

Human Health Risk Assessment of Oil and Gas Activity in Northeastern British Columbia



June 2015

Presented by Bart Koppe, Intrinsik Inc.

Overview of Project

- **Phase 1 HHRA.** Identification of health concerns relating to Oil and Gas Development in NE BC. Completed in 2012 by the Fraser Basin Council.
- **Phase 2 HHRA.** Assessment of the potential health risks in NE BC (with emphasis on chemical emissions). Completed in 2014 by Intrinsik.
- **Phase 3 HHRA.** Communication of findings.

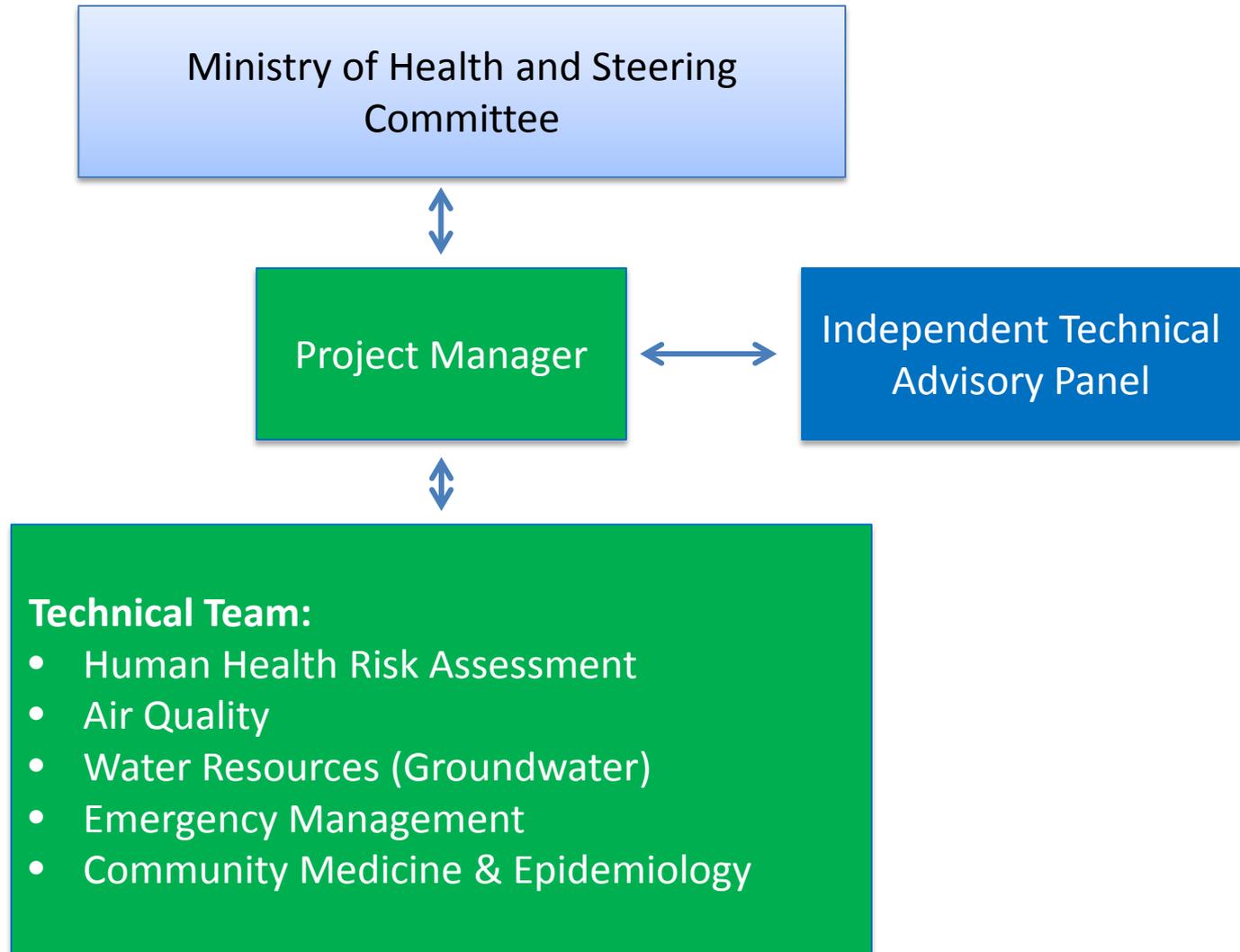
Goals of Phase 2

1. To assess the health risks associated with oil and gas activity in NE BC
2. Where appropriate, provide recommendations to address potential health risks

Phase 2

- Scope of Work determined by Ministry of Health and Steering Committee
- Focus on chemical related risks
- Intrinsik awarded contract after a public, competitive bidding process
- Study team of independent consultants, led by Intrinsik

