

# **WESTERN CANADIAN FORUM ON WATER AND HYDRAULIC FRACTURING**

## **MEETING CAPTURE REPORT**

APRIL 2016



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CWN would like to thank the many contributors involved in its water and hydraulic fracturing program, including those that conducted and advised on previous research projects, responded to the national prioritization survey and engaged as forum participants.

CWN also thanks its partners for supporting the forum and the survey, including Alberta Innovates – Energy and Environment Solutions, the Canadian Association of Petroleum Producers, Environment and Climate Change Canada, Government of British Columbia, Government of Northwest Territories and Government of Yukon.

## EXECUTIVE SUMMARY

The rapid expansion and evolution of unconventional oil and shale gas development in Canada has raised challenging questions and concerns about managing the impacts of hydraulic fracturing on water. To gain the most value from existing knowledge and capacity to address these questions, there is a need to better understand what is already known, what is most needed to inform decision making, and what is reasonable for advancement through targeted research. Those involved in making, influencing and informing decisions related to hydraulic fracturing will benefit from identifying shared knowledge needs and prioritizing opportunities to advance those needs through shared investment in research.

CWN is Canada’s premier water research management and design organization, and an innovation hub for water policy and practice. CWN is dedicated to advancing important conversations for Canada through collaboration and knowledge mobilization in areas where water and its management are critical to decisions on policy and practice.

As one of its core focus areas, CWN established a national program on water and hydraulic fracturing to identify key questions and support the use and generation of knowledge to inform decisions.

Based on the findings of CWN-funded multi-disciplinary research projects, an overview report and the results of a national prioritization survey, CWN hosted the Western Canadian Forum on Water and Hydraulic Fracturing (the forum) to facilitate further discussion on shared priority areas identified within and across sectors and regions. The forum brought together participants from federal, provincial, territorial and Indigenous governments, industry, non-government organizations, as well as leading researchers to discuss ways to move forward collaboratively on shared priorities and outcomes related to water and hydraulic fracturing.

### **Shared priority areas**

The following six shared priority areas were discussed at the forum and highlight areas for the prioritization of shared interests and opportunities to invest in collaborative research:

## **Cumulative effects frameworks and baseline data**

Developing a framework to monitor cumulative effects and baseline data is a key opportunity for collaboration. Establishing guiding methodologies and metrics that are tailored to regional contexts and move decisions forward (despite uncertainties) continue to be a challenge. Research is needed to develop consistent approaches and best practices drawing on physical, social sciences and traditional knowledge. This will enable a reciprocal exchange of knowledge between Indigenous communities, researchers and decision makers, ensuring that core principles and valued information are incorporated within environmental assessments and cumulative effects monitoring.

## **Data and knowledge management**

Priorities to improve data and knowledge management are integral to enhancing the accessibility, consistency, integration and communication of information. Additional gap analysis is required to highlight knowledge already collected and determine what is most needed to inform decision making. Research on developing standardized formats, common protocols, disclosure requirements and appropriate information technology systems will allow for comparison and alignment across regions and individual sites. Given the notable lack of trust with respect to characterizing risks associated with hydraulic fracturing, research projects that improve the communication of technical information, including the development of materials for general audiences, will help enhance public confidence.

## **Risk and toxicity**

Additional research is needed to assess environmental and human health risks and toxicity concerns, including further monitoring of aquifer conditions to detect leakage of methane and other contaminants, and understanding long-term behaviour of wells and subsurface conditions. Characterizing contaminants, evaluating exposure pathways and managing toxicity risks associated with injected fluids and flowback were also discussed, given the uncertainties around how contaminants combine and interact. Furthermore, monitoring “known problem” sites or “worse case scenarios” can help decision makers understand the nature of the risks involved and establish best practices.

## **Water balances/Social and economic cost-benefit analyses**

Establishing regional water balances, forecasting models, and conducting socio-economic cost-benefit analyses were identified as areas of shared interest. Forum participants noted social and health impacts must be assessed alongside economic and environmental considerations, despite acknowledgement of the challenges associated with defining, valuing and integrating these metrics.

## **Public concerns and engagement, including disproportionately impacted communities**

Public concerns and fears about hydraulic fracturing activities need to be better understood and addressed through engagement and collaboration, in particular with Indigenous, remote and rural communities among those most vulnerable to associated risks and impacts of hydraulic fracturing. First Nations participants spoke of the need to build relationships through collaboration and genuine consultation. Conducting comparative analysis of Indigenous experiences across North America would help decision makers identify effective engagement strategies around hydraulic fracturing. Research assessing public concerns expressed across Canada could inform the design of appropriate engagement and knowledge integration strategies.

Given the range of research opportunities that could be applied to address these shared priority areas, forum participants also reflected on criteria considered most important in evaluating the feasibility of potential projects. Participants agreed that future projects must add value by addressing knowledge needs and concerns, informing decisions and leading to tangible outcomes for multiple sectors and those with differing perspectives. Affordability could also leverage resources, avoid duplication and facilitate the scalability of projects. Research capacity and timeliness were noted as essential components to capitalize on existing knowledge and expertise using collaborative approaches, and to take advantage of windows of opportunity as they arise. Other suggestions included the need for projects that have leaders who champion the research and build public confidence through transparent and accessible results.

Based on CWN's process of prioritizing shared knowledge needs and opportunities to advance knowledge through research, an analysis of strategic research options is being developed for further discussion among program partners.

## INTRODUCTION

The recent expansion of unconventional oil and shale gas development, together with a rapid evolution in techniques and technologies, have raised a host of challenging questions for those involved in making, influencing and informing decisions related to water and hydraulic fracturing. Given that hydraulic fracturing is a relatively young industry in Canada, a broad array of questions and concerns continue to be asked regarding the effective monitoring and management of cumulative effects, environmental and human health risks to water quality, availability and use of water, as well as social and economic considerations. In order to get the most value from existing knowledge to address these questions, decision makers must understand what is known, what is not yet understood and which areas are most important and of shared interest. Recognizing today's economic context and the need to leverage existing funds and resources, those connected to water and hydraulic fracturing decisions will benefit from the prioritization of shared interests and opportunities to invest in collaborative research.

