around six themes that include: regional context, watershed hydrology, watershed geomorphology, water quality, stream and riparian ecology, and watershed management decision support (e.g., watershed assessment, restoration, measurement methods, climate change, etc.). Each chapter summarizes basic scientific information that is often required when managing water resources in forested environments. Some chapters incorporate case studies to move discussions from concepts to the applied and practical. Each chapter also presents a comprehensive list of references, many of which are electronically linked for reader convenience. The Compendium has a unique regional focus and is for a British Columbian audience. The Compendium was developed with the input of end-users. A team of FORREX staff, over 60 volunteer authors and more than 100 volunteer reviewers have worked to complete the Compendium. Authors and reviewers include technical specialists from government, university and industry from within BC and from around the world. As draft chapters have been completed, they have been made available on the FORREX website (http://www.forrex.org/program/water/compendium.asp), resulting in more than 141,000 downloads since 2006. In the fall of 2010, the Compendium will be jointly published by the BC Ministry of Forests and Range and FORREX as Land Management Handbook 66 (http://www.for.gov.bc.ca/hfd/pubs/Lmh.htm).

THE ORGANISATION:

The ***Canadian Okanagan Basin Technical Working Group (COBTWG)*** is a tri-partite working group dealing with technical issues associated with management of salmon and resident fish stocks and their associated habitat requirements in the Canadian portions of the Okanagan River basin. Participants to the COBTWG include:

Fisheries and Oceans Canada
Okanagan Nation Alliance Fisheries Program
B.C. Ministry of Environment.

Camille Rivard-Sirois
Okanagan Nation Alliance

MAIN PROJECTS:

The ***Re-introduction of Sockeye Salmon into Skaha Lake*** is a 12-year experiment to reintroduce and re-establish the indigenous sockeye salmon back into their historic habitat in Skaha Lake. This project reaches to stabilize and rebuild the declining wild Okanagan Sockeye population, to return sockeye to their former habitat and migration range, and to revitalize the Okanagan Nation salmon fishery.

The project ***Providing Fish Passage at McIntyre Dam*** refitted in 2009 the gates at McIntyre Dam in order to allow fish passage. With this modification, salmon is now able reach Vaseux Lake, an important historic habitat which they have been unable to access for the last several decades.

The ***Okanagan River Restoration Initiative project*** (ORRI) is a plan to re-naturalize one of the most biological sections of the Okanagan River. By re-creating a wider floodplain, restoring the riparian vegetation and re-meandering a part of the channelized river, ORRI will provide a better habitat for salmon and trout reduce risk of flooding and improve water quality.

The ***Fish Water Management Tools project*** (FWMT) is a computer model developed specifically to help authorities manage water flows in the Okanagan River in a "fish friendly" manner. The model uses real time field data to make predictions and decisions witch benefit kokanee and sockeye salmon while respecting the needs of other water users.

Sustainable Water Resources Management Planning In Arsenic Affected Areas Using System Approach – A Case Study

Anjuman Shahriar and Rony Das
University of Western Ontario

Elevated arsenic level has been reported in several regions of BC. An affordable and sustainable safe water sources can play an important role to solve the arsenic contamination problem ensuring the supply of safe drinking water. In order to optimize the use of available resources, planners and decision makers need economic and effective models, techniques, and tools. In this study the multi-objective analysis technique has been used using Compromise programming technique to determine the optimal alternatives and achieve the best compromise between the selected optimization objectives. The concept of most robust compromise solution has been used as a replacement for the best compromise solution in order to find out alternative(s) which is less sensitive to the change in preferences. A case study has been presented in this study where six alternatives have been used such as: Pitcher Filter, Arsenic Iron Removal Plant (AIRP), Rain Water Harvesting (Household Type), Rain Water Harvesting (Community Type), Integrated Use 1 (combination of tubewell water and household rain water harvesting in the ratio of 1:1), and Integrated Use 1 (combination of tubewell water and community based rain water harvesting in the ratio of 1:1) to select the arsenic free safe and economic water resources alternative among which household based integrated water use has been found to be the most robust compromise solution.

Water Quality in Okanagan Basin Lakes: Current Status & Long-Term Trends

Michael Sokal
Ministry of Environment - Environmental Protection Division

Widespread urban development and extensive agricultural activities challenge water resource management of five large lakes (Wood, Kalamalka, Okanagan, Skaha and Osoyoos) in the Okanagan basin. These water bodies provide important habitat for aquatic life, community drinking water, irrigation, and provide a variety of tourism and recreational opportunities. Consequently, protecting the water quality of these lakes is essential.

Decreasing water quality and nuisance algal blooms in the 1960's led to improved municipal sewage treatment and reduced nutrient loading to Okanagan, Skaha, and Osoyoos lakes. The current Ministry of Environment monitoring program was subsequently initiated to provide water quality data to decision makers within government, industry and to inform the public. These data are used to identify

current status and trends in lake water quality within the Okanagan Basin, to determine success and challenges remaining in the control of excessive nutrient or other contaminant loading from point and non-point sources.

The monitoring shows that nutrient concentrations in Okanagan basin lakes have changed through time as a result of both natural and anthropogenic influences. Different watersheds, surface area, volume and land use, result in varying effects of nutrient enrichment or reduction. Phosphorus concentrations in all lakes show the influence of climate variation, however, trend assessment can be complex particularly in the larger lakes. For smaller lakes where phosphorus reduction actions have been implemented, there are marked decreasing trends. These improvements can take decades to manifest themselves, re-enforcing the need to be proactive in identifying emerging water quality issues and working towards timely solutions.

E.3. Victoria

Understanding Nitrate Variability in Regional Groundwater Monitoring Data

Gwyn Graham
Environment Canada

Monthly observations of elevated nitrate concentrations in a regional transboundary aquifer have been recorded over an 18-year period using a network of dedicated monitoring wells. This relatively high-frequency and long-term data record provides information on the spatial and temporal distribution of non-point source agriculture-derived nitrate contamination in this aquifer. Understanding the drivers of nitrate variability in monitoring well records is important to interpretation of groundwater quality impacts due to changes in land use practices above the aquifer. The focus of this study is to improve the understanding of the influence of natural climate factors on groundwater nitrate variability in this aquifer. There is apparent correlation between average nitrate concentrations and precipitation, with long-period cycles (6-7 years). These apparent precipitation cycles appear to influence nitrate concentrations by approximately +/-30% of the Canadian Drinking Water Guideline for nitrate (10mg/L nitrate-N) as well as influencing average water table elevations. Normalized nitrate data for 22 individual monitoring wells was assessed for a range of intrinsic factors including precipitation, water table elevation, depth below water table, and apparent groundwater age. Higher frequency nitrate variability coinciding with seasonal precipitation patterns are evident in many of the monitoring wells, particularly in younger (more recent) groundwater. Frequency analysis indicates potential correlation between groundwater nitrate concentrations and ENSO (El Niño) events. Assessment of the long-term groundwater data also highlights the risks of groundwater quality trend interpretation of short-term data sets.

Changing with the flow: scenarios for future supply and demand in a subwatershed of the Okanagan Basin

Kirsten Harma
Institute for Resources, Environment and Sustainability, University of British Columbia

Annually replenished surface water sources are critical for meeting water needs in British Columbia's Okanagan Basin, but are becoming increasingly stressed through climate and land-use changes and growing water demand. WEAP, an integrated water management model, was used to consider future scenarios for water supply and demand in an unregulated and a reservoir-supported stream that supply the District of Peachland. Potential changes to the magnitude and timing of streamflow were evaluated in response to the following scenarios: (i) climate change (derived from the HadCM3 and CGCM2 GCMs for the 2020s and 2050s), (ii) a simulated prolonged drought, (iii) land cover change resulting from a Mountain Pine Beetle (MPB) outbreak, and (iv) combinations of these conditions. The model was used to simulate interactions between water supply and water use to evaluate stress on municipal water users and aquatic ecosystems. Results demonstrate that all future climate conditions will critically reduce streamflow relative to demand (societal and ecological) in at least a few months of "normal" and "dry" years. In all cases, even with the higher flows expected under the MPB scenario, the combination of demand, reservoir operations and climate variability result in less than optimal conditions for instream flow needs. Beyond its implications for the District of Peachland, this work demonstrates a method of using an accessible modeling tool for integrating knowledge from the fields of climate science, forest hydrology, water systems management and stream ecology to aid in water and land management decision-making.

Freshwater Conservation Analysis of BC's Central Interior Ecoregion

Sara Howard
The Nature Conservancy of Canada

The Nature Conservancy of Canada's BC region has recently completed an ecoregional assessment of the BC Central Interior. The ecoregional assessment includes both a freshwater and terrestrial analysis. The purpose of the freshwater analysis is to provide a regional scale, biodiversity-based context for implementing conservation efforts of freshwater ecosystems and species. The methods for the freshwater analysis include using Marxan software and information on biodiversity and threats to identify a selection of watersheds as priorities for freshwater conservation efforts.

Distribution of Non-Native Freshwater Species in British Columbia

P. Hubregtse[1], V. Karpouzi[1], S. Pollard[1], M. Herborg[1] and T. Hatfield[2]
[1] Ministry of Environment; [2] Solander Ecological Research Ltd.

Non-native species are cited as the greatest agent of biotic change in freshwater systems. Biotic impacts of non-native freshwater species include predation, competition, parasitism, disease, hybridization, and habitat modification. Vectors of introduction and spread include – accidental transport on boats, trailers and fishing gear, deliberate release, escape from aquaculture facilities, and natural secondary dispersal once introduced.

In British Columbia, 134 non-native freshwater species have been recorded. Nearly 75% of these species are vascular plants, followed by fish (17%). The remaining species are amphibians, invertebrates, turtles, and algae. The majority of observations of non-native freshwater plants and fish have been recorded in five freshwater drainage areas in southern British Columbia. Most non-native freshwater plants have been recorded in the Okanagan, Lower Fraser, and Thompson freshwater drainage areas, whereas most non-native freshwater fish have been recorded in the Lower Fraser, East Kootenay, and West Kootenay freshwater drainage areas.

Application of a source water quality index to assess the vulnerability of Canadian communities to drinking water quality deterioration

Tim Hurley, Student
University of Victoria

Drinking water quality is currently one of Canada's most pressing public health concerns. The vast majority of Canadians rely on surface waters as a drinking water source. Unfortunately, surface waters are particularly susceptible to deteriorations in quality. Projected landuse and climate scenarios are forecasted to increase the risks posed to surface drinking water sources, highlighting the need for an effective tool to examine drinking source water quality and variation. Adopted as a national freshwater quality index, the Canadian Council of Minister's of the Environment Water Quality Index (CCME WQI) compares measured water quality parameters to guideline values to produce an overall quality score. Despite widespread use of the CCME WQI within Canada, its application to Canadian drinking source water quality has not been explored. Research at the University of Victoria's Water and Aquatic Sciences Research Program is currently being carried out to validate the application of the CCME WQI to surface source waters. In consultation with a panel of drinking water quality experts, source specific parameter selection criteria and guidelines are being developed to guide index use. Alternative index aggregation techniques are also being explored to better characterize source water quality conditions. Ultimately, the surface source water CCME WQI will serve as a useful tool to examine

climate/landuse/water quality interactions and to communicate quality conditions and risks to the public.

The Death History of Canals of Mega City Dhaka

Sabreena Nasrin
Lecturer, Department of Civil Engineering, Stamford University Bangladesh

Dhaka, the capital city of Bangladesh is one of the populous Mega Cities in the world. In recent years Dhaka City is facing extensive water logging during the monsoon (May to October) as a common and regular problem of the city like water pollution, traffic congestion, air and noise pollution, solid waste disposal, black smoke etc. Canals of Dhaka used to be the connecting channels of the rivers surrounded by the greater Dhaka district. Even now whatever is left of the canals is used as the primary drainage system for Dhaka. But most of these canals have vanished due to a variety of reasons: unplanned urbanization, encroachment, lack of co-ordination between the government agencies and lack of maintenance to the system. The few canals left are on the verge of extinction as they have lost their flow, blocked by either roads or unauthorized structures. These canals are used to drain out millions of cubic meters of domestic and industrial sewage to the surrounding rivers from the center of the city. Since the canals-- the primary drainage system of the city-- are blocked, they cannot carry the huge volume of storm water generated during the monsoon. In fact, experiments done by the donor agencies have killed many canals. Prescribed and funded by World Bank, ADB and Japan International Cooperation Agency (JICA) four major canals -- Dholai Khal, Shegunbagicha Khal, Paribagh Khal and Dhanmondi Khal (now Panthopath) -- were converted to box culverts in the mid 1980s. Such conversion has virtually killed these canals, since the Drainage Department of DWASA is not equipped with machinery to clean the huge length of box culverts. Another major cause for narrowing the channels of the canals is dumping of solid wastes. Because of a lack of dumping facilities, people dump solid wastes into the canals and other drainage system. If this situation exists than these canals will be a history soon. This is the right time to revive these canals if we want to protect them from being extinct.

Compendium of Forest Hydrology and Geomorphology in BC

Robin Pike
BC Ministry of Forests and Range

The "Compendium" was created to consolidate current scientific knowledge and operational watershed management experience into a readily accessible document. The Compendium consists of 19 chapters that describe specific watershed processes and the effects of disturbances on these processes across different regions of the province. The Compendium is organized around six themes that include: regional context, watershed hydrology, watershed geomorphology, water quality, stream and riparian ecology, and watershed management decision support (e.g., watershed assessment, restoration, measurement methods, climate change, etc.). Each chapter summarizes basic scientific information that is often required when managing water resources in forested environments. Some chapters incorporate case studies to move discussions from concepts to the applied and practical. Each chapter also presents a comprehensive list of references, many of which are electronically linked for reader convenience. The Compendium has a unique regional focus and is for a British Columbian audience. The Compendium was developed with the input of end-users. A team of FORREX staff, over 60 volunteer authors and more than 100 volunteer reviewers have worked to complete the Compendium. Authors and reviewers include technical specialists from government, university and industry from within BC and from around the world. As draft chapters have been completed, they have been made available on the FORREX website (http://www.forrex.org/program/water/compendium.asp), resulting in more than 141,000 downloads since 2006. In the fall of 2010, the Compendium will be jointly published by the BC Ministry of Forests and Range and FORREX as Land Management Handbook 66 (http://www.for.gov.bc.ca/hfd/pubs/Lmh.htm).

Community based issues and solutions: Alexis Creek First Nation and Stellat'en First Nation

Dibya Shrestha
University of Victoria

Dibya Shrestha[1], Juan Cereno[2], Eddison Lee-Johnson[3],
Darlene Sanderson[4], Stephen Dèry[5], Monique Auger[4]

[1]Community based research lab (UVic), [2]Tl'etinqox-T'in government office, [3]Stellat'en First Nation, [4]Centre for Aboriginal Health Research (UVic), [5]Northern Hydrometeorology Group (UNBC)

To address pressing water issues in First Nation communities, a call was put out to all First Nations in BC by the Centre for Aboriginal Health Research (UVic) to conduct community-based research. Alexis Creek, Stellat'en First Nation and Nahdley Whut'en were respondents. The communities chose their own theme on water and their own speakers/resource people to address these theme(s) of choice.

In Alexis Creek, the participants included community members, Health Canada, councillors, elders, youth and educators from Alexis Creek, researchers from the University of Victoria and University of Northern British Columbia. Community mapping was used as one of the tools for engaging dialogue between diverse community members and researchers in understanding water issues of the community. It is a method of story-telling utilizing local knowledge and involving everyone from the community. The topographical 1:50000 map and Google map from the area were used and the mapping exercise was carried out in three groups. Asset based development, participatory planning and transformative learning were exercised during the group interactions. The Elders created a vision for the future and summarized stories and legends from the area. The youth identified specific areas of interest in the community. The councillor and adults group outlined reserve boundary lines and indicated wildlife reserves and traditional names of the area. They also emphasized a need for training in water sampling procedures and connecting with other Nations. This mapping exercise also assisted in creating a water declaration and action plans for the protection of water resources in Alexis Creek.

Stellat'en First Nation hosted a workshop with Nadley Whut'en that focussed on traditional water governance, impacts of provincial law on First Nations, and climate change. These two communities identified issues, concerns and strategies for action that address both climate change and water issues.

The influence of climate change on the microbial contamination of water under variable land use scenarios

Jacques St Laurent
University of Victoria

Climate change poses a potential increase to the risk of waterborne enteric illness. Changes in temperature and hydrology are likely to effect the concentrations and types of waterborne pathogens in drinking source water.

This study aims to identify the role and relationships between climate variables and the microbial contamination of source water under different land use scenarios.

The initial phase of the study examines the variability of fecal indicator bacteria (FIB) in waters across BC to see how the correlation between climate parameters and microbial contamination varies across regions with different climate regimes and within these regions under different land use.

The second phase is examining the types and concentrations of pathogens that occur during extreme rainfall and snowmelt events in order to identify emerging pathogens that may pose a risk to health under anticipated severe weather events.

This poster, set out in four sections, describes the background, objectives, methods, and anticipated results of the study. Correlations between climate and FIB are graphically shown for four contrasting data sets. A graph showing the complexity of temperature/FIB relationships is shown alongside an example of Generalised Linear and Additative models used to examine the explanatory power of each climate parameters.

This work is part of the IRC Water and Aquatic Research Program at the University of Victoria.

APPENDIX F: BREAKOUT SESSION I – PARTICIPANTS' INPUT

TABLE OF CONTENTS

F. Breakout Session I – What are the key issues pertinent to the sustainable management of water resources and aquatic ecosystems?

