FINAL REPORT

Climate Change Impacts to the Oil and Gas Sector in Western Canada - How are we Preparing?

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EXECUTIVE SUMMARY

Many scientists agree that a changing climate will likely manifest itself in increased frequency and severity of extreme weather events, such as floods, storms, droughts, and natural disturbances such as forest fires, landslides and insect outbreaks, as well as changes in temperature (average highs and lows), and precipitation patterns (timing, amounts and types [rain vs. snow]). These changes are expected to have a significant impact on the full range of upstream oil and gas sector activities including exploration, infrastructure development and production, and transmission, especially in western Canada. Potential climate change impacts that are expected to affect the oil and gas sector include physical damage to infrastructure and access structures, changes to operational activity schedules and timing, and reduced effectiveness of current sector strategies and activities to meet government regulations, policies and standards. Adaptation strategies will become increasingly important to ensure that the sector continues to meet its environmental obligations and adequately protects its infrastructure and operations into the future. The extent of the oil and gas sector leaders' awareness of and viewpoints about the full range of possible climate change impacts to the industry, and their level of preparedness to address these impacts has been relatively unknown and was identified as a priority information need by the Energy Working Group of the Adaptation Platform.

An online survey and follow-up interviews of sector leaders in both the upstream and transmission oil and gas industries in British Columbia, Alberta and Saskatchewan were conducted in the spring and summer of 2014 to;

1) Assess the corporate culture and policy regarding climate change,
2) Determine the current state of awareness of the potential climate change impacts on the sector's operations and infrastructure,
3) Ascertain whether there are any perceived barriers to climate change adaptation,
4) Determine if any climate change strategies have been or are being developed,
5) Identify any information needs, and
6) Determine the best methods for information sharing within the oil and gas sector.

Twenty-eight people completed the on-line survey and another six were interviewed. All survey respondents were oil and gas company employees with approximately equal numbers representing small (<100 employees), medium (100-500 employees), and large (>500 employees) sized companies. All

three western Canadian provinces, all sector business areas (e.g., production, transmission, and exploration) with the exception of conventional gas production and all company roles (e.g., management, operations, environment) were represented in the survey responses. Five of the six people interviewed were oil and gas company employees while the sixth was a consultant. All three provinces were represented as were all business areas with the exception of oil pipelines and oil and gas exploration. Four interviewees worked for large companies and two worked for medium-sized companies.

Opinions and experiences about climate change and the potential impacts it will have on the oil and gas sector in Western Canada varied widely among respondents. Views from the oil and gas sector leaders ran the full gamut between those who don't accept climate change and those who agree that climate change is occurring but feel hindered by government policy in their efforts to adapt. Opinions about the occurrence of climate change varied by province and business area, and to a lesser degree by respondent role in their company and company size. Respondents from Saskatchewan and those representing oil and gas pipeline and exploration companies were the most certain about the existence of climate change. Operational respondents were less certain than those having other roles in their companies. Survey respondents from small companies appear to be less certain about climate change and its predicted impacts and are less likely to consider climate change when making management decisions or to have strategies in place to address those impacts compared to respondents working for medium or large companies. Less than half of survey respondents said that their company had a strategy to prepare for a changing climate. Due to the complex nature of projecting climate change impacts on the sector, it is recommended that companies implement collaborative internal approaches that engage experts, technicians and specialists to develop adaptation strategies. Furthermore, because of the diversity of opinions and experiences, a multi-faceted and comprehensive outreach approach should be used to increase the sector's knowledge about the predicted impacts changes to the frequency of extreme weather events and natural disturbances, as a result of a changing climate, may have on the sector's operations and/or infrastructure.

Cost increases were the most frequently mentioned risks associated with climate change, followed by worker health and safety and environmental damage. Loss of social license to operate was of least concern across all respondents. Compressed time available to conduct field operations and develop and build infrastructure, impacts on access availability and structures, increased need for emergency

preparedness plans, and increased potential for physical damage were the potential impacts of changes to temperature, precipitation patterns and natural disturbances on operations and/or infrastructure cited most often by respondents. Many respondents stated that extreme weather events would have minimal impact on the sector's infrastructure as the current engineering design standards and criteria already take these events into account. However, given that the frequency and severity of extreme weather events as well as natural disturbance processes are expected to increase over the next few decades, it is recommended that design standards and criteria continue to be monitored to ensure that they remain adequate to ensure the continued safe operation of the sector's infrastructure. This may also require continued research on the risks and potential impacts of a changing climate on the sector's operations and infrastructure as well as on the associated costs of adaptation.

Some survey respondents felt that current government regulations, policies and standards make it difficult for companies in the oil and gas sector to modify management practices to adapt to a changing climate. This sentiment was expressed more often for respondents with company operations in Alberta and British Columbia than for respondents with company operations in Saskatchewan. Some respondents commented that the regulatory process is slow and lacks the flexibility to deal with issues and situations arising as a result of a changing climate. An analysis of both federal and provincial government policies that further examines which policies are considered hindrances and what policy changes could help provide incentives and remove barriers for energy sector companies to address climate change through modification of management practices should be conducted as a start in eliminating barriers to adaptation in the sector.

Lack of local/regional climate change monitoring data as well as models and other forecasting tools to help the sector make operational or environmental decisions regarding adaptation to a changing climate was identified as a key information gap and increased efforts, funded by government, to gather this data and develop these models and tools is recommended.

Industry associations are the most trusted information source and electronic newsletters from those associations are the most effective method for distributing information on climate change and its predicted impacts to oil and gas sector leaders. It is recommended that oil and gas sector industry associations take a lead role in fostering the dialogue on climate change within their sector and in

identifying opportunities for coordinated climate change adaptation strategies given their role as a trusted and representative body that addresses relevant issues across their membership.

The survey design was limited by the required use of a non-probability sampling method which does not allow for extrapolation of survey results to the larger population of industry leaders. However, potential respondents identified for the study were deemed to be key energy sector leaders with extensive knowledge and influence on their company's or client's activities and plans. Because of their influence in the sector, their perceptions are likely to have broad application in company operations and planning relating to extreme weather events. A second study limitation was that some potential respondents to the survey were missed due to incorrect email addresses.

Future studies designed to gather information about the sector's preparedness for climate change would be best accomplished through engagement such as focus groups or workshops rather than surveys of individuals. It is also recommended that future discussions on the potential impacts of a changing climate on the sector should use more neutral terms such as 'extreme weather events' and 'climate variability' instead of 'climate change' and should be framed in a risk and cost reduction context.

INTRODUCTION

Many scientists agree that a changing climate will likely be linked to a rising frequency and severity of extreme weather events in Canada, such as floods, storms, and droughts, because warmer temperatures tend to produce more violent weather patterns (IBC 2012). A changing climate could result in changes in temperatures (average highs and lows), which may, in turn, affect permafrost levels, timing of winter freeze up and/or spring melt as well as changes to precipitation patterns (timing, amounts and types [rain vs. snow]) in some areas which could result in raised or lowered water tables and changes to run-off patterns and timing. Natural disturbance regimes are also expected to shift in North America in the coming decades as a result of a changing climate, with increases in the frequency and severity of wildfires, and insect outbreaks (Intergovernmental Panel on Climate Change [IPCC] Working Group II, 2007; IPCC 2011). A regional assessment of Canada's vulnerability to climate change reached the same conclusions, noting that in the prairies the most significant threat is the projected increase in climate variability and the frequency of extreme events (Sauchyn and Kulshreshtha 2008) while British Columbia has the highest certainty of shifting disturbance regimes (Walker and Sydneysmith 2008).

These changes are expected to have a significant impact on the full range of upstream oil and gas sector activities including exploration, infrastructure development and production, and transmission, especially in western Canada. Climate change impacts that are expected to affect the oil and gas sector include:

1) Changes to the frequency and severity of natural disturbance events such as forest fires, landslides, and storms. These events can cause physical damage to production infrastructure (well sites, power supply, equipment), and access infrastructure (washed out or blocked roads due to fires, wind storms, etc.).
2) Changes to the diversity and extent of plant species distribution. This will subsequently impact the success of site reclamation under the new climatic conditions.
3) Reductions in the effectiveness of strategies and techniques used to meet government regulatory and policy requirements, such as those employed to mitigate habitat loss for species at risk, or manage invasive plant species.

Adaptation strategies will become increasingly important to ensure that the sector continues to meet its environmental obligations and adequately protects its infrastructure and operations into the future.

PURPOSE / OBJECTIVES

The extent of the oil and gas sector leaders' awareness of the full range of possible climate change impacts to the industry, and their level of preparedness to address these impacts has been relatively unknown and was identified as a priority information need by the Energy Working Group of the Adaptation Platform. In September 2013, Resources North and partners, with support from Natural Resources Canada and the Science and Community Environmental Knowledge (SCEK) fund, undertook this project to assess the current state of awareness and action on climate change adaptation among oil and gas company leaders operating in Western Canada, identify potential opportunities to improve awareness and preparedness, and identify opportunities to coordinate efforts for climate change adaptation. The project focused on both the upstream and transmission oil and gas industries in the provinces covered by the New West Partnership area, where there was an agreement signed between British Columbia, Alberta, and Saskatchewan to improve coordination of oil and gas development. The findings of this project are expected to be valuable to the oil and gas sector associations, including the Canadian Association of Petroleum Producers [CAPP] and the Canadian Energy Pipeline Association [CEPA], and the Federal and western Provincial governments (Saskatchewan, Alberta and British Columbia) as well as the sector itself.

The project was designed to:

1) Assess the current level of awareness among oil and gas company leaders of the potential impacts of a changing climate on the sector's infrastructure and operations;
2) Raise the level of the awareness within the sector of the potential impacts of climate change on their infrastructure and operations;
3) Identify opportunities for companies to work with government, academia and others, as appropriate, to develop and implement adaptation strategies and action plans;
4) Identify opportunities for synergies among key players in the sector, that could result in collaborative approaches to reduce costs and protect their investments; and
5) Increase economic certainty, environmental protection and social licence with respect to operations and infrastructure.

METHODS

The project team used a mixed research method involving an on-line survey using SurveyMonkey® which was administered in March 2014, as well as phone interviews that were conducted in August and September 2014. The purpose of the study was to gather information and perspectives from a broad spectrum of personnel from oil and gas upstream and transmission companies in western Canada as well as their contractors/consultants relating to the potential impacts of a changing climate on the sector's operations and infrastructure and the sector's response. The survey and interviews were based on a series of research questions developed in consultation with a steering committee of energy sector stakeholders in January-February 2014 (see Appendix I for list of steering committee members). Demographic questions were also included in the survey to enable cross-tabulations. The introductory letter, survey questionnaire and interview protocol are found in Appendices II and III. The research questions included:

1) What is the corporate culture and policy around climate change? To what degree do executives as well as environmental and operational staff recognize that climate change is occurring? Do they anticipate that climate change could affect their operations?

2) To what degree are company leaders and environmental and operational staff aware of the potential impacts of climate change on their operations and infrastructure? And if they are aware, how are they planning to adapt? Are there any existing company policies that would hinder their company's ability to adapt? Are there other barriers?

3) To what degree are the environmental and operational staff aware of, or have already experienced, the potential impacts of climate change on extreme weather events/natural disturbance regimes such as forest fires, landslides, wind storms, and flooding.

4) Do existing government policies or standards help or hinder attempts to adapt to climate change. Do the environmental and operational staff perceive that changes in climate will affect their ability to meet provincial regulations and standards?

5) To what degree are the environmental staff aware of the potential changes to plant species diversity and extent. These changes might influence;
    a. Site reclamation and restoration efforts.
    b. Presence of invasive plant species.

6) Have companies begun development of, or already developed, adaptation strategies to address the potential impacts of climate change on their operations and infrastructure? And if so, what do the strategies look like?

7) What types of information do the environmental and operational staff need? And where do they currently get information to inform their decision-making around potential adaptation to

climate change. What methods/techniques do they think would be the most effective in increasing the level of knowledge within the sector of the potential impacts of climate change on operations and infrastructure?

The purpose of the interviews was to gather information related to the project research questions, and to clarify, verify and garner a better understanding of some of the sector's responses to the on-line survey questions.

Survey and Sampling Design

A list of 191 potential respondents representing a range of oil and gas company representatives were identified by project staff and the steering committee during the initial phases of the project (October 2013 to February 2014). Potential respondents were identified as key energy sector leaders who were expected to have extensive knowledge and influence on their company's or client's activities and plans relating to extreme weather events. Based on feedback from the steering committee, the project team drafted and then beta-tested a questionnaire by asking three natural resource management professionals not associated with the project to complete the survey and provide comment. To minimize measurement error, we used both closed ended and open ended survey questions, used simple, clear and short sentences that avoided jargon, and included definitions of unfamiliar terms. The final 37-question questionnaire was sent out via email to the potential respondents (summarized in Table 1) on March 6 and 7, 2014 with a deadline for completion of March 21. Email reminders were sent to non-respondents on March 14 and March 21. The survey was closed at 7 pm (PST) on March 21. The email invitation included a project description, assurance of anonymity, and a link to the on-line questionnaire. Potential respondents were not asked to include their name or affiliation but they were asked a series of demographic questions to identify their role in the sector, province(s) of operations, and their core business area.

The Canadian Association of Petroleum Producers (CAPP) and the Canadian Energy Pipeline Association (CEPA) staff distributed the questionnaire via email to selected members to protect the confidentiality of the email addresses of the CAPP and CEPA membership (as requested by their respective executive boards as a condition for project participation). Prior to survey distribution to the CAPP membership, a CAPP representative contacted their member companies to determine the most appropriate person to receive the survey. The CEPA representative determined that the most appropriate people to receive the survey were those participating on the CEPA Climate Change Working Group. The project team

distributed the questionnaire via email to other potential respondents who were members of the Energy Producers Association of Canada (EPAC) and the Pipeline Contractors Association of Canada (PCAC). Email addresses for the latter were obtained through an internet search of publically available contact information of member companies. Individuals involved in company operations or management were selected.

Given that respondents were selected by their associated industry associations to receive the survey, the study used a non-probability sampling design.

Table 1: Survey Distribution List

Association	**Potential respondent description**	**Number of potential respondents**	**Distributed by**
Canadian Association of Petroleum Producers (CAPP)	Environmental and/or Operational staff of member companies	86	CAPP
Canadian Energy Pipeline Association (CEPA)	Climate change working group members of member companies	13	CEPA
Explorers and Producers Association of Canada (EPAC)	Environmental and/or operational staff and/or senior managers of member companies	76	Project team
Pipeline Contractors Association of Canada (PCAC)	Senior or operational managers of member companies	16	Project team
Total		191	

The survey response data were compiled in an Excel spreadsheet. The project team cleaned the data and conducted a descriptive statistical analysis using Excel. Summary tables and graphs were prepared. Several cross tabulations were conducted to break out responses by province of company operations, primary company business area, respondent's role within their company and company size.

Interview Process

Potential interviewees were identified by the project team and steering committee based on the interviewees' knowledge and experience within the oil and gas sector in western Canada. The project team developed the interview questions after a cursory analysis of the on-line survey results. Prior to their interviews, interviewees were emailed the questions, and a consent form assured confidentiality, explaining that their names would not be identified in the report. Interviewees were asked to print and

sign the form indicating their willingness to be included in the study. Project staff conducted the approximately 40-minute one-on one interviews with six respondents by telephone in August and September 2014. Interview data were compiled and summarized, sent to the respondent for review with a 7 day deadline, and then incorporated into the analysis of the survey.