CWN established a national program on water and hydraulic fracturing to identify key questions and support the use and generation of knowledge to inform decisions. Based on the findings of CWN-funded multi-disciplinary research projects, an overview report and the results of a national prioritization survey, CWN hosted the Western Canadian Forum on Water and Hydraulic Fracturing (the forum) in February 2016. The goal of the forum was to facilitate further discussion on shared priority areas identified within and across sectors and regions. The forum brought together participants from federal, provincial, territorial, and Indigenous governments, industry, non-government organizations, as well as leading researchers to discuss ways to move forward collaboratively on shared priorities and outcomes related to water and hydraulic fracturing.

The forum confirmed and refined the shared understanding of priority needs and opportunities identified through the CWN research projects and national survey, identified ongoing work/existing commitments to advancing identified priority areas, and identified the best near-term opportunities to address priority areas through shared research.

This report provides a clear summary of the priorities that emerged from the forum, and provides the basis for an analysis of strategic research options to respond to shared national and regional priorities.

## CANADIAN WATER NETWORK APPROACH

### **Water and Hydraulic Fracturing Program**

The need for scientific knowledge to underpin decision making with respect to water and hydraulic fracturing in Canada is vital. CWN initiated a national program to address the broad array of water and hydraulic fracturing issues and support both the use and generation of knowledge to inform decision making in Canada.

CWN's water and hydraulic fracturing program was designed with the following overarching questions in mind:

1. What are the key shared questions that underpin decisions on water and hydraulic fracturing in Canada?
2. What is the state of knowledge? What do we already know that can help answer the questions underpinning decision making?
3. What are the most relevant knowledge needs related to these key shared questions that are important to informing decision making?
4. What are the best opportunities to address those knowledge needs through research?

CWN's water and hydraulic fracturing program addresses each of these questions through: the identification of key knowledge needs and which research approaches will be required to address those needs; the recognition of where each of the needs are in relation to the overall decision making context; and the identification and prioritization of shared regional and national needs and opportunities.

An overarching element of the program is identifying strategic research options that respond to shared national and regional priorities. This work is critical to supporting the generation of knowledge to inform decisions surrounding impacts of hydraulic fracturing on water – its use, management, protection and ecological and socio-economic importance.

### ***Research Projects and Overview Report***

To begin to address the four overarching questions, CWN funded [five multidisciplinary research projects](#) in 2014-2015 to investigate where knowledge gaps are most centrally connected to decision makers' needs and questions involving water and hydraulic fracturing.

The goal of the CWN-funded projects was to examine the overarching questions listed above from the perspective of four key areas for managing impacts of hydraulic fracturing on water: watershed governance and management approaches for resource development, including Indigenous rights and concerns; wastewater handling, treatment and disposal; groundwater and subsurface impacts; and landscape and surface water impacts. Research project teams were created with leading researchers from across Canada working with international colleagues and consulted representatives from government, Indigenous communities, industry and non-governmental organizations. The teams conducted comprehensive reviews to identify key knowledge needs in the context of advancing decisions, and presented practical research approaches that could be used to address these needs.

Based on the findings of the project teams, CWN released its [Water and Hydraulic Fracturing Report](#) in October 2015 as an overview report providing high-level framing to complement the detail offered by the individual multi-disciplinary research teams, as well as other leading international research work. Taking a step back from individual research projects to look at the larger decision making context, the overview report summarized what we know and what we need to know, in terms of the most relevant knowledge needs impacting decision making with respect to water and hydraulic fracturing, and opportunities to address those decision needs through targeted research.

Given the range and complexity of the knowledge needs and opportunities identified throughout the research projects and presented in the overview report, the next steps involved further prioritizing

shared areas of interest across sectors and regions. A two-part prioritization process was undertaken consisting of a national prioritization survey and a forum.

### ***National Prioritization Survey***

In partnership with Environment and Climate Change Canada, a national prioritization survey was conducted to determine where shared regional and national priorities exist, and begin to identify the best opportunities to advance knowledge through a shared investor approach.

Drawing on the key knowledge needs and opportunities that were highlighted in the overview report, the survey was developed to solicit input from key individuals and organizations who contribute to the discussion on water and hydraulic fracturing in Canada, including: all four levels of government, including Indigenous governments, industry and industry associations, non-governmental organizations, and researchers in various sector, including government and academia. See **Appendix A** for additional details on the survey design, distribution and high level results.

Survey responses were analyzed to identify agreement on priorities within sectors and regions, as well as alignment on priorities across sectors and regions. Although there were some areas of specific interest to particular sectors, regions and perspectives, the following are areas of shared interest that emerged as strong priorities across groups:

- cumulative effects and baseline data monitoring,
- lack of data and disclosure,
- risk and toxicity assessments and aquifer monitoring,
- water balances, and
- social and economic cost-benefit analyses.

The shared priority areas and observations identified through the survey served as the basic structure for discussions during the forum.

### ***Western Canadian Forum on Water and Hydraulic Fracturing***

Informed by the results of the national prioritization survey, the forum was structured around key shared priorities, as well as areas of specific interest to particular sectors, regions and perspectives. The objectives of the forum were to:

1. Confirm and refine understanding of priority knowledge needs and opportunities identified by the survey;
2. Identify ongoing work or existing commitments to advance priority areas; and,
3. Identify best near-term opportunities to address priority areas through shared research.

The forum brought together over 50 participants from federal, provincial, territorial, Indigenous community governments, industry and industry associations, non-government organizations, as well as several leading researchers in the field of water and hydraulic fracturing (see **Appendix B** for the list of forum participants). Partners included Alberta Innovates – Energy and Environment Solutions, the Canadian Association of Petroleum Producers, Government of British Columbia, Government of Northwest Territories and Yukon Government.



Forum participants discussed and reflected on how the priorities identified in the survey resonated for them, and highlighted examples of ongoing work or existing commitments in order to help identify opportunities for shared progress and avoid duplication of efforts. Participants also proposed criteria they felt were most important in evaluating the feasibility of potential collaborative research projects with the best opportunities for shared investment.

