Hydraulic Fracturing:

Working Together to Address New Challenges, A Canadian Story

BC Oil & Gas COMMISSION

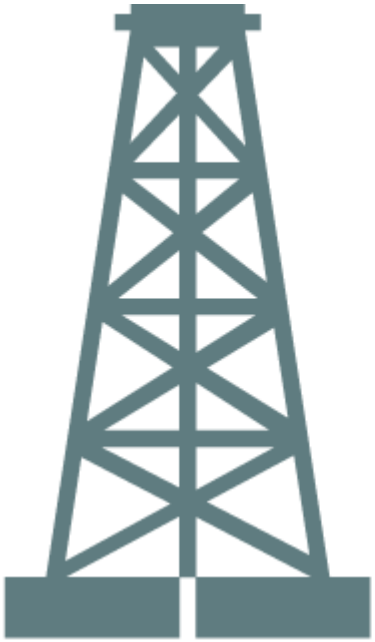
Alberta Energy Regulator

DACC
Drilling and Completion Committee

PSAC
working energy

Hydraulic Fracturing
Working Together to Address New Challenges: A Canadian Story

Stu Venables
Senior Petroleum Geologist
BC Oil and Gas Commission



Water Used for Hydraulic Fracturing

2012

419 wells

7,137,429 m^3

2013*

433 wells

5,341,635 m^3

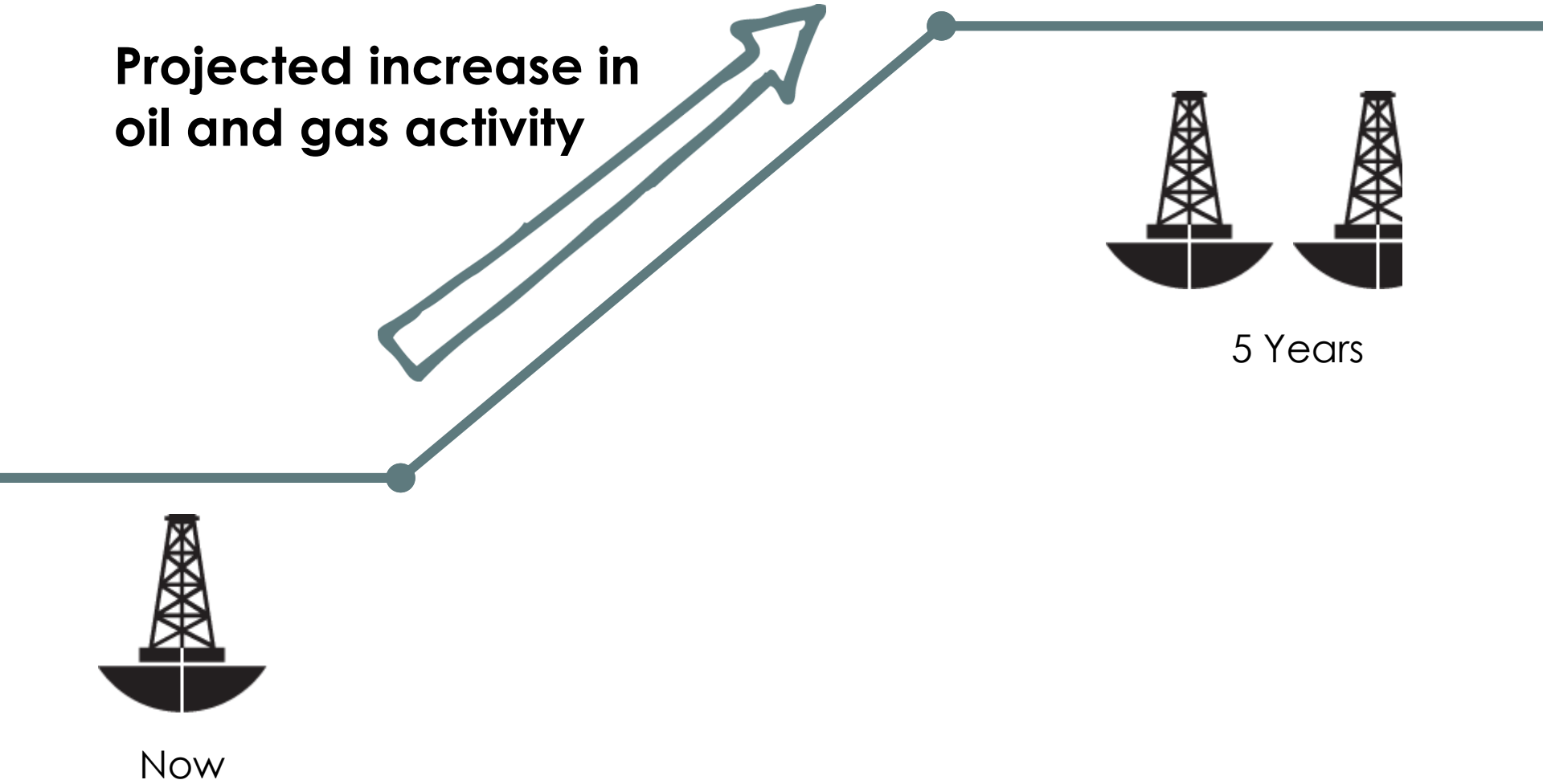
US Conversion

7,137,429m^3 = 15.7 x 10^8 Imp Gallons

5,341,635 m^3 = 11.8 x10^8 Imp. Gallons

*unaudited

Projected increase in oil and gas activity



Rising Water Needs

How have we responded with proactive water management?

Changes to water licensing approvals and legislation

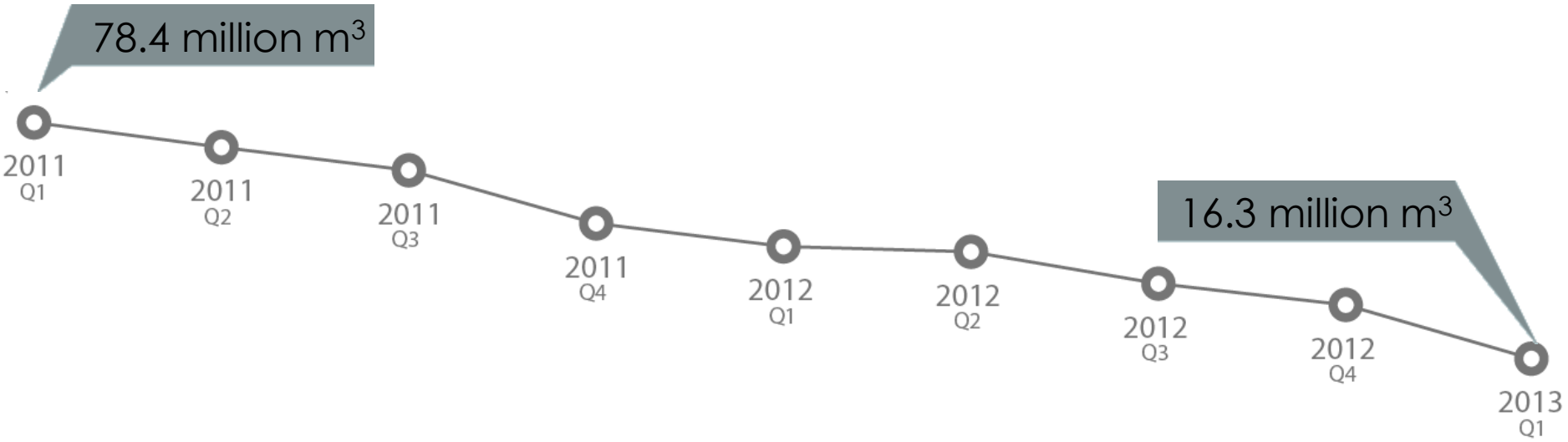
Water Licence Application

- water supply/demand analysis
- rationale supporting volume of water requested
- hydrology of the applicable water sources

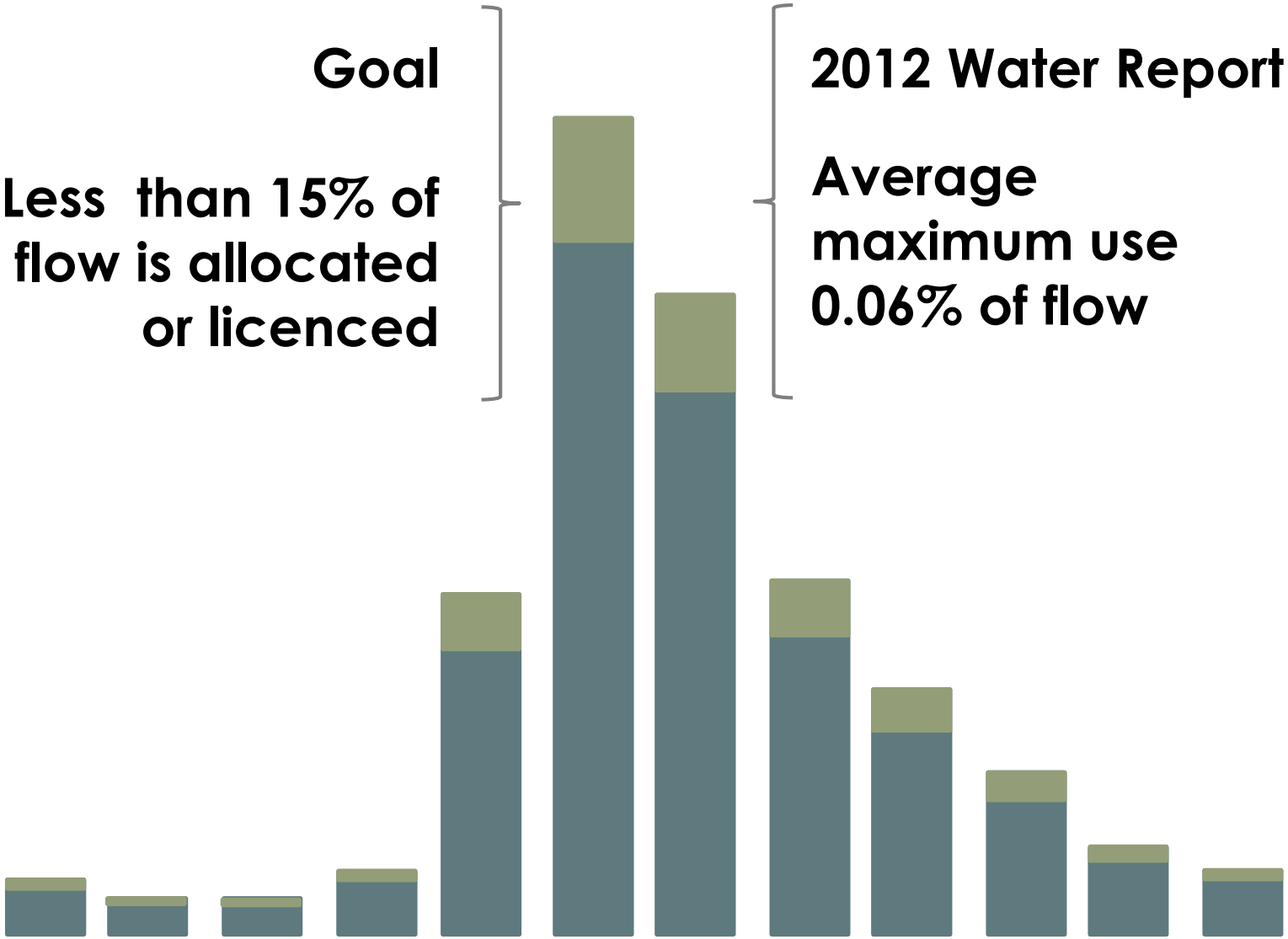
Riparian Values
Avoiding to maintain stream channel processes, temperatures and ecological integrity of shoreline and upland areas.