The interview response data were integrated with the survey results data to provide a comprehensive overview of the respondents' current level of preparedness for potential climate change impacts on their infrastructure and/or operations.

Project Team and Steering Committee

The project team consisted of Melanie Karjala (Resources North Association), Alan Wiensczyk (Trout Creek Collaborative Solutions), Dr. Shawn Morford (Benchmark Social Research and Program Evaluation) and Jason Morris (University of Northern British Columbia). Ms Karjala administered the project and led the development, delivery and analysis of the interview phase of the project while Mr. Wiensczyk led the development, delivery and analysis of the survey. Dr. Morford provided input on the survey design and analysis and Mr. Morris provided input on the qualitative design and analysis. All members of the project team were also participants on the project steering committee. The Project Steering Committee consisted of representatives from the following project partner organizations;

- Canadian Association of Petroleum Producers (CAPP)
- Canadian Energy Pipeline Association (CEPA)
- BC Oil and Gas Commission
- BC Ministry of Environment Climate Change Secretariat
- Saskatchewan Ministry of Environment Climate Change
- Alberta Environment and Sustainable Resource Development – Policy Division

Study Limitations

Because of the requirement by the partnering organizations for member confidentiality , it was not possible to use a random sampling method. As a result this study used a non-probability (non-random) sampling method which does not allow for extrapolation of survey results to the larger population of industry leaders.

However, potential respondents identified for the study were deemed to be key energy sector leaders with extensive knowledge and influence on their company's or client's activities and plans. Because of their influence in the sector, their perceptions are likely to have broad application in company operations and planning relating to extreme weather events. In addition, many of the questions in the survey asked respondents to answer on behalf of their company or their clients on what their company or their clients were doing in regards to climate change awareness and adaptation. A random sampling method was not appropriate for these kinds of questions. The study also included a series of interviews to triangulate the quantitative results.

The list of potential survey respondents and interviewees was compiled in cooperation with two member-based organizations (CAPP and CEPA) along with internet-based searches for members of the Energy Producers Association of Canada (EPAC) and the Pipeline Contractors Association of Canada (PCAC). We assumed that the membership lists contained the majority of sector leaders in western Canada. However, it is probable that some leaders were missed, as in some cases only a general email address for a company was available and it was not possible to determine if the survey reached the person with the appropriate level of expertise. Staffing changes, reorganizations, and company amalgamation that frequently occur within the sector may also have led to some missed responses.

One of the challenges of the study was that some survey respondents were employed by companies with operations in multiple provinces which created some difficulty in interpreting the results regarding barriers created by government policies and standards.

RESULTS

Response Rate

Of the 191 oil and gas sector employees and contractors/consultants who received the questionnaire, (Table 1), seven email addresses generated delivery error messages reducing the sample size to 184 potential respondents. A total of 28 people responded to the survey resulting in a response rate of just over 15%. Of the 28 respondents, 23 (12.5%) completed the entire survey while five partly completed the survey.

Respondents were asked to provide comments on expected impacts to their company's or their clients' operations and/or infrastructure. Comments were reviewed for similarities among respondents and grouped into thematic areas. In addition, cross tabulations of survey responses using the province of operations, company role, company primary business area, and company size were examined and are discussed where trends were noted.

Of the 13 key oil and gas sector personnel identified as potential interviewees, six were interviewed. The others were either unavailable or did not respond to the interview request.

The response rate for the on-line survey portion of the project was lower than expected, possibly because of lack of available time for sector leaders, lack of required level of expertise, lack of interest, or low priority for recipients. One respondent commented after the survey had closed that they were unable to complete the survey as some of the questions were outside of their area of expertise and they had wanted to consult with others in their company before answering but were unable to due to their own time constraints. In addition, one email response noted that climate change adaptation doesn't currently make their list of priority issues that they are putting their time and resources into, citing that commodity price volatility, lack of availability of drilling rigs and pipe, rising materials and services costs, regulatory permitting, provincial taxation & royalties, workforce skill shortages, pipeline protests, and aboriginal consultation are much higher priority issues for them than climate change or extreme weather events. These comments are consistent with our findings that some energy sector leaders don't consider climate change risk and adaptation as seriously as the science would suggest is needed.

Survey Respondent Profile

Business and demographic information were collected to provide background information about the respondents and to enable cross-tabulations to look for trends among respondents. Respondents provided their sector involvement, primary business area, company size, province of company operations, role within their company, age, years of experience in the sector, and education level.

All survey respondents were oil and gas sector company employees. No contractors or consultants completed the survey. With the exception of conventional gas production, all business areas within the oil and gas sector were represented. Table 2 shows the respondents by primary business area and province of operations.

Table 2: Respondent Primary Business Area and Province of Operations

Primary Business Area		**Number of Respondents**	**Percent**	**Number of respondents by Province***		
				Alberta	**Saskatchewan**	**British Columbia**
Oil Transmission Pipeline		2	7	2	1	1
Gas Transmission Pipeline		4	14	3	2	3
Oil production	Conventional	4	14	2	3	1
	Unconventional	8	29	8	1	1
Gas Production	Conventional	0	0	0	0	0
	Unconventional	3	11	2	0	3
Oil and Gas Exploration		4	14	2	2	2
Other		3	11	3	1	2
Total		28	100	22	10	13

* Survey respondents could select more than one location to allow for companies having operations in multiple provinces.

Five survey respondents selected 'other' and provided the following business areas:

1) Gas distribution pipeline
2) Integrated oil and gas
3) Oil sands production
4) Conventional oil and gas, oil sands, shale gas
5) Conventional and unconventional oil and gas

The survey responses from the respondent who indicated their business affiliation as "gas distribution pipeline" were added to the gas transmission pipeline business area while responses from the

respondent who indicated “oil sands production” were added to the unconventional oil production business area. Three other respondents were left as ‘other’ since it was not possible to determine their primary business area from their answer.

Respondents were also asked to provide information on the location(s) of their company’s or their clients’ operations. Respondents could choose multiple locations to allow for companies having operations in more than one province. A solid majority of respondents (79%) had operations in Alberta, while 46% had operations in British Columbia and 36% had operations in Saskatchewan. Other areas of company operations included Newfoundland, Manitoba and the Yukon, and the United States.
Ten respondents were from small companies (less than 100 employees), nine were from medium (100-500 employees) and nine were from large (greater than 500 employees) companies.

Almost half of the survey respondents were involved in management (48%) although all company roles were represented by at least one respondent (Table 4). One respondent selected ‘other’ and indicated that they were involved in “Policy and Government Relations.”

Table 4. Company Role of respondents

Company Role	**Number of Respondents**	**Percent**
Management	11	48
Planning	1	4
Operations	3	13
Environment (general)	3	13
Environment (Climate change specific issues)	4	18
Other	1	4
Total	23	100

Survey respondents’ years of experience in their current field ranged from less than five to more than 20 (Table 5) with the highest percentage of respondents having more than 20 years of experience (≈ 40%).

A strong majority of survey respondents were over the age of 40 (70%) and all were over the age of 20. All respondents had some level of post-secondary education with the vast majority having attended university (91%) and having received an undergraduate degree (39%) or a post-graduate degree (52%).

Five survey respondents did not answer the questions regarding their company role, years of experience, age, and education level.

Table 5. Years of Experience in current field

Years of experience	Number of Respondents	Percent
Less than 5	1	4
5-10	5	22
11-15	4	17
16-20	4	17
More than 20	9	40
Total	23	100

Interviewee Profile

Five of the six people interviewed were oil or gas company employees and the sixth was a consultant. One interviewee represented a gas production company (both conventional and unconventional), and two interviewees represented oil production companies (1 conventional and unconventional, 1 unconventional only), and two interviewees represented gas pipeline companies. The consultant has worked with both oil and gas pipeline companies (Table 6). All five employees interviewed worked for companies with operations in Alberta, three also have operations in Saskatchewan and two also have operations in British Columbia. One interviewee indicated that their company also has operations in

Table 6: Interviewee Business Areas and Province of Operations

Primary Business Area		Number of interviewees*	Number of interviewees by Province**		
			Alberta	Saskatchewan	British Columbia
Oil Transmission Pipeline		0	0	0	0
Gas Transmission Pipeline		2	2	1	1
Oil production	Conventional	1	1	1	0
	Unconventional	2	2	1	0
Gas Production	Conventional	1	1	0	1
	Unconventional	1	1	0	1
Oil and Gas exploration		0	0	0	0
Consultants		1	1	1	1

* Interviewees could work for a company that had more than one business area.
** Interviewees could work for a company with operations in multiple provinces.

Ontario, Quebec and the United States. The consultant has worked with companies in all three western provinces. Four interviewees work for large companies (greater than 500 employees) while two work for a medium sized company (100-500 employees).

Extreme Weather and Climate

Nearly half of survey respondents working for companies with operations in British Columbia (46%) and/or Alberta (45%) and 90% of respondents working for companies with operations in Saskatchewan said that they had observed extreme weather events within their company's geographic operating area within the last two years. Respondents listed "abnormally high snow pack, the 2013 flood in Calgary and 2011 flood in SE Saskatchewan, and colder temperatures" as examples (see Appendix IV – Q5 for list of extreme weather events observed).

There were also some observed differences between company business areas. Seventy-five percent of both gas transmission pipeline company respondents and conventional oil production company respondents indicated that they had observed extreme weather events within their company's geographic operating area within the last two years. By contrast, 75% of unconventional oil production respondents and 100% of unconventional gas production respondents said that they had not observed extreme weather events. Fifty percent of both oil transmission pipeline respondents and oil and gas exploration respondents had observed extreme events.

Observations about extreme weather events also varied by company role and also by company size. Nearly half of those in management (45%) and three-quarters of those working in climate change specific environmental roles had observed extreme weather events, while all survey respondents in operations and in general environmental company roles had not. Two-thirds of respondents working for a large company (over 500 employees) had observed extreme weather events, while two-thirds of respondents working for a medium sized company (100-500 employees) and 60% of respondents working for a small company (less than 100 employees) had not observed extreme weather events in their company's geographic operating area.

Most respondents who had observed extreme weather events indicated that the extreme weather events had slowed down or temporarily suspended administration, planning, development and

operational activities but had not affected exploration, environmental, decommissioning activities or the transportation of product to market. The exception was one respondent from Saskatchewan who indicated that the weather event had temporarily suspended exploration activities, and two respondents from the same province who said the event had slowed down transportation of product to market. The vast majority of respondents who had observed extreme weather events in their geographic operating area (12 of 13) indicated that the slow down or temporary suspension lasted 1-7 days while the remaining respondent from Saskatchewan indicated that the slow down on the transportation of product to market lasted for longer than a month.

When asked if they thought that the extreme weather event they observed in their company's operating area could be a result of a changing climate, two respondents indicated that they believed it could be, while three said that that they did not believe it was. Eight were not sure. Responses were similar across all three provinces, as well as across primary business area and company role. There were some differences between company size with half of the respondents working for small companies indicating that they did not believe the extreme weather event was a result of a changing climate while 67% and 83% of respondents from medium and large companies, respectively, expressed uncertainty. Several survey respondents commented that they felt it was difficult to link climate and weather.

> "*The connection between climate and weather is difficult to ascertain*"
>
> "*Not sure anyone can say with any reasonable certainty*"

> "*Scientific facts do not support climate change. This was just a once in 50 year event.*"
>
> *"There has been no trend in the climate warming in Canada for over 300 years. The weather however has proven to CHANGE over the years from warming to cooling over and over again."*

Other respondents disagreed that the climate is changing in Canada at all.

One respondent thought that increased precipitation is likely impacted by climate change. See Appendix IV – Q8 for all comments provided by respondents to the question of the potential link between weather events and a changing climate.

Of those who responded that they had observed extreme weather events, nine selected "not sure" when asked if they anticipated that there may be more frequent and/or severe weather events in the future than would have occurred without a changing climate, three said "yes", while one person said "no." Nine were also not sure how far in the future they thought the onset of more frequent and/or severe weather events would be while one person indicated that they thought that the onset of these events would be in 0-5 years. Several respondents commented that the frequency and severity of extreme weather events is likely to increase as the climate changes. Others were less certain. Please refer to Appendix IV – Q9 for additional comments received from survey respondents.

> *"The frequency of these events would be expected to increase if projections of climate change are accurate."*
>
> *"As per the findings of the Intergovernmental Panel on Climate Change Assessment Report, climate change will very likely lead to more severe weather conditions throughout western Canada."*

> *"I don't know the science behind changing climate so I can't say if it is part of normal climate fluctuations or not."*
>
> *"Open ended - what time frame is "future"? and How can we attribute those events to changing climate?"*

Changing Climate

Almost 60% of all survey respondents agreed or strongly agreed that global climate change is occurring (Figure 1). One respondent strongly disagreed, while the remaining respondents were neutral.

Respondents with operations in British Columbia and Alberta were similar with 54% and 52%, respectively, strongly agreeing or agreeing that global climate change is occurring, while respondents with operations in Saskatchewan showed a higher level of agreement (70%). The remaining respondents from all three provinces were neutral with the exception of one respondent with operations in Saskatchewan who strongly disagreed.

All oil and gas pipeline company respondents and half of oil and gas exploration respondents agreed or strongly agreed that global climate change is occurring. For all other business areas, less than half of respondents agreed with the majority being neutral. One respondent from a conventional oil production company strongly disagreed that climate change is occurring.

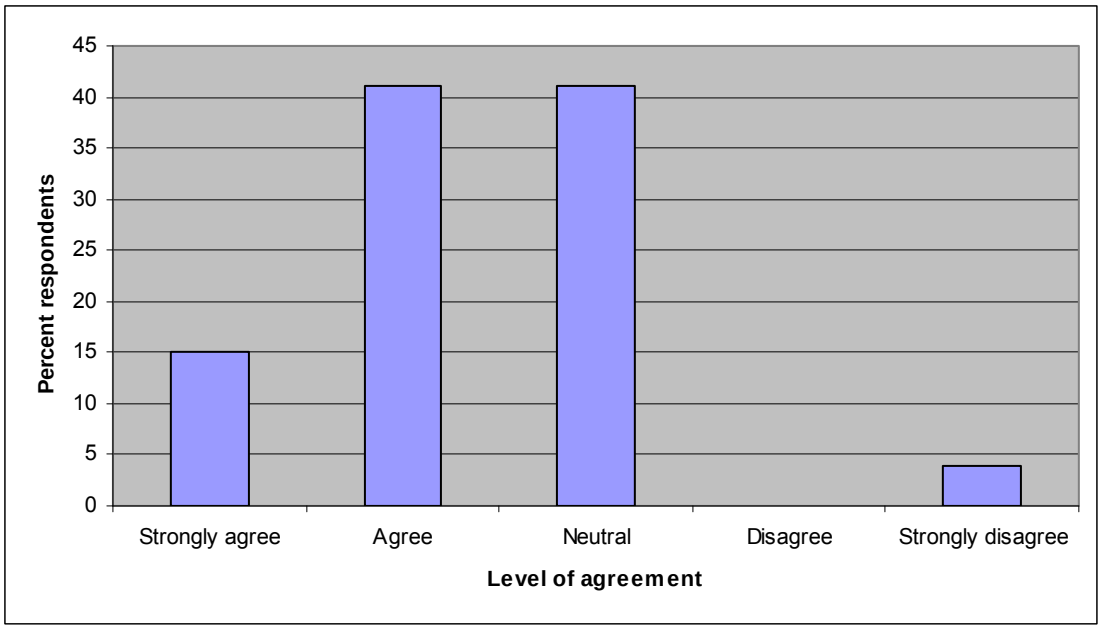

Figure 1. Level of agreement with the existence of global climate change.