There were two guiding questions for this breakout session:

- What are the key issues pertinent to the sustainable management of water resources and aquatic ecosystems?
- Where are the knowledge gaps?

Three rooms were used within each location to target discussions on one of three topic areas: surface and ground water hydrology; watershed health (people and aquatic ecosystems); and water governance (social, policy, and regulatory tools to better conserve and manage water). Participants were asked to choose one room to participate in the discussion. For the first task, participants were given sticky notes and were asked to write issues that fell within the topic area and that were pertinent to the sustainable management of water resources and aquatic ecosystems. Participants were then asked to place their sticky notes on a large challenge wall at the front of the room after which the participants and facilitators grouped the sticky notes together into common categories. For the next step, participants were asked to vote, using coloured sticky dots, on the categories they felt were most urgent. After this first round of voting, the most urgent issues were circled and the participants were asked to vote a second time on the urgent issues that the participants felt had the least amount of available information.

Participants in all locations expressed concern over the voting process. In general, participants felt that all issues were important and should be given attention. They were also generally concerned that the process would be used to prioritize action by the Province and felt that this

process was not the appropriate manner to conduct a prioritizing exercise. For this reason, the results of the voting are not presented in the main proceedings but, so as not to lose this information all together, the results of the voting are listed in Appendix G.

The input received by participants in the form of sticky notes and the grouping of sticky notes, was used to generate the descriptions below. The sticky note comments were used as an outline for each category. In some cases, sticky notes were moved to other categories where they seemed to fit more closely.

F.1. Watershed Health

F.1.1. Prince George

Monitoring & Data - Area specific (geographic area & ecological system area) data are lacking for many regions of the province. Yet this information is needed to set scientific baselines so trends can be recorded and also to allow for overall watershed and regional management. Monitoring needs to be complimented by work to define watershed health and associated indicators. Work is also needed to identify the minimum and optimal conditions needed to maintain watershed health.

Research (Ecosystems) / Requirements (Human) - Further research, and broad sharing on the findings, is needed to establish the links between environmental condition and human health that moves beyond the obvious links such as toxic pollution. What would a systems thinking perspective of the health of watersheds (including people) look like? How can we measure health? Emerging contaminants, such as pharmaceuticals with little information on prevalence and health impacts to humans and ecosystems, pose a direct threat to health and need further research. Water quality in general, including both surface and groundwater and their interaction, needs to be monitored to establish links with human health. Ecosystems experience many regional stressors, for example, Mountain Pine Beetle, drought and El Nino and Lanina events. How resilient are watersheds to these stressors combined with local stressors such as water extraction at low flows or changes in nutrient inputs? Nutrient run off needs to balanced as both too little and too much of an input to aquatic ecosystems can affect the health of these systems. Are stream channels resilient to increased peak flows? Research will help establish the connection between ecosystem and human health which in turn can help motivate action.

Impacts of Economic Development on Land and Water Use - Development and the amount of industry in watersheds can impact the land and water. This is evident with lakes where overdevelopment of lake shores with year round homes and cabins can impact sensitive lakes and lead to the destruction of riparian habitat. Excessive boating on these lakes can erode shorelines and disturb wildlife. Development must balance the cumulative impacts of land use practices with economic realities. Habitat connectivity must also be maintained.

Legislation - Results based legislation that can be applied and enforced, yet is flexible to changing conditions and future unknowns, is needed to protect watersheds. The legislation must clarify water rights and overlapping jurisdictions. In populated areas it needs to recognize and resolve the multiple interests that are present. But who will speak for the ecosystem values not represented in unpopulated areas?

Planning & Management - Alternatives are needed to replace past practices in land and water management. These alternative management practices need to acknowledge and support the link between watershed health and the cultural and economic health of rural communities. There needs to be incentives for water conservation, riparian conservation, and the protection of riparian health. Beetle kill and fire have already impacted watersheds. Planning is needed for the heavily used and impacted watersheds, especially in light of climate change. We need to focus on fundamental questions, such as, how do you allocate water and balance needs for aquatic life and ecosystem services?

Funding - There is a lack of on the ground expertise because there is no funding to support these initiatives. Funding also needs to be directed towards watershed districts to focus on educating watershed users and consumers.

Community Engagement - Community engagement includes public and end-user education, maintaining the enthusiasm of local and rural volunteers, and citizen involvement. Environmental education on how the public and users can maintain watershed health will increase user stewardship. How can politicians be engaged?

F.1.2. Kelowna

Education & Communication - Effective communication of key issues to the public is necessary to demonstrate the need for action. This should include education efforts to give the public a better understanding of ecosystem needs (e.g. low flow impacts to ecosystems) and encourage conservation to support demand management efforts. Traditional Ecological Knowledge (TEK) can also play a role in helping people to understand the link between water, ecosystems and people.

Regulatory - Watersheds face a myriad of stressors that need coordinated regulations and enforcement to counter. For example, livestock grazing occurs in and near lakes and streams causing trampling and contamination; motorized vehicle recreation is impacting watersheds; and logging is not occurring responsibly. Right now, land-use decision-making is fragmented and focused on short term economic benefits. Stronger regulations are needed to protect source water, riparian areas, and groundwater. There is a window of opportunity to make changes to regulations while the economy is down; for example, the whole forest tenure system needs a radical change. A new regulatory framework must ensure that governments work together on a watershed basis (rather than limited to jurisdictional boundaries that do not follow watershed boundaries); that water and health are not sidelined; that demand management is more than just supply management; that actions such as rainwater collection are mandatory rather than voluntary; and that efforts to protect watersheds by one government are not undermined by development decisions of another (e.g. protect watersheds but sell lots for development without regard to water).

Compliance & Enforcement - Limitations in compliance and enforcement prevent the closing of the adaptive management cycle. Managers must be able to enforce behavior change where necessary. Current efforts such as developing partnerships between ranchers and Ministry of Forest and Range are limited by decreasing or complete lack of funding. Compliance and enforcement are also necessary to conserve wetlands and prevent chemical seepage (e.g. pharmaceuticals and personal care products) from septic tanks. It is important to maintain

compliance in forestry operations to ensure the protection of riparian zones and class A lakes and to limit non-point source pollution.

Science & Data - There are both theoretical and specific gaps in science and data and improvements are needed in the management of this information. Theoretical gaps include undefined terms (what is a watershed?) and questions of spatial and temporal scale and their interactions and synergies. Specific gaps include indicators for cumulative effects, better understanding of groundwater-surface water interaction, dynamics of glacier fed streams, and adaptation strategies for climate change. In some cases, data exists for numerical modeling but they are not in a useable form or in a centralized system that can be easily accessed. Terrestrial values and invasive species also need to be considered when designing new scientific studies.

Monitoring - Consistent monitoring is an essential component of managing watersheds. But the right questions need to be asked to close the adaptive management cycle; questions that investigate the efficacy of management actions, such as regulations, to protect ecosystems. Equally important questions are those aimed at tracking the conditions and responses of ecosystems, such as the affects of low flow, to inform new management strategies. Monitoring can address enforcement and effectiveness questions regarding best management practices (for example, how effective is storm water management?). Water metering data can act as incentives for water conservation. Together, the information generated by a comprehensive watershed-monitoring program can be used to improve public and political understanding of the issues that threaten watersheds.

Funding for monitoring programs is far lower than what is needed. Funding needs to be identified and secured for the hydrometric network to improve the availability of hydrometric data by supporting flow-monitoring stations. Water quality concerns, such as pathogen tracking, also need to be included in a watershed-monitoring program.

Access management - (This was identified as an issue but no further information was collected to expand upon this statement.)

Working together - We need to empower local residents and groups to work together to find solutions to watershed issues. But there is no support or funding for small or unconventional projects. Who will fund these initiatives?

Water quality - Non-point source water pollution, such as agricultural runoff of pesticides and nutrients, needs to be tracked and managed.

F.1.3. Victoria

Water Quality - Clear water is necessary to support all life, including humans and aquatic life such as fish. Efforts to manage water quality need to be integrated with the management of water quantity, as quality is related to the concentration of pollutants and therefore the dilution potential of waterways. Storm water run-off, a consequence of impermeable urban surfaces, causes pollutants to flow into streams and other water bodies. Water quality standards need to keep up with emerging threats such as PPCPs, pathogens and new chemicals.

Cumulative Effects - Cumulative effects should be incorporated into watershed planning, management and decision-making. Planning is essential to ensure individual decisions are not made in isolation, to make prevent unforeseen consequences of decisions on linked attributes, and to resolve competing water interests through conservation. Impact studies are needed to understand watershed connections.

Climate Change - Climate change will continue to impact both water quality and quantity by changing seasonality of stream flow and groundwater resources; increasing water temperature; and increasing the occurrence of floods and droughts.

Riparian Health - Healthy riparian ecosystems support species diversity and ecological resilience. Riparian corridor protection, ideally through regulated setbacks, is necessary to protect fish habitat and spawning grounds. Healthy riparian ecosystems also depend on the health of upland areas (i.e. soils, vegetation and land management).

Watershed management - Watershed boundaries often do not follow political boundaries yet integrated land and water management is fundamental to watershed health. Watershed-wide management is not common but usually more site-specific. Government and decision makers need to be willing to make necessary and tough choices to protect water resources and watershed health (e.g. from results based to regulated & compliance based). There needs to be adequate guidance, legislation, and senior government commitment as well as more mechanisms for collaborative efforts, to ensure minimal impacts from land use and to effectively protect habitat for aquatic ecosystems.

Water Quantity - Ecological flow requirements of aquatic species and ecological processes need to be respected in all water use decisions. Low flow conditions can affect aquatic ecosystems, for example, by reducing the ability of fish to spawn due directly to low flow or to secondary effects such as increased water temperature and higher concentrations of pollutants. To ensure flow security for aquatic ecosystems, conservation efforts are necessary and planning should include a safety factor to account for anticipated fluctuations due to the interaction of climate change, weather events (such as droughts), and water needs of human communities. Mitigation of extreme peak flows is also necessary to reduce the damage to fish spawning grounds.

Water needs to be protected and conserved for all uses. At the root of this issue, we must question: how do we view water, as a natural resource or a life-giving element?

Communication & Community Involvement - There is generally a lack of public understanding regarding the value of ecological services within watershed. Education is needed to increase community awareness of watershed health and involvement in watershed management. Specifically, more work can be done to increase the awareness of how individual actions affect watershed health. Currently there is no good venue for easily sharing knowledge with the public and for integrated dialogue among all watershed players (including all levels of government, local First Nations, NGOs, communities, academics, planners, health workers and industry). Lack of integration is particularly a problem when using watershed studies that are paid for by resource extraction companies, as these studies often lack critical information that is necessary to be effective.

Conservation and Land Use Planning - Ultimately activities on the land will affect the health of water resources and aquatic ecosystems. For example:

- forestry practices such as clear-cutting can decrease infiltration leading to increased runoff and increased sedimentation;
- agricultural practices such as the application of chemicals and bio-solids can impact water quality; urbanization, in part caused by taking land out of the Agricultural Land Reserve for development, leads to a decrease in natural vegetation and an increase in impervious surfaces (pavement) which in turn leads to increased runoff and increased pollutants entering water ways;
- poor mining practices can impact water quality; and increased land development for industry can increase waste discharge.

Local land use planning is necessary to:

- check unconstrained land development and land privatization which reduces opportunities for the protection of ecological goods and services
- ensure all aquatic species and habitats (not just fish) are conserved, possibly through freshwater protected areas representing a range of habitats and species
- that old growth areas are large enough to support the biodiversity that only exists in them;
- that pollution control regulations protect oceans, glaciers, streams and lakes. Urban and rural development is currently unsustainable and uncoordinated;
- ensure industrial activities are conducted within ecological and environmental limitations; and
- that industries are held accountable for meeting environmental protection goals. Implementation of best management practices is needed to reduce industrial and agricultural pollution.

Governance over resource extraction decisions should not be left to one person like a chief inspector. Overall, we need to ask, are urban watersheds a healthy place to raise a family?

Data and Monitoring - Clearly established scientific baselines and consistent long term monitoring are necessary to manage and conserve water resources and aquatic ecosystems. Monitoring and inventory of water quality, water levels, and aquatic biodiversity within each watershed provides feedback to assess and adjust management approaches. Long term (decades, not years) funding mechanisms are needed to ensure consistent, uninterrupted data collection. Monitoring programs should be independent, i.e. not paid for directly by industry, but the cost of monitoring could be incorporated into the cost of permit fees. Monitoring programs should collect timely data at the correct sampling frequency and at adequate locations to get an accurate picture. They also need to consider the accumulation of threats to watershed health (mining, IPP's logging, etc.). Historical data from watershed residents needs to be integrated into long term studies. There needs to be mechanisms put in place to share data, experiences, and best practices.

Indigenous Peoples - Indigenous peoples' original teachings needs to be recognized, included and applied in water policy development at all levels of government. This includes indigenous law and indigenous science including Traditional Ecological Knowledge (TEK). Support is needed for indigenous people's language and cultural practices, in part through education that supports the full inclusion of TEK in schools. Community-based research hosted by indigenous

communities, TEK and local knowledge should be given stronger recognition in water and watershed management. This could be tied to education about and the implementation of the UN Declaration on the Rights of Indigenous Peoples at the local level.

Invasive Species - Non-native and/or invasive species in ecosystems need to be identified and researched to understand where they come from.

F.2. Surface and Groundwater Hydrology

F.2.1. Prince George

Wetlands - Wetlands are important for surface water storage, water quality and groundwater recharge. Wetland loss and damage can impact these functions and services. Constructed wetlands are created to prevent the overall loss of wetland area but are the attributes and functions of constructed wetlands comparable to natural wetlands? Is there a net loss in ecosystem services? We need to map and classify existing wetland distribution as well as wetlands already drained.

There is a lack of surface and groundwater research in Northern BC and the inappropriate application of groundwater models that have not been calibrated. We need to develop and use coupled groundwater-surface models to address general water use decisions and in particular, low flow situations.

Monitoring and Information - Current water quality and quantity monitoring in the North is lacking as well as historical data. The resultant lack of information is especially prominent outside major urban centers (i.e. for rural and remote communities). There is little information on Northern BC's aquifers: their extents, volume, recharge areas, vulnerabilities and chemistry. And little information on the amount of surface and groundwater extracted by the many existing and potential users of water.

Monitoring and Information collection initiatives need program funding to sustain monitoring networks and inventory and to: quantify the amount of surface and groundwater being withdrawn by both public and private users (commercial and personal use); establish monitoring stations throughout BC that include climatic, hydrometric and groundwater sensors at the same location; and identify groundwater recharge areas so they can be protected. The mandatory submission of log records by well drillers is also an essential step for collecting water well information.

Regulations - Policy to support integrated watershed management needs to move beyond rhetoric. An increase in capacity is needed to enable integrated watershed management as well as an increased recognition of the role of land use and management in influencing water quantity, quality and continuity at the landscape scale. Providing the necessary information, such as knowing who holds water licenses within a watershed and how much they are allowed to extract, may increase capacity for enforcement. Clarity around how to report violations is also needed, as well as a commitment by government to respond to these issues in a timely manner. Licensing and enforcement of groundwater resources is necessary to protect this water resource.

Communication, Education & Engagement - Public and stakeholder viewpoints range from thinking that there will never be a shortage of water to a fear that there will not be enough. Communication and education is needed to inform individual perspectives and to develop a stewardship ethic. Generally there is a lack of understanding by stakeholders and communities about the science behind watershed management, for example, recognizing that groundwater resources do not follow river basin boundaries. Also more awareness is need regarding cumulative impacts, how to minimize impacts, and how to get involved.

Engagement events can bring together different stakeholders with competing interests for resources. These multi-stakeholder events can identify what the key services and functions of water are and identify a vision for the future. They can provide avenues for information transfer as well as play a role in identifying the information that is available and the information that is needed to address future issues. Events with policy developers and scientists may help to communicate and incorporate science into policy, but there is no guarantee that the science will provide the basis for decision-making. How does one ensure that watershed science is not ignored or manipulated during decision making?

Contaminants - There are multiple avenues for contaminants to reach both groundwater and surface water. Contamination may occur in aquifers as a result of oil and gas activities (e.g. fracking). Transportation corridors (highways, railways, pipelines) and specifically the effects of transportation corrosion can contaminate ground and surface water resources. Agricultural and urban runoff can also add contaminants and increase the suspended sediment loads of surface waters. In some cases the fate of contaminants and sediments are unknown. Pollution monitoring and remediation strategies are needed.

F.2.2. Kelowna

Information and data - A well-recognized adage, "you have to measure it to manage it", needs to be taken seriously for watershed management. Specifically, there needs to be information collected on how much water we have (supply side) from water inputs (rain and snow), surface flow (more hydrometric stations) and groundwater assessments; and how much water we use through regulated water metering of surface and groundwater withdrawal by all users (municipal, agriculture and industry). We do not have this complete picture of water supply and demand, but it is necessary to generate water mass balance models to inform allocation decisions. How can surface and groundwater hydrometric networks be improved to support this information need? Groundwater in particular needs regulation to ensure the submission of well records (at least 251 to 501 wells missing in database) is mandatory and water withdrawals are recorded. To increase the utility of well descriptions, trained scientists should conduct them.

There are also outstanding questions that need to be addressed to further watershed management. These include:

- How can we incorporate traditional ecological knowledge, most of which is oral, in a lasting way?
- What is a healthy aquatic ecosystem?
- What is meant by "in-stream flow requirements" or ecological requirements?