Water
Avoiding waterworks, water supply wells, aquifers, watersheds.

Total volume of water approved has decreased steadily due to changes in the Commission's approval processes.



Northeast Water Tool (NEWT) stream flow data



Suspension of short-term water use during low stream flow conditions

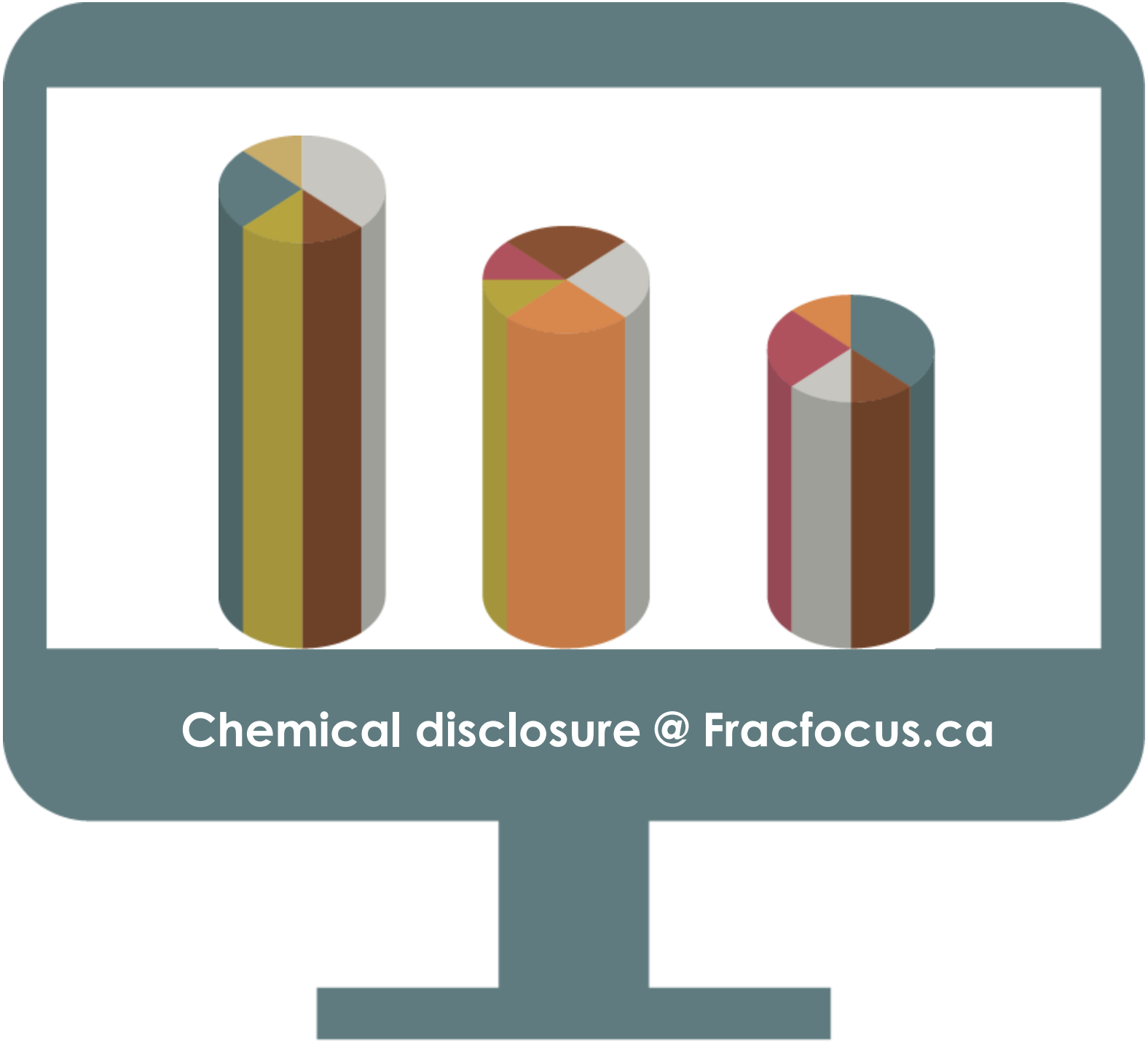
Directive 2010-05 (Aug 2010)

Effective immediately, the Commission is requiring suspension of water withdrawal from rivers, lakes and streams, previously approved by the Commission under Section 8 of the *Water Act*, for the following basins within the Peace River Watershed:

- Kiskatinaw River
- Pine River
- Halfway River
- Moberly River

Directive 2012-01 (Aug 2012)

Oil and gas operators are required to suspend all short-term water withdrawals in northeast B.C., previously approved by the Commission through Section 8 of the Water Act. The Commission will assist in identifying options for an alternative short-term water supply should it be required during this period.

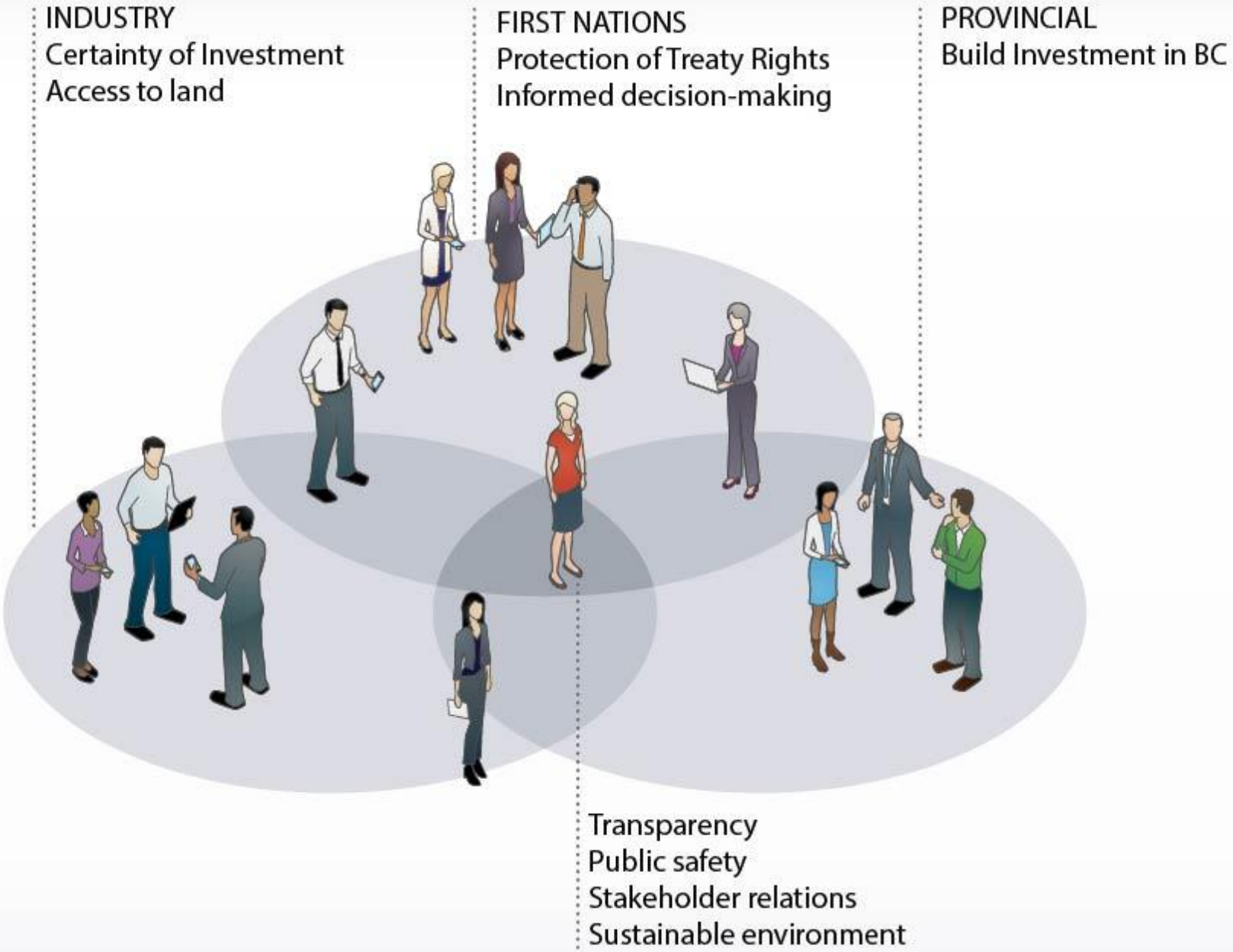

Chemical disclosure @ Fracfocus.ca

Yukon
Whitehorse
Northwest Territories
Yellowknife
Nunavut
Iqaluit
Newfoundland and Labrador
St. John's
British Columbia
Victoria
Alberta
Edmonton
Saskatchewan
Regina
Manitoba
Winnipeg
Ontario
Toronto
Ottawa
Quebec
Québec
Charlottetown
Prince Edward Island
Fredericton
New Brunswick
Halifax
Nova Scotia
CANADA – Political
International boundary
Provincial/territorial boundary
Alberta Province/territory
Ottawa National capital
Scale
0 250 500 750 1 000 km

Alternatives to water

Municipal wastewater
Deep or saline sources
Flowback
Nitrogen and CO_2
LNG or propane

Three-tiered opportunity for input


INDUSTRY
Certainty of Investment
Access to land
FIRST NATIONS
Protection of Treaty Rights
Informed decision-making
PROVINCIAL
Build Investment in BC
Transparency
Public safety
Stakeholder relations
Sustainable environment

Input
Expectations
Considerations
Feedback
Thoughts
For
Industry

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BC Oil and Gas Commission

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Alberta Energy Regulator

Hydraulic Fracturing; Working together to Address New Challenges, a Canadian Story

Ron MacDonald, Senior Advisor, Oil & Gas
May 20, 2014

Outline

- NEW Alberta Energy Regulator
- Hydraulic Fracturing in Alberta
- Need for New Rules
- Directive 059 and 083
- Industry Response
- How are we doing?