The majority of respondents from management, planning, environment (general) and environment (climate change specific issues) agreed with the statement while all operational respondents were neutral.

Over half of respondents working for large or medium companies agreed while just under half of respondents working for a small company agreed. One respondent working for a small company strongly disagreed that climate change is occurring.

Forty percent of all respondents agreed or strongly agreed that a changing climate could affect their company's operations and/or infrastructure while 18% disagreed or strongly disagreed (Figure 2).

Fifty-four percent of respondents with company operations in British Columbia, 40% with operations in Saskatchewan and 33% with operations in Alberta agreed or strongly agreed that their company's operations and/or infrastructure could be affected, while only eight percent from British Columbia, 14% from Alberta and 30% from Saskatchewan said that their company's operations and/or infrastructure would not be affected.

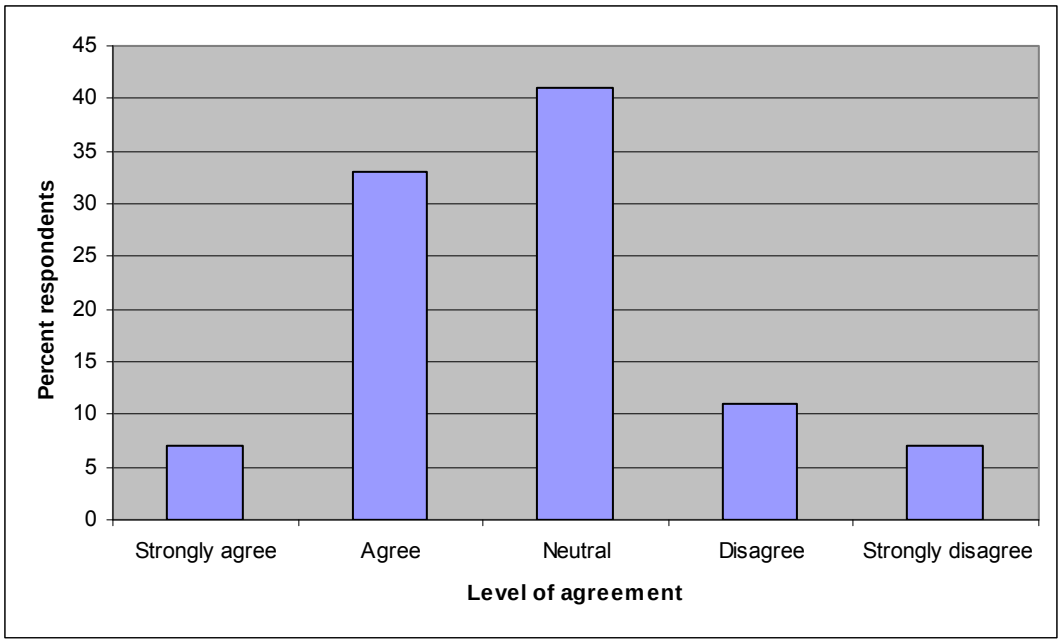

Figure 2. Level of agreement that a changing climate could impact company operations and/or infrastructure.

Three-quarters of gas transmission pipeline respondents, half of the oil transmission pipeline respondents and two-thirds of the 'other' respondents said a changing climate could affect their company's operations and/or infrastructure while three-quarters of conventional oil production respondents indicated that it would not. Most respondents in the remaining business areas were neutral. The conventional oil production business area responses were further explored during the one-on-one interviews. The three interviewees who were involved in the oil and gas production sector commented that the impacts of any extreme weather events such as large temperature extremes and/or wet/dry extremes are already taken into account in the design standards and criteria for production facility infrastructure and hence would not be expected to have an effect.

All respondents who had company roles relating to the environment (climate change specific issues), 36% of management respondents and 33% of respondents in the environment (general) or operations agreed or strongly agreed that their company's operations and/or infrastructure would be affected by a changing climate. Eighteen percent of management respondents did not think that their company would be affected while the remaining 45% were neutral. Forty percent of respondents working for a small company disagreed or strongly disagreed that a changing climate would impact their operations and/or infrastructure while 50% of respondents working for a medium sized company and 44% of respondents working for a large company agreed or strongly agreed that there could be an effect.

All of the interviewees agreed that climate change is occurring and would have some affect on their company's or their client's operations and/or infrastructure and therefore needs to be addressed.

Survey participants were asked if they had observed their company participating in planning activities to prepare for potential impacts of a changing climate on their company's operations and/or infrastructure. Forty-one percent of respondents indicated that they had observed their company participating in planning activities while 40% said that they had not (Figure 3).

Over half of the respondents with company operations in British Columbia (54%) and almost half of respondents with company operations in Alberta (48%) had observed some climate change planning in their company, while half of respondents from a company with operations in Saskatchewan had not. The observation of climate change planning efforts also varied by business area with 75% of respondents from gas transmission pipeline companies and 50% from oil and gas exploration respondents having observed company climate change planning efforts, while 75%, 67% and 50% of respondents from conventional oil producers, unconventional gas producers and oil transmission pipelines, respectively, had not observed any company preparatory planning efforts to address the potential effects of a changing climate on their infrastructure and/or operations.

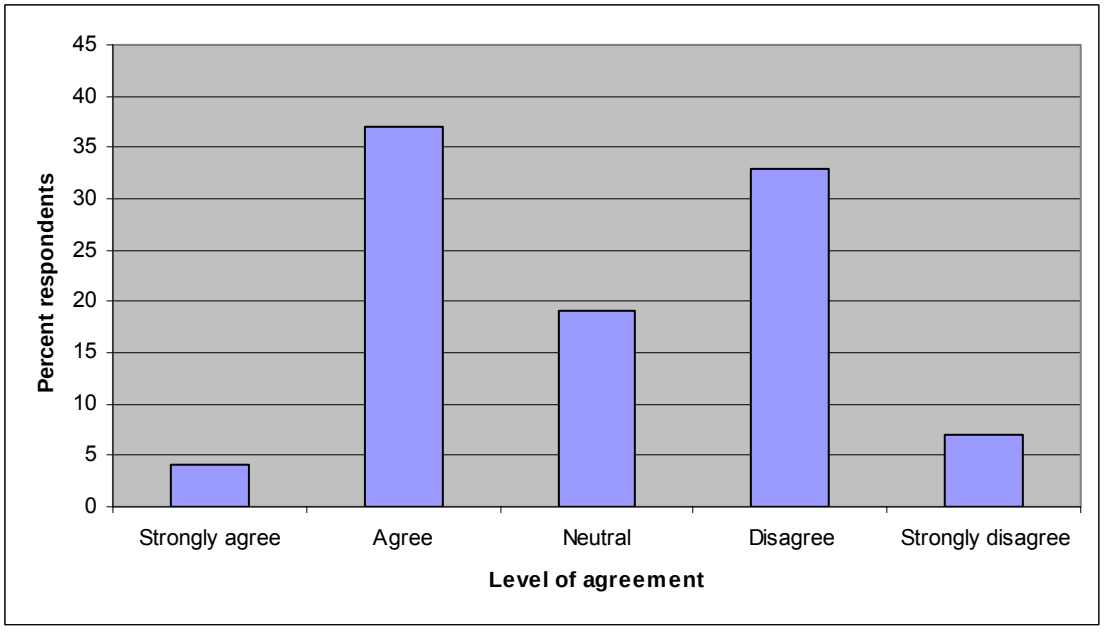

Figure 3. Level of agreement with observation of company participation in planning activities to prepare for potential impacts of a changing climate.

Only the environmental staff dealing with climate change specific issues (100%) and a small percentage of general environment (33%) and management (27%) staff had observed their company planning for potential climate change impacts while the remainder had not.

The vast majority (70%) of respondents working for a small company said that they had not observed their company planning climate change adaptation activities while 50% of respondents working for a medium-sized company and 66% of respondents working for a large company said that they had.

Participants were also asked if they had observed their company implementing changes to operations and/or infrastructure to prepare for a changing climate. Over half of survey respondents (56%) said that they had not while only 26% said that they had (Figure 4). This response was relatively consistent across all three provinces.

When asked if they observed their company implementing climate change preparedness activities, responses followed a similar variability by business area. Three-quarters of respondents from gas transmission pipeline companies and half from oil and gas exploration observed their company implementing climate change preparedness activities, while 75%, 71%, 67% and 50% of conventional oil

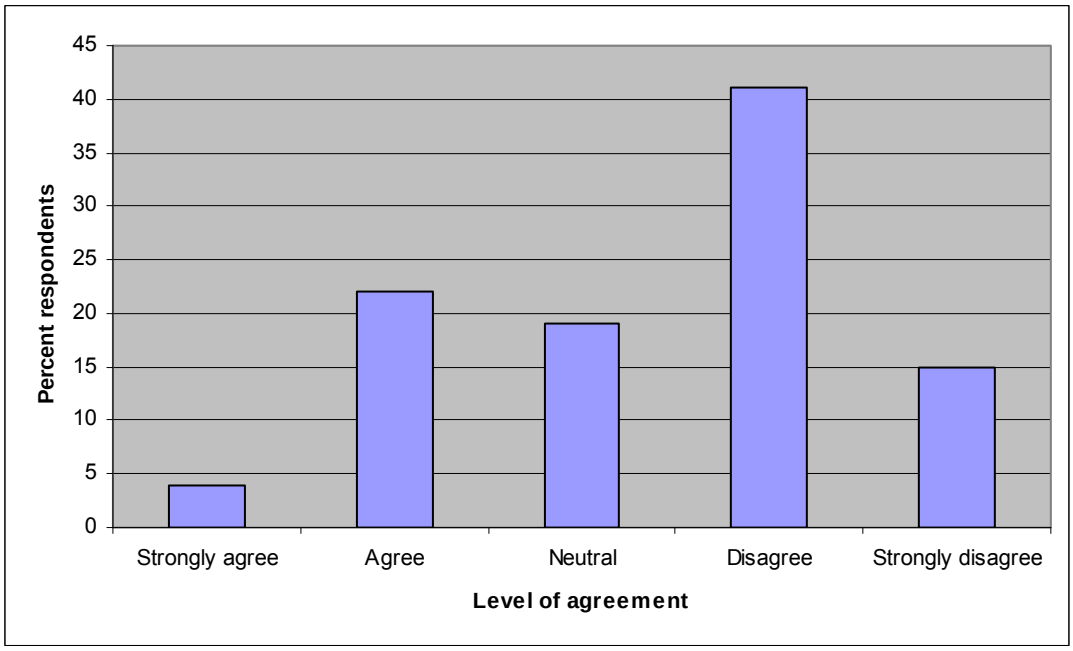

Figure 4. Level of agreement with observation of their company implementing activities to prepare for potential impacts of a changing climate.

producers, unconventional oil producers, unconventional gas producers and oil transmission pipelines, respectively, had not.

Only 75% of the environmental staff dealing with climate change specific issues and nine percent of management staff had observed their company implementing climate change preparedness activities while the remainder said that they had not made that observation.

Company size also influenced the observation of company implementation of climate change preparedness activities. Ten percent of respondents working for a small company and 25% of respondents working for a medium-sized company agreed that they had observed their company implementing changes to prepare for a changing climate while 44% of respondents working for a large company agreed or strongly agreed.

Respondents were also asked about the integration of extreme weather into their company's management decision-making, in particular, operational decision-making, long-term forecasting/planning, risk management planning, designing infrastructure, and when developing long-term strategic plans. In all cases with the exception of risk management planning, a higher percentage of respondents said their company is not currently making management decisions in these areas in response to current or predicted changes to the frequency and severity of extreme weather, than who said they were (Table 7).

Table 7. Percent of respondents indicating that their company considered current or predicted changes to the frequency and severity of extreme weather when making management decisions, by decision type.

Management Decision	Yes	No	Not sure
a. When making operational decisions	26%	63%	11%
b. When doing long-term forecasting/planning	37%	52%	11%
c. When doing risk management planning	44%	41%	15%
d. When designing infrastructure	37%	48%	15%
e. When developing long-term strategic plans	26%	52%	22%

Responses regarding operational decision-making and the development of long-term strategic plans were generally consistent across all three provinces. However, for long-term forecasting/planning, risk management planning and designing infrastructure, British Columbia was the only province for which there was a greater percentage of respondents who said that the frequency and severity of extreme

weather events is being taken into account when making these types of decisions. There was a greater percentage of respondents who operate in Saskatchewan and Alberta who said their companies did not. This was particularly evident for respondents with operations in Saskatchewan where 60% of respondents answered 'No' for the integration of severe weather events into long-term forecasting/ planning, and infrastructure design.

There were also some differences across business areas. There was a consistently higher percentage of respondents from both conventional and unconventional oil producers as well as oil and gas explorers answering 'no' for all five decision and planning types while a greater percentage of respondents involved in unconventional gas production answered 'yes' to four of the five decision and planning types, the exception being 'when making operational decisions.' A greater percentage of respondents from both the oil and gas transmission pipeline companies answered 'yes' to operational decision making and risk management planning, with no clear trends for the other three management options. There were not a lot of differences in responses between company roles with the exception of 'risk management planning' for which a greater percentage of respondents working in the environment (climate change specific issues) answered yes, the frequency and severity of extreme weather events is being taken into account when making these types of decisions.

Company size also had an influence on responses. The vast majority of respondents (70%+) working for a small company indicated that extreme weather events are not taken into account for any of their company's management decisions, whereas over half of respondents (55%) working for a large company said that they were taken into account in their company's risk management planning and infrastructure design decisions. Sixty-three percent respondents working for a medium sized company said that extreme weather events were taken into account when doing risk management planning and half said that they were taken into account when doing long-term forecasting/planning.

As a follow up to survey questions about management decisions in response to extreme weather events, interviewees were asked about their company's preparation for climate change variability or extreme weather events. All indicated that their company or their clients plan and implement preparatory activities, although these plans and activities were not specifically developed and implemented to address climate change or variability, but to mitigate risk. All interviewees noted that their company's infrastructure design standards and plans take into account extreme weather events and conditions.

Several interviewees also stated that their company has risk management plans and/or emergency preparedness plans and procedures to address catastrophic events, including those that are weather-related. One interviewee added that in his company these plans are regularly reviewed and tested to make sure that they are still effective.

Risk Factors

Respondents were asked about their perception of risk relating to a change in the frequency and severity of extreme weather events to both operations and infrastructure. For operational risk factors, operational cost increases were the most frequently selected risk factor across all respondents (75%), followed by health and safety-related incident increases and environmental damage, both at 58%. Loss of social licence to operate was the least concern (Figure 5). Please refer to Appendix IV – Q13 for a list of additional comments received from survey respondents on operational risk factors.