- What are the effects of climate change and associated changes in vegetation on surface and groundwater supplies?
- What are, or will be, the affects of chemicals not currently monitored, like estrogen mimickers, medical residuals and other by-products?
- What are the more subtle/less obvious impacts of water control structures on hydrology, hydrogeology and aquatic ecosystems?
- What affects will climate change have on low flows?

Sharing - To gain the full use and application of collected data and information is needs to be shared amongst all users. This could be through a one-stop shop for water data and also a method to encourage the sharing of scientific knowledge across disciplines. This will require a coordinated effort to bring together governments, NGOs, volunteers, universities and industry to develop a standardized means to exchange information. This must allow for the incorporation of regional variability in basin characteristics (hydrologic, biologic, geologic, etc.) in a provincial effort. A first step may be to target holders of GIS data (all governments including First Nations) in an effort to reach an agreement to give open access to data. A second step may be to ensure all data submitted to government in government files is available to the public in an useable format (i.e. not in pdf documents). The data that are available needs to be analyzed and used (for example, Diana Allen's aquifer maps) and tied directly to outcomes.

Science and Technology - Science and technology needs to be applied to answer some outstanding questions and address uncertainties. Specifically, we need a better understanding of:

- the connection between surface and groundwater
- in stream/ecological flow needs for aquatic ecosystems
- water mass matrix
- the current conditions of headwaters (dams, reservoirs, riparian areas)
- areas sensitive to water use
- effect of interactions between landscape disturbance (e.g. fire, logging, urban development) and climate change on surface and groundwater resources
- groundwater flow in bedrock systems in mountainous terrain
- geothermal systems (heat island effects and possible contamination from poor drilling and instillation)
- water quality needs of aquatic organisms (good water quality for humans is not the same as what's needed for aquatic ecosystems)

Policy - Current water policy lacks a long-term vision and focus that is needed to prevent a tragedy of the commons. Definitions, such as sustainability, are vague and thresholds, such as minimum water levels for surface water bodies, have not been established. Our moralistic view of water has not been resolved: on one hand there is the view that water is a priceless resource and a human right that should be free to everyone, yet on the other hand there is a concern that free water can lead to waste and that market tools are necessary to ensure efficiency. In general, policy solutions need to: be based on natural (e.g. aquifers and watersheds), not political boundaries; recognize the connection between groundwater and surface water; protect source water within watersheds; and facilitate relationships between researchers and people on the ground. Policy solutions will also need to help us prepare for climate change and drought. Examples from Europe, such as limited water population, may be useful to apply in BC.

Policy solutions will need to provide appropriate decision making tools and to target specific inefficiencies. For example, the inability of ranchers to obtain water licenses for off-creek watering has lead to continued direct access of cattle to streams. Policy solutions will also need to clarify areas of overlapping jurisdiction, for example the ability of the *Fisheries Act* to trump the *Water Act* making application of the *Water Act* difficult.

Water users don't necessarily want to be managed yet there is a need to distinguish between water wants and water needs on a watershed basis. There is, therefore, a need to ensure that policies are enforceable through laws and regulations rather than optional guidelines. Technical studies uncover issues but there is no means to correct the situation, in part due to the lack of staff (or staff with the necessary expertise due to internal shuffling) within the Ministry of Environment. The *Water Act* must be enforceable.

Water has value to ecosystems, not just people. In ecosystems all water has a purpose, and therefore, any use of water will have an impact on natural systems. Surface water is without borders, flowing freely, but aquifers are contained yet a threat to one system will affect the other. How can we increase political will to address surface and groundwater threats and challenges?

Money - Funding is needed to support monitoring, short-term studies (1-3 years), and to address water science and research needs. It is also needed for auditing programs for water usage. Funding arrangements for watershed science programs need to be multi-stakeholder and multi-disciplinary and should reach out to private interest groups.

Education - Education is needed to build public knowledge and awareness so the public can become engaged in water management discussions. This is particularly important with groundwater as the public may not understand the characteristics of groundwater and has drastically wrong impressions, for example, the perception that groundwater is strictly the property of the landowner. A general increase in education on the link between ecosystem services and water and land management is needed to develop personal values towards water. Fostering understanding and related values towards water will help in encouraging water conservation and to develop support for personal accountability towards water use (through water meters).

This education needs to include clear information on topics such as how much water we use and also the effect of low flows on aquatic organisms. Tougher questions such as, "how much groundwater should we share?" can also be raised through public education to promote discussion necessary to support water conservation and sustainable water use.

F.2.3. Victoria

Data Issues - There is a lack of high quality, current data on groundwater and surface water resources. For example, aquifer characterization is very limited or non-existent for most of the province; there is no data on actual groundwater use; and there is a lack of data to support water allocation decisions through reliable accounting of water demand and supply. In some cases, data used for analyses is antiquated historical data and is inadequate to answer present day questions; in other cases there are no historical data to assess the impacts of water

extraction for industrial uses (e.g. IRPs, Natural Gas Extraction). To compensate for the lack of data, modeling is being used as the sole source of information for decision making but there needs to be a mix of field based information as well as modeling approaches. High quality studies, supported by data collection and modeling, are conducted in the private sector, but how can this be moved into the public realm? Currently there is a lack of human resources within government for monitoring, analysis and reporting and no stable funding or resources for some observational networks. The spatial coverage of the current monitoring regime needs to be increased and expanded water quality variables (e.g. pharmaceuticals) that are currently not being monitored need to be added. There needs to be stable, long term funding to carry out a "Made in BC" regional groundwater-surface water monitoring program. The lack of data is a major problem, what action can we take while waiting for "more data"? How can the lack of willingness to fund objective water science and research be overcome?

Data Collection - There are many gaps in our understanding of water resources in BC that require data collection to fill. These gaps include:

- the interaction of aquatic ecosystem functioning and water levels;
- changes in high elevation temperature and precipitation;
- potential impacts of precipitation harvest (rainfall/snow melt); and
- current lapse rates (rate at which air temperature falls with increasing altitude) and how this will change with future climate change.

Programs designed to monitor surface-groundwater interactions will need to cross-watershed and political boundaries as political boundaries and aquifers do not often follow watershed boundaries. Well records should be mandatory for all new wells as these records provide essential data for hydro-geological assessments and models and also provide an indicator for areas of high aquifer development and use. Using these records, a provincial overview of groundwater demand could be conducted to identify areas of high groundwater demand. Aquifers should be included in infrastructure risk assessments of rural communities. Groundwater quality monitoring networks also need to be established.

There are basins that are currently not gauged making it difficult to estimate water supply. Surface water source areas need delineation for specific intakes so the dynamic and non-stationary effects of changes in land cover (e.g. forest harvesting, mountain pine beetle, changes in wildfire frequency) can be incorporated in land use and water allocation decisions.

Monitoring efforts need to be coordinated and to integrate data collection and reporting with data quality standards and clear definitions of what is collected. These also need to be bolstered with continued investment in key databases (e.g. WELLS database, river monitoring networks) and web tools that allow consultants to input data on projects across the province such as aquifer characterization. A priority should be given to a water assessment project that would collect and grade all existing data: historical and current. This project could address issues in data quality and data confidence.

Groundwater-surface water interaction - There is a general lack of understanding on groundwater-surface water interactions. At a high level it is clear that these two are linked through the hydrological cycle but site specific details are unclear and more research is needed. In the interim, this interaction needs to be communicated to policy makers and decision makers especially in regards to water allocation decisions where aquifers may be connected to streams

or lakes (e.g. impacts to existing licenses). Current regulations do not recognize this interaction. There needs to be more discussion and collaboration on allocation decisions so that the consequences of either surface or groundwater extraction can be considered for the entire system.

Values - Values can come into play when interpreting data with a specific objective in mind (e.g. human health, ecological services, environmental health). Politicians and senior bureaucrats need to consider all information, even "bad news stories" reported by researchers, rather than using only science that supports their political will. Public and politicians have a low awareness of water issues.

Action Implementation & Public Safety - There needs to be action taken to reduce the impacts of flooding. Also the impacts of urbanization on watershed factors such as stream flow and groundwater recharge need to be addressed.

Regulation - The current water allocation process is inflexible and out-dated and needs to updated. This process, however, is complex and time consuming so there needs to be a system in place to prioritize water issues in policy implementation (e.g. delays in seeing Groundwater Protection Regulations completed). Legislation to protect groundwater is urgently needed. This legislation and associated regulations should include: the mandatory metering of groundwater use to make available essential data for water balance studies; the regulation of groundwater and surface water use (rather than maximum allowable volume); the disclosure of groundwater analysis; licensing of groundwater extraction; and mechanisms for enforcement. Policy development should be driven by science rather than politics and should include water protection goals such as the maintenance of minimum water requirements. New water regulations need to act as a bridge between the *Environmental Management Act* and the *Water Act* to prevent the contamination and environmental impacts associated with waste management. Strong regulations will allow BC to meet its water supply commitments but we must also consider the question, if there are legal rights to water, can these be taken away?

Ecosystems - To inform management decisions there needs to be a stronger link established between water quality and supply issues with ecosystem goods and services and human health. This will become increasingly important as populations continue to grow and make changes to land-use. An example is changes in muskeg/peat wetland hydrology - how will that affect watershed resilience and human health?

Climate Change - What tools can help managers make decisions in the face of future uncertainty? There are many unknowns as past conditions can no longer be used as a predictor of future climate change impacts on water resources. For example, what will be the new norm in stream flow of glaciered basins with projected changes in glacier volumes?

Water Demand - Currently there is a poor understanding of water demand in the province, especially of groundwater withdrawals but to develop responsible and informed water budget for watershed and ground watersheds, managers need to know who uses water and much water is being used. Other factors such as the availability of clean potable drinking water, cumulative impacts on aquifers with multiple users, and the amount of water needed by agriculture, also need to be assessed. This information needs to be communicated to the public to increase public awareness of water management challenges, costs, and options. Options

such as collection of rainwater during dry seasons to lessen individual well drawdown of aquifers can then be discussed in an informed manner.

F.3. Watershed Governance

F.3.1. Prince George

Education - Education to raise public awareness around water issues. People won't get behind something they do not understand and lots of people do not think water is an issue. For example, increasing awareness of municipalities and the public around groundwater vulnerabilities may lead to an increase in groundwater well protection areas. This should not be a one off project, but a long-term extension program about science, policy and governance.

Needs, Values & Priorities - A clear process for allocating water resources to balance all the different needs associated with water (i.e. safe adequate water vs. industry needs vs. cost to consumers). The process must include considerations on ecosystem requirements and how much water is actually needed by people compared to what they think they need. This in turn requires information on the amount of water actually being used and the economic valuation of water. It will also need to consider the economic impacts of water decisions and how they are linked to employment, growth, and waste. For example, what are the implications of selling water for profit? The process will need to consider, what is *a right to water* compared to *an interest in water* (e.g. Aboriginal rights, current water licenses). To make the inherent tradeoffs necessary in water decisions, the process must be guided by clear objectives, but what are these objectives? Fostering the well being of people and the environment? Protecting the resource?

Inventory, Monitoring, and Data - There is a lack of reliable, timely information and basic inventory data. There is also a lack of political will to support monitoring programs and a resultant lack in funding for adequate monitoring networks. This may be partly improved by ensuring that all available information is accessible to all. Currently it is unclear who the creators and holders of information are and who has access to it. More surface water monitoring stations in small, medium, and large sized basins are needed and the placement, maintenance and funding of these stations should be coordinated with the Federal water survey. Also the reporting of water withdrawal under permits should be mandatory.

Human Relationships, Knowledge and the Decision Making Process - There is a lack of trust in local decision-making. But relationships and trust are required for effective governance. A dedicated role is needed to act as the glue between different groups involved; to cultivate links among and within disciplines, sectors and communities; and to develop inclusive relationships that bring all people on the knowledge ladder together.

Watershed Focused Governance - What scale should water governance occur at? Is it possible to be too local? Who decides? Discussions are shifting from a model with government at its centre to a multi-stakeholder governance model. This is an important different that is not always understood. It is part of creating a shift to integrated watershed governance that is inclusive of all stakeholders compared to a limited government process that includes only water

and water users. An inclusive process may also overcome the decreasing connection between government and stewardship groups.

Legislation - Water legislation and policy is antiquated, insufficient and inadequate and does not allow for the flexibility that current water issues require. Both the legislation and agency responsibilities are fractured. Is the solution a Ministry of Water? Definitions of water systems must include all aspects and users. Better direction from government is needed on watershed guidelines for water quantity and quality.

Policy Development - Overlapping jurisdictions has resulted in a lack of comprehensive watershed management and a First Nations governance, policy and regulation vacuum. Water policy that is created is driven by a "need" for development to support and encourage population growth. Is this a wise context? Science can act as a driver of policy as can past land use plans. Policy development needs to engage end-users, especially in regards to licensing of groundwater. And new water policy needs to be implemented and enforced at the watershed level.

F.3.2. Kelowna

Value of Water and Willingness to Pay - There needs for greater education around the value of water as a resource and our reliance on the ecological goods and services that are provided when water remains in ecosystems. End users must be willing to pay for the water they use.

Water Use Strategies, Data Needs, and Plans - To manage water proactively, we need to know what people value and to measure those values rather than relying on the squeaky wheels as a measure of public values. This will be useful in determining how to influence the individual water user and predicting how people will respond to different policy tools. It also needs to be made clear who has the rights and bears responsibility for water uses. This social knowledge may help to get political and public acceptance for proposed water solutions.

On an ecological front, minimum stream flows for connectivity and health need to be identified along with climate change scenarios that will inform both immediate decision making and future planning. This knowledge of social motivations, ecological systems, and potential changes due to climate change can be used together to develop local watershed plans and water use plans that are ecosystem specific.

Fractured Planning and Governance - The Provincial government will make the ultimate decision on water governance but what governance model can overcome the fractured planning, jurisdiction disconnect, provincial silos, and lack of coordination? Or provide adequate representation for local people? What is the most appropriate design for institutions? Historically they have been organized in a top-down way, will a distributed model improve the situation?

Whatever the governance model, it will need to overcome the reluctance of elected officials to make decisions. It will also need to resolve situations where a jurisdiction cannot manage for their responsibility. For example, municipalities (or improvement district) are responsible for water safety but decisions on land use and source water protection are a provincial responsibility.

Funding for Infrastructure – Responsibilities assigned by the Province must be backed by resources. For example, the Province demands specific standards that may cost big dollars (e.g. filtration plants) but makes no companion financial commitment. Resources to manage and test water needs to be given to the people and governments that hold the responsibility for providing water. Resources are needed in the form of funding, capacity, and accesses to revenue sources.

Competing interests/stakeholders - Multiple stakeholders compete for a limited resource that in some cases cannot be divided.

F.3.3. Victoria

Watershed Based Scale - Water needs to be managed on a watershed basis even though watersheds are nested (e.g. Fraser Basin vs Nicola), and watershed boundaries do not often overlap with political boundaries. The collaborative approach of integrated watershed management is needed to ensure water decisions are not made in isolation. Long term demand management plans and watershed protection plans should be the basis for all land use decisions. Natural areas and biodiversity also need to be linked to watershed protection and management plans. Watersheds need to be continuously monitored for industrial pollution and effluent entering watersheds and groundwater reserves.

Valuation - The way we value things impacts our decisions. Water is life, which is clear when one considers that 90% of our bodies are made of water and therefore water governance directly affects us as individuals. Current prevailing economic systems, however, favor narrow short-term ends. Safe and secure drinking water must be a priority and protected against over extraction. Tools such as conservation based pricing and other economic models that promote water conservation are necessary. Specific, measurable objectives regarding water conservation need to be embedded in policy and legislation.

Funding - There is currently a lack of funding for watershed planning and management. This extends to the capacity to collect and interpret data, capital funding for things like treatment plants, support for local public education projects, and support for First Nations and local residents' engagement in water governance. Who holds the responsibility to ensure governance programs are adequately funded? Right now there is a downloading of responsibility without authority and resources to govern water properly. There needs to be mechanisms in place to provide adequate funding for local water boards and community groups to address issues at a watershed level, to study efficient use of water, and to conduct planning and create implementation plans.

Public Involvement and Engagement - Currently there is no public mandate to focus on sustainable water governance because the public does not realize the extent of the issue. At a local level there is little understanding of the implications of provincial decisions on local water governance. But it is necessary to increase involvement of the public to: increase the political mandate to take action on water governance; to make sure that those that bear the risk of decisions have a say in the decision; and to encourage a shift in our cultural consciousness away from the idea that water is plentiful. Through collaborative processes, various disciplines need

to come together to create a clear definition of sustainability that is measurable. Greater transparency is needed in decision making to protect against the coercion of the political process by wealth and power. Media also has a role to play by making the connection between climate change and reported weather events. First Nations and public leadership are both needed on water and climate change issues.

Fragmented Roles & Responsibility - The current jurisdictional framework is fragmented, splitting responsibility and authority so local (municipal and regional districts), provincial, federal and First Nations all having jurisdiction over water. The fragmentation is throughout government contributing to a lack of communication among agencies. This has lead to confusion within the public of legal rights to access water and the roles and responsibilities of the different levels of government. The current regulatory regime (First In Time First In Right) is incompatible with modern methodologies. Within watersheds there is dispersed responsibilities and authorities for water allocation, quality and infrastructure, i.e. water purveyors, municipal governments and irrigation districts. Also, water and land decisions are not linked - responsibilities for land use are spread over many different agencies & groups. Who is responsible for water?