AER Mandate

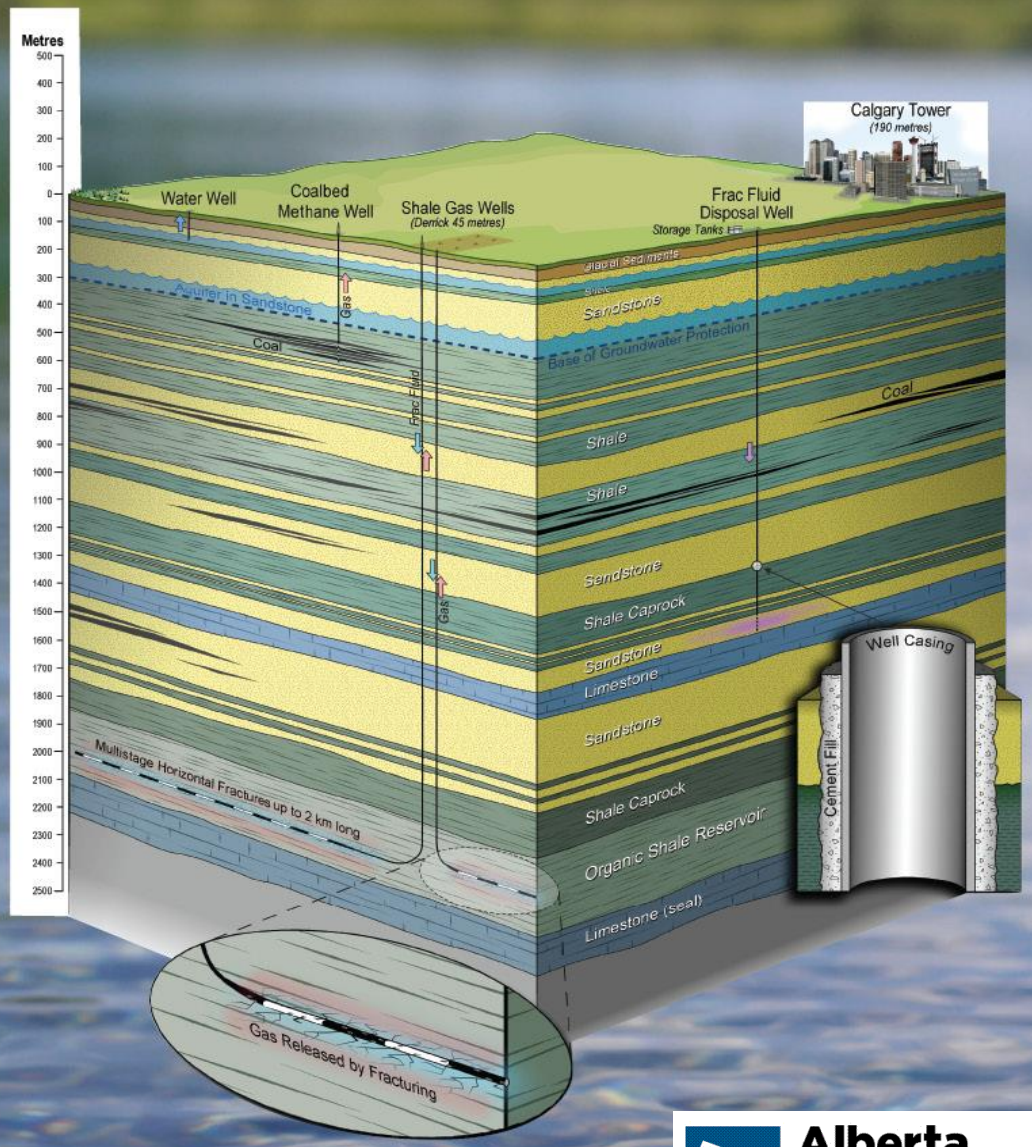
- *The Alberta Energy Regulator ensures the safe, efficient, orderly, and environmentally responsible development of hydrocarbon resources over their entire life cycle. This includes allocating and conserving water resources, managing public lands, and protecting the environment while providing economic benefits for all Albertans.*

Hydraulic Fracturing in Alberta

- Long history of Hydraulic Fracturing (HF)
  - Over 177 000 HF wells in Alberta
  - Unconventional resource interest
    - horizontal drilling technical advances
    - multistage HF
  - Over 8200 horizontal wells have undergone multistage HF since 2008

Regulatory Challenges

- Water management and protection
- Containment
- Hydraulic fracturing
- Surface infrastructure planning and cumulative impacts
- Resource recovery
- Engagement



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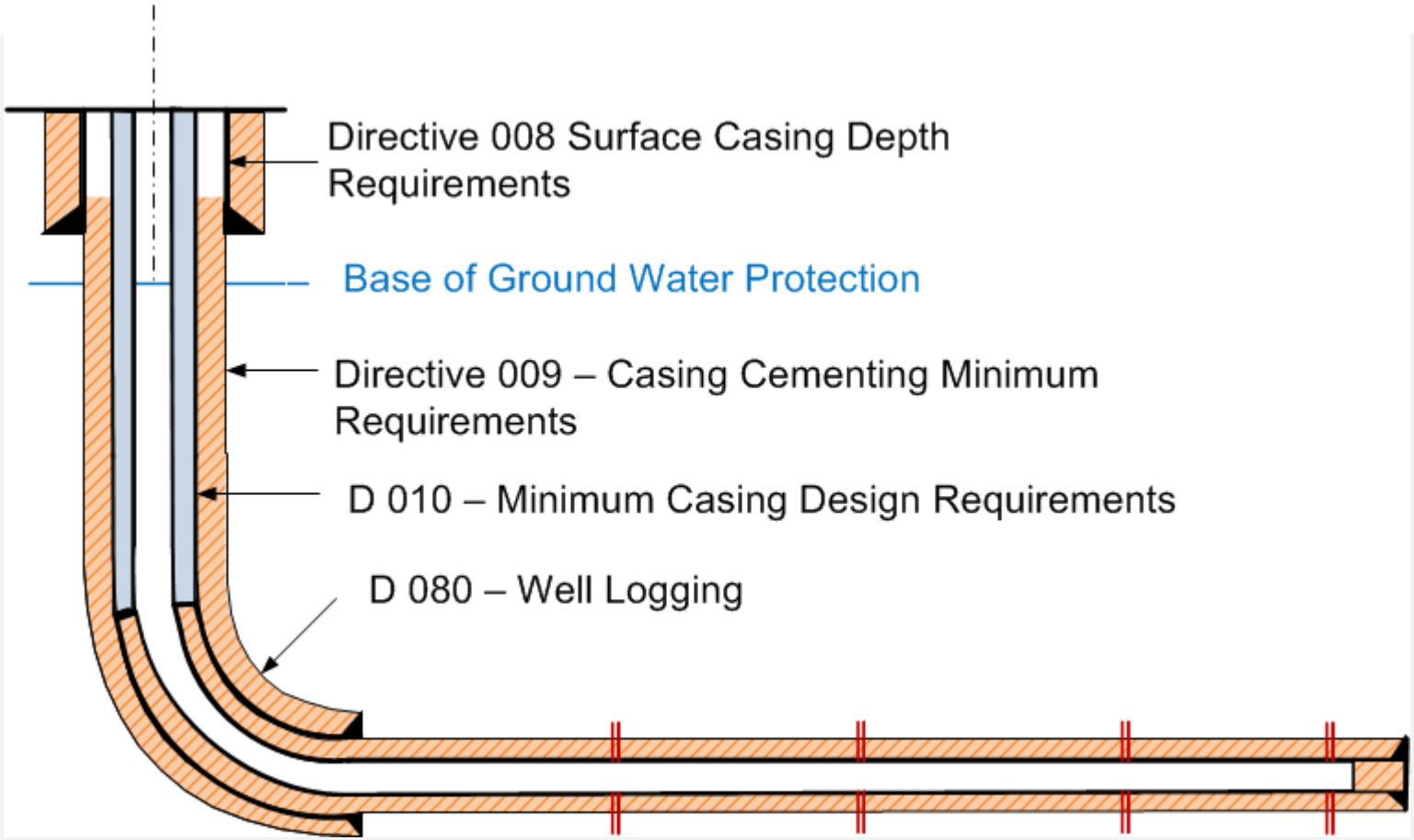
AER Rules


Directive 008 Surface Casing Depth Requirements
Base of Ground Water Protection
Directive 009 – Casing Cementing Minimum Requirements
D 010 – Minimum Casing Design Requirements
D 080 – Well Logging

AER Rules (cont.)

- Drilling and Completion Rig Directives
  - D 036 Drilling Blowout Prevention Requirements and Procedures
  - D 037 Service Rig Inspection Manual
  - D 027 Shallow Fracturing Operations - Restricted Operations (Coal Bed Methane)

The Need for New Rules

Interwellbore Communication

Problem Analysis

Interwellbore communication

Fracture communication with aquifer

Loss of wellbore Integrity

Air emissions

Toxicity levels of chemical additives

Surface foot print

Loss of surface containment – fluid & waste

Fresh water use

General nuisances

Alberta Energy Regulator

AER Responses

- Adopt Outcome Based Regulation
- Expand Prescriptive Regulations
- Increase Information Base
- Enhance Field Presence

Information

- Directive 059 Chemical and Water Disclosure
  - FracFocus.ca
- Draft Directive : Diagnostic Fracture Injection Test
- Pre-Operation Fracture Notification

AER Response

- **Directive 083 – Hydraulic Fracturing – Subsurface Integrity**
  - Outcome based - Regulatory Objective:

    To prevent the loss of well integrity at a subject well.

    To manage well control at an offset well in the event of interwellbore communication with a subject well.