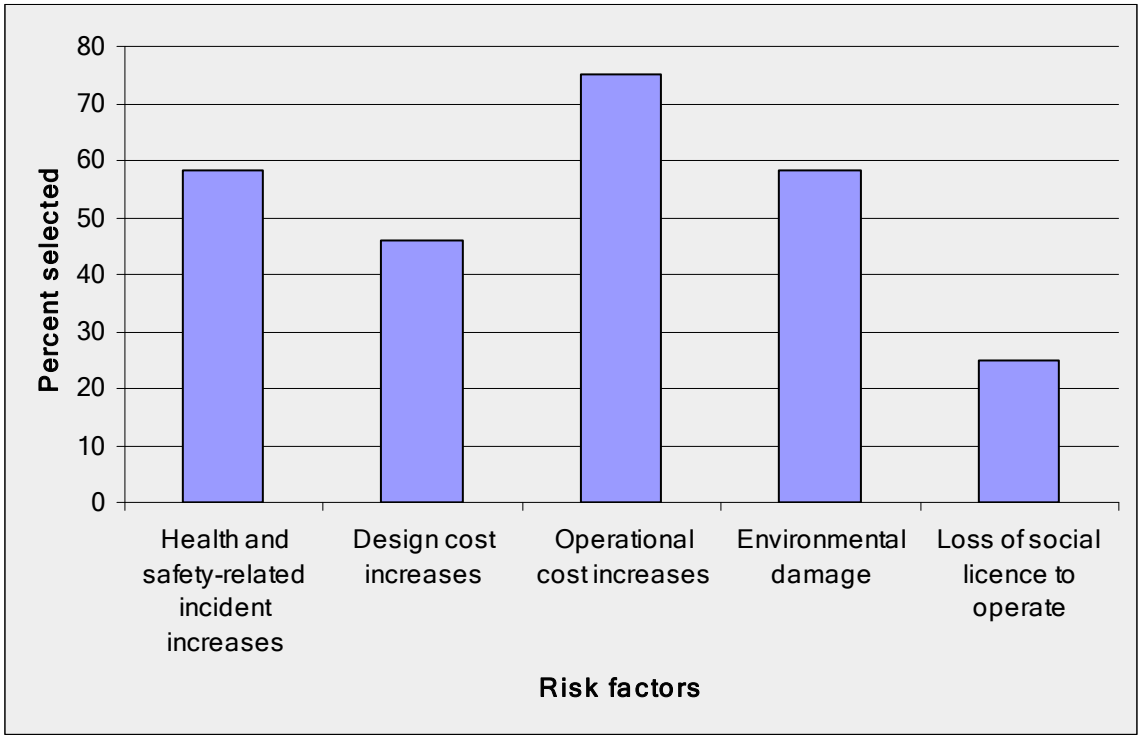

Figure 5. Operational risk factors from change in frequency and severity of extreme weather events.

There were no differences in perceived operational risk between respondents with operations in different provinces. All business areas showed a high level of concern regarding operational cost

increases and more oil transmission pipelines as well as oil and gas explorers selected health and safety-related incident increases as risk factor more often than the other business areas. All company roles also showed a high level of concern regarding operational cost increases. Management respondents also identified environmental damage as one of their perceived risk factors and environment (climate change specific issues) respondents identified heath and safety-related incident increases as a top risk factor.

Operational cost increases were the biggest concern for respondents from all sizes of companies although respondents from large and medium companies expressed more concern than those from small companies for health and safety-related incident increases and environmental damage.
With regards to the perceived risk factors relating to infrastructure, respondents reported operational cost increases and design cost increases most frequently (Figure 6). Loss of social license to operate was perceived to be a small risk by survey respondents. A pair of respondents commented that they felt that there were no risks to infrastructure. Please refer to Appendix IV – Q14 for a list of all comments received from survey respondents on the perceived risks to infrastructure.

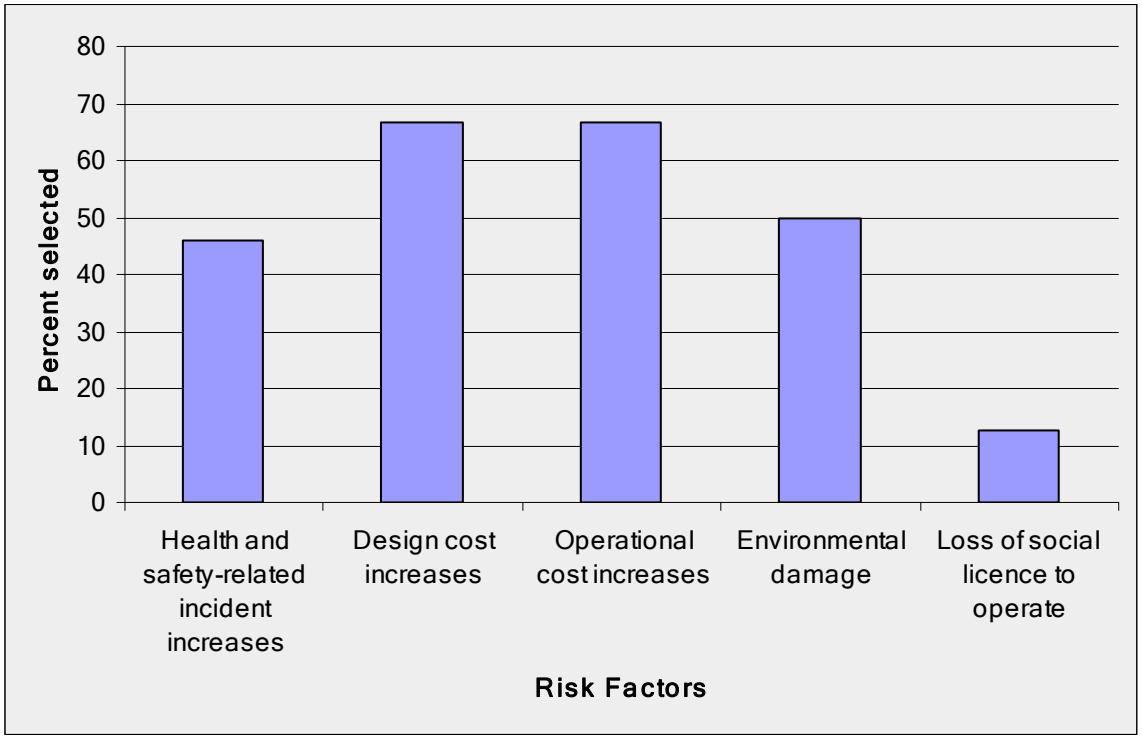

Figure 6. Infrastructure risk factors from change in frequency and severity of extreme weather events.

There were some small differences among respondents from the different business areas, but no provincial differences.

Respondents from over half of the business areas (oil transmission pipeline, conventional and unconventional oil producers, and unconventional gas producers) thought that operational cost increases would be their biggest risk, while oil and gas exploration and gas transmission pipeline respondents thought that the biggest risk would be design cost increases. Management and operations respondents thought that operational cost increases would be the biggest risk while both general and climate change specific environment respondents thought that design cost increases would be the biggest risk to infrastructure. Respondents from medium and large sized companies were more concerned about environmental damage than were respondents from small companies.

The interviews supported the results of the survey; the biggest risks to their respective businesses from changes in the frequency and severity of extreme weather events would be cost increases, both operational and design. Interviewees were asked if they agreed that design costs are a higher risk factor than social licence. Several agreed that these categories may not be mutually exclusive, and that good infrastructure design, safety and environmental protection will lead to social licence. However, two interviewees stated that loss of social licence was at least an equal risk.

> '*Costs are definitely an important factor, but for my company, social license is an equal priority. We need to show the public that the company is working with the environment responsibly*.'
>
> '*Social license has a significant impact on my company's ability to develop infrastructure, and our infrastructure crosses a lot of land and touches many communities and interests. Therefore social license is a huge issue*.'
>
> '*Increased risk of pipeline failure due to extreme weather events could lead to increased risks for public safety as well as reputational risk.*'

Other risks identified by the interviewees included slope stability, monitoring cost increases, and water sources and use. Interviewees were asked if they could estimate the magnitude of expected cost increases and the cost effectiveness of proactive versus reactive strategies. Interviewees explained that the anticipated cost increases are hard to pinpoint and will depend on the infrastructure involved as well the type of impact and adaptation required. One interviewee, however, estimated that pipelines design costs have increased 50% compared to 10 years ago (in the millions of dollars) and that there has been a

10-20% increase in operational costs (in the hundreds of thousands of dollars). Others said that there have been no increases in design costs for climate adaptation as their infrastructure is already built to be adaptable and withstand any impacts. Interview participants confirmed that being proactive is definitely less costly than being reactive, and felt that their companies were already implementing proactive strategies.

Temperature

Operationally, seven respondents noted that changes to the timing of winter freeze and/or spring melt due to changes in temperatures as a result of a changing climate would compress the time available to conduct field operations and to develop and build infrastructure, and may require the upgrade of access roads (i.e., winter roads to all-season roads) all of which would result in increased costs. Two respondents commented that a compressed activity timeframe could increase the potential for safety or environmental incidents and that more emergency response procedures and training will be required. Other respondents also noted that melting permafrost as a result of a change in temperature would make summer operations difficult and could negatively impact access. Another impact noted by a pair of respondents was changes to the localized demand for natural gas for heating. This would alter flows required for pipeline transport, according to one respondent.

Four respondents indicated that they did not expect changes in temperatures to impact their company's operations and four other respondents commented that they did not believe that climate change was occurring and thus it would have no impact on their operations (See Appendix IV – Q15 for a list of all comments received on temperature impacts on operations).

For impacts of temperature changes on infrastructure, the biggest concern raised by respondents was changes to road access. Other potential impacts included increased difficulty in the construction of new infrastructure, changes to infrastructure design requirements, and changes to slope stability which may affect pipeline integrity. One respondent noted that increased temperature and decreased permafrost would reduce the cost of infrastructure installation and likewise operating costs. Eight respondents said that they expected no impact on their company's infrastructure from changing temperatures, and two expressed doubt regarding climate change. One commented that it was "*Difficult to put significant*

capital into overdressing for temporary or occasional events." (See Appendix IV – Q16 for a list of all comments received on temperature impacts on infrastructure).

There were no discernable trends in survey responses between provinces, business areas, company roles or company size for temperature change impacts on operations or infrastructure.

Precipitation

The most common operational impact related to potential changes to precipitation patterns noted by respondents was access limitations due to increased winter snowfall and spring melt or increased rainfall in other seasons, especially in flood-prone regions. Two respondents commented that larger snow packs could lengthen the spring melt which could delay projects and shorten the field activity window, increasing costs. Other impacts to operations mentioned by several respondents included increased monitoring of groundwater levels and increased focus on storm water collection. Lack of water for industrial purposes was also noted as a potential impact. Eight respondents commented that changes in precipitation patterns would not impact operations and one respondent indicated that they didn't know if there would be an impact since their company's activities were short-term in nature (See Appendix IV – Q17 for a list of all comments received on precipitation impacts on operations).

Four respondents stated that changes to design criteria were required to ensure that sites have adequate storm water drainage and that facilities were built above the flood plain. Three respondents said that changes to runoff patterns and/or increased runoff could lead to increased erosion of access roads as well as watercourse crossings resulting in increased pipeline exposure. In addition these changes could also cause changes to slope stability and that any shifting in the ground could rupture or fracture a pipeline noted one respondent. Six respondents felt that there would be no impact to infrastructure and one said they didn't know since their company did not have any infrastructure that could be affected (See Appendix IV – Q18 for a list of all comments received on precipitation impacts on infrastructure).

There were no discernable trends in survey responses between provinces or company roles for precipitation pattern impacts on operations or infrastructure. Seventy-five percent of respondents

working for oil and gas exploration companies indicated that there would be little effect on their operational activities and since their companies have minimal infrastructure there would be no impact.

Ecological Processes

Forty-two percent of respondents indicated that they did not know if climate change induced changes to natural disturbances and other processes that are a regular part of our ecosystems would occur in their company's operating area, while 31% expected that changes would not occur, and 27% said they would expect such changes (Table 8). There were some minor differences between provinces, with over half of the respondents with operations in British Columbia (58%) expressing more uncertainty about whether these changes would occur in their company's operating area than the either respondents with operations in Alberta (30%) or Saskatchewan (44%). There were also some minor differences between company size with 60% of respondents working for a small company indicating that these changes would not occur in their company's operating area compared to 13% of respondents working for either a medium company or a large company indicating the same.

Respondents who expect that changes will occur in their company's operating areas indicated that operationally, the potential impacts included increased need for monitoring of local geological changes, increased need for forest fire preparedness and evacuation plans, and decreased access to sites (See Appendix IV – Q20 for list of all comments received on natural disturbance impacts on operations).

Table 8. Expectation of changes to disturbance patterns and ecological processes.

Response	Percent of respondents (%)	Number of Respondents
Yes	27	7
No	31	8
Don't know	42	11
Total	100	26

Potential impacts on infrastructure included increased exposure and/or failure of pipeline infrastructure and resulting increased costs for mitigation and/or replacement and increased potential for physical damage to the infrastructure from forest fires or flooding (See Appendix IV – Q21 for list of all comments received on natural disturbance impacts on infrastructure). There were too few responses to

these two questions to determine if there were any provincial, business area or company role differences.

Survey respondents were asked to rate their personal level of awareness regarding the impact that changes to the extent and diversity of plant and tree species occurring in the ecosystems in which they operate as a result of changing temperatures, precipitation patterns and ecological processes may have on site reclamation and restoration efforts and the presence of invasive plants. Most respondents (92%) were at least somewhat aware on how these changes would impact site reclamation and restoration efforts, and only slightly fewer (83%) were at least somewhat aware on how these changes would impact the presences of invasive plants (Table 9). There were no differences between provinces, business area or company role in the level of awareness. Twenty percent of respondents working for a small company were not aware of the impact these changes would have on site reclamation and restoration efforts and 33% of respondents working for a small company and 14% of respondents working for a large company were not aware of the impact on presence of invasive species.

Table 9. Level of awareness of impact of changes to extent and diversity of plant species on site reclamation and restoration efforts and presence of invasive plants.

	Very aware	Aware	Somewhat aware	Not at all aware	Total
a) Site reclamation and restoration efforts	8%	32%	52%	8%	100%
b) Presence of invasive plants	4%	38%	42%	17%	100%

Company Strategies

Survey participants were asked about the existence of company strategies to prepare for a changing climate. Only 40% of respondents said that their company had a strategy while 36% did not and 24% didn't know. This varied by province with no respondents with company operations in Saskatchewan indicating their company had a strategy and 25% saying that they didn't know. Alberta and British Columbia almost identical in their response distribution with almost half of respondents (45% and 47%, respectively) saying that their company had a strategy in place.

There were also some differences between business areas with respondents from gas transmission pipeline or unconventional gas production companies having strategies, while respondents with conventional oil producers or oil and gas exploration companies did not. Responses from those working

for unconventional oil production companies were mixed with 43% having strategies and 28% not having strategies.

Some minor differences also existed between company roles. Three of the four (75%) respondents involved in climate change specific issues said their company had a strategy while the fourth didn't know. Of those involved in a management role, 36% indicated that their company had a strategy while 45% did not and 18% didn't know.

Some differences were also evident among different sized companies. Ten percent of respondents working for a small company indicated that there company had a strategy and 70% said that their company did not. Fifty percent of respondents employed by a medium company and 71% of respondents working for a large company indicated that their company had a climate change strategy in place while 25% of medium-sized company respondents and none of the large company respondents said that their company did not.

Of the 15 respondents whose companies or clients did not have strategies or did not know, there were none who indicated that their company had any plans to develop such strategies in the next 6-12 months. Several respondents provided comments on the types of strategies their company had in place that included insurance and engineering design, and plans to install additional mitigations and protections for newly installed infrastructure. Several respondents also commented that strategies in response to a changing climate were not necessary (See Appendix IV – Q23 for a list of all comments received on company climate change strategies).