A new water governance framework must create clarity around jurisdiction over water, integrating legislation and eliminating conflicting regulations. This new framework must create formal lines of accountability and clear roles and responsibilities of all parties. It must also recognize the jurisdiction of First Nations over water. New legislation should include an overarching goal to protect water, which has precedence over other land use decisions. The new framework must support adaptive management, being flexible enough to adapt to changing conditions while providing some certainty to water users. It should also coordinate land use decisions with water planning and allocation and provide a central hub to organize all agencies and groups to overcome a patchwork approach.

Watershed management may require a shift to partnerships with local government and groups to manage water resources. If, however, water continues to be the property of the province, how can water governance responsibilities be delegated so that the structure is equitable? Local government officials may need more education and training on water to ensure there is adequate ecological expertise to make decisions. There also needs to be a direct connection between responsibility, authority and resources required for water management.

Local governments should hold the ability to protect watershed ecological functions, processes, goods and services but will need to grapple with the uncertainty associated with cumulative impacts and climate change. This can be supported by access to accurate and reliable data, such as monitoring and reporting by all water users including residential reporting supported by water meters. Watershed scale management will require participation by local experts and informed residents. This may in turn require the continued education of local residents to accept limitations identified by science.

Data - Proper governance requires understanding of what is being governed (how much, quality, connectivity, etc) and a willingness to apply knowledge to real world problems to find solutions. This basic premise is undermined by the lack of information on groundwater, surface water, their interaction, modeling of supply (and demand), and population usage. This information needs to be made available to decision makers. Information is, however, often incomplete and our understanding uncertain, requiring a flexible framework that can be changed as new

information becomes available and the use of the precautionary principle in the interim. New processes for including stakeholders in data gathering, knowledge creation, and policy development are needed as well as better ways to transform research into policy frameworks.

Holistic Multiple Interest Approach -

- Is there Canadian Water?
- Is there Russian Water?
- Is there Indian Water?
- Is there Common Water?
- Is there Fish Water?

Managing water will require understanding other peoples' perspectives of water and creating a shift from an economic to an ecological approach to water governance. This new approach will need to balance the societal and economic desires of various stakeholders while upholding values such as watershed health. To develop a balanced approach, fundamental question need addressing, such as:

- how to managing competing interests and priorities for water use to secure the public and environment good;
- how do we get users to accept and to make the change that is required; and
- how to integrate climate change scenarios and adaptation to climate change into policy and decision making?

As a start, government needs to acknowledge that any water strategy involves politics and any process, such as modernizing the *Water Act,* needs to include consultations with First Nations. The priority for water needs to be elevated so we can move beyond talking to taking action. Urban development must be guided by municipal policy so that ecologically respectful methods are used, not just the cheapest.

Scarcity - Increasing water scarcity is occurring in certain areas of the province that may require specific tools and approaches not yet needed by other areas of the province. A broader set of policy tools needs to be considered (e.g. economic tools such as pricing and markets) to encourage water conservation.

Protection - Headwater areas need conservation to protect source water quantity and quality.

Standards - There needs to be a set of national and provincial standards and/or key performance indicators applicable to water conservation, rain water harvesting, water re-use, and water treatment. These standards should be universally applied to all governments and proponents to ensure safe treatment and distribution of water.

Communication - Water management is complex in our changing word and the issues are difficult to communicate. Scientific disagreement, while a healthy part of science, can confuse the public about what is important. The public needs to be educated on water and climate change issues so they can engage in water governance; good governance requires an engaged public, and the ability to educate the public is reliant on adequate and accurate knowledge of the situation. The public needs to be made aware that there is a potential shortage of water in BC and that who they vote for will impact how water is managed and protected in BC. The fact

that Aboriginal Title and Rights includes water needs to be more effectively communicated to ensure that First Nations are involved in any discussion on water governance.

Collaboration - Water governance needs ownership and buy-in from all sectors and agencies with an interest in water (e.g. agriculture, mining, petroleum, health, transportation). This will enable watershed level land and water planning and create the mechanics for effective and meaningful collaborations across all interested parties. Although there is not one model that will fit all regions, it is clear that with the shrinking public service, there is an increasing need for partnerships with academics, industry and indigenous people.

Achievement and Accountability - There needs to be clear accountability from proponents and government on water protection.

Legal Knowledge Transfer - Aboriginal Title and Treaty Rights applies to water. This has been recognized by Supreme Court Rulings and needs to be embraced and incorporated into new water governance systems. Time horizons of treaty with First Nations: for as long as the grass grows, as long as the water flows.

G. Voting Results

G.1. Prince George

Watershed Health

Issue	Urgency	Information Poor
Monitoring & data	7	6
Research (Ecosystem)/ Requirements (Human)	12	12
Impacts of Economic Development on Land and Water Use	7	6
Legislation	2	10
Planning/ Management		3
Funding	6	1
Community engagement	14	8

Surface and Groundwater Hydrology

Issue	Urgency	Information Poor
Wetlands	6	15
Monitoring/ Information	12	15
Regulations	6	
Communication/ Education/ Engagement	11	
Contaminants	4	12

Water Governance

Issue	Urgency	Information Poor
Education	3	3
Needs, Values, Priorities	3	9
Inventory and monitoring data	4	15
Human relationships, knowledge and decision making processes	5	1
Watershed focused governance	15	4
Legislation	9	3
Policy development	3	7

G.2. Kelowna

Watershed Health

Issue	Urgency	Information Poor
Education & Communication	4	5
Regulatory	12	1
Science/Data	9	13
Monitoring	13	6
Access Management	3	0
Working together	2	4
Water quality	8	4

Surface and Groundwater Hydrology

Issue	Urgency	Information Poor
Information or data	11	11
Sharing	2	8
Science & technology	2	8
Policy	11	12
Money	9	3
Education	12	10

Water Governance

Issue	Urgency	Information Poor
Value of Water and Willingness to Pay	12	10
Water Use Strategies, Data Needs, and Plans	21	13
Fractured planning and governance	22	26
Funding (Infrastructure)	5	11
Competing Interests/ Stakeholders	1	6

G.3. Victoria

Watershed Health

Issue	Urgency	Information Poor
Water quality	7	11
Cumulative effects	12	13
Climate change	4	2
Riparian health	1	2
Ecological flow		1
Watershed management	7	9
Water quantity		3
Communication and community involvement	1	2
Conservation and land use planning	12	13
Valuation and political decision making	2	
Groundwater		1
Data/monitoring	14	6

Surface and Groundwater Hydrology

Issue	Urgency	Information Poor
Data issues	0	11
Data collection	27	18
Groundwater-surface water interaction	11	7
Values		
Action implementation		
Public safety		
Regulation	13	22
Ecosystems	0	2
Climate change	0	4
Demand	13	10
Cumulative impacts	0	1

Water Governance

Issue	Urgency	Information Poor
Watershed based scale	19	19
Valuation	4	
Funding	5	11
Public involvement and engagement	3	6
Fragmented roles and responsibilities	13	24
Data	12	6
Holistic multiple interest approach	16	23
Scarcity	3	1
Protection and standards	3	3
Communication	8	20
Collaboration	16	23
Legal knowledge transfer	5	1

APPENDIX H: BREAKOUT SESSION I – PARTICIPANTS' INPUT

TABLE OF CONTENTS

H. Breakout Session II – Communication methods of groups within watersheds

The purpose of the second breakout session was to explore information needs and communication methods of different groups of water practitioners. For the Water Symposium, the groups refer to the five groups described in the Water Symposium Discussion Paper. A brief description for each group is given below:

- Scientist - a social or natural science researcher, technical person (such as someone who collects data in a monitoring program), a technical specialist or other person who provides scientific expertise on water science and issues.
- Policy-Maker - An elected official, politician or a political advisor or policy analyst within government or within another organization.
- End-User - A person who implements policy by carrying out operational procedures and making site-specific decisions. For example, a person who works in the natural resource sector, local government or as a water purveyor.
- First Nations - Descendents of the first peoples of Canada who have a unique relationship and interest in water based on Aboriginal title, rights, and treaty. First Nations knowledge of water is rooted in traditional water management uses and practices.
- Stakeholder – A group that shares specific concerns about water and takes action regarding this concern with other members of society. Examples include groups representing the

water interests of agriculture, tourism or power production, as well as those groups, such as NGOs and local stewardship groups, who work to protect, conserve and restore freshwater systems.

To begin, participants were asked to form into small groups that ideally had a member from each of the groups listed above. As a first task, the small group was asked to pick an urgent issue identified in breakout session I and to identify a specific role that each group may play in the issue (scientist, policy-maker, end-user, stakeholder and First Nation), the type of information the role would need and the general characteristics of this information.

In the second part of this breakout session, facilitators asked participants to come back together to discuss communication methods within and among groups. The specific questions asked were:

- How do individuals communicate within each group?
- What are some of the ways these groups communicate with each other?
- What are some different ways that they could communicate in the future?

Information collected across the province for this breakout session was similar and therefore responses for all breakout rooms in all locations were summarized together. This first part of this breakout session was useful to get participants thinking about information needs and characteristics of that information. Participants generally found the activity difficult as the issues were too general and did not lend themselves well to the exercise. All the tables collected are presented in Appendix D. These will be useful in the future as a start for information and knowledge gap assessments. The general characteristics of the information required for each group were taken from the tables and are summarized below. The information characteristics were summarized into two categories: *general*, which lists the characteristics of the information, and *context* which lists broader types of information a group may need to understand the situation.

Input collected in the second exercise on communication methods was categorized by format: written, person-to-person, group meetings and other. The category, person-to-person, could also be called, one-on-one or face-to-face. Communication methods within each table were ordered from specific to general.

H.1. What are the characteristics of information needed by the different groups?

Scientist

General

- Quantitative and qualitative
- Data
    - Data as raw as possible
    - High quality (QA)
    - Meta data

    - Sufficient quantity & distribution, i.e. monitoring
    - Comparison data from nearby watersheds
    - Spatially explicit
    - Long-term
    - Length of record & stability of record
- As local as possible
- Seasonal information
- Timely

Context

- Research questions
- Projections
- Information regarding the costs and economies of decisions within the scope of the issue
- Links to plans and policy
- Common language and definitions

Policy/Decision-Maker

General

- User friendly information
    - Interpreted and analyzed
    - Plain language
    - Graphs and visual aids
    - Simplify complexity
- Decision support
    - Triggers thresholds, criteria for making change
    - Cause and effect data
    - Base-line data
    - Scientific uncertainty
    - Comprehensive summaries
- Characteristics (general)
    - Consistent, accurate and accountable
    - Holistic
    - Scientific
    - Transferrable
    - Local (specific to their area of influence)

Context

- Case Studies
- Projections for the future good or bad
- Different perspectives (social, economic & environment)
- Cost of policy to assess reality of actually implementing a policy
- Cross sector integration of information
- Decision support

- Costs and economies of decisions within the scope of the issue
- Relative impacts of short and long term decisions
- Complete and holistic representation of impacts of decisions

End-User

General

- Neutral
- Clear, practicable, and enforceable
- User friendly information
  - Brief summaries
  - Analyzed data
  - Understandable science
- Easy to access information and data (e.g. data outside of journal articles)
- Site specific
- Portability

Context

- Historic knowledge of how "things" have changed
- Different perspectives (social, economic & environment)
- First Nations values
- Environmental assessment
- Holistic
- Development of policy
- Accountability
- Compliance
- Terms – conditions of licences
- Local projects

Stakeholder

General

- Information in plain language easily understood to general public
- Brief summaries
- Practical
- Applied information
  - Credibility
  - Scientifically defensible
  - Visual (descriptive map, etc.)
- Transferrable
- Basic monitoring data
- Analyzed data
- Guidelines
- Certainty

Context

- Ideas and thoughts for mitigation and improvements
- All kinds, e.g. education, modeling
- Holistic

First Nation

General

- Practical
- Understandable
- Accessible
- Compliance related
- Perspectives honoured
- Oral History
- Observation & Experience
- Scientific data
- Access to data and water resource information

Context

- Application of traditional ecological knowledge
- Links between plans and policy
- Decision support
    - Information regarding the costs and economies of decisions within the scope of the issue
    - Balanced (social, economic, environmental)
    - Cultural, health and social implications
- Community decisions
    - Indigenous mapping and deciding what part should be shared
    - Levels of decision making – culturally based traditional governance model
- Access to capacity development opportunities in order to meet resource gaps

H.2. How do individuals communicate within each group?

H.2.1. How do Scientists communicate with each other?

Written	Group meetings
• Publications (articles, papers)	• Seminars
• Popular Science magazines	• Meetings
• Peer reviews	• Symposiums
• Multidisciplinary journals	• Conferences
• Extension materials (reading outside discipline)	• Multidisciplinary conference
	• Workshops
• Reports, working papers	• Community of practice
• Email	• Professional Associations
• List servers	Other

- Databases

Person-to-person

- Joint projects on specific issues
- Collaboration with colleagues
- Telephone
- Informal means (social interaction)
- Share Point Sites
- Stakeholder involvement increases multi-disciplinary

H.2.2. How do Policy-Makers communicate with each other?

Written

- Info notes
- Legislation
- List serves
- Emails

Person-to-person

- Socials
- Coffee talks
- Lunch dates

Group meetings

- Professional Associations
- Cabinet meeting
- Communities of Practice
- Policy working groups
- UBCM
- Consultation processes
- Meetings
- Committees
- Workshops
- Symposiums
- Conferences

Other

H.2.3. How do End-Users communicate with each other?

Written

- Journals
- Internet – blogs
- Newsletters

Person-to-person

- Collaboration
- Informal (Tim Horton's, Pub)
- Partnerships
- Phone calls

Group meetings

- Government facilitated collaboration
- Outreach events
- Public workshops
- Professional group
- Associations
- Symposiums
- Roundtables

Other

- School system
- Advertising
- Social media

H.2.4. How do Stakeholders communicate with each other?

Written

- Message boards
- List servers
- Emails

Person-to-person

- Community advisors
- Briefings
- Social (friends for dinners, walks)

Group meetings

- Short courses
- Roundtables
- Consultation (Government looking for input)
- Community groups
- Working group
- AGM/Community meetings

• Telephone • Coffee shop	• Workshops • Forums • Seminars • Associations • Committees • Conferences Other • Conflicts

H.2.5. How do First Nations communicate with each other?

Written Person-to-person • Family to family • Cultural	Group meetings • Tribal councils • Union of Chiefs • Traditional gatherings • Potlatch • Coast Salish gatherings • Chief & Council • Associations • Union of BC • Conferences • Workshops • Meetings Other

H.3. What are some of the ways these groups communicate now (between groups) and how could they communicate?

H.3.1. Scientists and Policy Makers

Communicate Now	Could communicate in the future
Written • Briefing notes • Decision notes • Policy decisions • Government & internal reports • Service plans • Research proposal • Funding requests & grants • Scientific policy recommendations • Conference summary • Executive summaries • Reports • Journals • Newspapers Person-to-person • Staffing	Written • Collaboration centre/ clearing house to broker info between scientist & policy makers • Websites to access information • A directory that lists experts and policy contacts • Surveys Person-to-person • More two-way communication • Regular cabinet briefings • Person to person modeling scenarios • Management recommendations • Management decisions Group meetings • Roundtables/ Committees

• Informal request for information • Request for review • In advisory capacity (e.g. panels, papers) • Lobby? • Consultation • Expert opinion • One on one contact • Personal relationships • Contracts Group meetings • Presentations: delegations, councils • Industry meetings • Presentations • Focus groups • Consultations • Professional organizations • Teams • Task-force • Think-tanks • Symposiums • Meetings • Seminars • Workshops • Conferences Other • Crisis management • Indirectly through Non-governmental organisations (NGOs) • Policy improvement mechanisms • Educational institute collaborations • Same person • policy → funding → research	• Public lectures • Facilitated exchange Other • What do policy-makers need? Define questions • Policy-maker job jar. Database to define research questions & list of problems that need solving. Use existing aggregates (conferences) to gather ideas. • More integration – breakdown silos • Tie knowledge translation to funding • Adaptive management • More proactive • More consistent • Keep message simple • Bottom up as well as top down includes transparency and accountability • Use policy for societal good rather than political good • Long term (> 4 yrs) • Social media • Using Web to interact with diverse groups • Canadian water networks (e.g.) • One point of contact

H.3.2. Scientists and End Users

Communicate Now	Could communicate in the future
Written • Access to papers • Notification (drought warnings) • Government media releases • Funding projects • Impact studies and reports • End User reports • Journals • Peer review process	Written • Internet/web pages • Interactive databases Person-to-person • Reciprocal relationship where they actually listen Group meetings • Coalitions (inter-jurisdictional, multi-use groups facilitated

• Pamphlet • Magazines • Web sites Person-to-person • Technical Advisory Committees • Applied research collaboration • Participation and research • Sampling/monitoring • Informal communication • Contracts • Consultations • Internal Group meetings • Professional organizations • Advisory committees • Public lectures • Industry associations • Public meetings • Evidence based planning • Field tours • Open houses • Workshops • Seminars • Conferences • Poster sessions Other • Extension • Special events • Delayed publication • Industry induced gag-orders • Educational institutions • Media • Markets	• Technical advisory committee • Public lectures Other • Message simple and in context • Emphasis on application • Meet stakeholders & policy makers at front end • Ask the right questions • Common language • Education • More integration – breakdown silos • Using Web to interact with diverse groups • Canadian water networks (e.g.) • Information about who does what – directory • One point of contact

H.3.3. Scientists and Stakeholders

Communicate Now	Could communicate in the future
Written • Notification (drought warnings) • Extension materials (e.g. FORREX) • Indicators • Joint reports • Reports • Funding requests	Written • Policy briefs • Extensions Person-to-person • Recommendations & interpretation • Personal visits & personal relationships • Partnerships

• Trade journals • Journal articles • Publications • Websites • Pamphlet Person-to-person • Collaborative science • Review reports & provide feedback • Pre & post research building • Consultants • Informal communication • Projects Group meetings • Advisory committees • Project steering committees • Collective groups (Land trust Alliance) • Stakeholder driven workshops • Science Forums • Town Hall meetings and presentations • Public meetings • Presentations • Field trips • Public forum • Open house • Symposiums • Meetings • Conferences Other • Through end-user • Research institutes • Community based monitoring, e.g. stream keepers, eelgrass mapping • Media • Link through policy makers	Group meetings • Community coalition groups • Participatory research events • Conferences for stewardship groups (attended by scientists) • Community visits • Public lectures • Hands on activity • Wine & Cheese events • Using Web and webinars to interact with diverse groups Other • Online GIS • Community mapping network • Communication geared to community application • Stewardship • Information about who does what – directory • One point of contact • Answer the right questions • Readable • Relevant • Art • Multi disciplinary scoping • Read their papers, Google to find, internet, TV, Forrex • More integration – breakdown silos • Canadian water networks (e.g.)

