Significant Exploration Success in Northeastern British Columbia:
A Story of People Resilience and Learning from Failure*

Rob Spitzer

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1Apache Canada Ltd., Calgary, Alberta (robert.spitzer@apachecorp.com)

Exploration Examples

Ladyfern Gas Field
Conventional 600 BCF Gas Discovery in 2000
On platform in Upper Devonian Slave Point Formation (carbonate)

Horn River Gas Field
Unconventional (≈60 TCF) Gas Discovery in 2004
In Devonian-Carboniferous Besa River Formation

Liard Gas Field
Unconventional (≈ 100 TCF) Gas Discovery in 2009
In Devonian-Carboniferous Besa River Formation (but younger section than at Horn River)

Summary of Learnings/Validation

- Early is better.
- Resilience – significant failure can lead to more significant success.
- Move quickly.
- Understanding your competition – the herd mentality.
- Social license is critical! Listening, seeking creative solutions and acting early are essential.
- Solid exploration proposals combined with company commitment are optimal.
• It all comes down to excellent people… always!

Reference Cited

SIGNIFICANT EXPLORATION SUCCESS IN NORTHEASTERN BRITISH COLUMBIA: A STORY OF PEOPLE, RESILIENCE AND LEARNING FROM FAILURE

MAY 20, 2013
AAPG ANNUAL CONVENTION
PITTSBURGH, PA

ROB SPITZER
APACHE CANADA LTD.
AGENDA

- Background
- Exploration
- A recipe for sustained success
- Basic ingredients
  - People
  - Business
  - Technology
  - Company Support
- Significant discoveries
  - Ladyfern
  - Horn River
  - Liard
- Summary
BACKGROUND

- 32 years of industry experience (18 Shell, 14 Apache)
- 50% Exploration, 50% Development
- Primarily in Canada (coast to coast to coast)
- Leading exploration groups for last 16 years
- Significant number of failures and some successes
- Currently EVP Apache Kitimat Upstream
OIL/GAS PRICES: PAST 30 YEARS

Significant price fluctuations are the norm!

- Cushing, OK Crude Oil Future Contract 1 ($/bbl)
- U.S. Natural Gas Wellhead Price ($/MMcf)

1986 Oil $30/bbl ↓ $8/bbl

Gas "surplus" disconnect from oil
HYDROCARBON EXPLORATION: WHAT IS IT? WHAT IS SUCCESS?

- In simple terms: finding new hydrocarbons

- What does success look like? A range of answers dependent on:
  1. Size of the find
  2. Profitability
  3. Impact on the company (companies) involved (stock price)

- Focus of this talk is: large finds, profitable and impactive to medium/large companies
4 KEY OBSERVATIONS/LEARNINGS

- The only constant in exploration is change
- There are many ways to be a successful explorer
- Quality of people is the primary factor determining success
- Failure is a key component of success (if one learns from it!)
RECIPE FOR EXPLORATION SUCCESS: KEY INGREDIENTS

- Quality of People
- Company Support
- Technology Utilization
- Business Acumen
- Quality of People
PEOPLE QUALITIES: WHAT TO LOOK FOR “TOP 10”

- Resilience
- Passion
- Focused
- Ability to connect data
- Curiosity/Creativity
- Objectivity
- Courage
- Not easily satisfied – hunger
- Able to pull the trigger
- Ability of individuals/team to excel with diversity of opinions - chemistry
“More than education, more than experience, more than training, a person’s level of resilience will determine who succeeds and who fails. That’s true in the cancer ward, it’s true in the Olympics, and it’s true in the boardroom.”

Dean Becker,
President & CEO Adaptive Learning Systems
Harvard Business Review – May 2002
WHY RESILIENCE IS IMPORTANT

- Generally there are more failures than success.
- Exploration for big, profitable accumulations is much less than a 50/50 proposition.