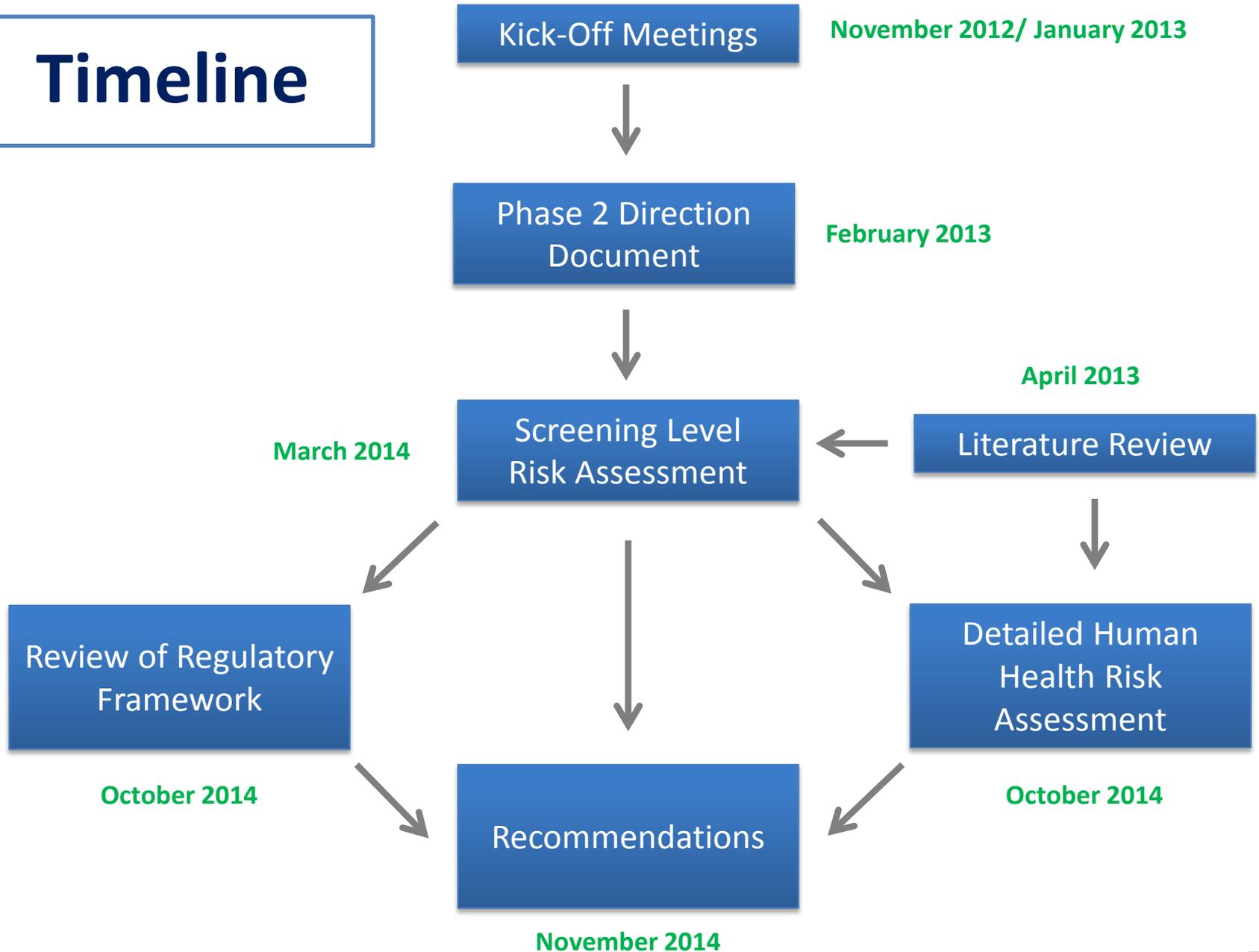
Study Team



Detailed Scope of work for Phase 2

- Developed step-wise:
 - Scope defined by Steering Committee
 - Phase 1 findings
(Fraser Basin Council report)
 - Input from Ministry of Health and Steering Committee
 - Input from Advisory Panel
 - Knowledge gained during each deliverable
 - Professional judgment

Timeline



Phase 2 – Document Control

- All reports reviewed by government representatives and technical advisory panel
- Intrinsik study team had final say over the content of the reports
- All data managed and stored by Intrinsik team
- Results available to industry at the same time as the public (March 2015)

What couldn't be included

- Social-related health impacts of oil and gas activity
- 'Cause-Effect' type analysis of health conditions
- Future oil and gas activities
- Water quantity and use issues
- Every possible source of oil and gas emissions within NE BC:
 - Variability of emissions from different sources
 - Large geographical area
 - Data availability and quality

How were oil and gas sources chosen for the Phase 2 HHRA?

- Screening Level Risk Assessment
- **50** categories of possible releases (air and water):
 - Accidents (blow out, pipeline breaks/leaks, spills)
 - Fracking/drilling specific issues
 - Flaring and malfunctions
 - Routine operations
 - Historical contamination (“legacy issues”)
- Ranking based on potential risk, impact to population and how large the scale of impact could be

Screening Level Risk Assessment

- Sources posing *greatest risk to the majority of individuals* selected for detailed HHRA:
 - **Continuous** release sources and production facilities
 - Included: gas plants, compressors, batteries, routine flaring, storage and handling, “fugitive” emissions
- Sources not selected for HHRA carried into regulatory review

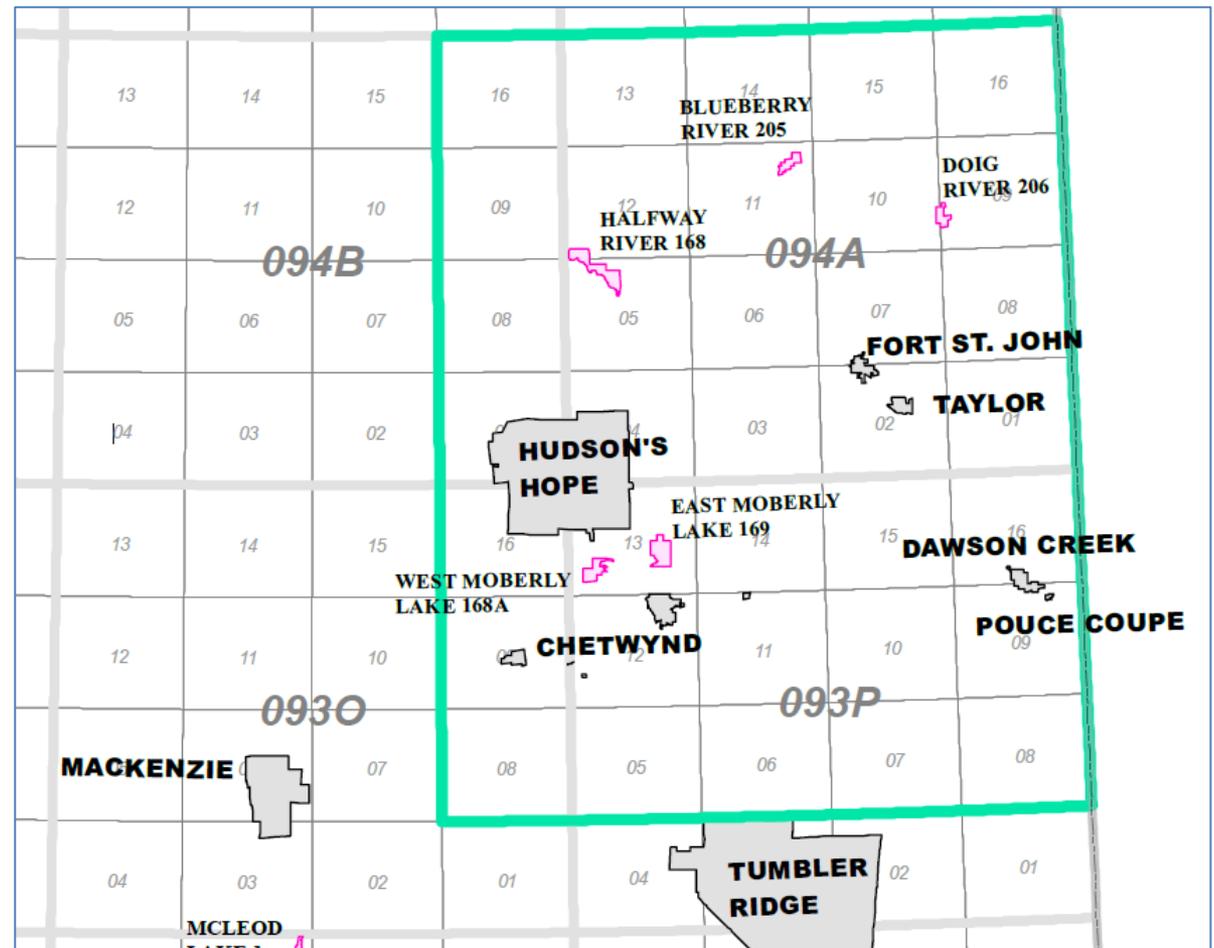
HHRA Study Area

Area:

~175 x 150 km

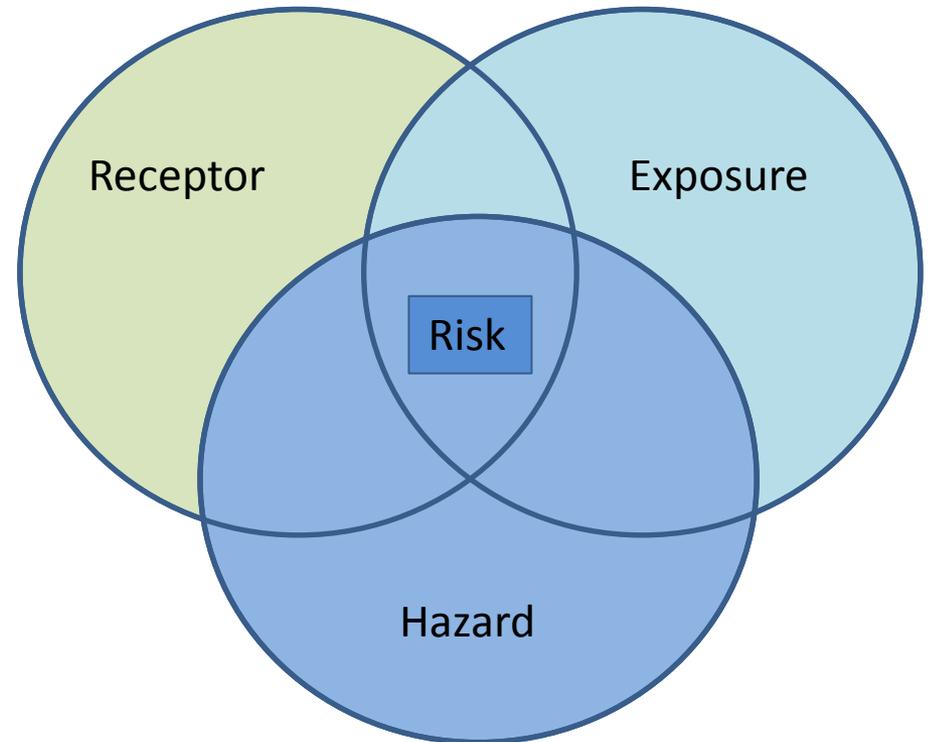
Includes:

- Highest population density
- Highest emission density
- Greatest variety of emission sources
- First Nations
- Represents worst-case scenario



What is an HHRA?

- Scientific study which provides an evaluation of potential health risks to people from exposure to chemical substances
- Risk depends on degree of exposure to a chemical as well as its toxicity
- Developed by regulatory agencies (Health Canada, US EPA, World Health Organization)
- “When in doubt, err on the side of caution”



How do we calculate risk?

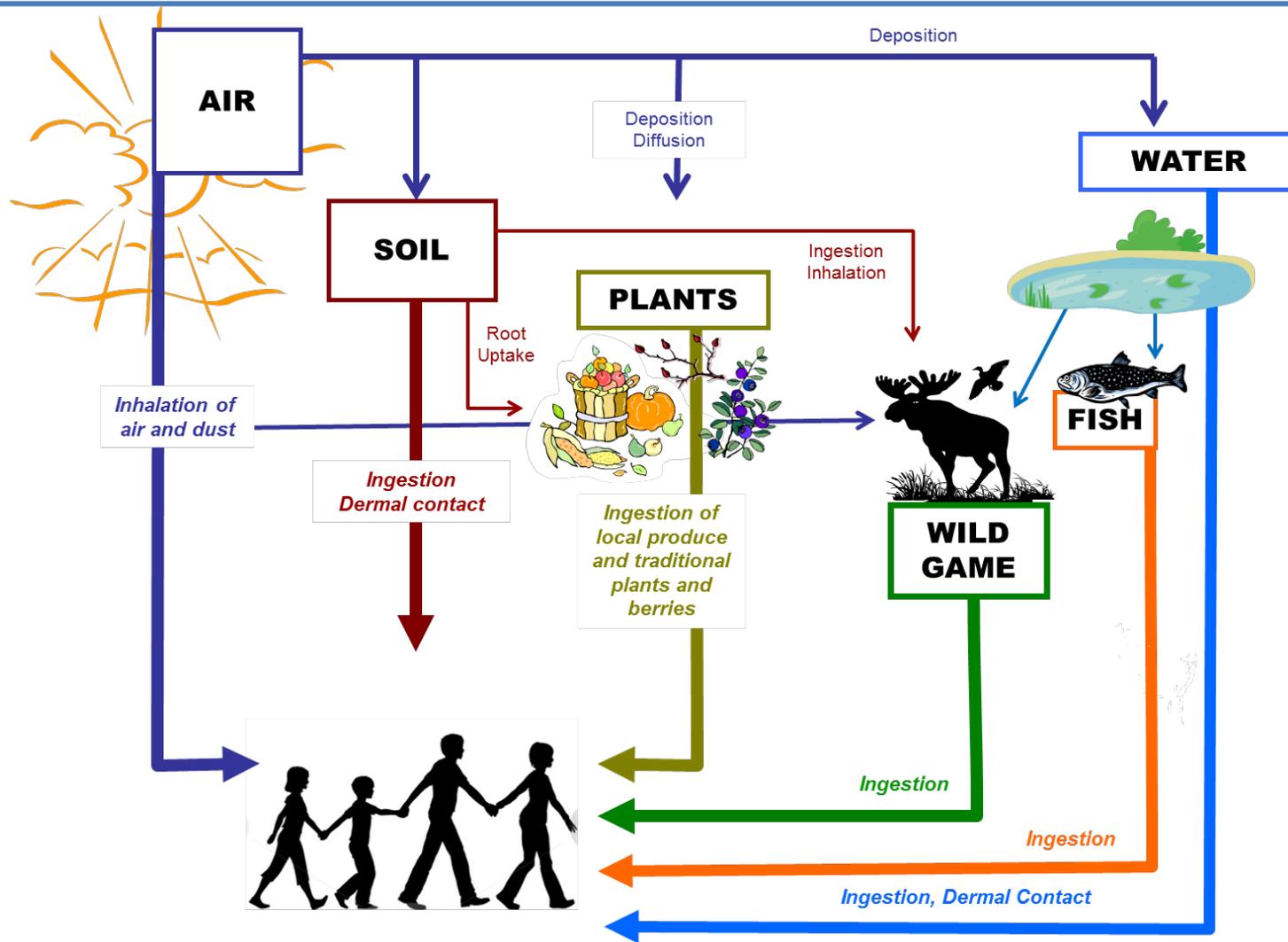
$$\text{Risk Ratio} = \frac{\text{Predicted Exposure}}{\text{Exposure Limit}}$$

- Predicted exposure can be in the form of an air concentration or daily dose
- Exposure limits are developed by regulatory and scientific agencies that recommend a “safe level of exposure” for a chemical
- Interpretation of risks:
 - Risk ratio ≤ 1.0 – associated with low health risks, even for sensitive individuals
 - Risk ratio > 1.0 – suggests an elevated level of health risk, the significance of which must be balanced against the degree of conservatism incorporated into the HHRA

How do we calculate exposure?