H.3.4. Scientists and First Nations

Communicate Now	Could communicate in the future
Written • Internet Person-to-person • collaborate • contract • relationships • direct communication • Research	Written • Mapping (social values, places of value) Person-to-person • Communication of TEK • TEK collaboration • Partnerships • Working relationships • Work side by side

• Commissioned studies of species at risk and land use plans • Collection of knowledge • Formal consultants • Partnerships with consultants/academics • Referrals • Oral tradition Group meetings • Attending Band Council meetings • Attending Tribal Council meetings • Technical working group • Workshops • Science Forums Other • Not enough Invitation • In house capacity • Topic specific	Group meetings • Multi interest groups in coalitions Other • Respect different world views in communication • Scientists to provide capacity-building in FN communities to allow them to conduct their own SAR studies & develop land use plans • Science geared to First Nations' questions • Sensitive to First Nations traditions • ASK what traditions are • Simple answers • Bottom line • Trust knowledge source

H.3.5. Scientist and End-User

Communicate Now	Could communicate in the future
Written • Regulations, Guidelines, Policies • Applications for permits • Community vision • Guidelines (best practices) • Info bulletin • Letter writing/ emails • Increasing use of government websites • Web pages • Brochures • Blogs • Letters to Minister • News • legislation Person-to-person • Enforcement officers • Lobbying • Talking to constituents • Lobby Group meetings • Symposiums • Community meetings • Workshops Other	Written • Clear legislative guidebook Person-to-person Group meetings • Webinars • Presenting/Reporting out to locals • Town hall meetings • Engage in meaningful policy develop • Taskforce/working group • Experience issues (e.g. field tours) Other • More proactive interactions • Clarity in regulations • Extension Officers • Consult at all levels • Citizen science • Eliminating technical jargon (interpreter) • Social media • Politely • Transparency • Honesty (both ways) • Forum, standardized information • Bigger picture • Minimize email

• media • education / mail • Elections • Newspaper/ TV/ all media • Could benefit from cross agency and/or industry public beta-testing • Media • Regulations • Permitting licensing • User groups	

H.3.6. Policy-makers and Stakeholders

Communicate Now	Could communicate in the future
Written • Petitions Person-to-person • Referrals • Lobby groups • One to one • Advocacy Group meetings • Working groups/ Committees meetings • Working groups • Committees • Open house • Consultation • Campaigning • Public meetings • round table consultation Other • protests • voting	Written • Organizational websites Person-to-person • Story telling • Partnerships • Consultative processes • Telephone Group meetings • Advisory boards • Council meetings • Public forum for key issues • Forum Other • Need for a whole of government approach to consultation • Goals discussion & how to get there versus punitive • Use media • Social media • Disconnect • Legislators & Scientists • Will to govern unpopular decisions • Idea of what constitutes knowledge • Report back– is policy working? • Brown envelopes • Local knowledge • Standardized information • Humour • Transparency • Politely • Honesty (both ways)

	• Bigger picture

H.3.7. Policy-makers and First Nations

Communicate Now	Could communicate in the future
Written Person-to-person • Communication of Traditional Ecological Knowledge • referrals Group meetings • Policy consultations • consultation • Attending Band Council meetings • Attending Tribal Council meetings • Consultation meetings Other • Improve reach outside of FN groups across all groups (science, policy, stakeholders, etc)	Written Person-to-person • Meet in person and talk • Share stories • Partnerships • Formal & informal methods of communication Group meetings • Involved in policy development Other • Increased knowledge of cultural protocols • Engage First Nations early on in decision making • Litigation threat avoided • Get rid of grey areas • Expanding idea of how much data is enough to act on • Shared legislation across boundaries/Agreement in Principal

H.3.8. End-users and Stakeholders

Communicate Now	Could communicate in the future
Written • Websites Person-to-person • Partnerships Group meetings • Town hall • Consultations • Open houses Other • Outreach • Media • Communication/Engagement	Written Person-to-person • Partnerships • Talk to end user when we discover problems Group meetings • Advisory Boards • Legal action • Monitor policy (adaptive management) • Public advisory committee (ie FBC) Other • Elected stakeholder representatives • Referendums

H.3.9. End-users and First Nations

Communicate Now	Could communicate in the future
Written Person-to-person • Hiring First Nations • Referrals • Projects • Information sharing Group meetings • Consultation Other • Agree	Written Person-to-person • Partnerships Group meetings • Proactive meetings • Participation in specific projects • Define commonalities • Cultural protocols Other • Trust

H.3.10. Stakeholders and First Nations

Communicate Now	Could communicate in the future
Written Person-to-person Group meetings • conference Other Written Person-to-person • Partnerships • Training • In the field collecting information Group meetings • Working boards Other	Written Person-to-person Group meetings Other Written Person-to-person • Partnerships Group meetings Other • Invite Proactive involvement between groups • Cultural protocols

APPENDIX I – INFORMATION NEEDS TABLES

These tables were created in small groups in Breakout session II. Participants chose an urgent issue and worked through the template to identify information needs of the different groups as well as overall characteristics of the information needed.

LIST OF TABLES

Table I1 - Watershed Health - Community Engagement (declining fish in watershed streams), Prince George

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nation
Who? Specific Roles	• Fisheries biologist • Discharge scientist (hydrologist)	• Ministry of Fisheries	• Conservation officer	• Rod & gun club? Fish & Game clubs • NGO eg. Stream keepers • Advocate & educate • Fund raiser	• Fisherman • chief
Specific Information	• Historical & current stock data • Local climate data • Stream flow & temperature records • Stream quality current & historic, nutrients, physical • Land use info • Water use info • Larger effect to geographic areas	• Summary of scientific info • Values – social, economic • Land use info • economic	• policy / laws	• who to educate? • Population base • User base • Who to advocate for • Sources of funds – eg. Partnerships eg. Lions Rotary	• Declining fish numbers in watershed streams • Which streams? • Fish counts pre & post • Cause & affect over community & biological diversity
Characteristics of Information	• Quantitative / qualitative – raw data • As local as possible • Comparison data from nearby watersheds	• Graphs and visual aids, user friendly info • Projections for the future good or bad. • Triggers thresholds, criteria for making change	•	•	•

Table I2. Watershed Health - Impacts from Land/Water use – Fore shore development, Prince George

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nation
Who? Specific Roles	• Limnologist • Hydrologist • Social scientist • Fisheries/aquatic biologist • Soil scientist / geologist	• Regional district board, municipal council, • Hereditary / band chiefs • DFO • MoE - habitat	• Government staff • Policy implementers	• Lake stewardship group • Property owners • Developer • Tourism business • farmers	• land use planner • land & resource manager • hereditary / elected chief
Specific Information	• Existing health / water quality of the lake • Fish species & wildlife & greater ecosystem • Water use • Lakeshore soil	• Laws • Regulations • Existing land use plans • All parties involved • Some understanding of the science & assimilative capacity of lake • Social issues / needs	• Regulations • Social issues / needs	• Regulations • Want unbiased info • Science re the lake • Is the water safe to use?	• Everything to the left • Other opinions • Views / perspectives • Information sharing
Characteristics of Information	• Long-term lake water quality data • Research questions • Scientifically defensible • Seasonal information	• Comprehensive documentation summarized well • Different perspectives (social, economic & environment)	• Different perspectives (social, economic & environment)	• Practical • Understandable (laymen's terms) • Perspectives honoured	• - Practical • Understandable (laymen's terms) • Perspectives honoured

Table I3. Watershed Health – Science/Data, Kelowna

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	-Academics -Researchers -Consultants		-Districts -Planners	-Community lobby groups -Community groups -Everyone -Interests groups	
Specific Information	-What communities are concerned about? e.g. why creek is running dry? -What needs of end-user?	-Need regulation to be tested to determine effectiveness	-Minimum flow -How much water being used -Impacts of land use decisions	-Needs research findings from scientists to be able to disseminate -Bridge people to bring community groups and research together	
Characteristics of Information		-Accessible (in terms of level) of data and information	-Control database of information -Accessibility of data (e.g. data outside of journal articles)	-Ideas and thoughts for improvements -Ideas and thoughts for mitigations	

* Centralized Database where people independently register themselves and their activities/research → may be at provincial level

Table I4. Watershed Health – Monitoring, Kelowna

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	-Tough one -Short term b. MoE and Env Canada Michael Noseworthy Quantity	-River Forecast Centre -Regional Manager/Director level	Municipalities Irrigation districts Industry (licence to operate) Forestry	-Collect data directly -Community data Osoyoos Lake Society -BCLSS - consultants	-Keith Louie, OKB -Howie Wright ONA -Colleen
Specific Information *Data Analysis*	Not mandate and rely on government b. – Hydrometric data	Scientist level provide information to their (Regional Managers)	-Licence to operate -Permits (IHA...) -Forest certification	-Private citizens -Trappers -Fishermen	-Archaeological -Fish monitoring -Cultural

and Data Collection	-(Nutrients baseline) WQ	teams/to make decision who then utilize info	fulfillment	-Wilderness watch	-Ecological info
Characteristics of Information	-Climate -Involved in setting standards -Training of volunteers to obtain info -Fish kill info	The ones who make decision and allocate resources to monitoring and which programs go forward and establish policy/standards on monitoring	-Compliance -Development of policy	-Secchi -Climate -Nutrients	

Table AI. Watershed Health – Water quantity and quality, Kelowna

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? A. Specific Roles GOV B.	Setting priorities. What requirements are setting standards				
Specific B. Information	Setting standards alone are large test Setting set points for drought levels	Making decision at manager/ director level on water quantity/ quality -Fish flows -Ecological in			
Characteristics of Information					

Generally the specifics of obtaining water quality/quantity is done through monitoring, But there is a difference on how people are affected by quality/quantity

Table I6. Watershed Health – Regulatory/Compliance/Enforcement, Kelowna

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	None existing -Further investigation -Consultation	-Conservation officers -Agency monitoring officers -FRAP -DFO	-Districts -Planners		
Specific Information CIE	Data from enforcement officers - to determine whether regulation working. Also provide data to regulation and policy -Data and situation to consult on infractions -Provide data ↳such as minimum flow requirements	-Communication between different officers from ministers lack communication -Multi industries dealing with specific issues but often scenarios involve all -Minimum flow requirement -Need information from scientist -What might work? -What are issues?	-Communication -Contacts with ministers -What will protect water quality	Lack of good contacts →CO won't provide contact information	
Characteristics of Information		-Information needs to reflect complex ecosystems not just specific line ministry -Data needs to be more central and shared			

Table I7. Watershed Health – Funding, Kelowna

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? a. Specific Roles b.	Solicits - professors directly Federal/Provincial/local government	-Typically a committee NRC, HCTF -Federal - peer review	-Water quality departments –RD	-Oceola Fish & Game -NGO's (usually charity#) -Environment club: FEF, RBC, FBC	-At Band level -Territorial Stewardship Council – Colleen Marchant
Specific a. Information b.	-Receive money from provincial foundation (usually specific) -Federal only $$ trouble issues i.e. Pine beetle Industry v. little funding -Limited sources not eligible fund's directly -OBWB	-Review of applications by committee -NERC includes peer review but committee	-Apply to OBWB -Usually partnerships	-Need to be registered non-profit -Timetable and window to operate in -Not coordinated window -Letters of support -Partners -Letters of approval	-Providing funding
Characteristics of Information b.	-Open topic certain fields -Other are targeted -Water is a difficult field to obtain funds. Little people/ industry interested -Need to develop partnerships -Compliance related		>Local projects (OBWB required) >Environment/WS Assessment >Education and awareness	-Basic monitoring - Outreach - Education and Awareness - Learning through action - Restoration/rehabilitation	

General – need reports sometimes from MoE

Table I8. Surface and Groundwater Hydrology - Education, Kelowna

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	Providing quality information - timely provided - ongoing research, immediate data transfer - constructive				
Specific Information Needs	- Educate end-user on understanding groundwater flow - average end-user knowledge about groundwater flow	-Decision made to bring water into the commodities trading - Stakeholders to reflect if policy is working and correcting issues	-Educate end-user on understanding groundwater flow - educating end-user on finite supply of water and inter-connectedness -BC's economy will be based on water		
	- open and active communication to provide policy ↔scientists				
Characteristics of Information				Stakeholders to implement policy to reflect scientific data	

ALL WATER USER'S MUST HAVE LICENCES.

If BC is trending to a Water Economy, we must define water as a commodity and begin to implement the knowledge into the BC Education system/curriculum for science.

Table I9. Surface and Groundwater Hydrology - Policy, Kelowna

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles		-Regional, municipal, provincial and federal government -First Nations -Stakeholders/ community members - Special interests groups	-Everyone that uses water - Wildlife, fish, aquatic organisms -On the ground individuals		
Specific Information Needs		-Need to understand broader perspective of issues/problems -Require real world information that is reliable	-Require frame of reference (e.g. before and after) -What are limits of sustainability? -What tradeoffs are we going to be required or make?		
Characteristics of Information		-Require consistent and accountable info -Cost of creating policy/reality of actually implementing a policy	-Values of end users -Historic knowledge of how “things” have changed -Simple and easy to use and easy to access and brief -Clear practicable and enforceable		

Table I10. Surface and Groundwater Hydrology - Budget, Kelowna

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	-Communicate issue urgency	-Prioritizing -Raising public awareness of budget information and debates	-Acceptance of metering		
Specific Information Needs	-Clearly understand funding about sources and opportunities	-What needs are there with regards to funding -Need to understand risk (urgency) -Efficient organization of requests -Knowing where scientists are focusing research	-Understand where they are going with regards to water -Knowing avenue for involvement/input -Education about water budget/water use -Consequences knowledge		
Characteristics of Information					

Table I11. Surface and Groundwater Hydrology – Science and Technology, Kelowna

Groups	Scientist	Policy/ Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	All Fisheries Biologists Hydrologists Geomorphologists Hydrogeologists WQ Chemists Climatologists				Nation/Council Bands Elder groups Scientists/ Consultant
Specific Information Needed	Historic data → scope → time →space Reactive – questions Proactive – vision/ planning META DATA Physical geography Streamflow Groundwater Climate Snow peeks Biology land use/ biophysical cover				Quantitative data Policy process Translation
Characteristics of Information	Connection to needs in water quality quantity Long-term and high quality META DATA Combine with TEK				Accessible

Table I12. Water Governance – Value of Water and Willingness to Pay, Kelowna

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	-What are variables? -What metrics?	-Should process in each watershed to assign comparative values for key uses	-Water undervalued$ -Water licences should be used or people lose them -Energy costs exceed costs for water		-Support elders who spoke
Specific Information	-	-Virtual water key -Moving toward industries that use less water -End users need to know how much water is used to produce products -Need to share info about ecological goods and services -Myth of entitlement -Competing uses of land (e.g. which is less damaging?) -How to compare impacts of different uses -Myth of abundance		-Cheap food policy is bad -Need to be monitoring -Need to value uses of water (comparatively) -Trade offs could be part of the equation -Need marketplace rewards (e.g. people moving toward organics) -Ranchers need info to make better choices	
Characteristics of Information		-Information regarding meters (value of water) -What to grow where? -Water/food education in school -How much is enough for fish? -Value of water is relative (e.g. Greenwood vs Kelowna) -Decisions are very complicated (must educate decision-makers about the			

		relative impacts of short and long term decisions			

Table I13. Water Governance – Competing Interests, Kelowna

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles					
Specific Information *Who* *What do they need* *Impacts-on risk on different stakeholders*	Information re; water quality quantity and timing of flow. i.e. movement	Raise issues at local government and brought up at UBCM Values within each watershed Information (validated) Consultants	Communication → re: rules/legislation users	Education	
	Integrated/Collaborative decision making				
Characteristics of Information	Information regarding the costs and economies of decisions within the scope of the issue				