<table>
<thead>
<tr>
<th>Failures</th>
<th>Small Successes</th>
<th>Major Successes</th>
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<tbody>
<tr>
<td>Redfish</td>
<td>Pickell</td>
<td>Ladyfern</td>
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<tr>
<td>Ootla</td>
<td>Ring Border</td>
<td>Horn River</td>
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<tr>
<td>(Horn River Deep)</td>
<td>Milo</td>
<td>Liard</td>
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<td>Nordegg</td>
<td>Simonette</td>
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<td>Palliser</td>
<td>Montney (oil)</td>
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<td>New Brunswick</td>
<td>Sask Ordovician</td>
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<td>Sask (Bakken)</td>
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<tr>
<td>Many more</td>
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QUALITIES OF RESILIENCY

- Optimism **without distortion of reality**

- **Finding positives** and meaning from failure

- Improving what you have – **finding a way**
PASSIONATE ABOUT FINDING

- People generally do better in endeavors they like
- Tendencies often show up early in life ~ curiosity
- For example:
  - Young rock and mineral collectors/finders
- Passion enables a person/group to overcome many of the “darker days” in exploration
Ability to quickly identify the key factors for success and direct energy towards resolving them

This provides significant competitive advantage in speed and better evaluation of risk and therefore decision making

This leads to better early decision making

“One is never far ahead of the pack.”
CONNECTING THE DOTS

- People can have exactly the same data and end up with totally different recommendations in vastly differing timeframes.

- Successful explorers have the ability to connect the data in a manner that is logical, based on reality, and is compelling to those holding the “purse strings”.
TECHNICAL EXCELLENCE

- Extremely important attribute for competitive advantage
- It is the foundation for good decision making
- Learning by doing/experimenting leads to more valuable technical information
- Successful exploration requires that as much data is utilized and integrated in all pertinent disciplines – no silos

“The best geologist is the one that has seen the most rock”

(McMaster University Professor 1978)
TECHNOLOGY

- Developing and/or quickly reacting to new technology can be a game changer in exploration

- 3D and horizontal multi-stage fracturing are excellent examples

- Good explorationists are always aware of new technology either by aiding a specific technology’s development or quickly finding analogs to industry successes
Good business decisions can generally only be made from staff recommendations which are of the highest quality – period!

Given the general lack of data in most new plays, as well as price uncertainty: chance of success can be further diminished by less than stellar technical, economic, strategic and execution work

These need to be managed well to be successful!
BEST BUSINESS PRACTICES

- Ability to make a **timely decision**
- **First in** → lowest entry cost + highest capture + highest ROR (success case)
- Spend capital proportionally to knowledge
- Understand full cycle risks/reward
- Large portfolio = choice
- Be strategic and plan
- **Think big with realism**
- Social license and stakeholders engagement with early communication is very important!
SPENDING WISELY: LAND EXPENDITURES VS. KNOWLEDGE

Important for maximizing ROR AND lowering cost of failure!

4 MAJOR EXPLORATION PLAYS

EXPENDITURE

APACHE WELLS IN PLAY

- Avg Total Land expenditure/play
- Avg$/Net Acre
Very important to have support, however, **not impossible** if it is weak

. . . Remember resilience, tenacity, quality of proposal etc. . .

These qualities can change/influence the level of a company’s commitment
COMPANY SUPPORT FOR EXPLORATION VERSUS QUALITY OF EXPLORATION PROPOSAL

- Poor Proposal
  - Hopeless
  - Low company support

- Excellent Proposal
  - Optimal
  - Strong company support
EXPLORATION EXAMPLES

Ladyfern
- CONVENTIONAL 600 BCF GAS DISCOVERY IN 2000

Horn River
- UNCONVENTIONAL (≈60 TCF) GAS DISCOVERY IN 2004

Liard
- UNCONVENTIONAL (≈ 100 TCF) GAS DISCOVERY IN 2009
LOCATION MAP: LADYFERN, HORN RIVER, LIARD

North American shale plays

Source: U.S. Energy Information Administration based on data from various published studies. Canada and Mexico plays from ARI. Updated: May 9, 2011
LADYFERN, HORN RIVER, LIARD STRAT COLUMN