## DISCUSSION OF PRIORITIES

The purpose of CWN's two-part prioritization process was to facilitate discussion around the key priorities that the survey identified as being shared by several sectors, groups or regions. The following section summarizes forum discussions around these shared priorities of interest. Specific examples of ongoing research projects and programs mentioned as being of particular relevance to the priorities discussed by forum participants have been noted, but are not intended to represent an exhaustive list of all current projects and programs.

### **Cumulative Effects Frameworks and Baseline Data**

The need to better address cumulative effects and achieve effective baseline data monitoring were identified as priorities for a large number of survey respondents. The importance of informing decisions in this area continued as a common thread during forum discussions. Given the relatively short-term nature of active operations involved in hydraulic fracturing at many sites, it was noted that assessing the incremental impact of any one individual hydraulic fracturing project presents a particular challenge to understanding its effects in terms of overall oil and gas activities as well as other broader activities affecting water over the long-term.

**Developing cumulative effects frameworks.** Participants discussed the benefits of designing watershed planning frameworks to assist communities, including those that are directly and often disproportionately impacted by hydraulic fracturing activities, in establishing the core values and principles that inform which valued ecosystem components are monitored and evaluated through the monitoring framework. Such planning was seen to be important for establishing effective cumulative effects monitoring, knowledge management and decision making processes that could achieve needed goals and ensure alignment with both community and regulator needs. Recognizing that any assessment of cumulative effects impacting an area is specific to the regional conditions and context, participants nevertheless identified the need for a common guiding framework or approach toward cumulative effects assessments. The role of a framework would be to establish the processes and steps that allow for the design of effective place-based collection of knowledge, including interpretation and use of both traditional knowledge and scientific data according to local needs. Participants identified the need for research involving collaborative, co-governance approaches that bring sectors and perspectives together to understand cumulative effects.

- The province of British Columbia is using a cumulative effects framework, alongside its GIS-based NorthEast Water Tool, to assess the impact of oil and gas activities in combination with the effects of other sectors on water.
- The province of Alberta aims to further operationalize its cumulative effects management approach. Ongoing research on cumulative effects outcomes and thresholds extends beyond the

impacts of oil and gas activities on water to other impacted media (land, air), other actors (municipalities, forestry) and other activities with the potential to contribute impacts. A [play-based regulation](#) pilot project in the Duvernay formation is utilizing a multi-sectoral approach to understand, assess and regulate cumulative effects.

**Establishing appropriate methods.** Researchers who participated in the forum noted large gaps in the development of cumulative effects methodologies, metrics and management that achieve effective results. It can take considerable time and extensive collaborative networks to determine appropriate methods with which to collect and interpret both traditional knowledge and scientific data in a way that meaningfully supports planning decisions. The complexity of the many issues and variables involved in considering the impacts of a full suite of conditions on a watershed makes it challenging to establish a workable and transparent approach that can move decisions forward in the face of uncertainty. This necessitates establishing the best monitoring approaches identified at the time, and adjusting accordingly as hypotheses are tested and new information arises.

- CWN's [Canadian Watersheds Research Consortium](#) (CWRC) is currently developing regional cumulative effects frameworks in six watershed "nodes" across Canada. Sectors, activities and impacted media are not studied in isolation. Co-governance frameworks are required to establish appropriate elements and goals that drive the monitoring approach and design (e.g., valued ecosystem components), develop effective baseline and ongoing monitoring processes, identify triggers, understand outcomes and thresholds, and ultimately create appropriate risk management tools. The goal of the program is to better coordinate and maximize the value extracted from the monitoring investments and activities being undertaken, establishing methods that build trust and address redundancy through integration.
- Within the CWRC's [Slave River and Delta Partnership](#) watershed node, researchers and partners are working to develop a community-based monitoring program that empowers communities in creating cumulative effects indicators, as well as incorporating traditional knowledge at all stages of research design and implementation, to assess changes in the health of the watershed.

**Establishing baseline data.** In order to effectively address questions of impact or cumulative effects, participants raised the need to establish and expand the collection of baseline data that enables the influence of activities to be determined. Participants identified the need for effective baseline monitoring to draw on physical and social sciences and traditional knowledge in those regions within which hydraulic fracturing occurs, as well as those downstream of these activities. This work was seen as central to enabling the monitoring of long-term trends and system changes to support cumulative effects assessments.

- Yukon Government is in its second year of baseline water quality, water quantity and groundwater monitoring in the Kotaneelee area, which is the only area currently proposed for hydraulic fracturing development. In the future, they will be looking for partnerships to monitor cumulative effects going forward.
- Baseline data and cumulative effects monitoring are key objectives for Government of the Northwest Territories, however, it is challenging to establish effective baseline information given the large land mass of the region, as well as the cost and time required.

**Establishing parallel systems of knowledge.** For Indigenous people, water is life. This connection to water is integral to Indigenous cultures and peoples' understanding of their relationship to the land. Indigenous communities continue to observe ecological changes in their surroundings and raise concerns about possible causes and what this might mean for the future. For example, participants mentioned they have observed that their water tastes and smells different. Food from the land tastes different, and there have been other notable impacts on hunting and fishing. Linkages have not been established between traditional knowledge based on experience and narrative, and scientific data collected by government, industry and the research community, in order to better understand these observations and their cause.

It was noted where industry provides assurances that there is no groundwater contamination resulting from hydraulic fracturing, communities lack methods to verify whether or not development activities are causing the changes they are experiencing. A reciprocal exchange of traditional knowledge and scientific data between Indigenous communities and researchers from industry and academia is needed to acknowledge and address concerns. A recent increase in the development of community-based monitoring approaches has assisted this knowledge exchange, but more remains to be done in this area. Research could assist in developing a consistent approach as well as generating guidance and best practices for creating parallel systems of traditional knowledge and scientific data within environmental assessments and cumulative effects monitoring.