(*Hard to slide conversation into this format)*

Table I14. Water Governance – Fractured Planning and Governance, Kelowna

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles *Authority*	-Need to delegate to local lowest common denominator to be responsible -Watershed institution needed to be in charge of process as it's hard to adjust government distributed government model	One senior government agency	No one at group	Ombudsman needed government responsible to us who gives service? Roles have been passed to local without funds or people	No one at group
Specific Information	-Brought in by watershed associations-advisory not regulatory -Local knowledge quick changes (snowpack info) -Ecologically based integrated management got municipalities to look at the focused databases. Targets before expansion of boundaries-Darwin	Thought there was going to be one ministry now there are many		-Who is responsible for what? Integrated. Land use, MoE -We can skew our data to get what we want RAR-consultant -We've forgotten about the environment -Connection of water drinkers to fish boats -What is the true cost of development	
Characteristics of Information *Payment comes to municipalities once list has been done planning steps towards wastewater*	-Policy seems to be to get more development, forestry-how can we now have an integrated approach -"We" know costs to people and the environment but some development still going ahead that is strictly economically based -Use info to stop bad development (car dependency) -Links between plans and policy	Authorizations being asked for by so many		Need good policy	

Table I15. Watershed Health – Data Monitoring, Victoria

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	Hydrologist Water quantity and quality info (snow pack monitoring)	MoE, DFO, BC Hydro	Stream keepers Municipality Regional Districts		Chief & Council
Specific Information	Surface water flows (year round) Groundwater Vulnerability mapping Long term high quality precipitation (includes levels& flows) – all season Instream health (CABIN)	Public health and safety Habitat protection (migration corridors) Ecological integrity			Safe drinking water supplies Safe septic fields
Characteristics of Information	Timing, sampling, frequency Length of record & stability of record Long-term commitment				

Table I16. Watershed Health – Watershed-wide Management, Victoria

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	Hydrologists Scientists Foresters Climatologist	4 orders of gov't - fed - prov - First nations - municipal International	Purveyors Recreational users Power generation Mining, Forestry, Oil/Gas, etc. Natural ecosystems	Communities	Whichever has traditional territory
Specific Information	Flow data Quality	Guidelines Regulatory certainty	Requirements/need Quantity required	Need/desires	TEK Needs
Characteristics of	Freshette	Ensuring	Sufficiency	Confidence in the policies	Oral history and

Information	Potability	accountability	Potability	and supply	scientific data

Table I17. Watershed Health – Quality, Victoria

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	Geo-hydrologist Water Quality Biologist Epidemiologist Toxicology	CRD Directors Prov-Fed 1st Trust First Nations	People owners Industry Local Gov't Water purveyors	NGO Public Info sharing and gathering	Health - Water Systems Operator
Specific Information					Community health reps building community capacity Water standards Water components contamination
Characteristics of Information					Water testing E/Coli – Application of traditional ecological knowledge and application Indigenous mapping and deciding what part should be shared Community decisions Levels of decision making – culturally based traditional governance model

Table I18. Watershed Health – Conservation and Land Use Planning, Victoria

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	Ecologist Economist	Municipal planner	Developer Environmental consultant	Rancher	
Specific Information	Identification of environmental impacts to be considering during land-use planning Value of ecosystem services Resource tenure Stakeholder analysis	Impacts of changes in streamflow Examples of low-impact development; alternative to conventional development Cumulative effects	Riparian area regulation BMPs Site inventory and site analysis	Permitted land uses Zoning and regulations Agricultural BMPs Impacts of ranching	
Characteristics of Information	Derived/processed data Interpreted and analysed contextual	Cause/effect data	Site specific	Applied information	

Table I19. Watershed Health – Cumulative Effects and Competing Uses, Victoria

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	Multiple disciplinary	Municipal planner	Policy analyst	Land/Water Conservation Organization	
Specific Information	Pollution and land use interaction effects Common definitions Model outputs Historical data Future projections Information needs of other groups	Recommendations Optional scenarios Risk assessment vulnerability	Thresholds economic info ←{and all of}→	Risk Uncertainty Biodiversity values Ecosystem services Threats to watershed health	
Characteristics of Information	Raw data Spatially explicit	Plain language Scientific Transferrable Visual Local (specific to their area of influence) *Cross sectoral and integration of information	← SAME →	Credibility Scientifically defensible Plain language (descriptive map, etc.) Transferrable Applied	

Table I20. Surface and Groundwater Hydrology – Groundwater-surface water Interaction, Victoria

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	Hydro geologist Hydrologists	Analyst Water Allocation Officer		Everyone -Scientists, Industries, First Nations-Government Communities Governments Health Authorities	TEK -self governance policy/decision making
Specific Information	Modelling –correlation between surface & groundwater Well logs Hydrometric Data Water Chemistry Climate Data Variability – Flow direction Geological Data Base Flow & Critical	Information to make allocation decisions -effect on aquatic ecosystem –needs of downstream users Integratio of SU/User perspectives	Certainty-how much water can I have & when Quality & Quantity & Quantity Cost & Source Discharge Control & re-use options		
Characteristics of Information			Understandable science Creative Sci/chem		

Table I21. Surface and Groundwater Hydrology – Water for Agriculture, Victoria

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	Agrologist Hydrologist Climate Scientist TEK	Irrigation district Local government Provincial (statutory decision-maker) First Nations	Farmer Hobby Farmer Commercial Farmer First Nation (commercial interest)		(incorporate into other categories)
Specific Information	Water budget Crop requirements-quantity Water quality for irrigation Health needs (crops for food consumption) Historic Knowledge (oral)	Licence volume vs Use All competing interests (i.e. Quantity needs)	Restrictions Allocation Quality (safe/not safe) Conservation/best practices recommendations Relation to economic needs (acres that need water – can I expand?)		
Characteristics of Information		Policy brief (8th grade level) Scientific "Proof"	Analyzed data Guidelines Brief summaries First Nations values (input) incorporated (evidence of that) Terms – conditions of licences	Analyzed data Guidelines Brief summaries Certainty! Terms – conditions of licences	

Table I22. Surface and Groundwater Hydrology – Groundwater Legislation, Victoria

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	Hydro geologist Hydrologist Consultant Academic researches	Government- Fed/ Prov/ Reg/ Mun/ FN Elected officials Policy analysis Planners	Fish farms, industry i.e. driller, forestry, mining Public Consultants Scientists Water managers/ purveyors	Public Industry NGO's Community coalitions Small water users Environment (ecosystems, species)	Small water system operations Community members Industries FN Gov't Scientists
Specific Information	Aquifer characteristics Supply Demand Types of users Water quality Location of recharge areas Data bases Source of contamination	All items listed under "scientists" possibly interpreted and prioritized by scientists or? Indicators Values of different groups (priorities)	Sources of contamination (for prevention) Input in development of legislation Legislation? legislation is enacted Understanding of decision making process "Buy-in" Local information informing policy	See End Users	See End Users
Characteristics of Information	High quality (QA) Sufficient quantity & distribution, i.e. monitoring Common language & definitions Timely, Time senses/duration, Projections Safety factor/ precautionary principle Info is communicated in a form that is appropriate for audience				

Table I23. Water Governance – Communication and Transfer, Victoria

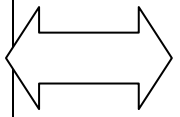
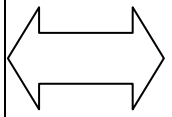
Groups	Scientist/ First Nations	Policy/Decision-Maker/ First Nations	End-User/ First Nations	Stakeholder/ First Nations	First Nations
Who? Specific Roles	Biologist All scientist experts	MEMPR MoE NGOs Regional Gov't Federal Gov't Municipal Gov't Business Sector	General public Agriculture Municipalities Business sectors Health authority Educational sectors	Business sectors Residential sectors	First Nations integrated into each of the other groups
Specific Information			Global information Natural information Regional/local information How they can be involved		
Characteristics of Information	Information objectives, needs data gathered is relevant to needs, Where are gaps, Verifiable data , results "trust" available research funding, accessibility of data	Accuracy, consultation, stakeholder/public opinion, precedence, diversity of communication avenues, short and long term implications, complete/holistic representation of impacts of decisions, funding, costs and sources	Safety, Quality, Data quantity, Transparency, Statutes, Regulations, Accountability Neutrality of information disseminated	 	

Table I24. Water Governance – Fragmentation of Roles and Responsibilities, Victoria

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles Accountability Jurisdiction Division of powers across levels of government	Government framework creates inherent fragmentation (unavoidable)-focus needs to be on equipping decision-makers (incl. permitting functions, etc.) with water science information	Natural resources management agencies MCMoE Oil & Gas Commission EMPMR	Community Water purveyor Commercial & Industrial	Confusion re: roles & responsibilities X-gov't and between levels of gov't (fed/prov/ municipal) Water decisions – burden of proof is on public-watchdog. (e.g. permits being followed correctly)	Band & tribal level? Fed & Prov gov't
Specific Information	Enforcing compliance of regulations, permits is currently relying on public Gov't not monitoring auditing	Issuing surface water licences for short-term water uses (e.g. oil & gas – shale gas, etc.) No consideration of impacts to adjacent or nearby groundwater & surface water resources	Historical knowledge Directly impacted by decisions Priority state Easy access to info	Community watershed vs Forestry managed watershed. Poor water quality & floods resulting Mining clarity consistency predictability (needs), e.g. Flathead Valley decision and mining interests (sudden decision?) Science Monitoring of permit/resource use behaviours	Boil water advisories Access to capacity development opportunities in order to meet resource gaps FN needs a& issues are often similar to those of other groups (e.g. policy, end-users, stakeholders
Characteristics of Information	Make sure resource management *Acts* / legislation doesn't trump water sustainability legislation	Water balance information on GW & SW availability and base-line water quality monitoring	Include in policy decisions Transparency in decision-	Is science available in timely and relevant manners? ↳it is available to all involved in decision	Access to data, water resource information, training, guidelines and resources Access to capacity

			making	process? Mining interests in clearly established water quality guidelines e.g. aquatic health e.g. nitrate toxicity & water? e.g. selenium task force Aggregate pilot policy (FVRD) – trying to resolve ministry/public conflicts	development opportunities in order to meet resource gaps Consultation needs Accommodation needs

Table I25. Water Governance – Issue at the Watershed Scale, Victoria

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	Biologists Foresters Engineers Geo-Scientists Fisheries Habitat Specialists Hydrologists Chemists	Water Managers Analysts Planners-Urban Politicians Foresters DFO MoE	Consumers Businesses Industry Farmers Institutions Municipal Staff	NGO's Water Board Community Groups Naturalists Eco-System Biota Residents	Tribal Council Elders staff
Specific Information	Effects	Water use data Public Opinion Surveys Academic OCP & Management Plans Eco-system data Rainfall data Snow Pack data Climate change Demographics	Water use data-per capita consumption Program Participation Climate Change Studies Weather data Economic forecasts Water & economics Demographics Water rates	Water quality/ quantity data Rainfall data Municipal By Laws OCP's Land Use maps Habitat maps Public Opinion Surveys Wildlife Studies Snow Pack Data Climate Change First Nations Knowledge	
Characteristics of Information	Raw Data: numbers Scientific Forums Databases	Models Water Demand projections Retail H_2O Database Case Studies Raw data Policy Briefs, Reports	Studies & Reports Newspaper Articles	Information easily understood to general public All kinds – education – modelling One page poster at grade 8 level	Oral History Observation & Experience

Table I26. Water Governance – Holistic Approach/Multiple Interests, Victoria

Groups	Scientist	Policy/Decision-Maker	End-User	Stakeholder	First Nations
Who? Specific Roles	Hydrologist / Hydro-geologist Social Scientist (Economist)	Federal Gov't Provincial Gov't Local Gov't Watershed Authority (e.g. OBWB)	All life	Agriculture Forestry Mining Hydroelectric Local Gov't/ Community Tourism/ Recreation Oil & Gas Environment Public	Traditional Ecological Knowledge (TEK) Elders Community members Chief & Council
Specific Information	Triple bottom line structure Baseline Ecosystem data Availability & needs Values Economic Impacts	? Needs (e.g. demand on resource) Water quality needs Info for comparison between alternatives	Needs	Triple bottom line structure Needs (e.g. level of service)	Traditional Ecological Knowledge (TEK)
Characteristics of Information	Holistic Collaborative Accessible (e.g. grade 10 level)	Holistic	Holistic	Holistic	Holistic

APPENDIX J: BREAKOUT SESSION III – PARTICIPANTS' INPUT

TABLE OF CONTENTS

J. Breakout Session III – How can knowledge creation, translation and exchange be better supported?

In this break-out session, participants worked in groups of four and asked each other one of four questions:

a. What do you see as the most important elements that must be in place to support the creation of information and knowledge?
b. What do you see as the most important elements that must be in place to support knowledge translation?
c. What do you see as the most important elements that must be in place to support effective knowledge exchange?
d. What are some key opportunities or new ideas that would improve information and knowledge creation, knowledge translation and/or knowledge exchange?

Afterwards, participants worked together in small groups to summarize the answers to one question. In this way, all responses for each of the four questions were summarized. Following the interview matrix, facilitators lead a group discussion around the question, "What are some of the major challenges and constraints to implementing these new ideas?"

The input summarized below was taken from the question summaries rather than the individual interview matrix answer sheets. Summary points from each breakout room were first themed. This involved reading all the responses and then decided on some specific themes such as collaboration, funding and strategy. Once all summary points had been themed, they were grouped, and a summary of each theme was written for each question.

J.1. Question A: What do you see as the most important elements that must be in place to support the creation of information and knowledge?

J.1.1. Prince George

WSS Governance

- Multi-year funding commitment from all levels of government to support research long term in natural science, social science and indigenous knowledge that is secure from the effects of changing governments.
- Processes to identify stakeholder priorities, to identify data gaps, and to collect and monitor the results of management efforts.
- Information and knowledge solves a problem and has value.

Collaboration

- Interpersonal relationships built on trust, understanding the issues from all points of view, and willingness to learn and listen and the acceptance and recognition by stakeholders to improve the process.

Infrastructure

- Need people who fully understand the issues, can assess validity and accuracy of information, and can conduct appropriate data analysis.

Outreach

- An organizational structure in place (i.e. institutional, community bases) that supports education (including infrastructure) and mentorship.
- Educating people on importance and relevance of research and to create an understanding that research is a long term process. Also need effective communication skills to turn information into knowledge.

J.1.2. Kelowna

WSS Governance

- Identify:
  - issues, goals, and objectives for the creation of information and knowledge
  - knowledge gaps

    - target audiences and their information needs
    - clear roles and responsibilities for users, providers, administrators, and contributors
    - a mechanism to continually build in feedback opportunities.
- First Nations perspective must be part of the process.
- Buy in from politicians and senior policy people and accountability for the creation of information and knowledge.
- Ongoing funding support to ensure longevity that is targeted to specific needs. Less reliance in short term funding for NGO's and more staff within provincial ministries.
- Make data collection a priority: A province-wide collection network, using technology to optimize the collection of data in real time, that is housed in the provincial data clearing house.

Collaboration

- Must work beyond science to include social, cultural, and environmental aspects.
- Enable collaboration within and among sectors (e.g. government, business, NGOs, First Nations, academia, end-users) and involve knowledgeable, credible people.

Infrastructure

- All key stakeholders included in the development and implementation of an information system that includes a process for information gathering and sharing and the identification of a common language.
- Optimize technological applications to support easy access and use.

Outreach

- Develop ways of summarizing and simplifying scientific understanding.

J.1.3. Victoria

WSS Governance

- A strategy to identify overarching goals and objectives for the creation of information and knowledge, to provide focus, and to encourage policy pull for information and knowledge.
- A strategy can reduce redundancy and anticipate the need for information so we can move away from being reactive.
- Rather than reinventing the wheel, the strategy should draw on examples from other jurisdictions.
- Part of the strategy will need to define priorities by compiling current information and assessing research and information gaps. This will provide a common focus and rationale for targeted research. Another objective is to acknowledge and incorporate Traditional Ecological Knowledge.

- The strategy should take an interdisciplinary approach and should include a feedback mechanism to recognize the results of research.
- Part of the strategy may include a central funding mechanism to support priority projects such as data collection.
- A willingness to support information and knowledge creation and the implementation of long term stable funding, preferably a funding cycle longer than the electoral cycles.

- Policies that support co-management would generate demand for information that can be understood and applied by all parties.

Infrastructure
- Knowledge management –
    - Consistent standards for data collection, analysis, and reporting using common indicators
    - Standardized access to data
    - A dedicated process to convert information into knowledge
- Opportunities for dialogue and exchange between science providers and users and those that involve holders of local knowledge and Traditional Ecological Knowledge.

Outreach
- Use a common language to communicate.
- Environmental education to generate curiosity and basic understanding

J.2. Question B: What do you see as the most important elements that must be in place to support knowledge translation?

J.2.1. Prince George

WSS Governance
- Time for people with knowledge and knowledge needs to reach out and build relationships.

Collaboration
- A willingness to listen, establish empathy and develop a sense of trust when building relationships. It takes learning on both sides to create some element of exchange.
- Respect for different types of knowledge (relevance, reciprocity, responsibility) and the history of how knowledge holders gained their knowledge.
- Recognition of the presence of "hidden languages" and the potential for miscommunication.
- Being open to ambiguities (everything is not black and white).
- Moving information and knowledge in multiple directions. Science is not the only form knowledge; receivers of knowledge can be scientists, policy makers and the larger community.
- Providing feedback on knowledge that is communicated. This is especially important to develop an awareness of the context from which users are requesting information.

Infrastructure
- Venues (workshops, forums, meetings, spaces) to facilitate communication (face to face or virtual) and provide opportunities for knowledge developers and stakeholders, users, and First Nations to talk and share. These venues allow people to learn what others are working on and the availability of useful information.
- Opportunities for face-to-face meetings are particularly important for First Nations' storytelling.

- More access to individual knowledge holders; perhaps through a directory that contains contact info for people in different fields and organizations.
- *Knowledge Management* – More access to information and knowledge. This could take the form of a repository for data, results, reports, and conclusions that is accessed through a web portal and searchable by key word. Also providing list serves for various topics as an ongoing communication tool and databases for knowledge being exchanged.