<table>
<thead>
<tr>
<th>BASIN</th>
<th>PLATFORM</th>
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<tr>
<td><strong>Permian</strong></td>
<td><strong>Fantasque Formation</strong></td>
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<td>U</td>
<td>Kindle Formation</td>
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<tr>
<td>M</td>
<td>Rundle Formation</td>
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<td>L</td>
<td>Mattson Fm</td>
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<td>Goleta Fm</td>
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<td>Rundle Group</td>
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<td>Banff Fm</td>
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<td>Exshaw Fm</td>
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<td>Fort Simpson Formation</td>
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<td>Muskeg Formation</td>
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<td>Lower Keg River Fm</td>
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<td>Upper Keg River Fm</td>
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<td>Evie Mbr</td>
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<td>Shunda Formation</td>
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<td>Pekisko Formation</td>
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<td>Banff Formation</td>
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<td>Exshaw Formation</td>
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<td>Kolcho Formation</td>
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<td>Tetcho Formation</td>
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<td>Trout River Formation</td>
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<td>Kakiska Formation</td>
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<td>Red Knite Fm</td>
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<td>Upper Mbr</td>
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<td>Jean Marie Mbr</td>
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<td>Fort Simpson Formation</td>
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<td></td>
<td>Muskwa Fm</td>
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<td>Slave Point Fm</td>
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<td>Watt Mbr Fm</td>
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<td>sulphur Point Fm</td>
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<tr>
<td></td>
<td>Muskieg Fm</td>
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Liard
Ladyfern
Horn River
LADYFERN DISCOVERY: ON THE GROUND
Apache reports 31 MMcf/day gas discovery in Canada

Houston, Feb. 17, 1999 -- Apache Corporation (NYSE: APA) today announced a Canadian gas discovery which tested at the rate of 31 million cubic feet (MMcf) per day. The discovery is in the Province of British Columbia on acreage acquired from Shell Canada late last year.

"Proved reserves acquired in the Shell Canada transaction were mainly oil, but the major upside lies in gas exploration on nearly 300,000 net acres and in the staff of highly motivated technical people who joined Apache," said Apache President and Chief Operating Officer G. Steven Farris. "This is one of the prospects they had developed prior to the acquisition."

LADYFERN = 5% Canadian Gas Production
B.C. Oil & Gas Revenues Surpass Forestry
THE STORY BEHIND THE HEADLINES

- 15 years of small finds/failures by the industry in the area
- Large gas finds unlikely in future
- Good work done at Shell previously to loosely identify the opportunity
- “Incremental 2D’s” shot over many years
- Then . . .
A CHANGE

- New Ventures group formed in 1997
  - Entrepreneurial, focused, good people . . .
- Only a $25M/year budget
- Committed to a 3D vs previous 2D’s in order to better map trap/reservoir
- 3D confirmed both
- Acquired land
- Ready to drill!!
THE ROLLERCOASTER

- Stop!
- Exceeded our budget of $25M by $2M
- “Wanted the money back” in order to stay on budget
- Only asset was 3D – therefore farmed out a significant interest including $2M for 3D
- Now ready to drill! Well not quite . . .
- Shell sold plains assets to Apache in December 1999
- Apache drilled discovery well in January 2000
- 100 mmcf/d well deliverability!
- 600 Bcf produced . . .
LADYFERN: PRE-DISCOVERY

Slave Point Palaeogeography

Hay River Fault

PLAINS EXPLORATION UNIT
Est. 1997

Cranberry 1974
595 BCF

Ladyfern
Wrench Fault
94H1

Hamburg 1981
495 BCF

PEACE RIVER ARCH CLASTIC EDGE
PRE-LADYFERN SITUATION (1999)

Slave Point Wells/Twp

- 0
- 1 - 2
- 3 - 4
- 5 - 6
- 7 - 8
- 9 - 10
- > 10

LADYFERN

BC AB

Sparse deep well control
HAMBURG AREA – MIDDLE DEVONIAN

Cum. Usable Raw Gas Bcf


Usable Raw Gas

Chinchaga
Cranberry
Hamburg
Ladyfern
Lapp
Chinchaga N.