## **Data and Knowledge Management**

Participants spoke of their experiences dealing with data and knowledge management challenges, including: understanding how and where lack of data and/or data disclosure inhibit decision making; the need for improved formats and standards that better enable comparison of studies and monitoring results; as well as issues related to knowledge integration, communication and engagement.

### ***Information Availability and Disclosure Needs***

**Assessing existing and needed knowledge.** An assessment of the implications of what is known and has been monitored is confounded by the fact that information collected from different sources – industry, governments, Indigenous communities, and research institutions – is not consistent, nor is it well integrated. Participants suggested further gap analysis is required to understand what data and knowledge have already been collected, who has it and where, and what data are most needed.

**Translating traditional knowledge for use in technical assessments.** It was suggested that those in decision-making roles, particularly with industry expertise, would benefit from a better understanding of the value of local and traditional knowledge to their work. Indigenous community members expressed a willingness to share knowledge and participate in decision making, but pointed to a lack of mechanisms and funding to do so. There is a need to translate parallel ways of knowing in order to appreciate the interconnections between water, land, air and human activities, and inform the study of long-term system changes.

- Government of British Columbia expressed interest in better understanding how to value traditional ways of knowing in parallel with scientific monitoring, and a desire to innovate toward gathering information differently in order to manage differently.

**Ensuring data and knowledge are accessible.** Data accessibility challenges identified by participants focused on: the proprietary nature of data; inconsistent formats that prevent effective integration and comparison; as well as associated costs of information technology required for data interpretation, storage and communication. Participants identified that agencies focused on building information platforms could benefit from better understanding what knowledge and data others need, and how it can be made more user-friendly and transferable to others.

- Industry is required to report to FracFocus, a chemical registry website that provides information about chemicals used in hydraulic fracturing. Some participants noted difficulties using FracFocus in its current format. It was suggested that relatively simple changes (e.g. software upgrade as the United States has done), would allow for enhanced search functions and analysis of risk.
- Improving data accessibility and disclosure were noted as key priorities by several participants and there is interest in collaboration to strengthen the exchange of data.

**Disclosing proprietary data.** There are a number of sensitivities associated with the disclosure of proprietary data. Although companies now disclose most of the ingredients they use, some remain trade secrets, and not all information required for a toxicological risk assessment (e.g., concentrations, mix of input chemicals with formation salts) is made available. Landowners have also expressed reluctance to disclose domestic well water data publicly as it might affect the value of their property.

### ***Formats and Standards***

**Determining what needs to be monitored.** What does science, as well as the needs of local and Indigenous communities, tell us about what needs to be measured? It was suggested that knowledge and data requirements be refined to better prioritize what is most needed to inform and improve decision making. However, it was also recognized that such narrowing of monitoring targets can be difficult given different that stakeholders may have diverse information needs. Other participants recommended engaging communities to identify and incorporate local concerns and associated information needs into monitoring frameworks.

**Making data more consistent.** To allow for comparison and alignment across regions and individual sites, participants spoke of the need to develop standardized formats, common protocols, compatible reporting requirements and information technology systems designed to share information, while keeping an eye on clearly defined monitoring goals.

- In one jurisdiction, multiple ministries collect data on water wells and integration of that data needs to be strengthened. A visualization of the region's water well data is expected in late 2016, allowing users of the visualization tool to search by year, contaminants and, where available, well depth. Across jurisdictions, there is an opportunity to develop guiding best practices and consistent formats for collection and management of data.

### ***Integration and Communication***

**Integrating various types of information.** Multiple partners and perspectives have water-related data and knowledge that are not well integrated due to different parameters, formats and timeframes, as well as confidentiality and quality assurance issues. This relates to understanding western science (physical and social sciences) and traditional knowledge in parallel, as well as measuring the full range of

costs and benefits (environmental, social, health, economic) across different media (water, land, air). Innovation and collaboration are required to develop more effective ways to integrate and communicate knowledge. Since this is a common good problem, stakeholders would benefit from greater integration, insights and access to knowledge across different sources.

**Communicating more effectively to foster trust.** Resource development and management is a frequently contested area and the issue of hydraulic fracturing is particularly contentious. Whereas, “for” and “against” positions are somewhat hardened in these discussions, for those areas where there are efforts to encourage and support discussions, there is a notable lack of trust from stakeholders relative to both industry and governments with respect to information characterizing the various risks associated with hydraulic fracturing. Part of the reason may involve the complexity of the issues, which is exacerbated by failure to effectively communicate the difference between concepts involved in decisions such as hazard, exposure, and relative risks. Lack of trust in information being presented also has to do with confidence in the source and the transparency of information provided.

For example, the perceived risks associated with exposure to toxins related to hydraulic fracturing and water has led to significant levels of anxiety, which can result in real, anxiety-related health impacts, regardless of whether toxicology data actually indicate a problem. The development and distribution of appropriate communications materials for general audiences and the creation of more effective forums for conversation were recommended as ways to enhance public confidence and trust in the validity of both the concerns and approaches.

**Engaging communities in data and knowledge management.** Participants suggested researching how best to bring traditional knowledge and western science together through shared conversation and learning. Collaborative research involving direct partnerships with local and Indigenous communities has the potential to improve trust in and acceptance of data, enabling support during the design, monitoring and communication phases of knowledge and data management. Communities should be engaged in determining what knowledge and practices are necessary to protect water from contamination. When community members are directly involved in the collection of water quality information, the process is more transparent and can lead to increased trust and understanding.

## **Risk and Toxicity**

Participants prioritized both assessing and mitigating risk and toxicity as a key area in need of further information or study. This included: improved monitoring aquifer conditions and understanding long-term impact on the conditions of water in supply wells; better characterizing contaminants and evaluating their transport and exposure pathways; as well as managing risks associated with fracturing fluids, flowback and produced water.

### ***Aquifer Monitoring***

**Monitoring aquifer conditions to detect impacts of fugitive methane or other contaminants.** Despite an increase in aquifer monitoring studies investigating the link between fugitive gas emissions in groundwater from hydraulic fracturing activities near domestic wells, the impacts on water quality are not well understood. If methane and other contaminants are migrating in the subsurface, decision makers and those affected by the contamination need confidence in knowing incidences of contamination are being detected, and the risks being mitigated.