    To prevent adverse effects to nonsaline aquifers
  - Plan requirement linked to Industry Recommended Practice (IRP) 24

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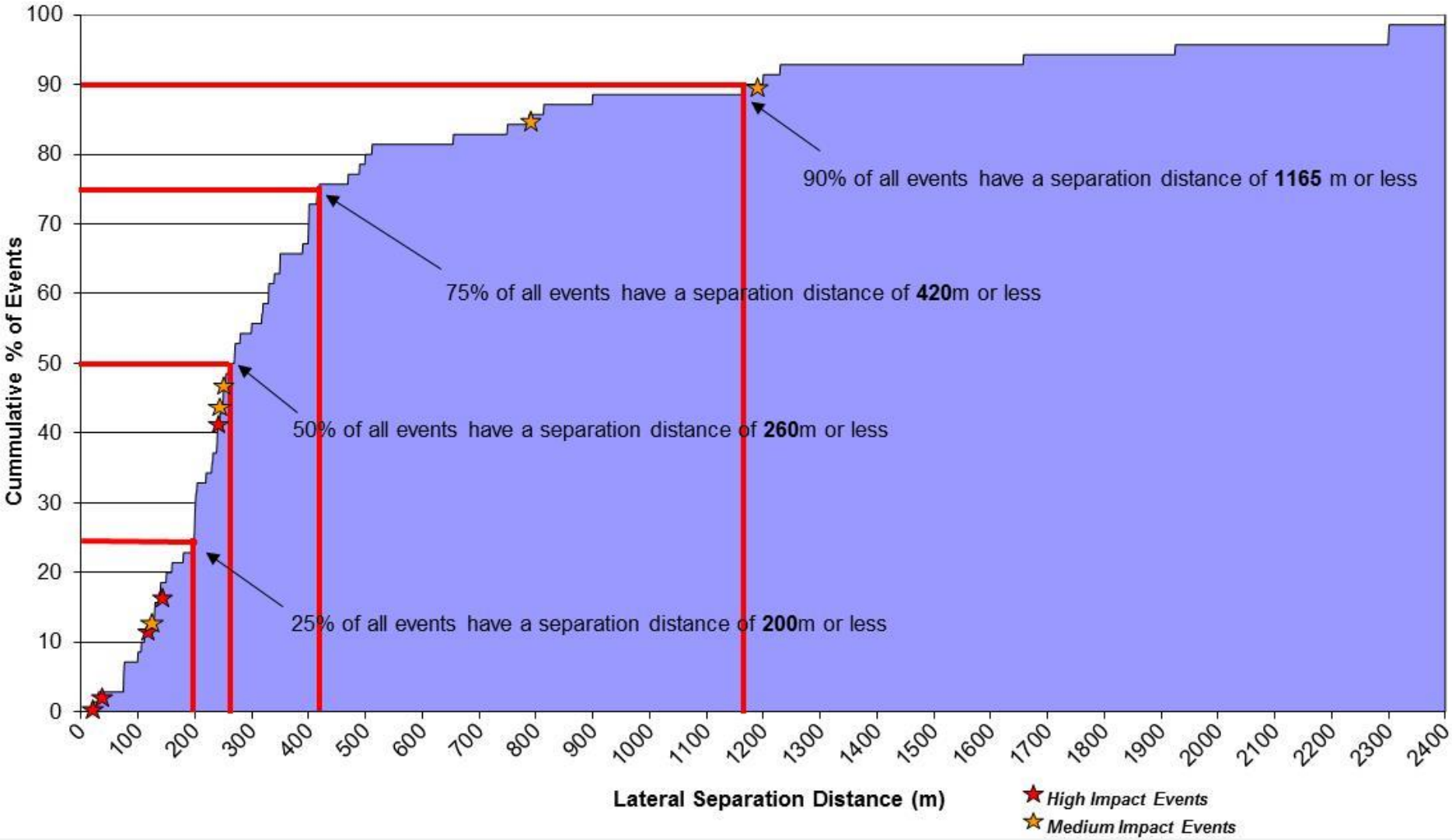
Directive 083: Hydraulic Fracturing – Subsurface Integrity

- **Increase wellbore integrity assurance**
  - Dual barrier design option
  - Single barrier option with additional requirements
- **Shallow Fracturing (2006 CBM)**
  - Prescribed setbacks and fracturing volume limitations
- **Inter-wellbore Communication**
  - Risk management plan for subject well (IRP 24)
  - Offset well operator notification
  - At-risk offset well monitoring plan and well control plan

Horizontal Well Interwellbore Communication Events
Lateral Separation Distance
(2012 and 2013 3rd QRT - 70 impacted wells)



Questions

DACC
Drilling and Completion Committee

Wally Kozak
Director, Industry and Government Relations
Calfrac Well Services

IRP 24: Fracture Stimulation *Interwellbore Communication*

A risk-based approach and its implications

Industry Recommended Practices: What

- A set of best practices and guidelines prepared by knowledgeable industry and government experts.
- Technical topics related to design, construction, and operations in the oil and gas industry, based on safety management principles.
- An IRP is <u>not</u>…
  - A practice manual
  - A regulation, act, or code

Industry Recommended Practices: Who

Professional associations comprise the Drilling and Completions Committee

Enform is administrator of logistics

DACC sponsors IRP developments

Industry Recommended Practices: Where

- An Alberta publication
- Subject Matter Experts from Western Canada appropriate to the topic
- Referenced across Canada

Industry Recommended Practices: Why

- **Why be involved?**

  To create a strong and progressive industry.
  - An opportunity for industry to collaborate and share wisdom.

- **Why comply?**

  Support industry accepted practices.
  - IRP 24 is referenced in AER *Directive 083: Hydraulic Fracturing – Subsurface Integrity*
  - Goal of self-regulation

IRP 24: Fracture Stimulation - Background

- Initiated in January 2012
- Interwellbore Communication chapter
  - Midway incident at Wildstream well (January 13, 2012)
  - Set as priority by AER
- Risk-Based approach
  - IRP 18: Upstream Petroleum Fire Explosion Hazard Management
  - IRP 22: Underbalanced and Managed Pressure Drilling
  - Frequency is low but consequences are high

IRP 24: Who is involved?

Celebrating 60 Years
CAODC
CANADIAN ASSOCIATION OF OILWELL DRILLING CONTRACTORS

NABORS INDUSTRIES LTD.

Government:

BC Oil & Gas COMMISSION

WORK SAFE BC

Government of Saskatchewan

Alberta Energy Regulator

National Energy Board

Manitoba

CAPP
CANADIAN ASSOCIATION OF PETROLEUM PRODUCERS

Canadian Natural

cenovus ENERGY

ConocoPhillips

Crescent Point

devon

encana natural gas

Husky Energy

Esso Imperial Oil

PennWest Exploration

nexen

PSAC
Petroleum Services Association of Canada

BAKER HUGHES

CANYON SERVICES GROUP INC.

CALFRAC WELL SERVICES

GASFRAC ENERGY SERVICES INC.

HALLIBURTON

Sanjel

FIRE POWER OILFIELD FIREFIGHTING LTD.

MILLENNIUM STIMULATION SERVICES

FMC Technologies

Schlumberger

EPAC
CANADA'S OIL & GAS ENTREPRENEURS™

ANDERSON

crew energy inc.

TRIAXON OIL CORP.

TRILOGY ENERGY CORP.

Other Subject Matter Experts:

Isolation Equipment Services

no-e'-tic

ENFORM

IRP 24: Development and Status

Dates	Activities
15-Jan-2012	IRP initiated
1-Oct-2012	First draft completed, industry review opened
15-Nov-2012	Industry review closed
Dec – Jan 2013	Nearly 300 comments reconciled
29-Jan-2013	Revised draft released for IRP 24 Committee feedback
26-Feb-2013	IRP 24 Committee feedback reconciled and approved
27-Feb-2013	Draft released to DACC for sanction approval
27-Mar-2013	DACC sanctioned IRP 24
Apr - Jun 2013	Initiated development of next chapters

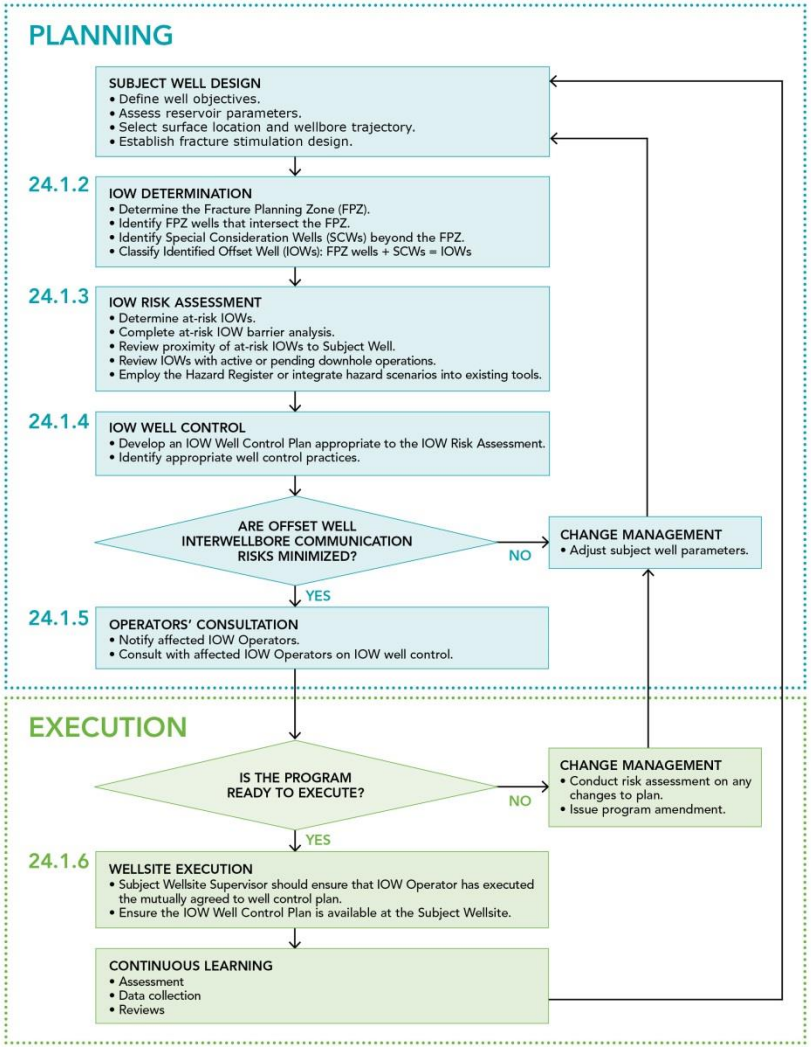
IRP 24: Fracture Stimulation - Premise

The Subject Well Operator **shall** be responsible for minimizing the risk of interwellbore communication causing a well control event at an Identified Offset Well as a result of fracture stimulation operations at the subject well.