15 years of small finds/failures
APRIL 1999 – WOULD YOU FARM IN ON THIS PROSPECT?

SHELL - HAMBURG SOUTH BANK
SLAVE POINT GAS PROSPECT

30-90 bcf
recoverable est.

back "reef"
porous stromatoporoid
bank margin

location

fore "reef" basin
Waves and swell
brachiopod marker

shale marker

CORE 10-13-94-13w6

Hydrothermal Concentres - Fracture Fill

Hydrothermal Dolomitizing Fluids

WATT MOUNTAIN FM.

MUSKED FM.

APACHE
LADYFERN: 0 → 500 MMSCF/D IN 18 MONTHS

Ladyfern Production (Actuals to Sept 1/2002)

5 miles

Total Field
APA / Murphy Prod

Apache
LADYFERN AREA: SLAVE POINT ACTIVITY – PRE-2000

Slave Point Wells

LADYFERN 2000

HAMBURG 1981

CRANBERRY 1974

60 miles

90 miles
LADYFERN AREA: SLAVE POINT ACTIVITY – 2003

Slave Point Wells
LADYFERN LEARNINGS

- Good people with chemistry
- Focus on key success factors (seismically mapping reservoir and trap)!
- Acquire 3D data to resolve what will determine success
- Cheap entry (first in) → even cheaper after farm out!
- There are many setbacks out of your control – resiliency is key to success
- Big fields can/and will be found!
- It is never easy!
UNCONVENTIONAL SHALES IN CANADA (2005)

- Early days
- No significant producing area yet
- Major players, Apache, EOG, Trident, MGV possibly Shell, Talisman
- Many isolated shale producers (both gas and oil)
- Recent increase in activity
- Resource is there – rate / reserves are the issue!

... My take on shales in 2005 ...
THE HORN RIVER HISTORY

Began exploration program for conventional gas opportunity in 2000

The Good
- Drilled three successful wells (depth ≈8500’)

The Bad
- Three rigs working the next winter logs looked good; however tested poorly

The Ugly
- Continued to drill 15 wells with exceptionally poor results. (5 mmcf/d total) many dry wells

... “the dark days” ...
MAKING SOMETHING OUT OF NOTHING!

- Scoured the uphole for possibilities
- Tested a conventional reservoir – failed
- Looked at shale – analog to Barnett?
- Tested shale zone → 100 mcf/d → encouraging (2004)
- Gradually have worked our way to 69 gross horizontal wells
  - Peak production (≈ 300 mmcf/d gross)
- 60 TCF + resource identified
- LNG project at Kitimat BC
  
  . . . “better days ahead” . . .
HORN RIVER: DIFFICULT TERRAIN AND REMOTE
PLANNING & EXECUTION CRITICAL TO SUCCESS
Many competitors focused on Horn River and Montney plays
Apache looked at other basins during this time
Liard at top of list: thickness, richness, high OGIP close proximity to Horn
Industry dogma was
- Area is unexplored
- Shale quality may be poor due to depth (11,500 – 15,000 ft)
- Potentially high drilling costs

... Saw a window of opportunity to be first and bought land ...
## Reservoir Liard NE-PA Marcellus Haynesville Units