- Ground level air concentrations are predicted using an air dispersion model
- Predicted air concentrations are based on reported air emissions across the study area
- Measured concentrations were only used for comparisons against predicted values

HHRA Model



Two Assessment Scenarios

- **Oil and Gas Scenario:** includes all ongoing air emissions from gas processing plants and various production facilities (e.g., compressor stations, fugitive emissions from tank storage)
- **Cumulative Scenario:** includes air emissions from O&G, other industries, transportation and community sources

How were Communities Included?

- 28 communities evaluated individually
- ‘Worst-case’ for entire study area also examined
- Different behavioural assumptions considered:
 - Traditional foods and lifestyle (hunting, fishing, medicinal plants)
 - Local country foods (beef, poultry, dairy, vegetables)
 - Residents (garden produce)
- All age groups
(including children and infants)

Fort St. John

- Largest community in study area
- Various oil and gas and other emission sources (e.g., traffic, industry)
- Focused on residential exposure:
 - Inhalation of air (short and long-term)
 - Contact with soil, surface water (swimming), consumption of garden produce, wild berries and fish
- **Results:**
 - Short- and long-term inhalation risks from oil and gas sources are **low**
 - **Low** potential for irritant effects from all sources combined
 - Risks from other pathways are **very low**

Dawson Creek

- Second largest community in study area
- Various oil and gas and other emission sources
- Like Fort St. John, focused on residential exposure:
 - Inhalation of air (short and long-term)
 - Contact with soil, surface water (swimming), consumption of garden produce, wild berries and fish
- **Results:**
 - Short- and long-term inhalation risks from oil and gas sources are **low**
 - **Low** potential for irritant effects from all sources combined
 - Risks from other pathways are **very low**

Chetwynd

- Smaller community potentially influenced by oil and gas and agricultural activities and community sources
- Inhalation (short- and long-term) and consumption of local country foods
- **Results:**
 - Short- and long-term inhalation risks from oil and gas sources are **low**
 - **Low** potential for irritant effects from all sources combined
 - Risks from other pathways are **very low**

Hudson's Hope

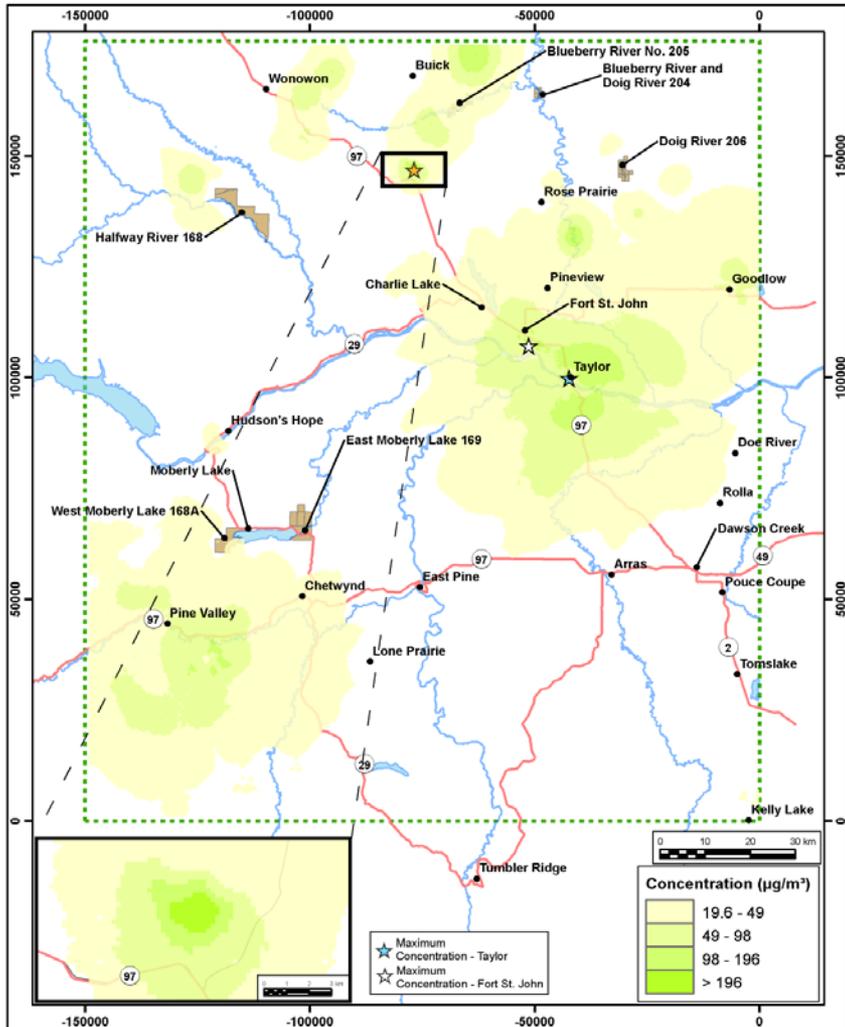
- Smaller community potentially influenced by oil and gas and agricultural activities and community sources
- Inhalation (short- and long-term) and consumption of local country foods
- **Results:**
 - Short- and long-term inhalation risks from oil and gas sources are **low**
 - **Low** potential for irritant effects from all sources combined
 - Risks from other pathways are **very low**

Taylor

- Smaller community potentially influenced by oil and gas and agricultural activities and community sources
- Inhalation (short- and long-term) and consumption of local country foods
- **Results:**
 - Short- and long-term inhalation risks from oil and gas sources **low**
 - **Low** potential for irritant effects from all sources combined
 - Risks from other pathways are very **low**
- H₂S

Inhalation Results for Study Area

- Findings of interest for the following air contaminants:
 - Nitrogen Dioxide (NO₂)
 - Fine Particulate Matter (PM_{2.5})
 - Sulphur Dioxide (SO₂)
 - Acrolein
 - Formaldehyde
- Factors Considered:
 - Concentrations relative to 'effect thresholds'
 - How often concentrations might be above guidelines
 - Is effect localized or widespread?
 - What is the cause of the risk (O&G, background, specific facilities?)