Outreach
- Know your audience, know the context and tailor your message appropriately. Also, deliver the message in a manner suitable for the audience (use plain language, appropriate body language and pitch to the right level).
- An understanding of the practical management and policy implications of your scientific work. Include this in papers and reports as a means to create the link between research and end user.
- Market ideas and concepts, using various media, to encourage people to care.

J.2.2. Kelowna

WSS Governance
- Framework to support translation, supported by all levels of government
- Ready access to policy makers (physically)
- Support for intergenerational knowledge translation and exchange
- Incentives for public and end-users to use knowledge
- Incentive for both researcher and end-users to be involved
- Feedback mechanism to determine effectiveness

Collaboration
- Inclusivity and respect for all knowledge holders, especially First Nations. All knowledge is meaningful and deserves consideration.

Infrastructure
- An easy, user friendly way for end-users to access knowledge and convey their own knowledge.
- A repository for expertise, to support continued connections, that lists who is working on what. Share information relevant to Water Strategy in conferences, forums and symposiums that are occurring throughout the year.
- Knowledge Broker –
  - Time and capacity to support translation
  - A science broker to synthesize and communicate knowledge for the public and other knowledge users

Outreach
- Frame issues to science providers that include policy considerations so research results will allow application to policy and decision makers. Follow the application of research to understand how the pubic adapts and responds to new ideas.

- Enable communication by using common language suited to the target audience.
- Increase historical understanding of the *Water Act* and other legislation, by-laws, standards, and guidelines.

J.2.3. Victoria

WSS Governance
- Determine what is required for knowledge creation and translation
- Identify the information needs of the audience and the best manner to communicate the information
- Identify the purpose or application of information before translation
- Determine the vehicle for translation
- Install a feedback loop to ensure translation was understood and used appropriately
- Framework to maximize benefits for the costs incurred
- Funding to support forums, tools, capacity, collaboration, and staff to ensure they have time to devote to knowledge translation.

Collaboration
- Respect for information and trust that the knowledge provided will be used.
- A willingness to share information
- Formal and informal forums to facilitate sharing
- A willingness to understand different forms of knowledge, break down silos (or learn how to deal with existing silos and work around them), and take an interdisciplinary approach to knowledge translation.

Infrastructure
- Knowledge Broker
  - Conduct quality assurance and control of data so that information and data clearing house is trusted and credible.
  - Translate the data into a common language to make it understandable
  - Continuously reassess gaps in information and target new work accordingly
- Access to information and knowledge providers

Outreach
- Message should be pertinent to audience and delivered in a language that is appropriate for the target audience.

J.3. Question C: What do you see as the most important elements that must be in place to support effective knowledge exchange?

J.3.1. Prince George

WSS Governance
- Provincial strategy that includes both blue sky (curiosity driven) and applied (needs driven) thinking.

Collaboration

- More opportunity for open communication, open minded and non-confrontational exchange.
- Willingness and commitment on behalf of both parties to listen, share, learn and to have confidence and trust in each other.
- Build cultural understanding and relationships, listen to Elder's stories, learn from the land, and remove language barriers.
- Communicate principals and perspectives.
- Conduct yourself appropriately when interacting with the land.
- Encourage creativity

Infrastructure

- A place to store and access knowledge in a form that is accessible and understandable to other groups.
- Venues for both formal and informal discussion (face-to-face or electronic) such as:
  - "Water Cooler" discussions
  - One on one
  - Blogs / forums
  - Conferences / symposium
  - Professional Association (Discipline specific)
  - Allow exchange outside of peer groups

Outreach

- A common language between individuals exchanging information
- A sense that the questions that need answering are important and regardless of whether or not there is an active (tangible) result, the results should still be communicated.

J.3.2. Kelowna

WSS Governance

- A research framework that supports and develops targeted research
- Leadership to create the political will necessary to provide sufficient time, resources, funding, and formal communication structure to enable knowledge exchange.
- Confidence that there is support for the development of the knowledge (funding framework) and that there will be an outcome
- Action that moves beyond planning and dialogue
- Integration amongst silos
- Relevance and multi disciplinary perspective

Collaboration

- Long term commitment necessary to build relationships and trust.
- A willingness to exchange and acknowledge both successes and failures to learn and share.

Infrastructure

- A clearing house of existing knowledge, that documents where and why it was generated, in order to provide easy access and that includes peer review of data, information, and interpretation.
- Multi-disciplinary forums, synopsis, journals, and meetings to promote the exchange of information and to increase the awareness of knowledge gaps, priorities and promote an understanding of needs amongst knowledge providers and knowledge users.

Outreach

- Common language that allows scientific information to be presented and understood.
- Public engagement and the creation of communication tools to increase common understanding of issues (drawing from both science and TEK perspectives).

J.3.3. Victoria

WSS Governance

- Establish what the need is through a gap analysis of knowledge generation goals and user needs.
- Provide a platform for knowledge exchange and ensure parties have the capacity to engage.
- Set common water goals and objectives to inform knowledge generation process.
- Government leadership and facilitation
- Commitment from government and stakeholders with demonstrated follow through
- Funding

Collaboration

- Open and honest approach to collaboration that builds trust and respect between parties and display sensitivity for all perspectives.
- A holistic approach with sensitivity for all perspectives: local, traditional, personal, as well as science, and a willingness to share, listen and understand. This type of approach may help to break down silos and biases.
- Establishing different levels on consensus.

Infrastructure

- Trusting and comfortable forums to facilitate the exchange of information and knowledge and to identify user needs
- A platform for sharing information that includes a directory of experts
- Resources to build and maintain a clearinghouse over the long term for information and a repository for knowledge.
- Knowledge brokers with multidisciplinary capabilities
- Access to historical knowledge including Traditional Ecological Knowledge

Outreach

- Present information appropriately to the audience using a common, easy to understand language.

J.4. Question D: What are some key opportunities or new ideas that would improve information and knowledge creation, knowledge translation and/or knowledge exchange?

J.4.1. Prince George

WSS Governance

- Resources to support this initiative (government multi-funding commitments)
- Incentives to share proprietary information

Collaboration

- Develop mutual respect among all groups, interests, and disciplines for others' perspectives and sources of information and knowledge.
- Commit to an ongoing relationship.

Infrastructure

- Knowledge brokers
    - Create roles for knowledge brokers that are part of team networks and who focus on outreach and knowledge translation. University knowledge holders or possibly librarians may fill this role but leadership is needed from universities.
    - Need to build the capacity and skill set for knowledge brokers. These individuals may also conduct literature reviews to summarize current research.
    - Support for the role of information and knowledge brokers (person's core business) within many institutions, not just one organization.
- Networks & Venues
    - Electronic media (wiki, discussion forums, social networking, community of practice) to connect geographically disparate groups and people and to specifically link knowledge seekers with knowledge holders.
    - Leverage current opportunities to bring people together face to face and make explicit clear vision and goals for knowledge translation (e.g. schedule on location to coincide with association meetings or annual meetings such as Canadian Water Resource Association).
    - Create new place based events.

Outreach

- Promote values of personal reliance such as lifelong learning, listening to the day-to-day needs of communities, and actively seeking answers to your own questions.
- Marketing campaigns to publicize water issues and create a sense of watershed health as a priority.

J.4.2. Kelowna

WSS Governance

- Development of framework for knowledge exchange
- Focus more on results and implementation, and less on process
- National water strategy
- Review Australian model

- Consultations with general public and water users
- Using crisis, such as climate change, as a catalyst for opportunity to build interest and secure funding
- Follow past decisions to ensure the science is reliable
- Prioritization –
    - Common goals determined by government using science
    - Input from end users of knowledge to set data needs and priorities.
    - Local initiatives to specified targets to provide local area based information
    - Integrated research and approach to ask the right questions so the answer is as practical as possible

Collaboration
- Share data collection strategies and joint buying of equipment
- Create opportunities for intergenerational communication
- Multi-stakeholder involvement, especially First Nations.

Infrastructure
- Local coordinator to coordinate information sources, forums and different interests
- Common database for water issues so data are easy to find and access and to prevent data from getting lost in universities.
- Networks & Venues –
    - Opportunities for face to face communication with First Nations
    - Annual think tank with stakeholders and scientists
    - List of contacts
    - More opportunities for knowledge sharing
    - More use of social media & technology

Outreach
- Use a common language to decode science language to stakeholder
- A sense of urgency is needed to engage with public and water users. Science based urgency is not political and therefore need a media campaign to raise the importance of water issues.
- Engage youth to improve awareness of issues. Promote learning through action outdoors. Funding for students as well as buildings.

J.4.3. Victoria

WSS Governance
- Increase links between science and policy and links with locals for historical and current knowledge.
- Funding to support collaborative research.

Water Policy

- Develop a new Water Authority to better represent the real economic value/benefits of water to province, as well as ecological goods and services.
- More transparency on water decision-making and clear description of policy options and trade-offs

Infrastructure

- Develop the capacity for translation through the creation of a specific role for a knowledge broker.
- Knowledge Management –
    - Free and open access to data from various levels of government, including a central registry of water information and contacts.
    - Standards for quality assurance and ease of comprehension and use.
    - A central water information website that can be applied at the local level
    - An interdisciplinary communication and information clearing house
- Networks & Venue –
    - More symposiums, town meetings and collaboration centers (e.g. in health areas).
    - A water related map of who (provincial/municipal/federal governments) is doing what as a means of finding appropriate contacts.
    - Use of new technologies to communicate.

Outreach

- Encourage an ethic of individual responsibility for water use. This can be aided by labelling commercial products in terms of their water use.
- Encourage a stewardship ethic through early education.
- Encourage community grassroots involvement in water planning and decision-making

J.5. What are some of the major challenges and constraints to implementing these new ideas?

J.5.1. Prince George

WSS Governance

- Lack of political will and understanding of science and the importance of water. Political will is needed to create long term support and overcome changes in Cabinet priorities. This is underlain by public apathy. Water is not in the constitution and therefore is subject to political will.
- A willingness to take responsibility and lead this initiative, to work pro-actively rather than reactively, creating crisis oriented policy.
- Longer term sustainability in resources to support people and equipment (e.g. water meters) needed to get the job done right.
- Scientists do not advocate which is a challenge to creating change. Science is not adequately utilized in political decisions. Although science is unbiased, maybe scientists need to become more opinionated.

Collaboration

- Trust and respect in working relationships.
- Looking at First Nations' culture in contemporary sense, as part of Western culture

Infrastructure

- Knowledge brokers whose job is to take time to meet, listen and learn. This person will need the skills, interests and passion necessary to translate knowledge.
- Local and regional initiatives for knowledge exchange that include a broad array of stakeholders and that facilitate the transfer of knowledge from the bottom up and top down.

Outreach

- Education is needed to give people an appreciation of the implications and to overcome ignorance (e.g. metering can help people understand their use).
- Improve understanding of surface and groundwater as one system
- Improve understanding of the decision making process and players involved.

J.5.2. Kelowna

WSS Governance

- Clarify of roles – who will do this work
- Convincing politicians that there is an issue that requires funding
- Identify information needs so that knowledge holders can become aware and communicate knowledge.
- Create a demand for knowledge and knowledge translation
- Identify issues, which parties work on which issues, and commonalities (this would require a major effort).
- Find funding

Collaboration

- Increase capacity for First Nations to engage
- Forster partnerships with universities, researchers and consultants.

Infrastructure

- Need local champions to co-ordinate knowledge translation and exchange process.
- A list of who is who.
- Knowledge management
    - Set one standard for data and ensure all data is validated to remove biases.
    - Keep up with available technology, for example, use a geo-referenced menu of information and knowledge sources.

Outreach

- Work with your target audience to get to know their needs.
- Increase awareness of the value of engagement to improve participation by the public in meaningful forums.

- Scientists need to increase communications to the non-technical audiences (e.g. blogs).
- Get students and the larger public outside to appreciate the environment.
- Create opportunities for mentorships and to get water education into public schools.

J.5.3. Victoria

WSS Governance

- To move forward on these new ideas, need a champion who would take ownership and responsibility for the strategy.
- Funding is the number one challenge, not just for science creation but also for communication and dissemination of science. Is it possible to tap into more revenue sources based on the importance of this issue?
- Need a plan with clear objectives, roles and responsibilities, targets and a schedule for producing progress reports. Also need a communication plan and to promote successes when they occur to convince decision-makers that knowledge translation and exchange is a good idea and necessary.
- Corporate and experimental history is being lost, as there is no means to transfer this knowledge. Need to transfer knowledge across the generational divide by making training and mentoring accessible.
- Some knowledge is proprietary but a subset could be shared, how can this be encouraged?
- Regulatory approach is essential even though people are prone to resist more regulations.

Collaboration

- Need to overcome the fear of change and to move beyond the need to protect one's turf. This is hard, but necessary to breakdown silos and promote interdisciplinary relationships.
- Build relationships on trust and reaching agreements on needs and objectives.
- Be open to other perspectives.
- We need to change our own thinking.
- There must be a willingness to move to common ground.

Infrastructure

- A knowledge broker to act as an unbiased and neutral party to generalize expertise and translate knowledge to a non-technical audience in an accessible way.
- Knowledge Management –
    - It is a challenge not only to build a knowledge management system that will standardize and centralize data and information but also to make sure people use it and that there is consistent funding to support it.
    - Information needs to be regularly distilled at the provincial level (e.g. water bucket).
    - Provincial government leadership is needed to bring data together in a standardized form so its use can be maximized.

Outreach

- Need to better communicate the importance of water to all water users to build social awareness and change public attitude toward water. Government has not been able to do this and it is not necessarily government's responsibility. Increasing awareness may take a grassroots campaign and more publicly recognized water champions (e.g. Mark Angelo).

- Useful to give the public real examples to show what conservation does for environment.
- Need to remember that there is no broadband Internet access in remote communities so how to reach these communities?
- Our consumer culture has led us to believe we have a “right to water”. Public needs to understanding the value and cost of water and the importance of water allocation for environmental needs.
- Education from primary school could take 20 years so we need education tools that have immediate impact.
- There is a resistance to metering so rather than make people pay (meter) could give incentives for conservation through lower rates for under certain usage (similar to BC Hydro).

APPENDIX K: BREAKOUT SESSION IV – PARTICIPANTS' INPUT

TABLE OF CONTENTS

K. Breakout Session IV – What should the WSS include?

The purpose of the fourth breakout session was to get specific input into what a Water Science Strategy should include. Participants were asked to identify critical elements for the Water Science Strategy in three main categories: social/institutional arrangements (governance), tools, and actions. For the next step, participants were asked to pick one of the categories and determine the level of impact each critical element would have and the amount of effort needed to implement it. Both impact and effort could be rated as high, medium or low giving nine possible combinations.

As a last step, participants were asked to identify tools for continuing the dialogue for developing a Water Science Strategy. The facilitators were given four questions to prompt the discussion. These were:

- What would you like to see happen over the next year to further our progress towards developing a WSS? What are our goals?
- What tools (e.g. blog, researcher database) could we use to keep in better contact and to keep the dialogue moving?
- Who are the key people who could be invited to participate in this initiative?
- Are there any things we can all do in the near future, say the next six months to a year, to enhance the knowledge translation process?

Key elements suggested by participants from each location were grouped and summarized by category (social/institutional arrangements, tools, and actions). Not all key elements were assigned an impact or effort by the group. For the final discussion on next steps, not all facilitators asked the questions listed above. In some cases, the discussion was kept general. The final discussion is therefore summarized either by question or in general depending upon the process used by the facilitators.

K.1. What are the critical elements necessary for Water Science Strategy (WSS)?