> *"Not necessary. These changes will be evolutionary, not revolutionary, and are a long ways into the future."*

Interviewees were asked to provide examples of strategies and activities that their company uses that could help with preparations for climate variability. Most of the interviewees said the main preventative strategy that is used by their respective company is ensuring that infrastructure design criteria take into account expected changes related to climate change such as melting permafrost, sea level rise, increased precipitation and temperatures. Other strategies mentioned include emergency preparedness plans to deal with things such as forest fires, floods and snow storms, strategies to deal with storm water, water crossings, and water storage, and monitoring activities for reclamation sites, and access infrastructure. The consultant noted that they have never been approached to conduct any vulnerability assessments. They added that the companies that they have done work for are used to responding to

events but questioned whether companies are building the necessary capacity to deal with the potential increase in the frequency of the events as a result of a changing climate. They also questioned if anything was being done by the regulators to ensure that engineers are adopting the necessary design standards to deal with the changing environment resulting from climate change.

Government Policies

Survey respondents were asked a series of questions on the impact of government policies, standards and regulations on the modification of management practices to adapt to a changing climate. Thirty-seven percent of respondents indicated that existing government policies or standards make it difficult to modify management practices while 23% thought that they are not a hindrance. The remaining 41% were neutral (selected "3" on a scale from 1-5, as shown in Figure 7).

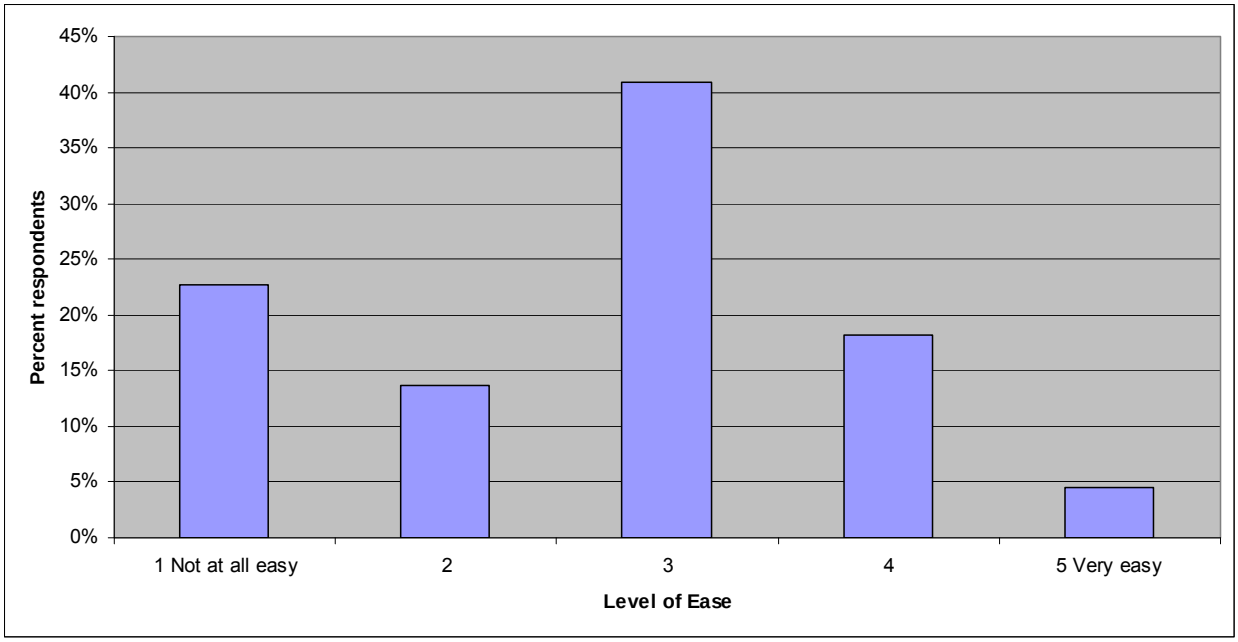

Figure 7. Perceived impact of existing government policies or standards on their company's ability to modify management practices to adapt to a changing climate.

There were some provincial differences in perception between respondents with regards to government policies or standards. More respondents with operations in Alberta or British Columbia than respondents with operations in Saskatchewan indicated that existing government policies and standards make it "not at all easy" to modify their management practices to adapt to a changing climate. Please

refer to Appendix IV – Q25 for a list of all survey respondent comments on the adaptation and government policies.

> "*Modifications to facilities in response to these risks require regulatory approval processes that can be lengthy.*"
>
> "*Government policies and standards are slow to change and often inflexible. Regulators infrequently meet to discuss common strategies. It is often difficult to obtain regulatory approval to execute programs and projects based on protecting infrastructure from climate change.*"

Gas transmission pipeline and unconventional oil respondents said that it was not at all easy to adapt management practices due to existing government policies or standards while respondents from the other business areas were mostly neutral. On average, respondents from small companies said that it was easy to adapt while respondents from medium and large companies indicated that it was not at all easy.

Half of respondents indicated that a changing climate would have little effect on their company's ability to meet current government regulations and policies whereas 17% thought there would be some effect. One pipeline respondent noted that "*Pipelines have a regulatory requirement to maintain a certain depth of cover. Climate change will likely make it difficult to maintain the depth of cover on a portion of our pipeline assets."* Please refer to Appendix IV – Q26 for a list of all survey respondent comments on climate change impacts on their ability to meeting regulatory requirements.

There were some slight differences between company business areas. Fifty percent of gas transmission pipeline respondents and 43% of unconventional oil producer respondents indicated climate change would have an effect on their ability to meet regulations whereas all of the oil and gas exploration respondents indicated there would be no effect. There were also some differences between respondents from different sized companies. Respondents employed by a medium sized company (100-500 employees) generally indicated that there would be a significant effect while respondents working for both small (less than 100 employees) or large (greater than 500 employees) generally thought that there would be no effect.

Most respondents (63%) were neutral when asked if existing government policies or standards create barriers to climate change adaptation, with 21% disagreeing or strongly disagreeing. Please refer to Appendix IV – Q27 for a list of all survey respondent comments on climate change adaptation barriers.

There were also some provincial differences for this question which corroborated the provincial differences noted earlier regarding how easy existing government policies and standards make it for companies to modify their management practices to adapt to a changing climate. No respondents with company operations in Saskatchewan strongly agreed or agreed that existing government policies or standards created barriers to climate change adaptation, while 57% disagreed or strongly disagreed. For Alberta and British Columbia 17% and 9% agreed or strongly agreed with the statement while the majority of respondents from these two provinces were neutral.

'Some do, some don't. Some of the tech funds spur innovation. Some of the prescriptive regulations stifle innovation'

"Existing policies and standards are inflexible; many of the adaptation techniques require a degree of regulatory flexibility based on site-specific considerations."

There were also some differences between business areas. All of the gas transmission pipeline respondents and 28% of the unconventional oil producer respondents agreed or strongly agreed that existing government policies or standards create barriers to climate change adaptation while 67% of respondents working for conventional oil producers and 50% of those in oil and gas exploration disagreed or strongly disagreed with the statement. The remainder of respondents from these other business areas were neutral.

Company size also played a role as well. Although most of the respondents from all three company sizes were neutral, just under half of the respondents working for a small company indicated that there are no government policy barriers to adaptation while 28% of respondents working for a large company and 25% of respondents working for a medium company said that there are.

Four of the six interviewees commented that they had experienced challenges with the regulatory process in the jurisdictions in which their company operates. The most common comment was that the regulatory process was slow and lacked the flexibility to deal with issues and situations arising as a result of a changing climate. One interviewee specifically mentioned the lack of flexibility in the allowable window (timeframe) for drilling within the regulation controlled permitting process.

'If climate change is causing events(e.g., floods, fire) that conflict with the timing to build access infrastructure or to conduct drilling operations, the regulations are not really set up for that.'

Another interviewee suggested the need for tools and policies that are consistent and a third stated that the industry could be more adaptive if regulators could integrate climate change more explicitly into policy and regulation. They also suggested that there needs to be more research on the impacts to the industry of a changing climate. Two interviewees responded that they had not encountered any regulatory issues and one mentioned that their company continues to be proactive in working with the regulators in Saskatchewan to address any regulatory or policy issues.

Information Needs and Sources

Survey participants were asked about the types of information that they would need to help them make operational or environmental decisions regarding adaptation to a changing climate. Monitoring data and predictive models, both at a local/regional level were the two types of information most often mentioned by both survey respondents and interviewees (See Appendix IV – Q28 for a list of all information needs identified by survey respondents). One interviewee suggested that these models and tools do exist, citing the Pacific Institute for Climate Solutions and the University of Northern British Columbia as two sources, but that the availability of the data and tools varies by region and is dependent on government. Interviewees suggested that funding for monitoring data collection and predictive model development should come from government. One interviewee noted that for their operations, industry would need to be responsible for the monitoring data collection provided that government set the data collection standards. However, other interviewees felt that climate change monitoring data collection should be lead by government.

Other information needs included general adaptation strategies and techniques and associated costs, and risk assessments. This was consistent across all provinces, business areas, company roles, and company sizes.

Respondents indicated that get information on the potential impacts of a changing climate within their field of expertise from:

1) Industry associations,
2) Independent contractors/consultants, or
3) Colleagues/peers outside of their company (Figure 8)

They are currently not getting their information from:

1) Non-government organization (NGO) technical specialists
2) Workshops/training sessions, or
3) Internet based information sources (Wiki's, discussion boards and forums, etc.) (Figure 8).

There were some differences across provinces regarding current sources of climate change information. Respondents from Alberta and British Columbia had a slightly higher preference for industry associations and a much higher preference for college or university researchers as well as government researchers/technical specialists than those respondents with company operations in Saskatchewan. Respondents from Saskatchewan had a higher preference for using NGO technical specialists than their counterparts from Alberta and British Columbia.

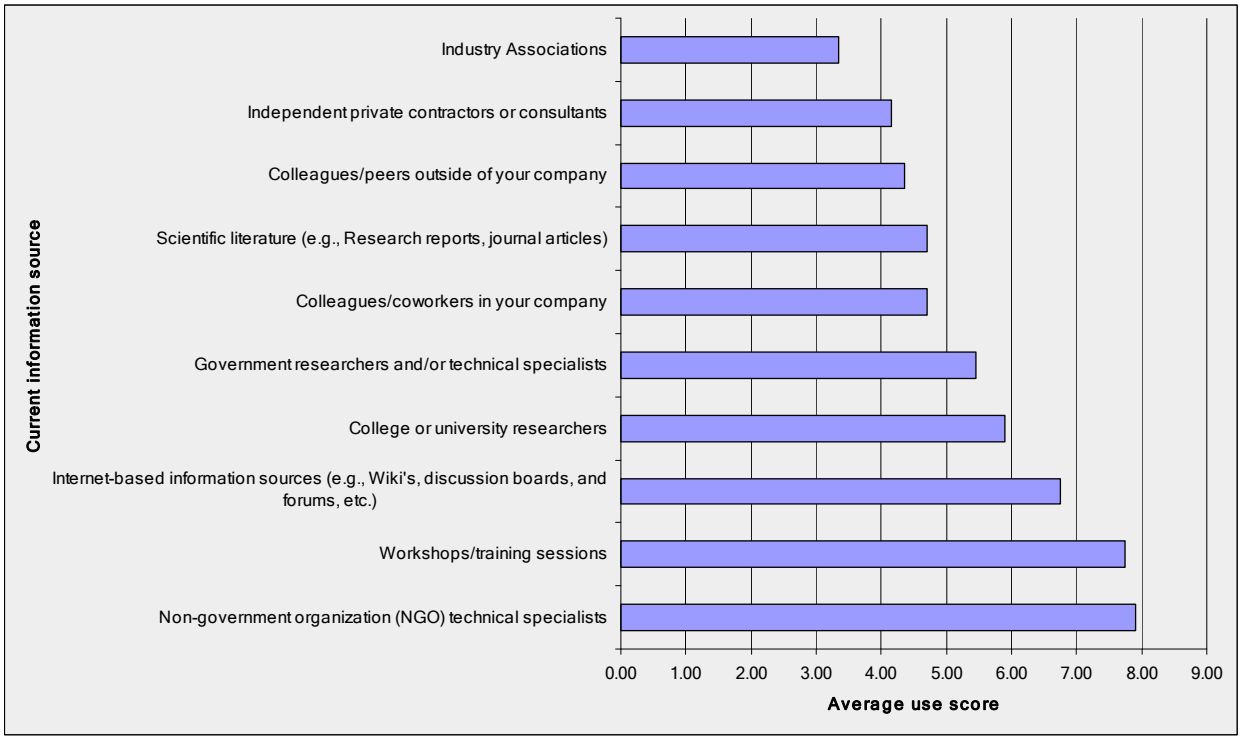

Figure 8. Sources of information on potential impacts of climate change within respondents' field of expertise. (Ranked from 1-10 where 1 is the most used and 10 the least used)

There were also some slight differences in current sources of information between business areas. While respondents from most business areas selected industry associations as the most used current source of information, those working for conventional oil production companies selected colleagues/co-workers within their company as the most used current source of information, followed by

colleagues/peers outside of their company, and tied for third independent private contractors or consultants and internet-based information sources. Those respondents working for oil transmission pipelines selected workshops/training sessions as the most used current source of information followed by industry associations, and NGO technical specialists.

Respondents employed by large companies ranked scientific literature the most used source followed by industry associations and government researchers and/or technical specialists. Respondents working for small or medium sized companies selected industry associations as the most used information source followed by colleagues/peers outside of their company and independent private contractors or consultants.

Respondents were asked to select their top three methods or techniques that would be the most effective for them to receive information on climate change and its predicted impacts. Industry associations were selected by 83% of respondents, followed by research reports (53%) and workshops and websites which were tied at 39%. The two least effective methods were webinars and on-line discussion forums/blogs (4.3%).

Provincially, industry associations were most frequently selected as the most effective method for receiving information among respondents from British Columbia, Alberta and Saskatchewan. However, extension notes were the second most frequently selected method for respondents with company operations in Saskatchewan, followed by research reports. No respondents from Saskatchewan selected webinars, on-line discussion forums/blogs or trade magazine articles while no respondents from British Columbia selected on-line discussion forums/blogs or trade magazine articles as their most effective sources of information on climate change and its predicted impacts.

All business areas with the exception of conventional oil producer respondents most frequently selected 'Industry associations' as the most effective method for them to receive information on climate change and its predicted impacts. Conventional oil producer respondents selected websites as their most effective method. Workshops were selected second most often by respondents from both oil and gas transmission pipeline companies, and oil and gas explorers, while research reports were selected second by unconventional oil and unconventional gas producer respondents.

Small company respondents ranked websites as the most effective method while medium and large company respondents ranked industry association newsletters as the most effective.

Survey respondents were asked about what methods or techniques would be most effective in increasing the overall knowledge level within the oil and gas sector of the recent science regarding the potential impacts of a changing climate on operations and infrastructure. Industry Association newsletters, distributed by email, were by far the most often selected method with 13 of 21 respondents ranking it as the most effective technique (Figure 9). The second most effective technique was workshops, followed by industry association newsletters distributed through regular mail. The least effective method was trade magazine articles, followed by social media and on-line discussion forums/blogs. Respondents from small companies indicated that websites were equally as effective as industry association newsletters sent out by email whereas those respondents from medium or large companies consistently favoured emailed industry association newsletters.