Two principle means for minimizing the risk of interwellbore communication well control events at an Offset Well:

1. Adjust the Subject Well's parameters.
2. Develop an appropriate Well Control Plan by using the Interwellbore Communication **Hazard Management Process.**

IRP 24: Hazard Management Process



24.1.2 IOW Determination

Identified Offset Wells (IOWs) are all offset wells within the Fracture Planning Zone (FPZ) plus all wells identified as Special Consideration Wells (SCW)

IOWs include energy wells in any of the following states:

- Licensed and not yet spud
- Drilling
- Completing or servicing
- Cased and standing
- Produced or injection
- Shut-in or suspended
- Abandoned in any form
- Orphaned

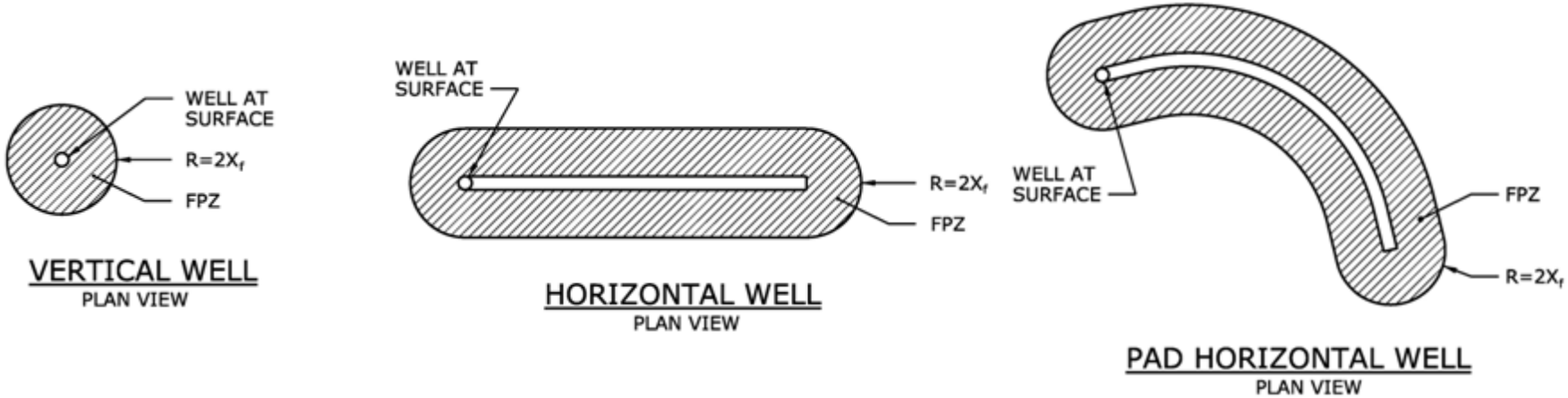
24.1.2 IOW Determination

IOWs are determined through the following stages:

1. Fracture Planning Zone (FPZ) Determination
2. Fracture Planning Zone Well Identification
3. Special Consideration Well (SCW) Identification

24.1.2 IOW Determination

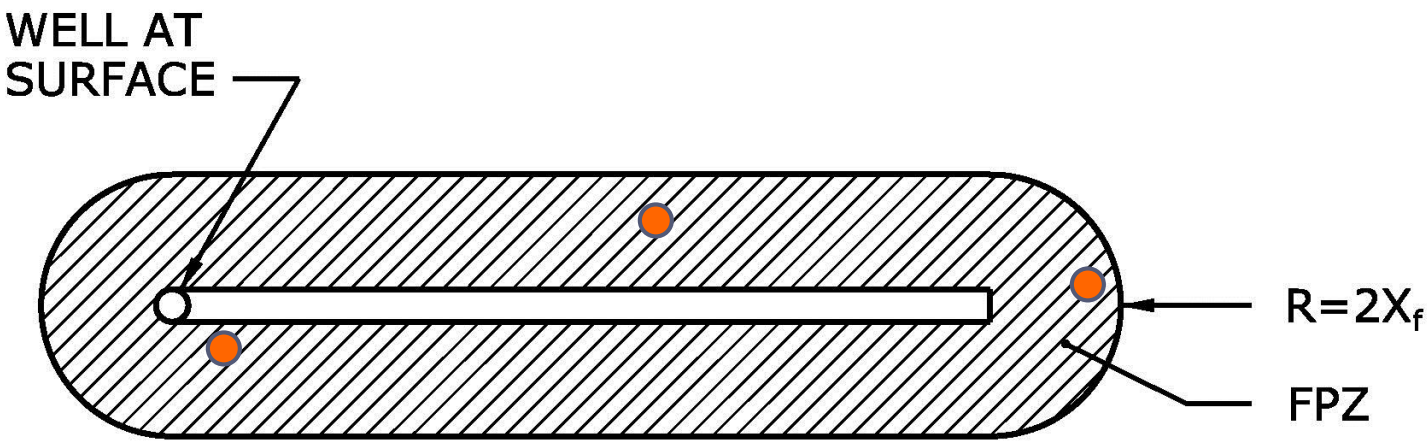
1. FPZ Determination
   - Determine the value for the fracture half length (X_f)
   - Using the longest X_f draw the outer boundary of the FPZ equal to twice the X_f



The Subject Well Operator **shall** determine and map the FPZ.

24.1.2 IOW Determination

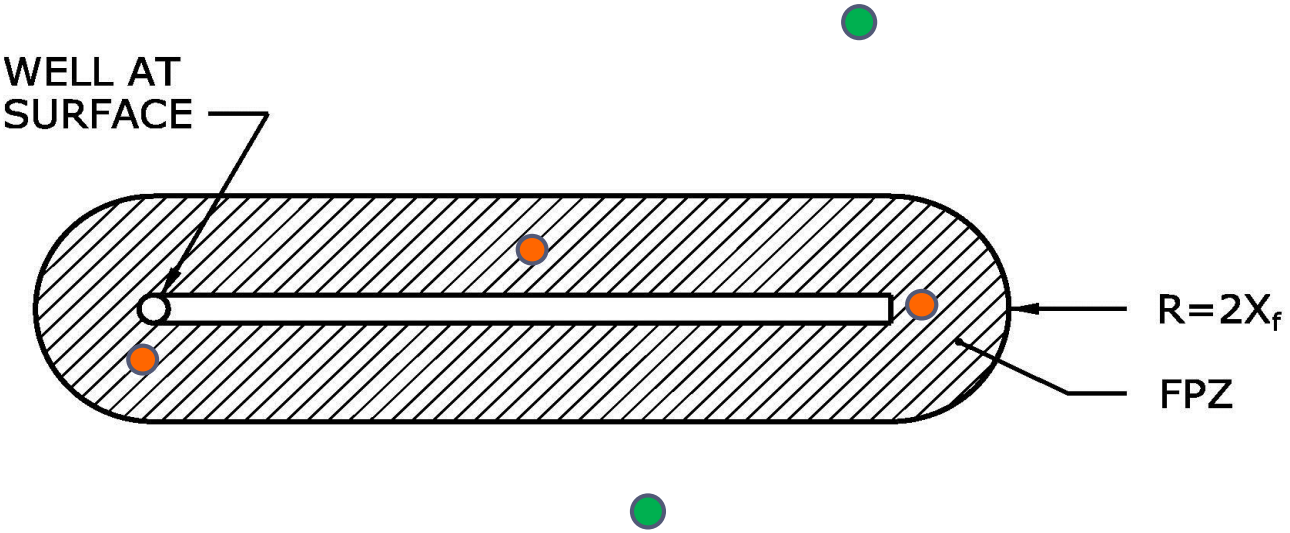
1. Determine an FPZ
2. FPZ Well Identification



The Subject Well Operator **shall** identify all FPZ wells on a map.