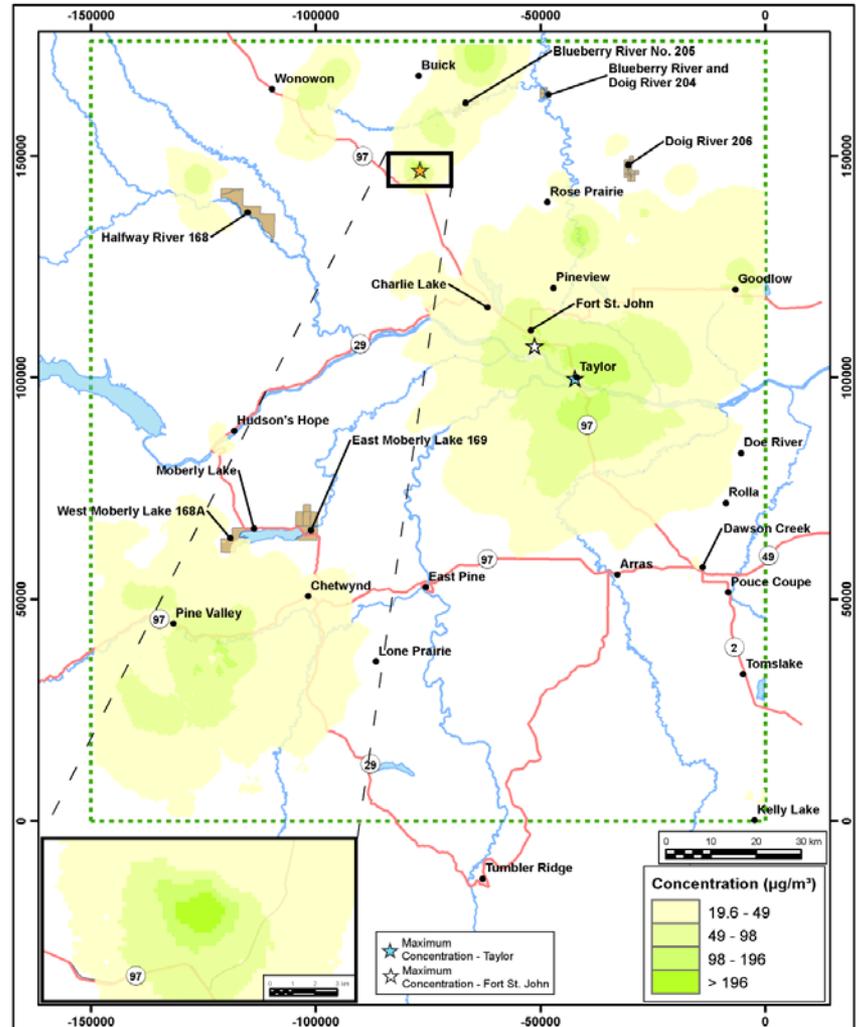
SO₂ - 1hr Averaging Period (99th Perc.)
Oil and Gas Activities Only

★ Maximum Concentration
● Communities
— Highways
— Streets
 Study Area Extent
■ First Nations
— Waterbody

True North Drawn by: NBN | Isoleth: 9
 Approx. Scale: 1:1,000,000 Date Revised: Aug. 8, 2014
 Project #1202326

Footnotes from Geobase Aboriginal lands, 2010
Waterbodies from Geobase/Aboriginal lands, 2010
Projections: Modified Lambert Conformal

BC Ministry of Health, BC, Canada



SO₂ - 1hr Averaging Period (99th Perc.)
Oil and Gas Activities and Background Sources

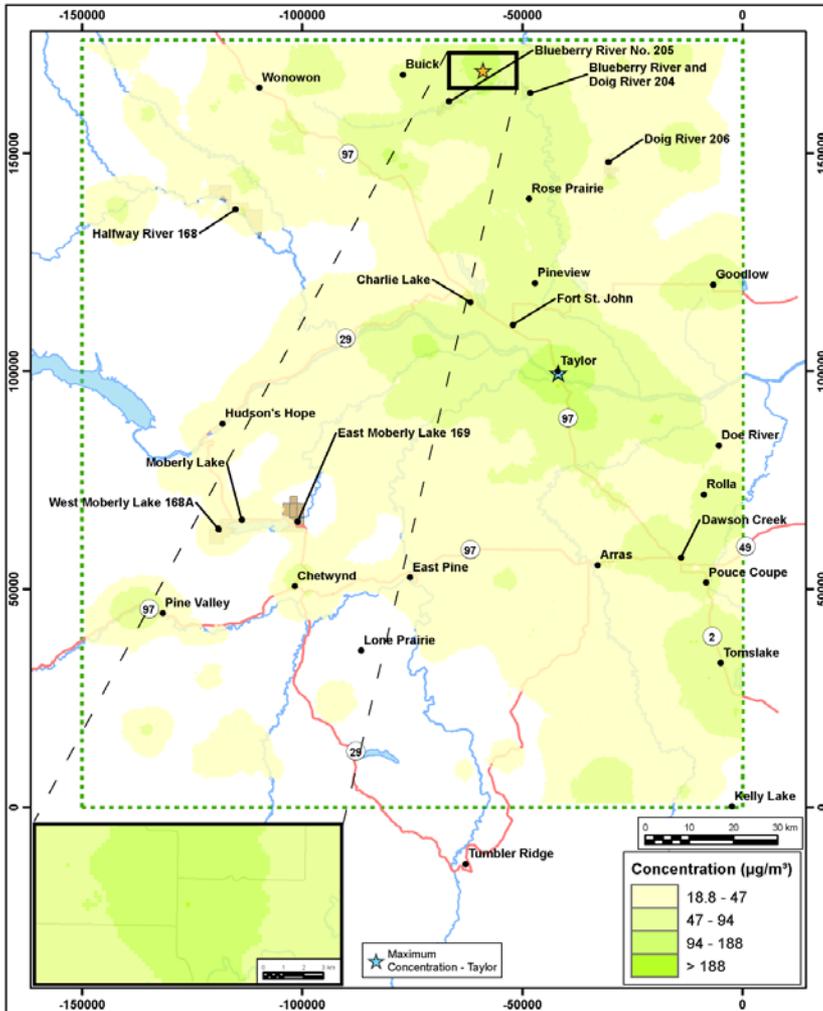
★ Maximum Concentration
● Communities
— Highways
— Streets
 Study Area Extent
■ First Nations
— Waterbody

True North Drawn by: NBN | Isoleth: 10
 Approx. Scale: 1:1,000,000 Date Revised: Aug. 8, 2014
 Project #1202326