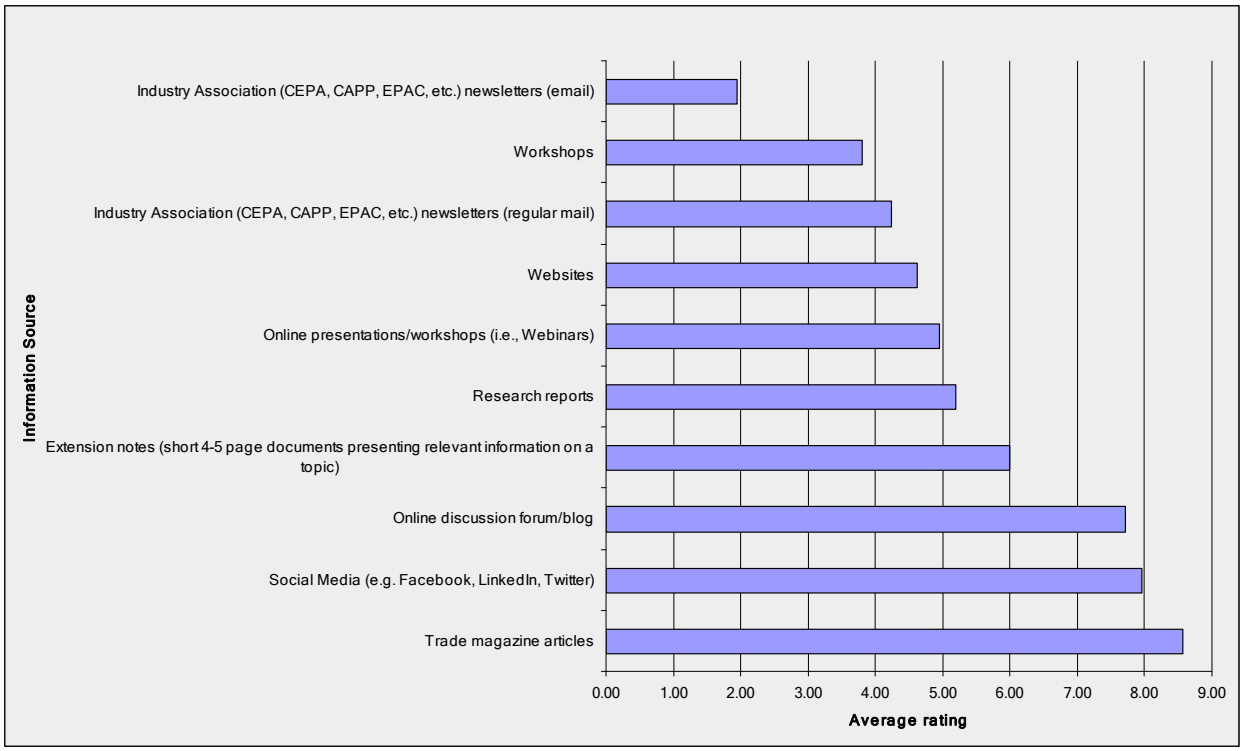

Figure 9. Effectiveness of various information sources for increasing the overall knowledge level within the oil and gas sector of the recent science regarding the potential impacts of a changing climate on operations and infrastructure. (Ranked from 1-10 where 1 is the most effective and 10 the least effective)

Climate Change Terminology and Oil and Gas Sector Resiliency

Interviewees were also asked two questions that were not asked of survey respondents. The addition of these questions was the result of project steering committee and project team discussions following the preliminary analysis of the on-line survey results. The first was what could be done to help the oil and gas industry be more resilient and proactive to the impacts of a changing climate. And the second was whether using the terminology "climate-change impacts" which is often used by policy makers is a barrier to advancing the discussion on preparedness for extreme weather events.

There were mixed responses regarding the potential barrier of terminology in advancing the climate change discussion. One interviewee thought that the current terminology was very much a barrier due to the recent use of the terms within the political realm while another thought that using other terminology would be useful to avoid any preconceived notions. The latter suggested that using other terms like 'extreme weather events' and 'climate variability' would avoid any negative connotations association with terminology. Another interviewee suggested that shifting the conversation about adaptation and climate change to having emergency response plans for extreme weather events would be more effective. In contrast, several people interviewed did not think that the terminology should be issue. They thought climate change is an issue that is a high public and policy priority and forms part of the landscape in which the industry must operate. Those in the natural gas sector felt their industry was part of the solution for mitigating the effects of climate change. Those in the oil sector cited significant investments in mitigation projects. One interviewee suggested that climate change appears to be too broad of an issue presenting a vague problem that is difficult to address. The industry is accustomed to using a risk-based approach so presenting the discussion in the context of reducing risk and costs would be beneficial. More research on the impacts to the industry of a changing climate and the risk associated with those impacts will help motivate the industry to develop solutions.

Interviewees were asked what could be done to help the industry be more resilient and proactive to the impacts of a changing climate. Said one, "*A more resilient industry will be one that looks at life-cycle costs – increased maintenance and amortize the initial cost over the lifespan of the facility."* A second said that monitoring and gathering of empirical data to help refine modelling projections and show what is happening locally is key to creating a resilient industry.

DISCUSSION

The purpose of this study was to address research questions relating to climate change impacts and adaptation from the perspective of oil and gas sector leaders in western Canada. Through an on-line survey and interviews, we explored how seriously various energy sectors leaders are taking what is widely considered by many in the scientific community as an inevitability: a changing climate that will ultimately affect how the sector operates and how it will need to respond.

All three western Canadian provinces were represented in the survey and interview results with the highest percentage of respondents representing companies with operations in Alberta. This is to be expected as this is where the majority of oil and gas resource development in western Canada is occurring and where a large proportion of oil and gas production and transmission companies are headquartered.

Extreme Weather and Climate

Our analysis of survey responses of energy sector leaders, showed that there is wide variability in how energy sector leaders view the existence of global climate change – only just over half of all respondents agreed that global climate change is occurring and the rest are neutral or strongly disagree. There appears to be considerable uncertainty about the reality of climate change among a wide array of individuals in the sector. Opinions about the occurrence of climate change vary by province and business area, and to a lesser degree, respondent role in their company and company size. Respondents from Saskatchewan and those representing oil and gas pipeline and exploration companies were the most certain about the existence of climate change. Operational respondents were less certain than those having other roles in their companies.

However, all of the sector leaders interviewed agreed that climate change is occurring and needs to be addressed which potentially indicates that the view that climate change is not occurring may not be as pervasive as suggested by the survey results.

There is also a wide range of opinion on whether a changing climate could affect company operations and/or infrastructure – just under half of respondents felt that there could be an impact while nearly a

fifth of respondents disagreed. The majority of respondents representing pipeline companies agreed while the majority of those from oil and gas production companies disagreed. Interviewees from the production sector indicated that any impacts of severe weather or natural disturbances are accounted for in the design standards and criteria for production facility infrastructure. However, design standards and criteria will need to continue to be frequently monitored and reviewed to ensure that they are adequate should the frequency and severity of the extreme weather events and natural disturbances increase as expected due to the changing climate.

Respondents working for small companies (less than 100 employees) were less certain about climate change and its potential impacts on their operations and/or infrastructure than those employed by medium (100-500 employees) or large (more than 500 employees) companies.

Only about half of respondents said that they had observed extreme weather events and this varied depending on what business area they belonged to. Not all who have seen extreme weather attributed it to climate change. Over half of those respondents either questioned the linkage between the extreme event they observed and a changing climate or expressed doubt regarding the climate change.

Climate Change Risks and Impacts

An equal number of respondents indicated they had seen their companies planning for impacts of a changing climate as those who said they had not. Only a quarter of respondents indicated that they had observed their company implementing climate change preparedness activities. A greater number of respondents working for a medium or for a large company indicated that their companies were actively planning and to a lesser extent implementing activities to prepare for a changing climate compared to respondents working for smaller companies.

There was slightly more consideration given for extreme weather events in risk management decisions than any other type of management decision. Only a quarter of respondents said that extreme weather events are considered when making operational decisions and the same percentage indicated they are considered when developing long-term strategies. Compared with respondents in other business areas, unconventional gas producers appeared to consider extreme weather events in most types of

management decisions. The vast majority of respondents working for small companies indicated that their company is not considering extreme weather events when making management decisions.

Cost increases were the most frequently mentioned risks associated with climate change, followed by worker health and safety and environmental damage. Loss of social license to operate was of least concern across all respondents.

Compressed time available to conduct field operations and develop and build infrastructure due to changes in the timing of winter freeze and/or spring melt was the most frequently mentioned concern related to climate change-induced changes to temperatures. Cost increases due to required upgrades to access roads and increased difficulty of summer operations due to melting permafrost were also noted. Most respondents felt that temperature changes would not impact infrastructure.

Impacts on access availability and the access structures themselves were the most frequently noted operational concern related to potential changes in precipitation patterns as a result of a changing climate. Ensuring adequate storm water drainage and construction of facilities above the flood plain were the two most cited concerns related to infrastructure. Respondents working for both oil and gas pipelines also expressed concerns that changes to run-off levels and patterns could lead to increased erosion of access roads as well as watercourse crossings resulting in increased pipeline exposure.

Just over a quarter of survey respondents expected that changes to natural disturbances and other processes (e.g., flooding, forest fires, landslides) would occur in their company's operating area, while just under half were unsure. The increased need for emergency preparedness plans was given as one of the main operational impacts of these changes while the increased potential for physical damage and resulting increases in costs for mitigation and/or replacement was the main infrastructure impact noted by survey respondents.

The vast majority of respondents were at least somewhat aware of how changes to the extent and diversity of plant and tree species would impact site reclamation and restoration efforts while slightly fewer were at least somewhat aware of how these changes would impact the presence of invasive plants.

Company Strategies

Less than half (40%) of survey respondents said that their company had a strategy to prepare for a changing climate and nearly a quarter of respondents didn't know if their company had a strategy or not. Of the respondents whose company didn't have a strategy or those that didn't know, all indicated that there were no plans to develop such a strategy within the next 6-12 months. Differences in the existence of strategies to prepare for climate change were evident between provinces, business areas, and company sizes. No respondents working for a company with operations in Saskatchewan indicated that their company had a strategy while almost half of survey respondents with operations in British Columbia or Alberta said that their company had such a strategy. Climate change preparedness strategies existed for respondents working for a gas transmission or unconventional gas production companies while no strategies existed for respondents working for conventional oil producers or oil and gas exploration companies. Almost three-quarters of respondents working for a small company indicated that their company did not have a strategy for addressing climate change impacts while half of respondents working for a medium company and almost three-quarters of respondents working for a large company said that their company had a climate change strategy.

One of the four respondents who had climate change-specific environmental roles for their companies and two of the eleven respondents in management roles indicated that they didn't know if their company had a strategy to prepare for addressing climate change issues.

Ensuring that the infrastructure design takes into account the potential impacts of climate change is the main preventative strategy currently being used by the companies of those people interviewed. Emergency preparedness plans are another strategy being used.

Government Regulations, Policies and Standards

Some respondents felt that current government regulations, policies and standards make it difficult for companies in the oil and gas sector to modify management practices to adapt to a changing climate. This sentiment was expressed more often for respondents with company operations in Alberta and British Columbia than for respondents with company operations in Saskatchewan. Respondents working for gas transmission companies or for unconventional oil producers also indicated that regulatory or

policy barriers to adaptation exist. Some commented that the regulatory process is slow and lacks the flexibility to deal with issues and situations arising as a result of a changing climate.
Half of the respondents working for a gas pipeline company and almost half of respondents working for an unconventional oil producer indicated that a changing climate would impact their ability to meet current regulations.

Information Needs and Sources

Regionally-based monitoring data and predictive models to assist with operational or environmental decisions regarding adaptation to a changing climate were the top two information needs cited by both survey respondents and interviewees. Interviewees suggested that government should provide the necessary funding to help support the collection of the required climate change monitoring data as well as the development of the predictive models. Government should also take a lead role in storing and making accessible the collected climate change monitoring data.

Industry associations are the most trusted source of information and emailed newsletters from those associations were perceived to be the best method for receiving information on climate change and its predicted impacts on the sector.

KEY MESSAGES

- A wide variety of opinions and experiences exists among respondents about climate change and the potential impacts it will have on the oil and gas sector in Western Canada. The oil and gas sector leaders surveyed run the full gamut between those who don't accept climate change and those who agree that climate change is occurring but feel hindered by government policy in their efforts to adapt.

- Small companies (less than 100 employees) appear to be less certain about climate change and its predicted impacts and are less likely to consider climate change when making management decisions or have a strategy in place to address those impacts compared to their counterparts working for medium (100-500 employees) or large (greater than 100 employees) companies.

- Climate change adaptation appears to be low on the priority list of junior and mid-sized oil and gas exploration and production company respondents given their other concerns regarding capital investment, operating costs, regulations and permitting, and skilled workforce shortages.

- Government policies are seen as a hindrance to climate change adaptation by a third of respondents, especially those from British Columbia and Alberta.

- Lack of local/regional climate change monitoring data as well as models and other forecasting tools to help the sector make operational or environmental decisions regarding adaptation to a changing climate was identified as a key information gap. Government should provide the necessary funding to ensure the collection and storage of this data, and development of the models and forecasting tools.

- Industry associations are the most trusted information source and electronic newsletters from those associations are the most effective method for distributing information on climate change and its predicted impacts to oil and gas sector leaders.

- The low survey response rate indicates the need for a different approach to engage the oil and gas sector in the conversation on climate change and adaptation. Focus groups or workshops may be better methods of engagement as interview participants felt that they needed to consult with colleagues on many of the questions posed and indicated that addressing climate change adaptation within the oil and gas sector will require a diverse team of company experts.

RECOMMENDATIONS

- Given the variability of the opinions and experiences among respondents about climate change, a multi-faceted and comprehensive outreach approach utilizing a variety of extension methods and techniques will be required to increase the sector's knowledge about the predicted impacts changes to the frequency of extreme weather events and natural disturbances, as a result of a changing climate, may have on the sector's operations and/or infrastructure. For example, preparing for climate change is good practice for risk management in general; even those in the energy sector who don't agree with climate change do agree with good risk management. And so, for example, an outreach program aimed at risk management in general could include climate change adaptation as one of the topics.

- Due to the complex nature of projecting climate change impacts on the sector, it is recommended that companies implement collaborative internal approaches that engage experts, technicians and specialists to develop adaptation strategies.

- Small companies could be more vulnerable to the impacts of a changing climate depending on the extent and diversity of their operations and may not have the necessary resources to focus on climate change adaptation. Companies operating in a small area or with a small number of facilities could be severely impacted should an extreme weather event or natural disturbance cause a shutdown/suspension of their operations at either a critical time or for an extended period. Outreach activities targeted specifically at small oil and gas companies are required to help them prepare for the potential impacts of a changing climate on their operations and/or infrastructure.

- An analysis of government policies that further examines which policies are considered hindrances and what policy changes could help provide incentives and remove barriers for energy sector companies to address climate change through modification of management practices would be important as a start in eliminating barriers to adaptation in the sector.

- Increased efforts to gather local/regional climate change monitoring data and develop local/regional models and forecasting tools is recommended. Or, if such tools do already exist,

then increased efforts are required to increase the awareness of these tools and to increase the sector's knowledge on how to use them in decision making.

- Many survey respondents and interviewees stated that extreme weather events would have minimal impact on the sector's infrastructure as the current engineering design standards and criteria already take these events into account. However, given that the frequency and severity of extreme weather events as well as natural disturbance processes are expected to increase over the next few decades, it is imperative that design standards and criteria continue to be monitored to ensure that they remain adequate to ensure the continued safe operation of the sector's infrastructure. This may also require continued research on the risks and potential impacts of a changing climate on the sector's operations and infrastructure as well as on the associated costs of adaptation.