- As a downstream jurisdiction, Government of Northwest Territories expressed concerns about transboundary migration of contaminants from activities upstream in British Columbia and Alberta. Public concerns about environmental and human health risks to groundwater have been voiced, and changes in the health and abundance of fish and wildlife have been observed by members of local and Indigenous communities.
- Government of British Columbia also acknowledged transboundary impacts as a key consideration for the province, including the need to advance knowledge required for bilateral water management where hydraulic fracturing is occurring or may occur in the future, given potential impacts downstream.

**Integrating monitoring efforts.** Aquifer monitoring must not only include methane migration, but also improve understanding of groundwater and surface water interactions, and the interconnections between water quantity and quality. It was noted that translating subsurface monitoring to policy and regulatory oversight has been particularly challenging, and further research was seen to be of value in ensuring knowledge informs decision making.

- Yukon Government is planning to conduct a major groundwater/subsurface investigation over the next three years led by Dr. Beth Parker and Dr. Aaron Cahill (University of Guelph G360 Center for Applied Groundwater Research), and Dr. Bernhard Mayer (University of Calgary).
- Government of Northwest Territories developed a [community-based water quality monitoring program](#) incorporating both scientific data and traditional knowledge to answer community questions regarding water quality. This includes knowledge from the Slave River and Delta Partnership watershed node.

**Understanding long-term behaviour of wells and subsurface conditions.** The public continues to express concerns regarding how current and legacy wells are monitored and managed, and where responsibility lies for protecting groundwater sources over the long-term, especially given potential future use of the resource. Participants confirmed that this remains a challenging, but high profile area.

- The Alberta Energy Regulator recently updated its Licensee Liability Rating program to address environmental and financial liabilities associated with abandoned wells.

### ***Characterization and Detection of Methane and Other Contaminants***

**Characterizing contaminants and evaluating exposure pathways.** It was suggested that risks associated with hydraulic fracturing sites be evaluated according to the triad of “source, pathway and receptor,” with monitoring efforts targeted accordingly. The inability to fully characterize the risks of groundwater contamination has led to a focus on identifying and managing exposure pathways. Participants discussed the potential for evaluating biogenic and thermogenic methane from wells on a site-by-site basis to better understand the sources of methane to the subsurface and domestic wells. Isotopic characterization was seen to be a useful tool in this area, but does not help identify receptors (i.e. what is ultimately impacted by contaminants). There are many uncertainties around how contaminants combine to create a different risk profile than they might pose individually, pointing to the need for both the characterization of contaminants and understanding exposure pathways. A suggestion was made to better integrate research on hazards with an understanding of exposure scenarios, since reduction of exposure reduces risk.

- A team led by Dr. Bernhard Mayer (University of Calgary) has used chemical and isotopic fingerprinting techniques to identify [sources of methane](#) in groundwater in Alberta. The research revealed that most groundwater contain biogenic methane at baseline conditions. The research team also found that deeper methane sources in the intermediate zone and in produced reservoirs have different [chemical and isotopic fingerprints](#), which should enable tracing of gas leakage once appropriate monitoring programs are in place.
- Yukon Government mentioned it is also working with Dr. Bernhard Mayer's research group (University of Calgary) on developing chemical and isotopic baseline surface water and groundwater monitoring approaches that are suitable for monitoring the environmental impacts of unconventional energy resource development in northern environments that feature permafrost.
- Geoscience BC is funding a study led by Dr. Michael Whiticar (University of Victoria) involving [carbon and deuterium isotope typing](#) in various natural gases from geological formations in Northeast British Columbia.
- Environment and Climate Change Canada is conducting work to better understand the impacts of shale gas development to surface and groundwater.

**Monitoring problem sites.** Participants suggested that improved understanding of many issues related to subsurface conditions could be achieved by monitoring known problem sites or worst case scenarios to: determine what is happening at those sites; better understand the nature of the risks involved and better communicate findings related to toxicity concerns. Demonstration projects established at problematic sites could assist in the following: understanding the long-term behaviour of wells and subsurface conditions; establishing best practices for monitoring and assessing well performance, and testing new techniques and technologies to detect contaminants and their impacts on water.

### ***Injected Fluids, Flowback and Produced Water***

**Characterizing and identifying risk of fluids and flowback.** Assessing the environmental and human health risks associated with contaminants of concern in injected fluids, flowback and produced water was identified as a key shared priority. Some participants expressed concern that not enough is known or disclosed about the contents of hydraulic fracturing fluids and flowback, nor about related chemical interactions. There are challenges with transporting and storing produced water, requiring a lifecycle approach to characterizing environmental risks posed by hydraulic fracturing fluids. A better understanding of toxicity risks will inform aquifer monitoring, assist with cost-benefit analyses and help in assessing health impacts.

- A team led by Dr. Daniel Alessi, Dr. Jonathan Martin and Dr. Greg Goss (University of Alberta) is partnering with Encana to characterize the environmental risk of flowback and produced water associated with surface spills. Funded in part by the Natural Sciences and Engineering Research Council of Canada, this research involves characterizing the potential impacts and determining markers of exposure to aid in clean-up efforts and inform mitigation strategies.

## Water Balances

Establishing regional water balances and developing forecasting models emerged as a key priority in the survey. Federal, provincial, territorial and Indigenous governments, along with industry, academic researchers and others must find ways to integrate data on water availability and water use currently being collected by various sources.

**Monitoring water availability and use.** Regional governments are involved in monitoring surface water flows and precipitation, together with the Water Survey of Canada.