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>Liard</th>
<th>NE-PA Marcellus</th>
<th>Haynesville</th>
</tr>
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<tbody>
<tr>
<td>Depth</td>
<td>(ft)</td>
<td>9500 - 15000</td>
<td>7000 - 11000</td>
<td>10000 - 13000</td>
</tr>
<tr>
<td>Thickness</td>
<td>(ft)</td>
<td>400 - 1000</td>
<td>150 - 400</td>
<td>100 - 300</td>
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<tr>
<td>Porosity</td>
<td>(%)</td>
<td>3 - 8</td>
<td>6 - 12</td>
<td>4 - 7</td>
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<tr>
<td>Water Saturation</td>
<td>(%)</td>
<td>15 - 20</td>
<td>15 - 45</td>
<td>20 - 40</td>
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<tr>
<td>OGIP / Sec</td>
<td>(BCF)</td>
<td>170 - 500</td>
<td>30 - 200</td>
<td>50 - 100</td>
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<tr>
<td>Thermal Maturity</td>
<td>(VRo)</td>
<td>&gt;1.5</td>
<td>&gt;1.6</td>
<td>&gt;1.7</td>
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<tr>
<td>Pressure</td>
<td>(Psi/ft)</td>
<td>0.85 - 0.92</td>
<td>0.5 - .65</td>
<td>~0.85</td>
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<tr>
<td>GOR</td>
<td></td>
<td>Dry Gas</td>
<td>Dry Gas</td>
<td>Dry Gas</td>
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<tr>
<td>Quartz+Carb</td>
<td>(Vol %)</td>
<td>&gt;90</td>
<td>65 - 90</td>
<td>60 - 70</td>
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<tr>
<td>TOC</td>
<td>(Wt. %)</td>
<td>3 - 6</td>
<td>2 - 10</td>
<td>2 - 4</td>
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- **Lower Besa River First Black Shale**
- **Best gas-shale reservoir evaluated in North America**
- **Excellent vertical and lateral reservoir continuity**

![Gas Filled Porosity](chart.png)
LIARD BASIN
CONTINUOUS GAS FILLED POROSITY

Net pay thickness 1,024 feet 708 feet 425 feet
Porosity 6.4% 7.0% 7.6%
OGIP BCF/section 502 365 290
Well Type Vertical Vertical Horizontal
Fracs 1 1 6
MMCF/D (30-day) 9.8 4.6 21.3
Total Vertical Depth 15,000 feet 13,200 feet 12,600 feet

Gas Filled Porosity
Top Besa River

LIARD BASIN
CONTINUOUS GAS FILLED POROSITY

Net pay thickness 1,024 feet 708 feet 425 feet
Porosity 6.4% 7.0% 7.6%
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Gas Filled Porosity
Top Besa River
Presenter’s notes: As I mentioned earlier, a key component to our strategy is balancing the short and long term and participating in large scale, long-term projects.

We are particularly excited about our promising LNG projects which we have established through two separate partnerships with Chevron, a key player in global LNG.

Our Wheatstone project in NW Australia is expected to come online by the end of 2016 and will monetize approximately 11 TCF gross of gas.

The Kitimat project in NW Canada will help Apache and Chevron monetize our significant shale gas resources in the Liard and Horn River basins which combined have nearly 50 TCF of gas.

Both projects are well positioned to deliver LNG to the growing Asian markets.

The potential size of each of these projects represents over 100,000 BOE/D of additional production for Apache – and at oil linked prices!
At 54° north, Kitimat is one of North America’s closest ports to Asian markets.