- Oil and gas sector industry associations should take a lead role in fostering the dialogue on climate change within their sector and in identifying opportunities for coordinated climate change adaptation strategies given their role as a trusted and representative body that addresses relevant issues across their membership.

- Future studies designed to gather information about the sector's preparedness for climate change would be best accomplished through engagement such as focus groups or workshops rather than surveys of individuals. It is also recommended that future discussions on the potential impacts of a changing climate on the sector should use more neutral terms such as 'extreme weather events' and 'climate variability' instead of 'climate change' and should be framed in a risk and cost reduction context.

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APPENDIX I

Project Steering Committee members

Name	Affiliation
Amanda Affonso Kai Horsfield Evan Wilson	Canadian Energy Pipeline Association (CEPA)
Jenna Dunlop Mikaela McQuade	Canadian Association of Petroleum Producers (CAPP)
Kim Graybiel	Saskatchewan Ministry of Environment – Climate Change
Howard Madill	BC Oil and Gas Commission (OGC)
Jennifer Pouliotte	BC Ministry of Environment Climate Change Secretariat
Nicole Spears Yvette Thompson	Alberta Department of Environment and Sustainable Resource Development – Policy Division

APPENDIX II

Survey Cover Letter and Questions

Introduction

Dear Energy Sector Leaders and Professionals,

We are inviting you to participate in an important and timely survey of the Oil and Gas sector leaders and professionals in Western Canada (Saskatchewan, Alberta and British Columbia) to learn about your perspectives and experiences with impacts and adaptation strategies relating to extreme weather events and other weather-related phenomena that affect your work.

This is the first stage of a project funded by the Science and Communities Environmental Knowledge (SCEK) fund, the results of which will be used to develop programs and other initiatives to assist the oil and gas sector in Canada.

The survey is voluntary, but your participation will greatly aid the sector in working together to develop and apply strategies that will help to mitigate potential weather-related phenomena that could otherwise increase costs and risk mitigation investments.

The survey should take about 20-30 minutes to complete. No individual respondent can be identified unless you choose to include your name.

This project is a collaborative effort between industry associations, government, and others (see below for full list) and is aimed at contributing to economic certainty, environmental protection, and 'social license' for the energy sector in Western Canada. This project is lead by Resources North Association, a multi sector not-for-profit organization based in Prince George, British Columbia (www.resourcesnorth.org) in collaboration with Trout Creek Collaborative Solutions (www.tccsolutions.ca).

Results of the project will be available by December, 2014, by contacting a project team member (see emails below).

The survey will close at 7 p.m. on March 21st, 2014.

Please do not hesitate to contact Al Wiensczyk (alan@tccsolutions.ca) or Melanie Karjala (melanie@resourcesnorth.org) for more information.
Thank you for your participation.

For statistical analysis purposes we respectfully request that you please ***do not forward*** this survey to others. If there is someone else within your organization who you think should be invited to participate in this survey either in addition to yourself or instead please send an email to either Al or Melanie and we will ensure that they receive a link to the survey.

The following partners are also involved in this project:

- Canadian Association of Petroleum Producers (CAPP)
- Canadian Energy Pipeline Association (CEPA)
- Saskatchewan Ministry of Environment, Climate Change Branch
- Alberta Environment and Sustainable Resource Development – Air Policy and Climate Change Branch
- BC Ministry of Environment Climate Change Secretariat
- BC Oil and Gas Commission (BC OGC), and
- Fraser Basin Council (FBC)

Business Information

1. Which of the following best describes your involvement in the oil and gas sector?

    a. Oil and gas sector company employee
    b. Consultant to the oil and gas sector
    c. Operational contractor to the oil and gas sector
    d. Other (please specify)

2. Which of the following best describes your company's or your clients' primary business area?

    a. Oil Transmission pipeline
    b. Gas Transmission pipeline
    c. Conventional oil production
    d. Unconventional oil production
    e. Conventional gas production
    f. Unconventional gas production
    g. Oil and gas exploration
    h. Other (please specify)

3. How many people does your company employ?

    a. Less than 100 employees
    b. 100 - 500 employees
    c. More than 500 employees

4. In which province(s) does your company or your client's company operate? (select all that apply)

    a. British Columbia
    b. Alberta
    c. Saskatchewan
    d. Other (please specify)

Extreme weather events

5. Have you observed any weather events in your company's or your clients' geographic operating area in the past two years that you would consider as "extreme events"?
    a. Yes
    b. No

    If yes, please describe

(*Respondents answering "No" to question 5 were not required to answer questions 6-10 and were automatically directed to question 11*)

Weather-related impacts

6. In which of the following ways did those event(s) affect your company's or your clients' business activities?

	Slow down	Suspend temporarily	Shut down permanently	No effect
Administrative activities	◯	◯	◯	◯
Planning activities	◯	◯	◯	◯
Exploration activities	◯	◯	◯	◯
Development activities	◯	◯	◯	◯
Environmental activities	◯	◯	◯	◯
Decommissioning activities	◯	◯	◯	◯
Product transportation to market	◯	◯	◯	◯

Comments:

7. If the event(s) slowed down or suspended any activities, for how long? (please select longest period if there was more than one)
    a. Less than a day
    b. 1-7 days
    c. More than a week but less than a month
    d. More than a month
    e. Not sure

    Comment: Please indicate which activity from question 6 was slowed down or suspended.

Extreme weather and climate

8. Do you think that the extreme weather event(s) you observed is/are a result of a changing climate?
    a. Yes
    b. No

    Please explain:

9. Do you anticipate that there may be more frequent and/or severe weather events in the future than would have occurred without climate change?
    a. Yes
    b. No
    c. Not sure

    Please explain:

10. How far into the future do you think will be the onset of more frequent and/or severe weather events?
    a. 0-5 years
    b. 6-10 years
    c. 11-20 years
    d. Greater than 20 years
    e. Not sure

Changing Climate

11. Please indicate your level of agreement with the following statements.

	Strongly agree	Agree	Neutral	Disagree	Strongly disagree
a. I think that climate change is occurring.	○	○	○	○	○
b. I think that a changing climate could affect my company's or my clients' operations and/or infrastructure in the future.	○	○	○	○	○
c. I have observed my company or my clients participating in planning activities to prepare for potential impacts of a changing climate on operations and/or infrastructure.	○	○	○	○	○
d. I have observed my company or my clients implementing changes to operations and/or infrastructure to prepare for a changing climate.	○	○	○	○	○

12. Does you company or client(s) currently make management decisions in any of the following areas, in response to current or future predicted changes to the frequency and severity of extreme weather events?

	Yes	No	Not sure
When making operational decisions?	○	○	○
When doing long-term forecasting/planning?	○	○	○
When doing risk management planning?	○	○	○
When designing infrastructure?	○	○	○
When developing long term strategic plans	○	○	○
Other (Please specify)			

Risk Factors

13. What do you perceive to be some risk factors relating to a change in the frequency and severity of extreme weather events?

Operationally? (Please select all that apply)

a. Health and safety-related incident increases
b. Design cost increases
c. Operational cost increases
d. Environmental damage
e. Loss of social license to operate
f. Other (please specify)

14. To Infrastructure? (Please select all that apply)

a. Health and safety-related incident increases
b. Design cost increases
c. Operational cost increases
d. Environmental damage
e. Loss of social license to operate
f. Other (please specify)

Temperature

15. Scientists anticipate that a changing climate could result in changes to temperatures (highs and lows) which may, in turn, affect permafrost levels, and timing of winter freeze up and/or spring melt.

    Please describe specifically how you think such changes in temperature would impact your company's or your clients' operations in the future.

16. Please describe specifically how you think such changes in temperature would impact your company's or your clients' infrastructure in the future.

Precipitation

17. Scientists also anticipate that a changing climate could result in changes in precipitation patterns (timing, amounts and types (rain vs snow)) in some areas which could result in raised or lowered water tables and changes to runoff patterns and timing.

    Please describe specifically how you think that such changes to precipitation patterns would impact your company's or your clients' operations in the future.

18. Please describe specifically how you think that such changes to precipitation patterns would impact your company's or your clients' infrastructure in the future.

Ecological processes

19. Scientists expect that changes to temperature and precipitation patterns as a result of a changing climate could affect natural disturbances and other processes that are a regular part of our ecosystems. (e.g., frequency and severity of wildfires, frequency of landslides, increased flooding, and increased forest insects and disease damage.)

    Do you expect that changes to these types of processes will occur in the future in your company's or your clients' operating areas?
    a) Yes
    b) No
    c) Don't know

(*Respondents answering "No" or "Don't know" to question 19 were not required to answer questions 20-21 and were automatically directed to question 22*)

Natural process impacts

20. Please describe specifically how you think that these natural process changes would impact your company's or your clients' operations in the future.

21. Please describe specifically how you think that these natural process changes would impact your company's or your clients' infrastructure in the future.

Plant species diversity

22. Scientists also anticipate that changes to temperature and precipitation patterns and ecological processes could also impact the extent and diversity of plant and tree species occurring in our ecosystems.

    Please rate your personal level of awareness regarding the impact these changes may have on;

		Very aware	Aware	Somewhat aware	Not at all aware
a.	Site reclamation and restoration efforts.	○	○	○	○
b.	Presence of invasive plants.	○	○	○	○

Company strategies

23. Does your company or your client currently have a strategy or strategies (e.g., operational, insurance, engineering design, planning) to prepare for a changing climate?
    a. Yes
    b. No
    c. Don't know

(*Respondents answering "Yes" to question 23 were not required to answer questions 24 and were automatically directed to question 25*)

24. Are there any plans to develop such strategies in the near future (6-12 months)?
    a. Yes
    b. No
    c. Don't know

25. How easy to existing government policies or standards make it for your company or your client to modify management practices to adapt to a changing climate?

1 Not at all easy	2	3	4	5 Very easy
○	○	○	○	○

26. What level of effect would a changing climate have on your company's or your clients' ability to meet current government regulations and policies?

1 Significant effect	2	3	4	5 No effect
○	○	○	○	○

27. Please rate your level of agreement with the following statement.

    Existing government policies or standards create barriers to climate change adaptation.
    a. Strongly agree
    b. Agree
    c. Neutral
    d. Disagree
    e. Strongly disagree

Information needs and sources

28. If you had to make an operational or environmental decision regarding adaptation to a changing climate what types of information would you need to help inform that decision (e.g., climate change projections, monitoring data, predictive models)?

29. Where do you currently go to get information on the potential impacts of a changing climate within your field of expertise? (Please rank from 1-10 where 1 is the most likely to be used and 10 is the least likely.

___ Colleagues/co-workers within your company
___ Colleagues/peers outside of your company
___ Industry Associations
___ Independent private contractors or consultants
___ College or university researchers
___ Government researchers and/or technical specialists
___ Non-government organization (NGO) technical specialists
___ Scientific literature (e.g., Research reports, journal articles)
___ Internet-based information sources (e.g., Wiki's, discussion boards, and forums, etc.)
___ Workshops/training sessions.

30. Please describe any other sources of information on the potential impacts of a changing climate that you currently use, if any.

31. What methods/techniques would be the most effective for <u>you</u> to get information on climate change and its predicted impacts? (Please select your top 3)

___ Industry Association (CEPA, CAPP, EPAC, etc.) newsletters (email)
___ Webinars
___ Workshops
___ Website
___ Research reports
___ Extension notes (short 4-5 page documents presenting relevant information on a topic)
___ Online discussion forum/blog
___ Trade magazine articles
Other (please specify)

32. What methods/techniques do you think would be most effective in increasing the overall level of knowledge within the oil and gas sector of the recent science regarding the potential impacts of a changing climate on operations and infrastructure? (Please rank from 1-10 where 1 is the most effective and 10 the least effective)

___ Industry Association (CEPA, CAPP, EPAC, etc.) newsletters (email)
___ Industry Association (CEPA, CAPP, EPAC, etc.) newsletters (regular mail)
___ Online presentations/workshops (i.e., webinars)
___ Workshops
___ Websites
___ Social media (e.g., Facebook, LinkedIn, Twitter)
___ Online discussion forum/blog
___ Research reports
___ Extension notes (short 4-5 page documents presenting relevant information on a topic)
___ Trade magazine articles

Demographic Information

33. In which one of the following roles do you spend most of your time for your company or your client's company?
    a. Management
    b. Planning
    c. Operations
    d. Environment (general)
    e. Environment (Climate change specific issues)
    f. Other (Please specify)

34. What is your title/position within your company?

35. How many years experience do you have in your current field?

    a. Less than 5
    b. 5-10
    c. 11-15
    d. 16-20
    e. More than 20

36. Which category below includes your age?

    a. 20 or younger
    b. 21-29
    c. 30-39
    d. 40-49
    e. 50-59
    f. 60 or older

37. What is the highest level of education you have completed?

    a. Less than high school degree
    b. High school degree or equivalent
    c. College diploma or trade school certificate
    d. University undergraduate degree
    e. University post-graduate degree
    f. Other (Please specify)

Appendix III

Interview Questions

1) What business area does your company fall into?
   Prompt: pipeline transmission, gas production, oil production, exploration, consulting/contracting

2) What is your primary province of operations (BC, Alberta, Sask.)?

3) Did you complete our survey that was distributed in March 2014?

4) **Producers Only:** In our survey, respondents who were producers said they did not think that their operations or infrastructure would be affected by a change in severe weather events. What do you think might be the reason for this?

5) Does your company make a concerted effort to prepare for climate variability or extreme weather events?
   Prompts: such as flooding, wildfire, invasive plant migration (reclamation)

6) In our survey, many respondents listed operational cost and design cost increases as the top risk factors related to climate variability and extreme weather events and the least concern was social license. Do you agree with this? What other risks are there? In your opinion, what could be the magnitude of these cost impacts? Do you think that it is more cost effective to be proactive than to have reactive strategies in place (e.g., insurance)?
   Prompt: For costs is it in the $10K, $100K, $1M range?
   Prompt: Many cited the Calgary flooding in 2013 as an operational impact to corporate offices.

7) Are there activities that your company is currently implementing that could help with preparations for climate variability? Are they preventative or reactive strategies? Can you provide examples?
   Prompts: Design modifications (e.g., sprinklers systems for wild fires, road design), monitoring activities (e.g., pipeline, access infrastructure at water crossings), reductions in water use (to deal with drought conditions).

8) Our survey revealed that there can be provincial policy and regulatory requirements and also barriers related to implementing adaptation efforts such as inflexibility, and a slow turn around for regulatory approval. Has this been your experience in (BC, Alberta, Saskatchewan)? What types of policy and/or regulatory barriers have you experienced? What changes do you think would allow your business to be more adaptive?

9) In our survey, respondents listed things like better long and short term local forecasting and modeling as things that would help them better prepared for extreme weather events. Do you think this would help the industry be more resilient to climate variability?

10) Many respondents did not agree that there is a need to prepare for climate variability outside of the known extremes. What do you think can be done to help the industry be more resilient and proactive? What would a resilient industry look like?

11) The terminology that is often used by policy-makers is “climate change impacts” - do you feel this is a barrier to advancing the discussion on preparedness for extreme weather events?

Appendix IV

Survey comments received for all questions

Please refer to the survey questions when reviewing the comments received. For some questions, the provision of comments was optional. In addition, some survey respondents chose not to answer questions for which comments were required. The tables below include all comments received from all survey respondents.