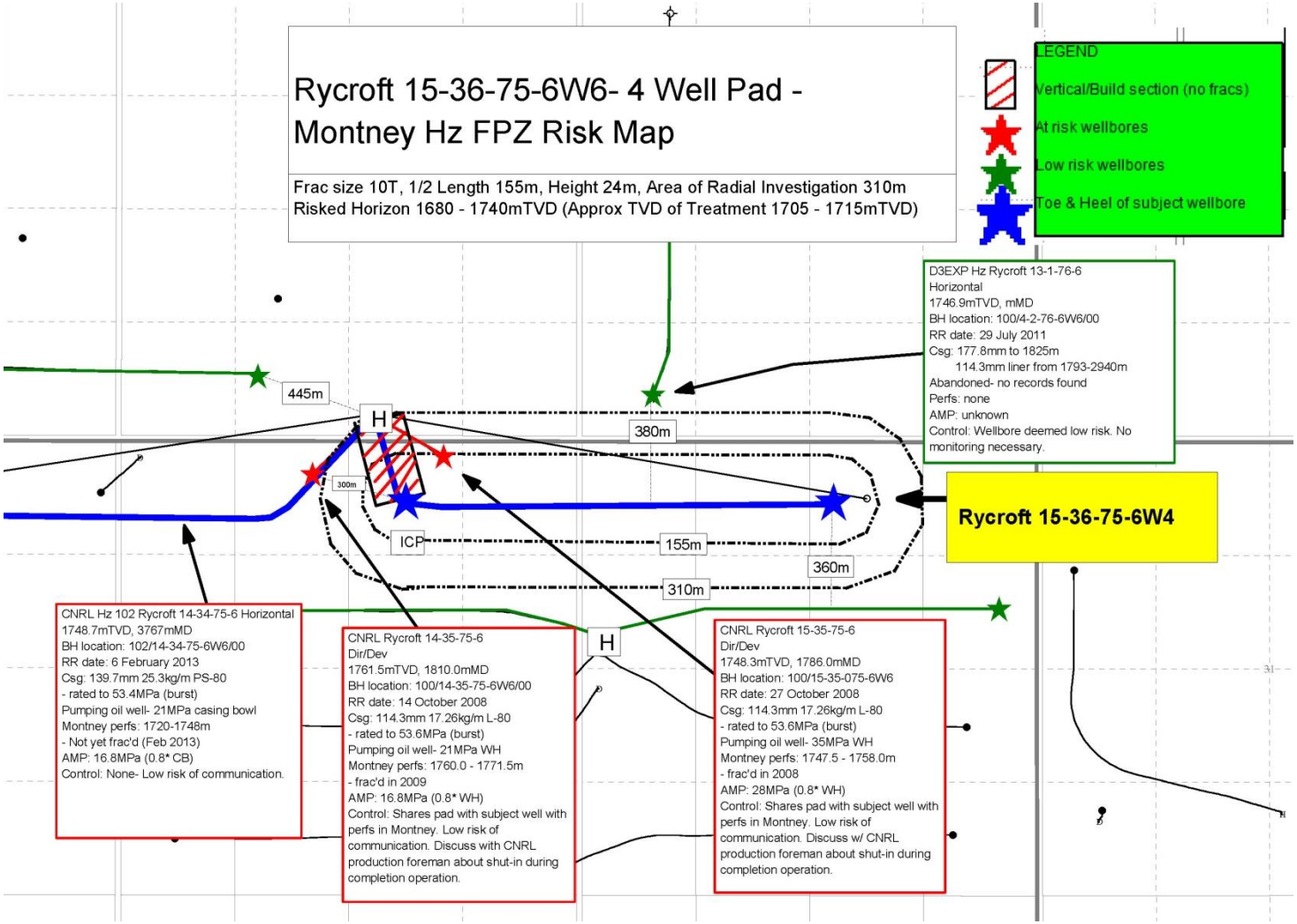
24.1.2 IOW Determination

1. Determine an FPZ.
2. Identify wells intersecting the FPZ.
3. SCW Identification

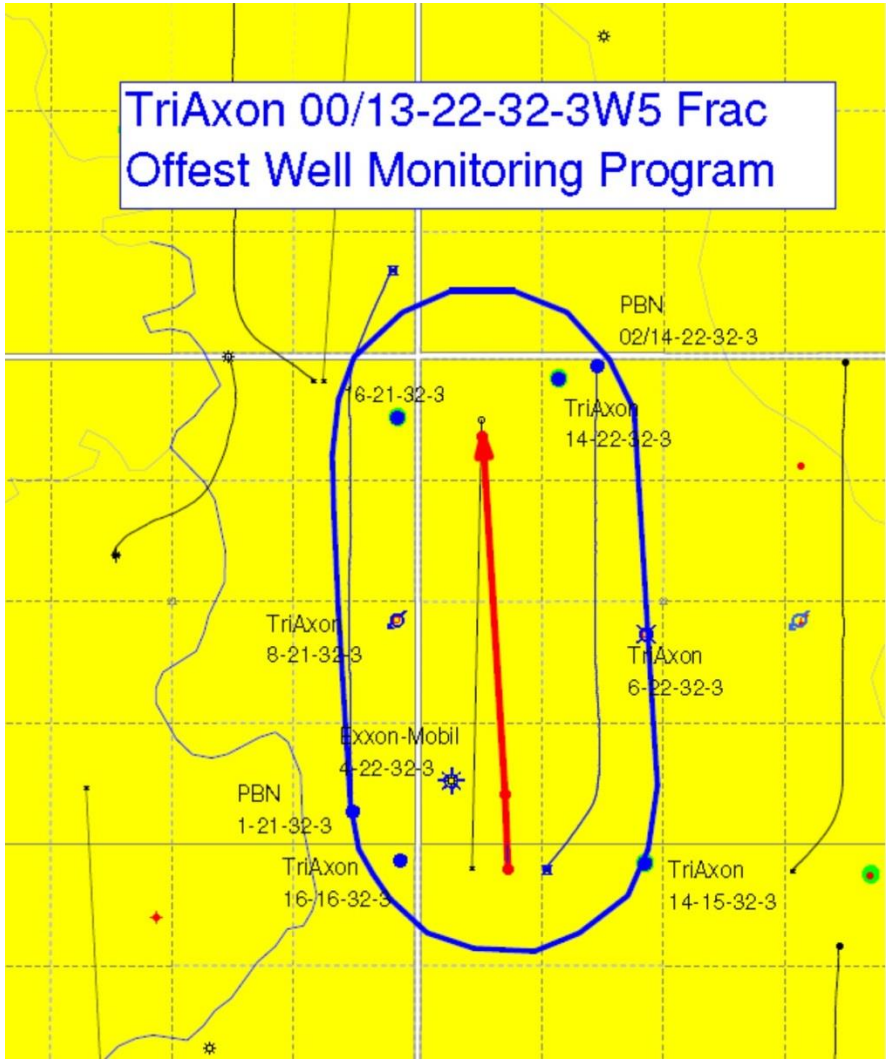


The Subject Well Operator **shall** determine SCWs beyond the FPZ.

Example


Rycroft 15-36-75-6W6- 4 Well Pad - Montney Hz FPZ Risk Map
Frac size 10T, 1/2 Length 155m, Height 24m, Area of Radial Investigation 310m
Risked Horizon 1680 - 1740mTVD (Approx TVD of Treatment 1705 - 1715mTVD)
LEGEND
Vertical/Build section (no fracs)
At risk wellbores
Low risk wellbores
Toe & Heel of subject wellbore
D3EXP Hz Rycroft 13-1-76-6
Horizontal
1746.9mTVD, mMD
BH location: 100/4-2-76-6W6/00
RR date: 29 July 2011
Csg: 177.8mm to 1825m
114.3mm liner from 1793-2940m
Abandoned- no records found
Perfs: none
AMP: unknown
Control: Wellbore deemed low risk. No monitoring necessary.
445m
H
380m
300m
ICP
155m
360m
310m
Rycroft 15-36-75-6W4
CNRL Hz 102 Rycroft 14-34-75-6 Horizontal
1748.7mTVD, 3767mMD
BH location: 102/14-34-75-6W6/00
RR date: 6 February 2013
Csg: 139.7mm 25.3kg/m PS-80
- rated to 53.4MPa (burst)
Pumping oil well- 21MPa casing bowl
Montney perfs: 1720-1748m
- Not yet frac'd (Feb 2013)
AMP: 16.8MPa (0.8* CB)
Control: None- Low risk of communication.
CNRL Rycroft 14-35-75-6
Dir/Dev
1761.5mTVD, 1810.0mMD
BH location: 100/14-35-75-6W6/00
RR date: 14 October 2008
Csg: 114.3mm 17.26kg/m L-80
- rated to 53.6MPa (burst)
Pumping oil well- 21MPa WH
Montney perfs: 1760.0 - 1771.5m
- frac'd in 2009
AMP: 16.8MPa (0.8* WH)
Control: Shares pad with subject well with perfs in Montney. Low risk of communication. Discuss with CNRL production foreman about shut-in during completion operation.
H
CNRL Rycroft 15-35-75-6
Dir/Dev
1748.3mTVD, 1786.0mMD
BH location: 100/15-35-075-6W6
RR date: 27 October 2008
Csg: 114.3mm 17.26kg/m L-80
- rated to 53.6MPa (burst)
Pumping oil well- 35MPa WH
Montney perfs: 1747.5 - 1758.0m
- frac'd in 2008
AMP: 28MPa (0.8* WH)
Control: Shares pad with subject well with perfs in Montney. Low risk of communication. Discuss w/ CNRL production foreman about shut-in during completion operation.

Example


TriAxon 00/13-22-32-3W5 Frac
Offest Well Monitoring Program
PBN
02/14-22-32-3
6-21-32-3
TriAxon
14-22-32-3
TriAxon
8-21-32-3
TriAxon
6-22-32-3
Exxon-Mobil
4-22-32-3
PBN
1-21-32-3
TriAxon
16-16-32-3
TriAxon
14-15-32-3

24.1.3 IOW Risk Assessment

1. Determine At-risk IOWs
2. At-risk IOW Barrier Analysis
3. IOW Proximity
4. IOWs with Active Downhole Operations
5. IOW 24 Hazard Register

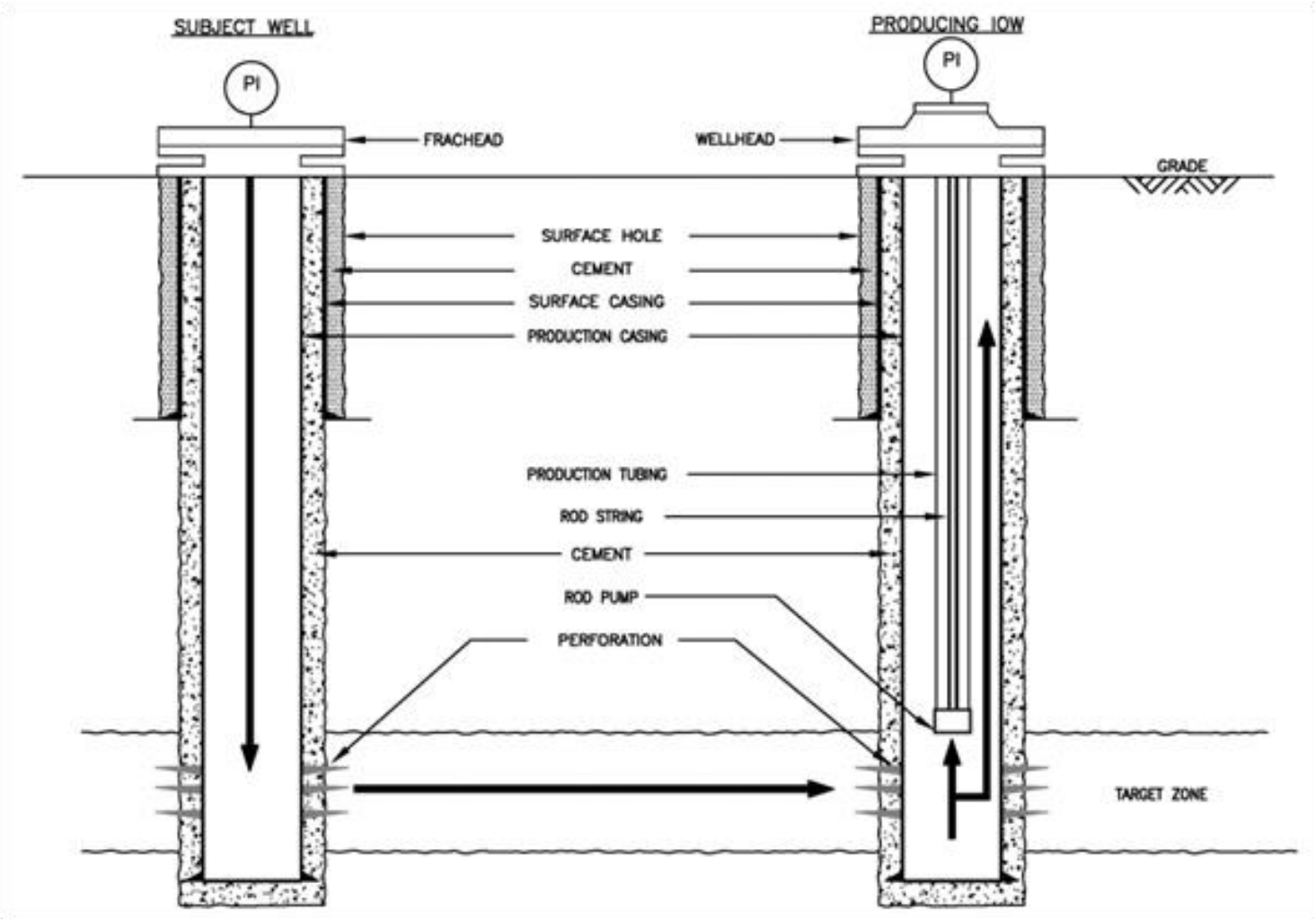
24.1.3 IOW Risk Assessment

1. Determine At-risk IOWs
   - Wells that require additional risk assessment include:
     - IOWs that penetrate the Subject Well target zone
     - IOWs that terminate near the Subject Well target zone

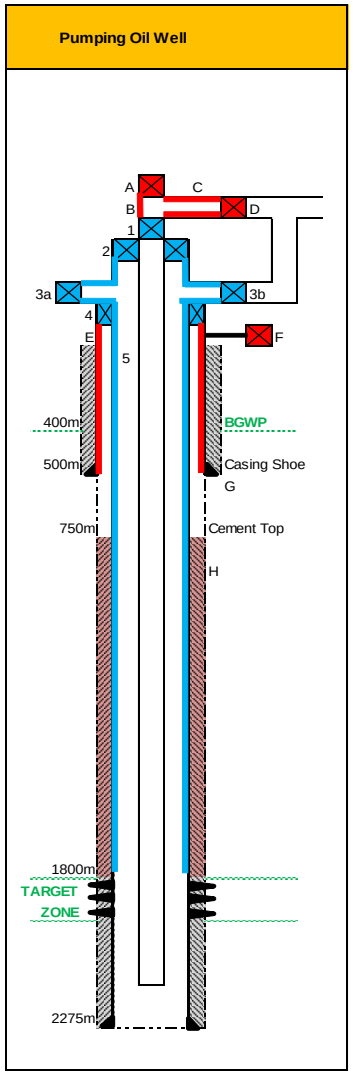
24.1.3 IOW Risk Assessment

1. Determine At-risk IOWs
2. At-risk IOW Barrier Analysis
   - The Subject Well Operator **shall** complete a barrier analysis on each at-risk IOW.
   - Step 1: Evaluate interwellbore communication flow path(s).
   - Step 2: Identify primary and secondary barrier systems.
   - Step 3: For each barrier system determine the **adjusted maximum pressure** for each barrier and identify the lowermost one.
   - Step 4: Assess groundwater protection.