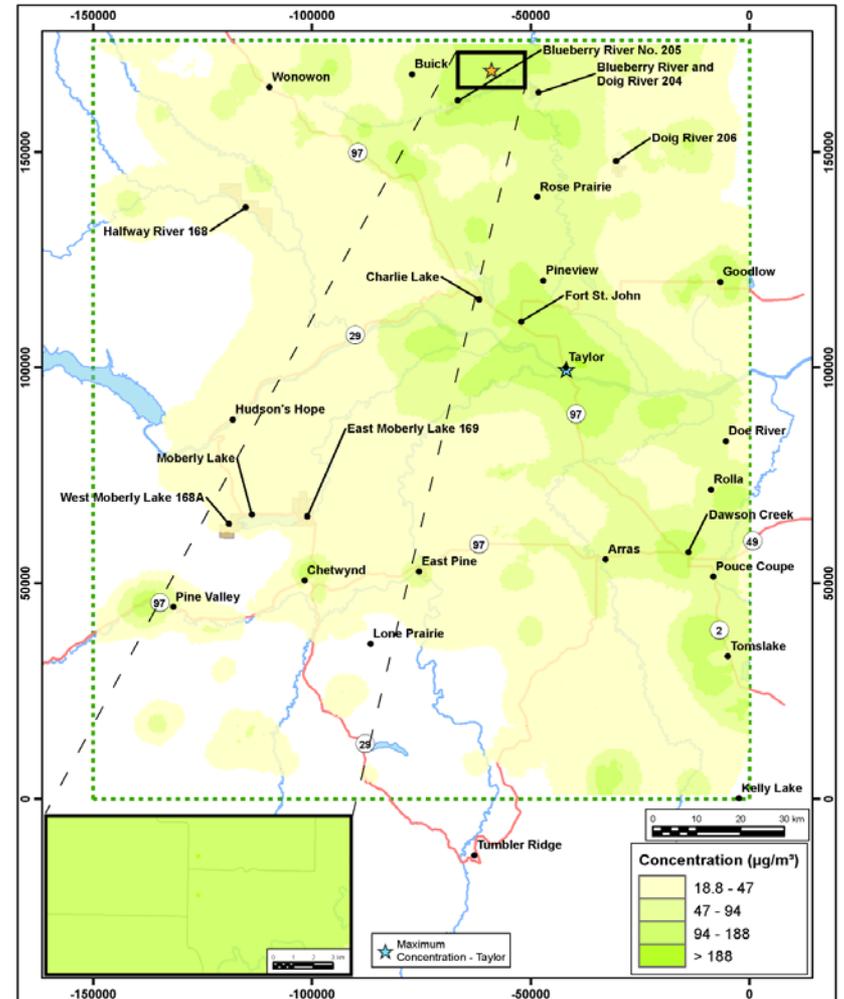
Footnotes from Geobase Aboriginal lands, 2010
Waterbodies from Geobase/Aboriginal lands, 2010
Projections: Modified Lambert Conformal

BC Ministry of Health, BC, Canada

Sulphur Dioxide (SO₂), Hourly

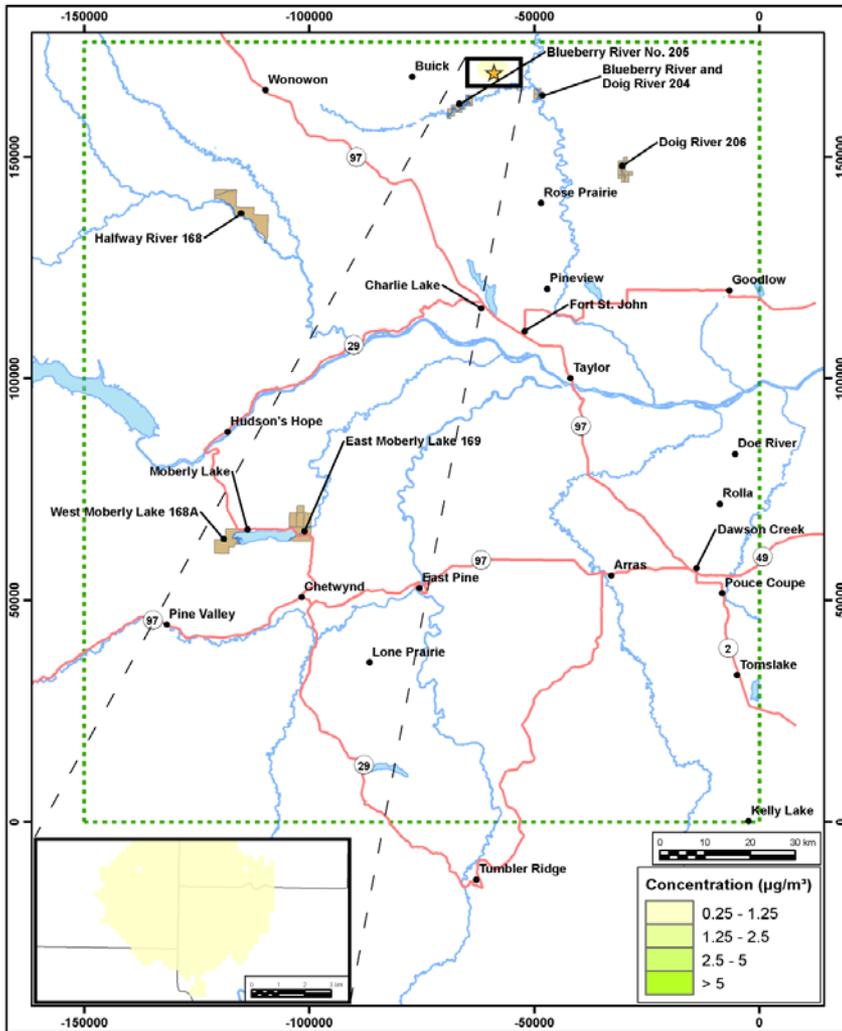


True North
 Drawn by: NBN
 Isopleth: 5
 Approx. Scale: 1:1,000,000
 Date Revised: Aug. 8, 2014
 RWDI
 BC Ministry of Health, BC, Canada
 Project #1202326



True North
 Drawn by: NBN
 Isopleth: 6
 Approx. Scale: 1:1,000,000
 Date Revised: Aug. 8, 2014
 RWDI
 BC Ministry of Health, BC, Canada
 Project #1202326