Q5. Have you observed any weather events in your company's or your clients' geographic operating area in the past two years that you would consider as "extreme events?

Theme 1 – Flooding
Calgary Flood of 2013
Flood in Calgary
Calgary Floods
Calgary floods
Calgary flood
Calgary flood
Flooding in southern Alberta which has impacted pipeline infrastructure.
Significant flooding in SE Saskatchewan in 2011 (beyond two years ago) and significant flooding in southern Alberta in 2013. Were these events considered extreme? Not sure...
Floods, Fire
Theme 2 – Temperatures
Temperatures are getting colder over the last 5 years.
Extremely cold this winter. Temperatures around -40 deg C plus wind, making it seem effectively colder.
Theme 3 – Precipitation
Abnormally high snow pack in 2012/2013 winter.

Q8. Do you think that the extreme weather event(s) you observed is/are a result of a changing climate?

Theme 1 – General comments
Increased precipitation likely impacted by climate change.
Theme 2 – Difficult to link climate and weather
Cause and effect of specific weather events is difficult to attribute. Climate change is measured by the relative frequency to which extreme weather might be observed, not by individual events.
Connection between climate and weather is difficult to ascertain.
Could be a part of normal fluctuations in weather cycles, could be a pattern of extreme weather due to changing climate.
Not sure anyone can say with any reasonable certainty.
It is hard to put any one weather event in the context of climate change.

Theme 3 – Climate change doubters
It was the 50 year flood which will happen (again).
Scientific facts do not support climate change. This was just a once in 50 year event.
As we all know there is no climate warming as the United Nations Panel on Climate Change has stipulated after being found to have been cooking the books on the weather as being consistently warmer over the last numerous years (They have admitted to falsely showing a warming trend over the last 18 years). There has been no trend in the climate warming in Canada for over 300 years. The weather however has proven to CHANGE over the years from warming to cooling over and over again. www.forbes.com/.../ipcc-in-a-stew-how-they-cooked-their-latest-climate-...
We are in an ice age, so it's not surprising to see -40 deg C, or worse. The climate is constantly changing/evolving, so this is a bit of an irrelevant question.

Q9. Do you anticipate that there may be more frequent and/or severe weather events in the future than would have occurred without climate change?

The frequency of these events would be expected to increase if projections of climate change are accurate.
As per the findings of the Intergovernmental Panel on Climate Change Assessment Report, climate change will very likely lead to more severe weather conditions throughout western Canada.
I am not qualified to answer that kind of question. From what I have heard, this is a possibility.
The scientific proof has yet to validate the climate theorists. 2013 was predicted to be open water season in the Arctic when it fact it was the heaviest ice coverage in recent memory. 2013 was also supposed to be a heavy hurricane season, which did not materialize. However, the last 5 week cold snap in Calgary has been unusual. Are these normal 'aberrations' or is it evidence of climate change? Who knows for sure?
The real question is why there is a change of climate. Given the historical climate changes the greatest climate change risk is another ice age. Our best option is to use our financial resources to prepare for climate variations.
I don't know the science behind changing climate so I can't say if it is part of normal climate fluctuations or not.
Open ended - what time frame is "future"? and How can we attribute those events to changing climate?

Q13. What do you perceive to be some operational risk factors relating to a change in the frequency and severity of extreme weather events?

Other (please specify)

There is no significant change predicted or ongoing so there are no additional risk factors over industry norms.

Q14. What do you perceive to be some infrastructure risk factors relating to a change in the frequency and severity of extreme weather events?

Other (please specify)

This question addresses the extreme weather, which is the same question asked 100 years or ago

or 100 years from now, the effects will always be the same but as to a varying degree.
I do not see any risk factors relating to infrastructure.
No risk

Q15. Please describe specifically how you think such changes in temperature would impact your company's or your clients' <u>operations</u> in the future.

Theme 1 – Operational impacts
It would reduce the time available to conduct operations in the field and as a result of the compressed activity costs of services would rise.
More emergency response procedures and training will be required. Maybe more technology implemented to isolate the system in the event of extreme weather.
Increase focus on technology to extend the drilling season.
As an operator, we would require additional funds to monitor and risk manage our infrastructure. Future extreme weather events occurring as a result of changing temperatures would likely require the implementation of contingency plans, which would strain resources from traditional operations. Changing climate would also likely result in changes in localized demand use of natural gas, altering the flows required for pipeline transport.
Will need to adjust operating parameters accordingly.
We would have to change the timing of drilling, completion and pipeline projects around the freeze up and spring melt. The areas in which my company operators, have year around access. Spring melt it typically the only time we have reduced access. An early spring melt would cut our winter work short but may also allow us to get back to work sooner in the summer.
Shorter construction season would put stress on completing construction more quickly – potential for safety or environmental incidents, operating interruptions due to flooded sites and access roads, change in chemical use in pipelines due to changes in ground temperature.
We would have to adapt to changing breakup window or build all weather access
We operate in an area where permafrost is extensive. However, bedrock is at or near the surface so the loss of permafrost would not have too significant an impact. There may be areas where access could be affected by the loss of permafrost.
We have Northern operations - this could impact work schedules.
Shortened winter construction season could lead to project delays.
Challenging for exploration work where permanent infrastructure isn't in place
Seasons could be prolonged for Arctic shipping which would be a positive. Melting permafrost would make summer operations more difficult. There are pluses and minuses. Is the balance sheet in the red or black. Again, no one knows for certain.
Winter drilling is dependant on the timing of winter freeze up and/or spring melt. It currently is very variable and is expected to remain that way.
The change in temperatures would affect us on the decision making of where we sell the gas to make the most of it.
Theme 2: No expected impact
Operationally it should not affect the operations significantly
I am not sure of the effect it will have on south of the permafrost line
We are barely impacted at all by break-up or permafrost, so zero impact.
Expect no impact
Theme 3: Climate change doubters

If we observed changes in patterns for break up we would have to adjust. But a couple of years does not set a pattern.
The changing weather will continue changing. There is no trend in any direction. For example we are now seeing glaciers growing rather than retreating. The hole in the Ozone in the Antarctic has been now proved to be an optical illusion. The earth will change as it does from morning to night and from night through the day, these are natural phenomenon. The scientists know and understand this. It is the spin from the doomsayers (some scientists included in this as in Dr. Suzuki) who are trying to profit from the fear instillers. Check out the facts for yourself. Do not fall prey to the rhetoric.
Not at all Scientists anticipate, doesn't mean it will happen. Climate change is a continuum, is has happened continually throughout history with or without the help of humans
Depends on time frame; not sure whether there is a scientific certainty of climate change at this time; impact on Athabasca area unknown

Q16. Please describe specifically how you think such changes in temperature would impact your company's or your clients' <u>infrastructure</u> in the future.

Theme 1 – Infrastructure impacts
It will make construction of new assets more difficult.
Changes to topography and runoff, effective slop stability and any shifting in the ground can rupture or fracture a pipeline.
It may increase or decrease the windows when we can access some of the remote areas where access is only possible when the earth is frozen.
Potential restrict access into infrastructure.
More moisture or extreme cold weather could have significant cost impacts, however if warmer winters then less cost and more reliability
Flooding of infrastructure.
Possible upgrade to roads
If temperatures rise and permafrost diminishes, the cost of infrastructure installation would likely decrease and likewise would the operating costs
This could impact machinery, roads.
Redesign required - different types of infrastructure. Long term Env Canada forecasts increased precipitation in northern Alberta and decreases in the south. If building in wetter areas where roads, pads, etc are already elevated, the amount of elevation may increase resulting in increased demand for fill, changes to design or challenges accessing resource
It would make Arctic operations more manageable but permafrost activities more difficult. Is our company better off or worse off on balance? Who knows.
Pipeline connection of wells would become more important as trucking would be limited for a few months of the year.
Theme 2 – No expected impact
Business as usual. Pay attention to the fact that it will be dark at night and light during the day. That the nights will cool off and the days will warm up.
Infrastructure is already designed for extreme weather conditions, so little change is required.
Localized temperatures will not likely significantly impact infrastructure directly.

Zero impact.
Near future minimal
No different than what is currently occurring
None
Theme 3 – Climate change doubters
Difficult to put significant capital into overdressing for temporary or occasional events
Not at all. See above "Scientists anticipate, doesn't mean it will happen. Climate change is a continuum, is has happened continually throughout history with or without the help of humans" (*copied from question 15*)

Q17. Please describe specifically how you think that such changes to precipitation patterns would impact your company's or your clients' <u>operations</u> in the future.

Theme 1 – Operational impacts
Construction of facilities should in all cases be commenced after the water levels have been studied and the contractor/operator is assured that they are above the flood plane.
It would reduce the time available to conduct operations in the field and as a result of the compressed activity costs of services would rise.
More maintenance on infrastructure.
Increased focus on storm water collection (already a requirement) Potential for production shut-in / impediment in flood prone regions
Increases in winter operation may make operations more challenging (e.g. driving to remote stations in periods of snowfalls). Operational costs would likely increase to respond to precipitation events.
Access to water More strict pump-off requirements More strict groundwater monitoring requirements
Higher snow fall could impact access to sites and increase snow removal costs. Larger snow pack could mean a longer spring melt which could delay projects.
More snow or rain will impact the transportation. Unless a huge deluge occurs the plant should not be affected too much
Access to wells, sites could be cut off temporarily or permanently.
Could cause seasonal disruption similar to breakup, sometimes happens now and in the past
Lack of water for industrial processes.
We need to more prudent when we think about the operational schedule.
It might effect oil sands operations, if they used fresh water but increasingly most aren't, so probably no impact.
Increased water management, storage, treatment, etc --> increased cost, space, etc
Theme 2 – Don’t know
don't know because our activities are exploration related so are short term in nature and without any permanence
Theme 3 – No expected impacts
Not at all
Should not affect our operations significantly.
Zero impact.

None
Minimal in near future; if real it would depend on water shed in region wher we operate
Right now, we deal with various levels of rain/snow. going forward, we expect variability
None

Q18. Please describe specifically how you think that such changes to precipitation patterns would impact your company's or your clients' <u>infrastructure</u> in the future.

Theme 1 – Infrastructure Impacts
As above, understand the flood plan and construct accordingly.
Pipeline connection of wells would become more important as trucking would be limited for a few months of the year.
Changes to topography and runoff, effective slop stability and any shifting in the ground can rupture or fracture a pipeline.
Potential for production shut-in / impediment in flood prone regions
Increases in run-off may lead to increased levels of erosion of watercourse crossings, causing increased amounts of pipeline exposure. Some above ground facilities may become flooded over periods of time, requiring additional storm water design.
Access to water Design implications for drainage
Roads and drainage would be the most significant issues
Floods can often ruin roads and bridges.
It would affect the operational schedule of our infrastructures as well.
Could require infrastructure upgrades
Long term Env Canada forecasts increased precipitation in northern Alberta and decreases in the south. If building in wetter areas where roads, pads, etc are already elevated, the amount of elevation may increase resulting in increased demand for fill, changes to design or challenges accessing resource
Theme 2 – No expected Impact
Not at all
None
Zero impact
None
Same as what happens now
None
Minimal in near future; if real it would depend on watershed in region where we operate
Theme 3 – Don't know
Don't know because we are exploring for oil and gas in an area that has virtually no infrastructure.

Q20. Please describe specifically how you think that these natural process changes would impact your company's or your clients' <u>operations</u> in the future.

Theme 1 – Operational impacts
Again, increased inspection will be required to monitor local geotechnical changes (e.g. landslides

leading to failure of transmission pipeline assets).
Access to sites could decrease
Forest fires would cause operational disruption and possible damage
Planning for fire and potential for evacuation of facilities

Q21. Please describe specifically how you think that these natural process changes would impact your company's or your clients' infrastructure in the future.

Theme 1 – Infrastructure impacts
Changes occurring as a result of ecological processes include increased exposure and/or failure of pipeline infrastructure. Additional capital expenditures for mitigation and/or replacement may be required.
Damage due to fires and flooding.
Our infrastructure is very limited so some damage could occur

Q23. Does your company or your client currently have a strategy or strategies (e.g., operational, insurance, engineering design, planning) to prepare for a changing climate?

Theme 1 - Strategies
Insurance and engineering design
On a macro level
Plans are developed to install additional mitigations and protections for newly installed infrastructure.
Not major, but we plan for downtime, which could be weather related
Theme 2 – Climate change doubters
The climate will change but there is no trend. Be careful on which scientists you are looking to for insight!
Climate change has happened throughout history, including before man. The majority of the influence is not man caused nor can it be man controlled.
Not necessary. These changes will be evolutionary, not revolutionary, and are a long ways in to the future.

Q25. How easy to existing government policies or standards make it for your company or your client to modify management practices to adapt to a changing climate?

Modifications to facilities in response to these risks require regulatory approval processes that can be lengthy.
Government policies and standards are slow to change and often inflexible. Regulators infrequently meet to discuss common strategies. It is often difficult to obtain regulatory approval to execute programs and projects based on protecting infrastructure from climate change.
Unknown - there is no need to adapt instantaneously to a potentially "changing climate" in the future.
Don't know
No comment

Q26. What level of effect would a changing climate have on your company's or your clients' ability to meet current government regulations and policies?

Theme 1 – Impact
Pipelines have a regulatory requirement to maintain a certain depth of cover. Climate change will likely make it difficult to maintain the depth of cover on a portion of our pipeline assets
Theme 2 – Don't know
Unknown
Theme 3 – Climate change doubters
Current regulations must be met and are enforceable under the law. A changing climate has no impact on the requirement to meet current regulations.
There is no trend in the weather patterns and as mentioned the weather does and will change going forward.

Q27. Existing government policies or standards create barriers to climate change adaptation.

The Government must stay alert and be knowledgeable of the fact that the climate does and will continue to change. They must understand that there is no long term trend. They should not waste taxpayers money because it is popular. Fads should not be used as a basis for forming policy.
Existing policies and standards are inflexible; many of the adaption techniques require a degree of regulatory flexibility based on site-specific considerations.
Some do, some don't. Some of the tech funds spur innovation. Some of the prescriptive regulations stifle innovation.

Q28. If you had to make an operational or environmental decision regarding adaptation to a changing climate what types of information would you need to help inform that decision (e.g., climate change projections, monitoring data, predictive models)?

Theme 1 – Needed information
Climate change projections specific to local areas were operations occur. Monitoring data for local areas. Not general climate change data.
Risk maps
Monitoring data, predictive models, cost alternatives, risk analysis.
Historical data Predictive models Emerging technology
Climate Change projections, predictive models, general adaptation strategies and potential costs
Monitoring data and short term predictors
Historical trends and predictive modelling at a local/regional level
Climate change specific to operational region; scientific basis and facts/trends
I would start by doing a risk assessment of the specific operation to determine where the vulnerabilities reside and then assess my data needs after that.
Precipitation and temperature forecasts
Monitoring data compared to historical trends
Theme 2 – Don't know
Not sure

Unsure
Theme 3 – Climate change doubters
Understand the source of climate change phases. Study solar activity and learn from it.
I would not believe any climate change predictions in the current politically charged environment. There are lots of arguments but not enough facts. I believe that climate change is occurring but don't believe that we know the full cause and we certainly have no idea of the proper course of action. If we destroy our economy in the vain attempt to turn back the clock on. *(Answer cuts off here).*
An honest presentation of the facts instead of the presentation of concepts by parties supporting a cause.
Most climate models are inaccurate from what I have observed. there's not enough unbiased view on this topic.