24.1.3 IOW Risk Assessment



24.1.3 IOW Risk Assessment



* O = Open, C = Closed

Barriers	OEM Capacity (MPa)	Adjusted Max Pressure (MPa)	Barrier Status *(O / C)	IOW Monitored (Y / N)
Primary Barrier System				
1. Polished rod BOP (Radigan)	14.0	7.0	C	N
2. Tubing hanger seals	14.0	7.0	C	N
3. Prod casing head valves (a,b)	14.0	7.0	C	Y
4. Prod casing hanger seals	14.0	7.0	C	Y
5. Prod casing (burst)	28.0	7.0	C	Y
Secondary Barrier System				
A. Polished rod stuffing box	1.0	0.5	C	N
B. Flow line tee	14.0	7.0	C	N
C. Flow line	14.0	7.0	C	Y
D. Flow line valve	14.0	7.0	C	Y
Secondary Barrier System				
E. Surface Casing	4.0	4.0	C	Y
F. Surface casing vent valve	3.5	1.0	C	Y
G. Surface Casing Shoe	4.0	4.0	C	Y
(18 kPa/m frac gradient)				
H. Prod casing cement / annulus	untested	untested	C	Y

24.1.3 IOW Risk Assessment

1. Determine At-risk IOWs
2. At-risk IOW Barrier Analysis
3. IOW Proximity
   - For well control planning, the Subject Well Operator **should** consider the proximity of the Subject Well to each at-risk IOW in relation to Adjusted Maximum Pressure(s) to minimize the risk of a well control event.

24.1.3 IOW Risk Assessment

1. Determine At-risk IOWs
2. At-risk IOW Barrier Analysis
3. IOW Proximity
4. IOWs with Active Downhole Operations
   - The Subject Well Operator **shall** ensure that at-risk IOW Operators with active downhole operations are aware of pending fracture stimulation operations at the Subject Well (see 24.1.5 Consultation).

24.1.3 IOW Risk Assessment

1. Determine At-risk IOWs
2. At-risk IOW Barrier Analysis
3. IOW Proximity
4. IOWs with Active Downhole Operations
5. IRP 24 Hazard Register
   - The Operator **shall** employ the content of the IRP 24 Hazard Register or integrate IRP 24 known hazard scenarios into existing organizational risk assessment processes to identify additional risk assessment considerations.

24.1.3 IOW Risk Assessment

IOW 24 Hazard Register Sample

Item	Hazard Scenario	Applicable	Cause	Threats / Consequences	HSE	NPT	Industry Suggested Controls and Mitigations
1	FPZ is Underestimated		- See Appendix A of IRP 24 document - Geology - Inadequate Modeling - Fracture Treatment Larger than planned - Multiple stages pumped into one stage unintentionally (inadequate stage isolation, frac goes only into one perforated interval on a multi-perforated stage, longitudinal frac, hz pancake frac) - Fracture Treatment type change from plan - Intersection of offset hydraulically fractured wellbores - FPZ reservoir depletion	- Loss of barrier integrity in an IOW - Unintentional interwellbore communication - Fault(s) can considerably extend fracture half length, thus increasing the likelihood of interwellbore communication to wells within the FPZ and beyond the FPZ (i.e., a fault can create FPZ estimation uncertainty) '- Packer or cement failing to isolate frac into desired interval - Ball activated system failure (ball not dropped, ball fails, downhole seat fails). Wrong ball dropped on sleeve. Extra ball in system accidentally left over from another well's frac operation - Friction diversion not working for limited entry frac - Seat is worn on ball/seat job so ball does not shift sleeve - Coil fraccing downhole isolation packer/tool fails and bypasses to previously fracced stages below it	1	1	- If faulting is anticipated, establish IOW well control plans based on a higher likelihood of interwellbore communication - Compile area experience for more accurate FPZ determination - Consider adding a fault related safety factor to intentionally expand the FPZ - If faulting is anticipated, consider all possible SCW's as at-risk - Micro-seismic to asses frac propagation behaviour when perforating multiple intervals for a single frac stage
2	Adjusted Maximum Pressure (AMP) Overestimation		- No recent pressure integrity tests conducted - Challenges with determining Adjusted Maximum Pressure on a barrier flow path based on operational history of component (how to effectively derate a component) - Casing and/or downhole equipment integrity issues due to corrosion, erosion, service, & age - Wellhead integrity problems due to corrosion, erosion, service, and age	- Loss of barrier integrity in an IOW - Inadequate allowance for response times during wellsite operations to prevent adjusted maximum pressure from being exceeded - Pressure integrity reliability of threaded components	1	1	- Conduct pressure integrity tests to verify Adjusted Maximum Pressure - Replace (if possible) barrier components of concern that have been integrity tested to the Adjust Maximum Pressure.

24.1.4 IOW Well Control Plan

- Each at-risk IOW **shall** have a well control plan that reflects its risk assessment.

- Well control practices may include, but not be limited to, one or a combination, of the following:
  - No action required
  - Monitoring
  - Shut-in
  - Pressure Relieving System
  - Installation of Additional Barriers
  - Adjust Subject Well Parameters

24.1.5 Operators' Consultation

- Collaborative consultation implies consensus decision-making that seeks the consent of all participants with the ultimate goal of avoiding a well control event.

- The Subject Well Operator **shall** initiate and persist with a consultation request until a mutually agreed well control plan is in place.

- The IOW Operator **shall** respond and engage in consultation with the Subject Well Operator.

24.1.6 Wellsite Execution

- Prior to initiation of fracturing operations, the Subject Wellsite Supervisor **should** ensure that the IOW Operator has executed the mutually agreed well control plan.

Continuous Learning

- Assessment
- Data Collection
- Knowledge Sharing

Thank you for listening

- To get involved in the development of upcoming chapters contact dacc@enform.ca

Questions?

PSAC

working energy

Leading Energy Services,
Supply, Manufacturing and Innovation

Hydraulic Fracturing: Working Together To Address New Challenges, A Canadian Story

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Who is PSAC?

- PSAC is the national trade association representing almost 250 service, supply & manufacturing companies within the upstream petroleum industry

- Member companies employ over 75,000 people

- Represent over 80% of the business volume generated in the Canadian oil and gas service industry

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working energy

Vision

To be the voice of Canada's upstream petroleum services, supply and manufacturing sectors

Mission

To champion the interests of its members and the industry

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PSAC Member Sectors

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PSAC is Working Energy

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Working Energy Commitment Founding Members

BAKER HUGHES

HALLIBURTON

CALFRAC WELL SERVICES

IRON HORSE ENERGY SERVICES

CANYON TECHNICAL SERVICES LTD.

MILLENNIUM STIMULATION SERVICES

Sanjel

ELEMENT technical services

Schlumberger

GASFRAC

TRICAN

PSAC working energy

Working Energy Commitment Statement of Principles

- Operate safely and responsibly
- Meet or exceed all environmental standards
- Act with integrity
- Continually improve our practices and services
- Treat all members of the community with respect, dignity and trust

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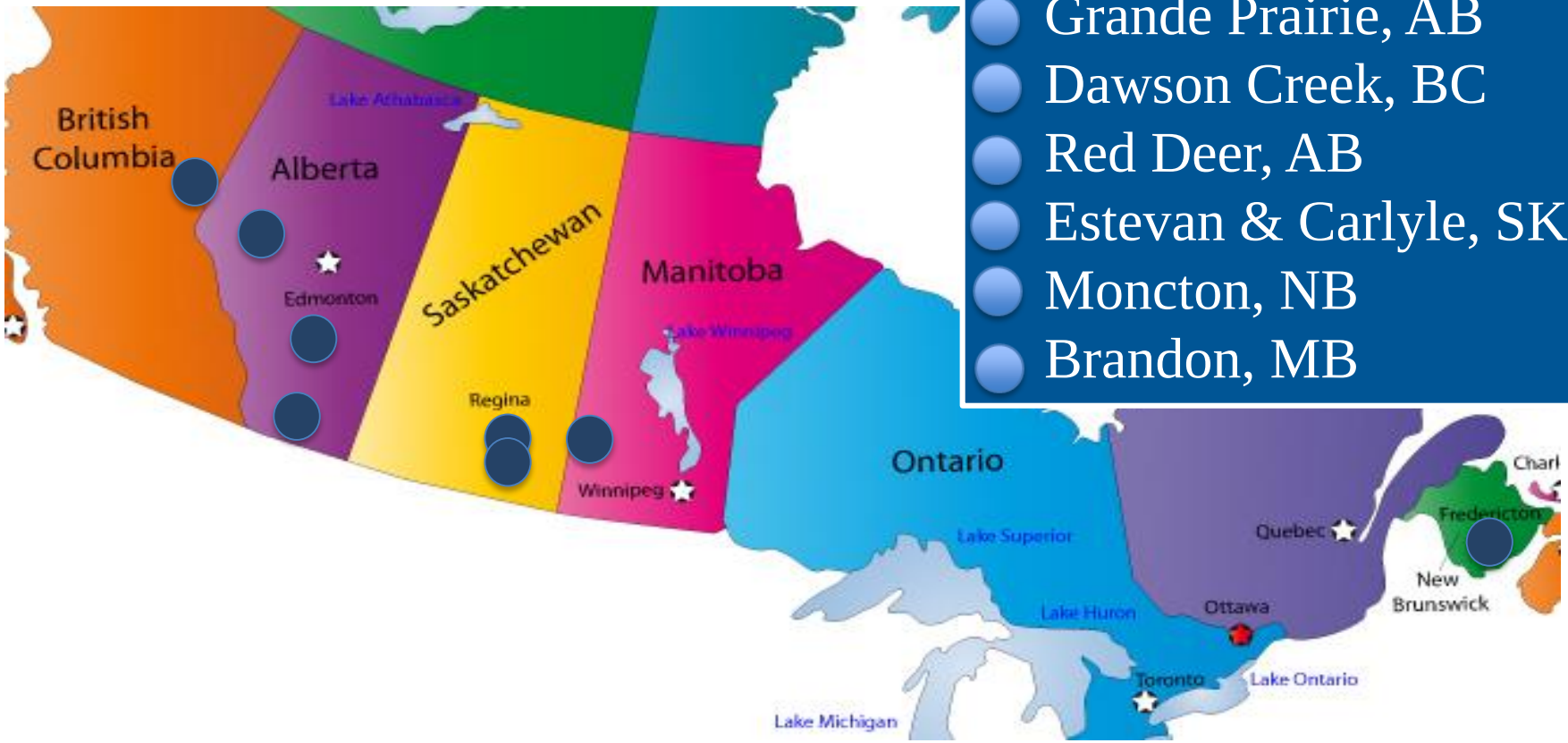
Public Engagement