- Government of British Columbia uses its NorthEast Water Tool to monitor water supply and demand. British Columbia's new Water Sustainability Act includes groundwater protection and water sustainability regulations, which involve the licensing of groundwater use.
- Water availability and use was noted to be of critical importance to the Province of Alberta. Companies are reporting water use to the Alberta Environmental Monitoring, Evaluation and Reporting Agency (AEMERA), and to the Alberta Energy Regulator. Integrated groundwater and surface water balances in the Duvernay formation will be published in 2016.
- A team led by Dr. Greg Goss (University of Alberta) is conducting water supply and demand forecasting research in Alberta, with one year remaining to complete the modelling. This research is part of the [Predicting Alberta's Water Future](#) (PAWF) project funded by Alberta Innovates – Energy and Environment Solutions with the support of many partners and collaborators. The project uses process-based Soil and Water Assessment Tool (SWAT) hydrologic modelling to project future climate change scenarios for Alberta and give policy makers, planners and consumers time to develop adaptation strategies to account for climate-induced changes in water supply.
- Government of Northwest Territories is working with Environment and Climate Change Canada on hydrometric monitoring, although they are finding it difficult to budget well due to the unpredictability of competing water demands including energy production, fire fighting, dealing with drought concerns, and providing for fish and wildlife.

## Social and Economic Cost-Benefit Analyses

Decision makers, including representatives from government and industry, acknowledged the importance of social and economic cost-benefit analyses, but noted difficulties in measuring value, defining appropriate social and health metrics to quantify costs and benefits and finding data specific to their region and context. Communities want to know how a particular industrial activity will affect them, and whether the activity is worth it when balancing costs versus benefits.

**Analyzing the economic costs of hydraulic fracturing projects, water sourcing and regulatory programs.** Government decision makers noted continued interest in improving their understanding of the economics of water management and use in hydraulic fracturing (e.g., capture, transportation, storage, treatment, disposal) as well as the financial implications of environmental regulations. Further research could also analyze the feasibility of different sources of water for fracturing, including saline water.



**Defining and assessing social and health metrics.** A number of participants also suggested that social and health impact assessments go hand-in-hand with economic cost-benefit analysis. Impacts may not show up in toxicology data, but appear within public health data. Health should be defined more broadly to include mental and spiritual wellbeing, in addition to physical health. Participants noted a lack of common understanding of social and health impacts and expressed interest in research on how best to monitor and integrate these metrics with economic and environmental monitoring. Health impact assessments are a viable tool for gathering valuable information, including technical as well as traditional knowledge to assess toxicity and cumulative effects.

- Yukon Government is in the beginning stages of conducting socio-economic analyses, with substantial progress expected within the next few years.

## **Public Concerns and Engagement, Including Disproportionately Impacted Communities**

Public concerns and fears about hydraulic fracturing activities must be better understood and addressed through engagement and collaboration, in particular with communities most vulnerable to associated risks and impacts.

**Assessing public concerns.** The public continues to raise similar questions regarding potential impacts of hydraulic fracturing activities on water. Indigenous, remote and rural communities are among those disproportionately impacted by hydraulic fracturing. Assessing concerns across Canada would help inform the design of appropriate engagement and knowledge integration strategies to increase public confidence and build trust. Industry leaders need to engage and communicate in more effective ways to understand local and traditional knowledge, and address ongoing concerns.

**Obtaining social license versus public confidence.** Participants discussed the concepts of social license and public confidence, noting difficulties in defining what these terms mean, how they are interpreted, measured and whether they are achievable. Further discussion and research on appropriate communications, engagement and decision making processes are seen to be of value.

**Collaborating with Indigenous communities.** First Nations spoke about the need to build relationships through a collaborative approach and genuine consultation right from the beginning of a project, and not simply consulting because it is a requirement. Building relationships and trust is key. This requires establishing best practices to enhance collaboration with Indigenous communities, and recognize their rights and interests in resource development.

**Conducting comparative analysis on effective engagement.** Collecting and comparing the experiences of Indigenous communities in North America was recommended to identify what has worked well for engagement around hydraulic fracturing impacts on water, and to learn from these experiences.

## **EVALUATION CRITERIA**

Given the wide range of potential research approaches (and associated costs) that could be applied to address the regional and national priority opportunities identified for shared investment in research, there is a need to better determine the basis for selecting preferred approaches among many options. In thinking about why various approaches were appealing as opportunities, forum participants were asked to reflect on what criteria they felt were most important in evaluating the feasibility of potential

research approaches that would help identify the best options for research. Based on this discussion, the following set of criteria has been proposed to assist in selecting future research projects:

- **Value added:** Projects must have potential to provide significant and observable return on investment by addressing knowledge needs and concerns, informing decision making and leading to tangible short- and long-term outcomes for multiple stakeholders and perspectives.
- **Affordability and scalability:** Given the current economic context and constraints, projects must leverage existing resources (funds and capacity) in order to share costs, avoid duplication and ensure results are transferable and scalable where needed.
- **Champion led:** Inertia is an impediment to completing projects and applying their results; champions help facilitate project approval as well as knowledge transfer.
- **Research capacity:** There must be available expertise to undertake the research in North America and apply it to a Canadian context. Where possible, research should be collaborative, engaging diverse perspectives through a multi-disciplinary and/or community-based approach to ensure appropriate support from those involved in and impacted by the research.
- **Timeliness:** Projects must take advantage of windows of opportunity as they arise, and provide timely outcomes that inform decision making when and where needed.
- **Public confidence:** Projects must seek to build public confidence and trust by being transparent, engaging multiple stakeholders and perspectives from the start and ensuring that results are made accessible.

## NEXT STEPS

The results of the two-part prioritization process – both the survey and the forum – have outlined a set of emerging key priorities. Combined with the previously CWN-funded research projects, a strategic research options analysis is being developed. This analysis will assist in determining what research options and shared projects are most feasible and warrant further discussion for water and hydraulic fracturing in Canada among project partners. Dependent upon responses to these options, development of a shared research agenda is proposed for mid-2016, with further development of research projects to follow.

## APPENDICES

### Appendix A: National Prioritization Survey

In November and December 2015, a national prioritization survey was undertaken to identify shared regional and national priorities, and further identify the best opportunities to advance knowledge through a shared investor approach. Survey invitations were sent to more than 240 potential participants from diverse sectors representing a variety of important perspectives involved in making, informing, and influencing decisions around water and hydraulic fracturing in Canada. Invitees included: representatives from federal, provincial and territorial government departments; local and Indigenous governments; industry and industry associations; non-governmental decision-makers; and researchers in various sectors including government and academia.