Table K1. Prince George - Impact-effort analysis for critical elements

Critical Elements	Impact	Effort
WSS Governance		
• Develop Water Science Strategy		
o Define WSS in a guidance document		
o Develop a problem statement and communicate to policy makers and the public to gain support for initiative		
o Develop terms of reference, goals, objectives and timelines for short, medium and long term goals		
o Develop strategy framework for implementation (work plans, timelines, roles and responsibilities)		
o Use past conditions to inform future strategies		
o Clarity goals, objectives and vision	High/ Low	Med/ Low
• Leadership		
o Political will	High	High
o Identify leadership → A champion	High	Med
o Identify people with appropriate skills to act as champions		
o Identify leadership role to garner political support and to take responsibility of developing and implementing strategy		
o Commitment from government		
• Funding		
o Funding committed longer term	High	Med/ High
o Income generation methods such as water revenue tied to funding water research and conservation		
o Secure long term funding for operations and capital expenses		
• Process		
o Use inter-disciplinary approach		
o Ensure multi party, multi-stakeholder involvement	High	High
o Develop a multi-stakeholder board	Med	Med
o Oversight group to ensure transparency	High	High
o BC roundtable on water science strategy	High	Med
o Develop cross sector board to implement strategy that can feed into regional and local watershed boards		
o Need mechanism to ensure process will continue		
o Long-term multi-partner strategy that has partners outside of government such as industry, water users, First Nations and other stakeholders. This will ensure longevity of the initiative.		
o Use National Round Table on Environment and Economy as a model		
o Engage public to inform strategy		
• Use watersheds as the basis for management and decision making	High	Low

• Pass legislation that enables the Water Science Strategy	Med	High
• Roles & Responsibilities		
o Identify stakeholder roles and responsibilities		
o Develop clear agreements between agencies to support arrangements		
o Create checks and balances that improve the use of science in government		
o Joint government and academic appointments		
• Human resources		
o Secure resources: e.g. people		
o Full time person hired to manage WSS		
o WSS leads need to be identified to participants		
o Follow through		
o Insult to those involved that no continuation of staff to support		
Potential WSS Action Items		
• Annual multi-stakeholder conference of needs and capabilities and a forum for government to announce policy and commitments	Med	Med
• Adopt watershed as basis		
• Create a common information repository with a common searchable database to increase knowledge sharing and to document what is known (e.g. Hudson Bay Archive).	High	High
• Develop a monitoring strategy	Med	Med
• Implement cost recovery mechanisms (such as charging for data ?)		
• Prioritize		
o List of priorities to inform a gap analysis (capacity & capability)	Low	High
o List of priorities to inform water allocation and use		
• Water Conservation		
o Metering! Policy framework for implementation.	High	High
o Promotion of conservation measures such as changes to building codes	High	High
o Water Budgeting	High	High
o Economic tools: pricing and financial incentives	High	High
o Water savings education and social marketing		
• Collaboration		
o Electronic media	Med	Med
o Communities of practice	Med	Med
o Equipment library	Med	Med
o Data sharing	Low	High
• Integrate with watershed management		
o Develop adaptive management frameworks		
o Feedback & evaluation of success of tools	High	Med
o Committees to oversee monitoring results and give advice on management adaptations		
o Identify water indicators to measure and report on		

o Evaluate effectiveness through monitoring		
• Create knowledge broker positions	High	High
o champion central information repository		
o dedicated to directing the flow of information (e.g. Hydrex)		
o Frame policy questions so scientists can focus research where it is needed	Med	Low
• Water conservation		
o Promotion of conservation measures		
▪ Competitions among communities for water conservation		
▪ Water savings education		
▪ Understand impacts		
▪ Social and water management		
▪ Building code, grey water recycle, xerscopes, appliances (e.g. toilet exchange)		
o Water metering		
▪ Meters on houses or creeks		
▪ Residential, commercial and industrial metering		
o Incentives to reduce water use		
▪ Economic tools → pricing and financial incentives		
▪ Water markets		
▪ Savings have to count		
▪ Water budgets		
o Tool kits for on the ground use		
▪ Adapt tools to region needs		
▪ Once tools are developed, adapting tools for specific regions increases the level of effort		
▪ Templates		
• Plans for farms		
• Workshops		
• Education		
• Conservation		
• WSS Communication		
o Regular updates to stakeholders		
o Water coalition - an open network composed of working groups		
o Method for continuous feedback on main objectives and common challenges		
o Electronic media (e.g. wiki's, blogs, list serves)		
o Social networking website		
• Outreach		
o Graduate students	Med	High
o Improve water education to both the public and youth so they are knowledgeable about the water cycle and the impacts of water use.	High	Low
o Create opportunities for students and young professionals	High	Low

starting out (e.g. co-op and mentoring opportunities).		
o Success stories	Med	Low
Water governance in general		
• Responsive legal framework		
• Process for shared decision making on a watershed basis that includes local governments and stakeholders		
• Water ombudsman		
• Water commission		
• Water network / coalition	High	High
• Water revenue	High	High
• Water commission	High	High
• Social marketing to spread water information and education	Med	Low

Table K2. Kelowna - Impact-effort analysis for critical elements

Critical elements	Impact	Effort
WSS Governance		
• Develop water science strategy		
o Identify scope, clear objectives and content of strategy	High	Low/ Med
o Identify champions across sectors	High	Med
o Create problem statement		
o Determine values	High	High
o Propose strategies to achieve objectives	High	High
o Identify performance indicators for strategy	High	High
o Put pressure on companies to follow the policy	Med	Med
o Use drought strategy as basis		
o Science based/multi-stakeholder/multi-jurisdictional; Consider Sustainable Water Strategy for the Okanagan as an example. This 100K program reviewed the state of the resource and the state of the information. The outcomes are confidential and so they cannot be shared.		
• Process		
o Form working groups to address issues	High	Med/ High
o Develop a memorandum of understanding between First Nations and provincial, regional and local governments		
o Convene multi-jurisdictional, multi-stakeholder group to clarify roles and responsibilities	High	Low
• Integration across government, discipline, and sector		
o Integrate strategies across silos and jurisdictions	High	High
o Federal water strategy?		
o Research consideration with other agencies (i.e. energy)	High	High

o Consult with Canadian Water Resource Association, BCWWA, GWABC, WEF	High	High
o Review Australia's Water Science strategy to identify gaps	High	Low
o Formalize relationship between developers of WSS and Australian counterparts	High	High
o Australia strategy/model similar for BC	High	Low
Potential WSS Action Items		
• Prioritize		
o Identify needs and capabilities		
o Define the end point (focus research, funding, how will it be used)	High	Low
o Define institutional roles and responsibilities, determine effectiveness and identify gaps	High	Med/ High
o Inventory of issues	Med	Low
o Define science resources available	Med	Low
o Develop a water priority of use doctrine that establishes societal value for different water uses. The consultation process for this project would be huge.	High	High
• Knowledge management		
o Disclosure of government 3rd party information	High	Low
o Company abstracts publicly available	High	High
o Compile company abstract in one area for government scientists to view and gather information.		
• Develop a baseline	High	High
o Build a baseline that documents, in detail, existing research and information	High	High
o Develop sustainability indicators – results and strategies		
o Provincial performance indicators to measure sustainability	High	High
• Extension		
o Extension strategy that includes training, education and translation	High	High
o Develop forums to address issues	High	Med
o Develop a primer on science and water with common language	Med	Low
o Educating institutions		
• Communication		
o Ongoing media communication strategy. This could have a high impact towards gathering public support if done well. It may be difficult to pitch the communication in a way that motivates the public. It could also be difficult to get government approval.	High	Low/ Med
o Twitter account	Low	Low

Table K3. Victoria - Impact-effort analysis for critical elements

Critical element	Impact	Effort
WSS Governance		
• Develop WSS Strategy		
o Define core values first	High	High
o Recognize basic needs that come from community (why are we doing this?)	High	High
o Create a clear framework with objectives	High	Med
o Clear roles and responsibilities	Med	Low
o Clear roles and responsibilities for water management and delivery of the WSS	High	Med
o Defining objectives	High	Low
o Develop project plan (objectives, milestones, resources, critical path, deliverables, review and feedback)	Med	Med
o Keep status-quo (no change in water science)	Low	High
o What is the foundation of the WSS?	High	Med
o Clear performance goals for success of WSS	High	Med
o Framework that allows collaboration	High	High
o Identify audience, roles and responsibilities	High	Low
o Incorporate policy capacity in the WSS	Med	Med
o Mission Statement	High	Med
o Set clear scope and objectives for WSS, e.g. to support management of water for all users including ecological users	High	Low
o Supporting legislation	High	Med
o Timeframe for implementation of steps and strategies	High	Low
• Proposed WSS Principles		
o Holistic approach (addresses all relevant issues)	High	High
o Not politically aligned	High	Low
o Transparency	Med	Med
o Relevant to province wide priorities and also responsive to locally relevant interests and priorities	Med	Med
o Collaborative approach to a WSS	High	Low
o Open dialogue and communication	High	Low
o Participation	High	High
o Shared accountability	High	High
• Leadership		
o Who “holds/owns” the strategy?	Low	Low
o Determine who will lead this initiative (i.e. provincial or federal)	High	Low
o Facilitator, coordinator, interpreter, dedicated position	High	High
o Lobbying to raise political awareness	High	Med
• Funding		
o Dedicate portion of water license revenue to Living Water Smart and new Water Science Strategy	High	Med
o Ensure ongoing commitment	High	Med
o Identify funding sources and requirements	High	Low
o Funding – a significant amount, not just from government	High	High
o Funding to develop and grow WSS	High	High

o Make long-term funding available for identified gaps	High	High
o More people and funding for field monitoring, inventory and research	High	High
• Process		
o Decision: who will make strategy	Low	Low
o What is the utility of water science – how will the Board be used?	Med	High
o Advisory council to raise profile of current science and understanding of issues	Med	Low
o Advisory council: government – scientists – policy makers – industry, etc.	High	High
o BC Water Science Council which includes NGOs, First Nations, Community, all levels of government, and academics	High	Med
o Create an environment with democratic oversight	High	High
o Democratic governance	Med	Med
o First Nations as a level of organization and as a stakeholder	High	Med
o From vision bring in relevant people to develop sub goals	High	High
o Get knowledge users involved	Med	Med
o Interagency consultation and/or committee (with senior level and information-generators support) to facilitate decision support on water science	Med	Med
o Local representation on water sub-council	High	Med
o Organizing multi-disciplinary and multi-agency committee with a neutral chair to scope objectives, goals, terms of reference and senior level buy-in	High	High
o Provisions for public and stakeholder engagement	Med	Med
o Set up a "BC Water Trust", e.g. Okanagan Basin Water Board	High	Med
o Set up arms length independent commission to lead the development and direction of the WSS	High	Med
o Use electronic communication to collect input rather than only conferences	Low	Med
o Water commission	High	High
o WSS led by an independent authority that is outside of any one sector	High	High
• Integrate across governments, disciplines and sectors		
o Working with other agencies	Med	Low
o Check with funding bodies and scientific councils e.g. CWRA, NSERC	High	Low
o Hard link to other strategies	Med	High
Potential WSS Action Items		
• Prioritize		
o Ask: Scientists/ Industry/ Municipalities/ First Nations/ Policy – what are the gaps?	High	Low
o Inter-ministry priorities	High	High
o Identify and address gaps in water science capacity	Med	Low
o Prioritize water science needs based on user needs assessment	High	Med

o Anticipate future research needs	Med	Med
o Guidelines for assigning priority to identified gaps	High	Med
o Identify issues and knowledge gaps	Med	Med
o Improve efficiency of process to fund water science projects	Med	Med
• Adaptive Management		
o Feedback loop (science policy link)	High	Med
o Feedback loops to check in with original guidelines and to determine if the regulation is working?	High	Med
o Understand scale difference and account for these	Med	Med
o Establish communication pathways	Med	Low
o Pathways for policy input to science	High	Low
• Tools		
o Water metering	High	Med
o Certification for water use	Med	High
o Guidance tools e.g. sample bylaws and policies	Med	Med
o User levy '(industry based) ' tiered	Med	Med
o Ministry of Water	High	Low
o Institutional arrangements that promote integration and cross-disciplinary work	High	Med
o Influence codes and regulation (incentives)	High	High
o Reinstate water quality and quantity monitoring programs	High	High
• Knowledge Management		
o Common set of QA/QL standards, data types, etc. between agencies	Med	Med
o Information clearinghouse	High	Med
o Standardize data collection	High	High
o Database of projects, data gaps, etc.	High	Med
o Develop data standards	High	High
o Information inventory	High	High
o Standard vocabulary	High	Med
o Unbiased neutral hosting environment e.g. academia	High	Med
o Access people as an information resource	Med	Low
o Website with entry forms	Low	Med
• Knowledge broker		
o Generation and interpretation of data/knowledge	High	High
o Knowledge/science broker	High	Med
• Engagement		
o Engage and educate water users	High	Med
o Facilitating communication with all water-related players	High	Med
o Incorporate community engagement	High	High
o Water stakeholders – who are they?	High	Med
o Identify opportunities for collaboration (regular face-to-face, etc.)	Med	Low
• Venue		
o An annual forum and report on the state of water in BC	High	Low
o Mechanism to bring interest groups together	Med	High
o Social avenue for relationship building	Med	Low

o Annual symposium to mesh water science and knowledge with user needs (build on this session)	High	Med
o Multiple levels of engagement and communication, a science coalition, a forum	High	Med
• WSS Communication		
o Blogs	Low	Low
o Communication	Low	Med
o Communication pathways – print/electronic	Low	Med
o Facebook and twitter	Low	Low
o Regular opportunities for knowledge exchange	Med	Med
o SharePoint site	Low	Low
o Training in interdisciplinary communications	High	Low
o Regular updates to decision makers and stakeholders	High	High
o Communication strategy	High	Low
o Ongoing blog or newsletter	Med	Low
o Online wiki	High	Low
o Better communication among organizations and institutions	High	Med
• Outreach		
o Early education all the way up to higher levels	Med	Med
o Educational program for implementation into province wide curriculum	High	High
o Indoctrination of the youths	Med	Med
o More cross-disciplinary university course i.e. water science/ water management/ water impacts	High	Low
o Targeted local education programs in elementary/secondary schools	High	Low
o Public buy-in	High	High
o Awareness campaign utilizing marketing principles	High	High
o Change social consciousness related to value of water	High	High
o Informed community to drive policy objectives	High	High
o Public forums, websites, or news articles	Low	Med

K.2. Next Steps - Summary for All Locations

K.2.1. What would you like to see happen over the next year to further our progress towards developing a WSS?

WSS Governance

- Relate to Living Water Smart document
- Identify steering committee and working groups
- Hire co-ordinator
- Develop plan to map the develop and implement WSS
    - Gather experience and ideas from other jurisdictions (e.g. Federal government, Saskatchewan)
    - Establish a set of priorities to set direction

    - Assign responsibility to those priorities
    - Define realistic deliverables
    - Develop work plan
    - Communication strategy
    - Research priorities
    - Timelines and deliverables
    - Garner political support
- Engagement to define mission, goals, and objectives
- Politician announcement to show backing for WSS
- Follow-up
    - Make symposium proceedings available
    - On going collaboration
    - Opportunities to review drafts
    - SharePoint (multi-media for different preferences)
    - Water day
- Report back to community and stakeholders
- Encourage First Nations across the province to participate

K.2.2. What needs to be done to continue the development of a Water Science Strategy?

- Keep the momentum and build on it
- Engage parties not present
- Clarify the vision
- Ministry of Environment needs to clarify ownership (BC or Regional, or Pilot)
- Ministry of Environment to establish working groups
- Review work done in Australia and through Water Smart
- Develop a communication plan to establish regular updates
- Publicity

K.2.3. What tools (eg. Blog, research database) could we use to keep in better contact and to keep dialogue moving?

- Meetings
    - Regional meetings and "check-ins" and round table discussions (bi-annual)
    - Conference calls and live meetings
    - Annual symposium's
- Ongoing updates
    - Monthly update from symposium organizers
    - List server (co-ordinator keeps participants informed)
    - Blog, list serve / emails
- Ongoing communication methods
    - Create website for Water Science Strategy with editor
    - Ministry of Environment to create an email distribution list with participants and other interested parties
    - Interactive web tools, e.g. SharePoint site

    - Tool for allowing for continual input (chats, RSS, list serves)
    - Wiki site to post breakout notes and allow participants to add to it
    - Info from symposium should go out to more than just those participating
- Publicity
    - Traveling road show – work

K.2.4. Who are the key people who could be invited to participate in this initiative?

- Government
    - Politicians
    - Health Authorities
    - Federal Representatives for federal agencies (e.g. National water policy)
    - Representatives from each BC Ministry
        - BC Ministry of Forests
        - BC Ministry of Tourism, Culture and the Arts
- Crown corporations
    - BC Hydro
- First Nations
    - Provincial First Nations organizations
    - BC Union Chiefs
    - Individual communities
    - Treaty 8 Tribal Association
    - Tribal Councils
    - Band offices
- Academic community
    - Research councils (NSERC – SSHRC etc)
- Non-government organisations
    - FORREX
    - Canadian Water Resources Association
    - BC Water and Waste Association
    - BC Ground Water Association
    - Association of Professional Engineers and Geoscientists of BC
    - Habitual conservation Trust fund
- Industry
    - Royal bank
    - Pacific western brewery
    - IPP Association
    - Terasen Gas
    - Big industries
    - Small industries
- Educators, post secondary teachers
- All of you
- Public

K.2.5. Are there any things we can all do in near future, say the next six months to a year, to enhance the knowledge translation process?

- Indentify working groups
- Directory of experts that lists:
    - Who has the knowledge and expertise?
    - Who is applying knowledge?
    - Who is developing policy?
- Workshop participants to communicate WSS results to their stakeholder groups
- Action for all: Relationship building

APPENDIX L: PARKING LOT NOTES

Within each breakout session, a flip chart was posted to record concerns, questions and issues that did not fit within the breakout session activities. In some cases, this was a facilitated discussion. In other cases, a flip chart was posted and people attached sticky notes or wrote comments as they arose. Parking lot comments recorded on these flip charts were collated for each location and are given below.

Though not captured on flip charts, during the facilitators' debrief, many facilitators commented on the difficulty of participants in contributing to the session given the ambiguities associated with the Water Science Strategy. It was not clear to many participants how information and knowledge translation and exchange were linked to a Water Science Strategy until the second day. There was also concern voiced in all locations about the capacity and political will of government to follow through on the WSS.

Prince George

There were no specific parking lot notes collected for Prince George.

Kelowna

- Provincial government needs to make a decision if water is a commodity or not.
- Need to have a federal law so that a change in government will not derail the process
- Communication needs to be viewed as a whole and not compartmentalized – larger plan.

Victoria

These comments were collected during Breakout Session 1 in the Watershed Health group.

- Some topics were more encompassing than others.
- Whole watershed managements could include all the other topics (riparian, indigenous people, land-uses, etc.)
- Riparian health is an important part of conservation and land use planning
- The process is quantitative but there is a huge underrepresentation of indigenous peoples concerns. Please do not prioritize according to numbers.
- To be inclusive, all issues and gaps need to be addressed.
- I worry that the changes to WAM will happen before the public has time to be informed.
- What power will this process have over legislative change?
- This was to be an open forum not just Science!
- Climate change will create new cumulative effects and competing uses.