Nitrogen Dioxide (NO₂), Hourly

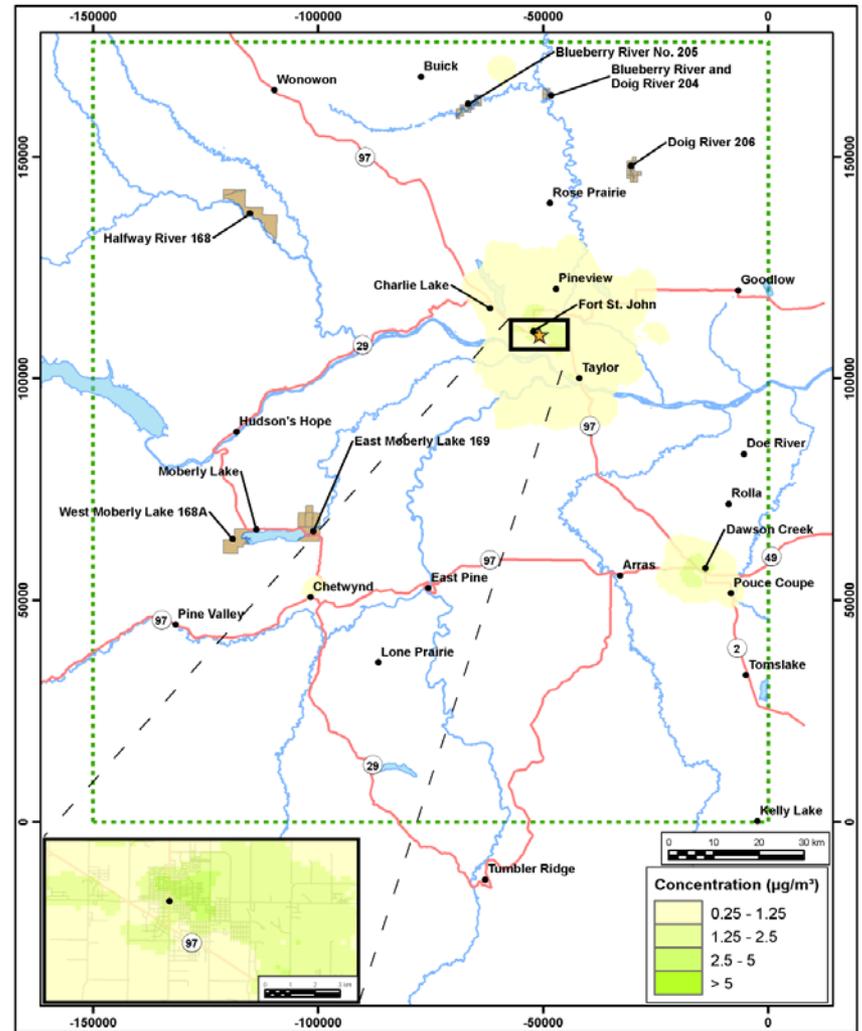


Acrolein - 1hr Averaging Period
Oil and Gas Activities Only

★ Maximum Concentration
● Communities
— Highways
— Streets
 Study Area Extent
 First Nations
 Waterbody

True North Drawn by: NBN | Isopleth: 1
 Approx. Scale: 1:1,000,000
 Date Revised: Aug. 8, 2014

BC Ministry of Health, B.C. Canada Project #1202326



Acrolein - 1hr Averaging Period
Oil and Gas Activities and Background Sources

★ Maximum Concentration
● Communities
— Highways
— Streets
 Study Area Extent
 First Nations
 Waterbody

True North Drawn by: NBN | Isopleth: 2
 Approx. Scale: 1:1,000,000
 Date Revised: Aug. 8, 2014

BC Ministry of Health, B.C. Canada Project #1202326

Acrolein, Hourly

Conclusion

The overall findings of the detailed HHRA suggest that the public health risks associated with oil and gas activity in NE BC are low

Uncertainties and data gaps described in the Screening Level Risk Assessment and the detailed Human Health Risk Assessment



Recommendations

Review of Regulatory Framework

Objectives: to identify where current regulations in BC are protective of public health and identify areas for improvement

Review considered:

- Relevant regulations, guidelines, directives
- Industry best management practices
- Sources not included in detailed risk assessment

Focus: [1] water quality, [2] air quality and [3] safety issues associated with **both** normal operations and accidental releases

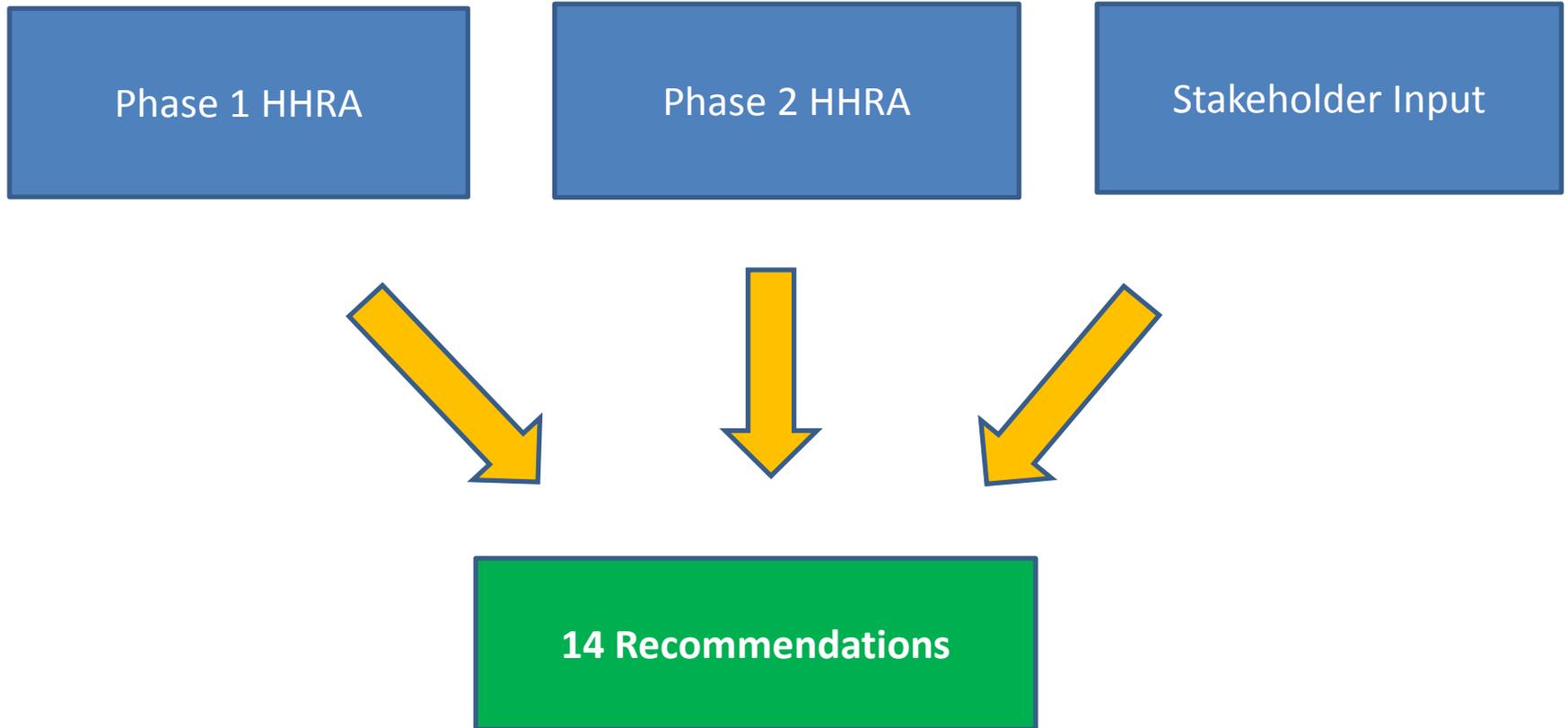
Key Findings of the Regulatory Review

- In general, existing framework is extensive and broadly protective of health
- BC regulations were generally similar to the measures that have been adopted in other jurisdictions and in line with applicable best management practices
- Some areas for improvement identified in the review