2013

- Drayton Valley, AB
- Lethbridge, AB
- Grande Prairie, AB
- Dawson Creek, BC
- Red Deer, AB
- Estevan & Carlyle, SK
- Moncton, NB
- Brandon, MB



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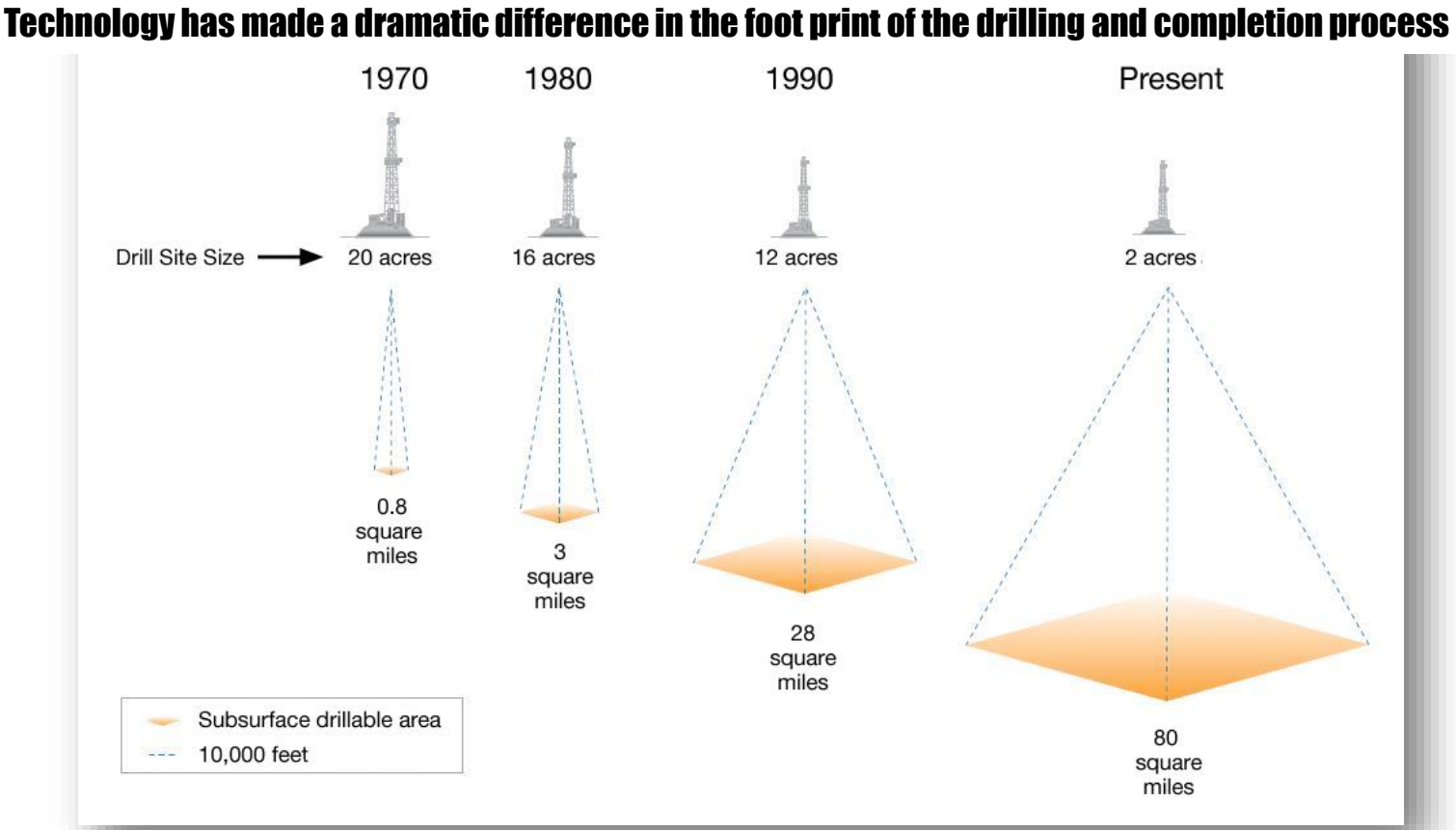
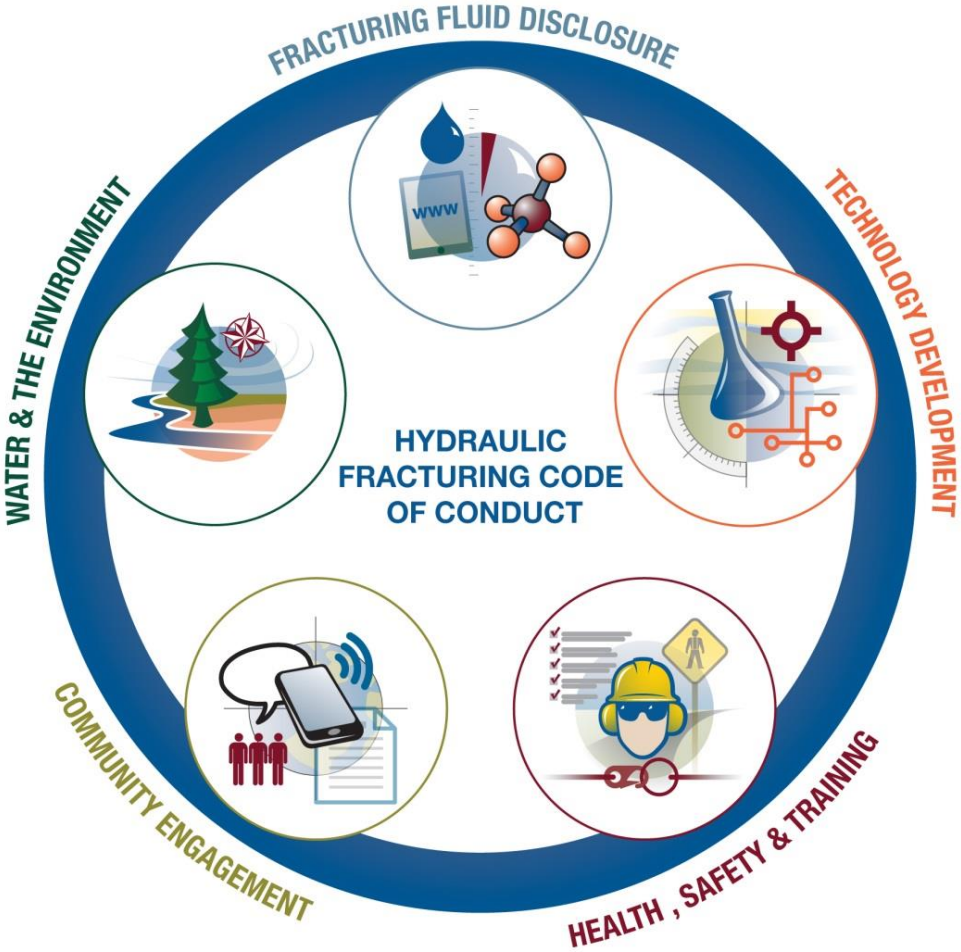
Environmental Footprint



Source: American Petroleum Institute

Hydraulic Fracturing Code of Conduct



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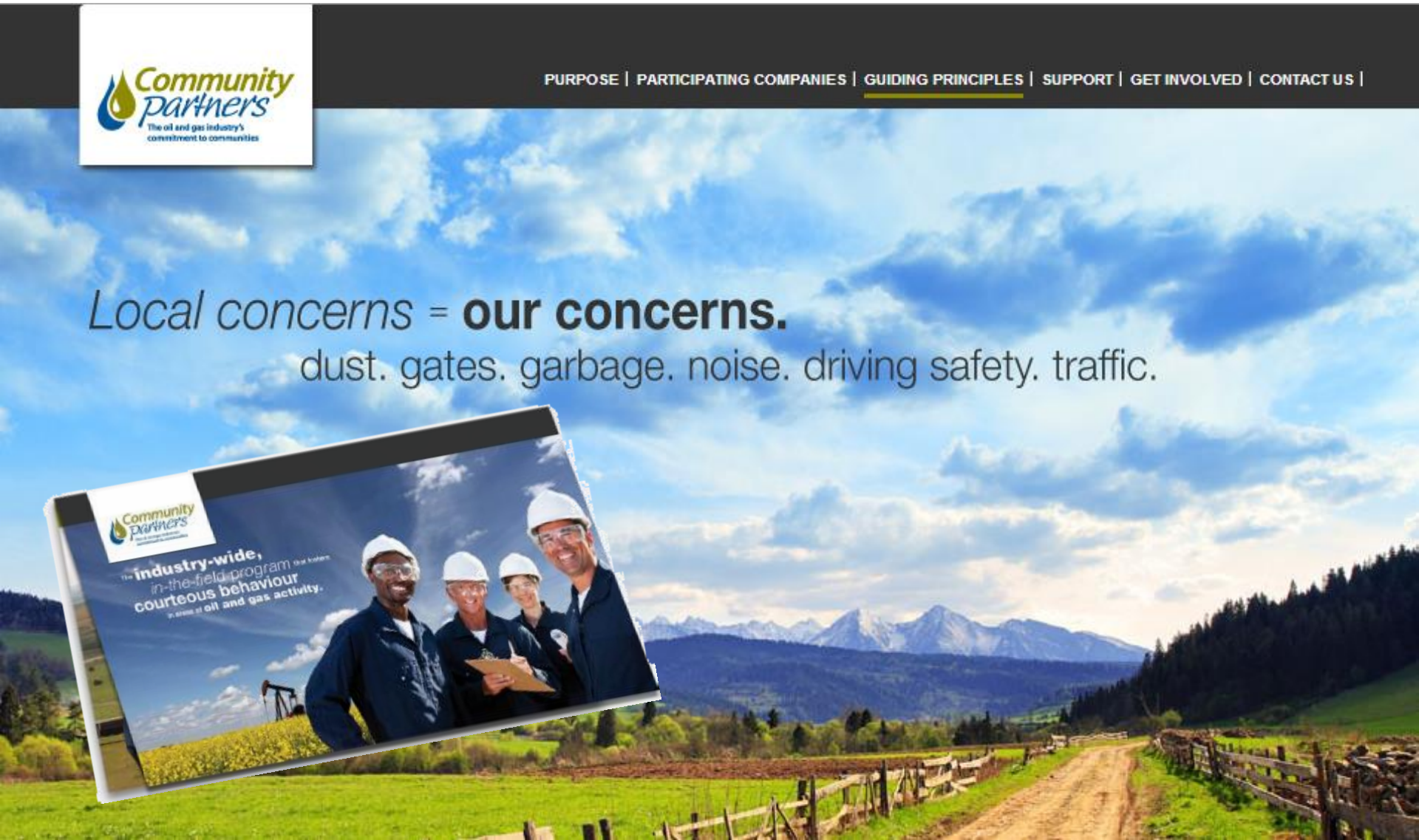
Community Partners



oilandgasinfo.ca and PatchWorks

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Thank you

For more information, please visit:

psac.ca