**Kitimat-Tokyo**
3,988 nm, 10 days

**Qatar-Tokyo**
6,500 nm, 16 days

- **Upstream operated by Apache**
  - Prolific Western Canadian basins
  - Low-cost Liard/Horn River Basin gas

- **Third Party Transportation – Joint**
  - Infield or 3rd party gas processing

- **Downstream operated by Chevron**
  - KM LNG Trains 1&2 planned for 10+ MTPA gross
  - Pacific Trails Pipeline to Kitimat (480 km)
  - Pre-investing for future expansion

| Apache WI | 50% |
| Partners  | CVX (50%) |
| First Delivery | Pending FID |
| Initial Gross Capacity | Up to 1.5 BCF/Day |
LIARD/HORN RIVER: ACTIVITY 2002

APA Wells
Deep Devonian Wells
Apache Land
Industry Land
Existing Pipeline

LIARD
HORN RIVER

APA

70 miles
109 miles
LIARD/HORN RIVER: ACTIVITY 2003

- APA Wells
- Deep Devonian Wells
- Apache Land
- Industry Land
- Existing Pipeline
LIARD/HORN RIVER: ACTIVITY 2004

APA Wells
Deep Devonian Wells
Apache Land
Industry Land
Existing Pipeline
LIARD/HORN RIVER: ACTIVITY 2008

APA Wells
Deep Devonian Wells
Apache Land
Industry Land
Existing Pipeline

70 miles
109 miles
LIARD/HORN RIVER: ACTIVITY 2010

APA Wells
Deep Devonian Wells
Apache Land
Industry Land
Existing Pipeline

109 miles
70 miles
LIARD/HORN RIVER: ACTIVITY 2011

APA Wells
Deep Devonian Wells
Apache Land
Industry Land
Existing Pipeline
LIARD/HORN RIVER: ACTIVITY 2012

- APA Wells
- Deep Devonian Wells
- Apache Land
- Industry Land
- Existing Pipeline
WORKING WITH STAKEHOLDERS AND FIRST NATIONS

- Significant oil and gas discoveries generally lead to development

- Development impacts people and environment

- It is vital to work with people early in the potential development

- At Horn River this was addressed by the formation of the Horn River Producers group in 2007
The long term success of major oil & gas projects is best assured by:

1) The early definition of success

2) Listening and addressing concerns of stakeholders and First Nations

3) Communicating and developing relationships

4) Working with dedicated people
WHAT DOES SUCCESS LOOK LIKE?

Success of this project means that the main concerns from each major stakeholder group – the community of Fort Nelson, the government representing the people of British Columbia, the First Nations and industry – are understood and addressed while responsibly developing the asset . . .
THE MODEL: ROAD TO SUCCESS

"People" Factors
- Voice in Ongoing Development
- Establish Process/Values and Develop Solutions to Concerns
- Identify Stakeholder Concerns
- Identify Stakeholders

"Technical / Economic" Factors
- Idea
- Evaluation Phase
- Development Phase

SUCCESS FOR ALL
ADDRESSING CONCERNS: LOCAL EMPLOYMENT

The communities’ clearly articulated concerns led to:

1) Focus on the issue
2) Set of HRBPG principles on local employment
3) Numerous job fairs in Fort Nelson
4) Development of a local employment office (Energy Services B.C.)
5) Funding of an Operator Training Program in Fort Nelson
6) Company offices in Fort Nelson

7) Result

... A significantly improved local employment picture ...
**Presenter’s notes:** At Horn River, 2011 Completions (our latest) averaged 92% Debolt water with our last pad averaging 97.6% Debolt.
SUMMARY OF LEARNINGS/VALIDATION

- Early is better
- Resilience – significant failure can lead to more significant success
- Move quickly
- Understanding your competition – the herd mentality
- Social license is critical! Listening, seeking creative solutions and acting early are essential
- Solid exploration proposals combined with company commitment are optimal
- It all comes down to excellent people... always!
acknowledgements/thank you

- People who have worked with me through many of the failures and the success and are currently part of our team
  - Ross Pitman (Geologist) 16 years
  - Kelvin Colquhoun (Geophysicist) 18 years
  - Joe Lamantia (Land) 18 years
  - Sharon Dixon (G&G) 17 years

- Many others who have contributed over 32 years including the Apache EPT group for work on unconventional reservoirs!

- Shell Canada for their training and learning environment

- Apache for their unwavering commitment to exploration in Canada