Recommendations

Recommendations Report



Recommendations - Public Safety

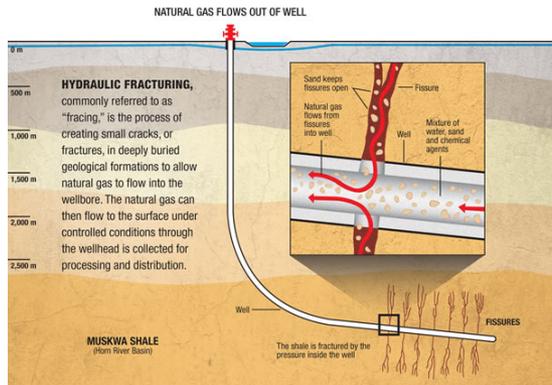
- **Recommendation 1:** The current tools used in calculating Emergency Planning Zones (EPZ) should be updated as they may not reflect current best practices
- **Recommendation 2:** Should consider the implementation of a *reciprocal agreement framework for setbacks* between the oil and gas industry and BC's communities
(prevent communities from encroaching on O&G facilities)



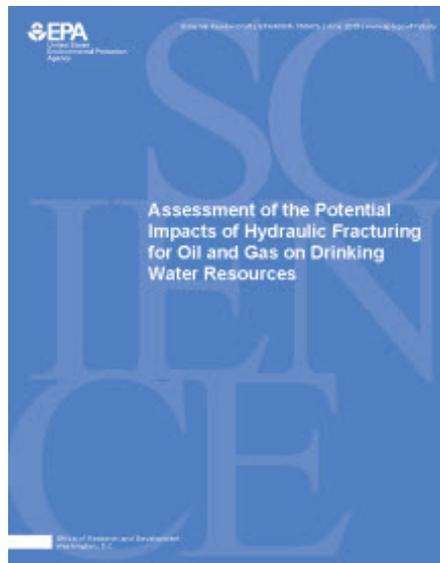
Recommendations - Flaring, venting and fugitive emissions

- **Recommendation 3:** The application of the existing BC ambient air quality objectives could be more transparent and defined in relation to flaring, venting and fugitive emissions
(objectives not specifically mentioned in regulations)

Recommendations - Hydraulic Fracturing



Source: BC Oil and Gas Commission



- **Recommendation 4:** Consider requiring *baseline, pre-drilling* groundwater testing to allow for 'before and after' comparisons. Testing practices and results could be made public.
- **Recommendation 5:** Consider providing more information about fracture fluids used to aid authorities and health professionals (including proprietary 'industry secret' ingredients)
(for the protection of health in emergency situations, diagnosis and treatment)

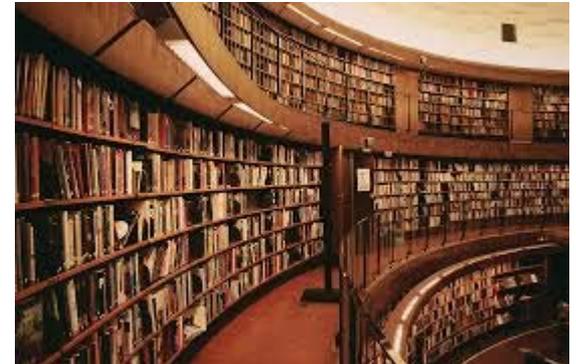
Recommendations - Legacy Sites

- **Recommendation 6:** Existing government tools and systems for ranking oil and gas sites and evaluating contaminated sites should be used together to help manage risk at legacy sites that were used by the O&G industry in the past
- BC Ministry of the Environment and the Oil and Gas Commission already have management plan for these sites
- Generally, the BC contaminated sites assessment program is considered to be effective in managing identified sites

Recommendations - Information management

Recommendation 7: Evaluate and improve existing databases and systems for managing permits, facility information, wells and flare data, make the systems easier to access and use

- Some databases are public, others are restricted
- Databases could be difficult to use
- Several databanks exist but many do not connect
- Opportunity for improving efficiency



Recommendations - Environmental monitoring

Recommendation 8: Consider using the information from the HHRA to help:

- Identify the location of future monitors
- Select the types of pollutants to be monitored.

(several data gaps in the existing monitoring programs were identified)

Recommendation 9: The conclusions of the HHRA should be re-visited once more measured data are available



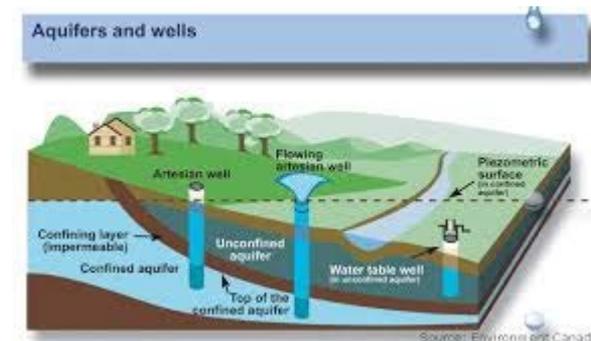
Recommendations - Environmental monitoring

Recommendation 10: Existing aquifer mapping should be expanded in the region to help enhance the protection of groundwater resources

(mapping could identify wells close to existing or historical O&G facilities)

Recommendation 11: Additional study of groundwater and surface water interactions with shallow aquifers and local groundwater flow conditions should be completed

(closer examination of how groundwater resources are 'linked' to surface water (rivers, lakes, ponds))



Recommendations - Environmental monitoring

Recommendation 12: Consider the overall goals of the existing environmental monitoring programs for soil, water and biota with respect to quality, quantity, and transparency

(is the existing system providing the necessary information for evaluating human health?)

Recommendations - Health surveillance

Recommendation 13: 'Tailoring' of health surveillance to identify whether or not there are differences in disease rates in areas identified in the HHRA with the highest predicted air concentrations (e.g. Fort St. John)

(may help identify any linkages between existing health conditions and existing air quality)

Recommendations - Standards Development

BC's Air Quality Objectives

Recommendation 14: The existing Ambient Air Quality Objectives should be reviewed and updated

(this is in progress as of 2014)

Contaminant	Avg. Period	Level	Air Quality Objective		Date Adopted	Date Last Reviewed	Source
			$\mu\text{g}/\text{m}^3$	ppb			
Carbon Monoxide (CO)	1 hour	A	14,300	13,000	1975	-	PCOs for Food-processing, Agriculturally Orientated, and Other Misc. Industries
		B	28,000	25,000			
		C	35,000	30,000			
	8 hour	A	5,500	5,000	1975	-	PCOs for Food-processing, Agriculturally Orientated, and Other Misc. Industries
		B	11,000	10,000			
		C	14,300	13,000			
Formaldehyde ^b	1 hour	Action Episode	60	50	2005	-	Provincial AQO
Nitrogen Dioxide (NO ₂)	1 hour	MAL	400	213	1975	1989	NAAQO
		MTL	1000	532	1978		
	24 hour	MAL	200	106	1975		
		MTL	300	160	1978		
	annual	MDL	60	32	1975		
MAL		100	53				
Ozone (O ₃)	1 hour	MDL	100	51	1974	1989	NAAQO
		MAL	160	82	1974		
		MTL	300	153	1978		
	8 hour	CAAQS	123	63	2013	-	CAAQS
	24 hour	MDL	30	15	1974	1989	NAAQO
		MAL	50	26	1974		
	Annual	MAL	30	15	1974		

Thank you!