Survey respondents were asked to self-identify as **decision makers** (those involved in making decisions related to hydraulic fracturing policy, regulations, or investment), **influencers** (those who are influencing decisions by engaging with decision makers around hydraulic fracturing priorities and concerns), or **informers** (those informing decision making through research).

The survey consisted of three sections:

1. **Knowledge needs:** Survey respondents were asked to identify up to 10 priorities from a list of 26 knowledge needs that represent, from their perspective, what we most need to know to inform decisions related to hydraulic fracturing and water.
2. **Opportunities to advance knowledge through research:** Survey respondents were presented with a list of 24 opportunities to advance knowledge through research, and asked to select up to 10 opportunities that, from their perspective, had the most potential to inform decision making.
3. **Opportunities with best potential to be addressed through a shared investor approach:** Decision makers and influencers were presented the same list of 24 opportunities as in section 2, and were asked to select up to 10 opportunities that, from their perspective, had the best potential to be addressed through shared investment.

Each of the knowledge needs and opportunities to advance knowledge through research presented were drawn from CWN's [Water and Hydraulic Fracturing Report](#), and were based on the results of CWN's [five research projects](#). As such, the needs and opportunities had been identified by experts as key areas of interest for informing decision making. The goal of the survey was to determine where shared regional and national priorities exist, and begin to identify the best opportunities to advance knowledge through a shared investor approach. The survey was not intended to eliminate interest areas from further consideration, or to generate a list of ranked priority areas.

One hundred five (105) respondents completed the survey located in regions across the country (Western Canada 38%, Northern Canada 19%, Central and Atlantic Canada 18%, Indigenous community or territory 5%, Canada-wide 17%, other 3%). Of these, 57 self-identified as decision makers, 13 as influencers, and 35 as informers.

Figure 1 below provides a breakdown of the sectors represented within the three respondent categories.

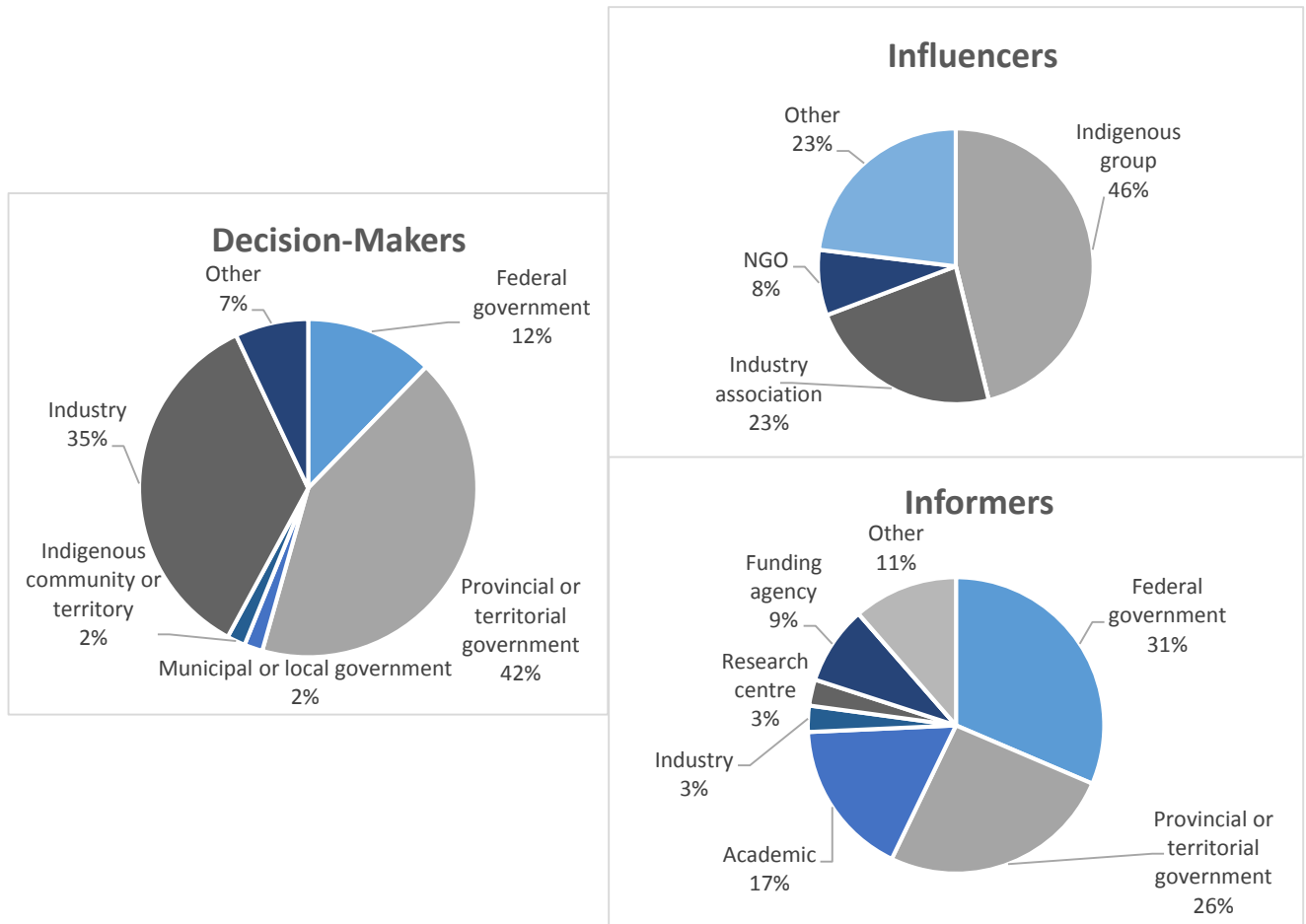


Figure 1: Sectoral representation by survey respondent category

Survey responses were analyzed to identify agreement on priorities within sectors and regions as well as alignment on priorities across sectors and regions. High level results were as follows:

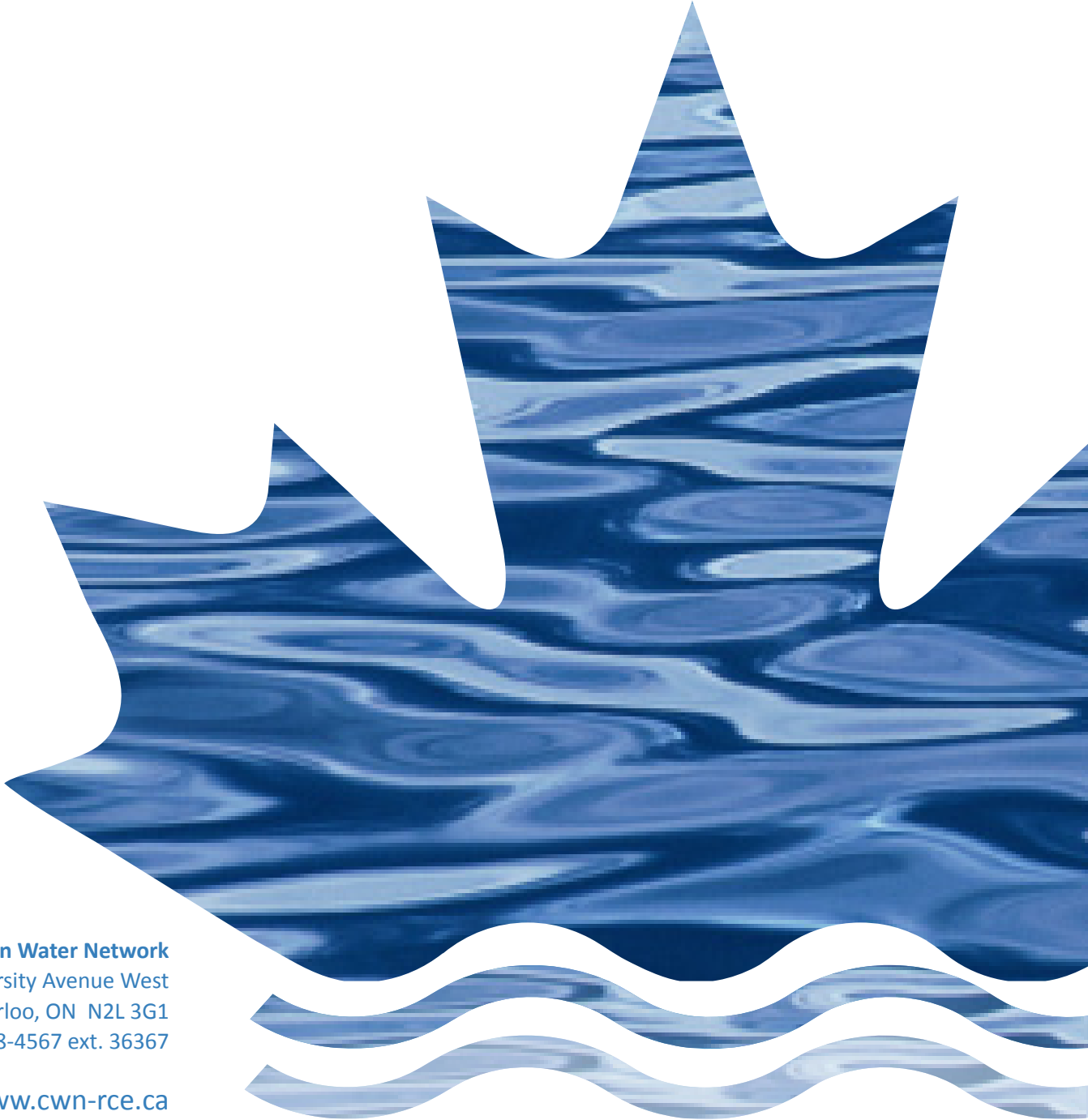
- **Overall shared priorities:** cumulative effects, effective baseline data and monitoring; human health risks; social and economic cost-benefit analyses; and regional water balances.
- **Knowledge needs:** cumulative effects monitoring, water balances and use, and toxicity and risk management. Fugitive methane, lack of data and disclosure, thresholds and indicators, and subsurface impacts were also identified as priorities for some sectors and regions.
- **Opportunities to advance knowledge through research:** design of monitoring frameworks to support cumulative effects, assessing human and environmental health risks, and developing regional cumulative effects-based water plans. Other priorities related to contaminant and wastewater toxicity, regulatory approaches, and baseline data specific to groundwater quality.
- **Opportunities with best potential to be addressed through a shared investor approach:** social

and economic cost-benefit analysis, with additional priorities in some sectors and regions related to data and disclosure, standards and formats, and toxicity particularly around wastewater.

For a more detailed description of the survey methodology and results, please see CWN's full report on the national prioritization survey.

## Appendix B: List of Forum Participant Organizations

Alberta Energy  
Alberta Energy Regulator  
Alberta Environmental Monitoring, Evaluation and Reporting Agency  
Alberta Environment and Parks  
Alberta Health  
Alberta Innovates — Energy and Environment Solutions  
Alberta WaterSMART  
Aseniwuche Winewak Nation  
Bellatrix Exploration Ltd.  
British Columbia Ministry of Environment  
British Columbia Ministry of Forests, Lands and Natural Resource Operations  
Calfrac Well Services Ltd.  
Canadian Association of Petroleum Producers  
Canadian Society for Unconventional Resources  
Canadian Water Network  
ConocoPhillips  
Driftpile First Nation  
Encana  
Environment and Climate Change Canada  
Golder Associates Ltd.  
Husky Energy  
Metis Local 1990 - Grande Prairie  
Mount Royal University  
Natural Resources Canada  
New Brunswick Health  
Nexen Inc.  
Northwest Territories Environment and Natural Resources  
Northwest Territories Industry, Tourism & Investment  
Pembina Institute  
Shell  
SLR Consulting Ltd.  
Stratos  
Sucker Creek First Nation  
University of Alberta  
University of Calgary  
Yukon Environment



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