



# Market Leading Canadian Oil Sands Expertise

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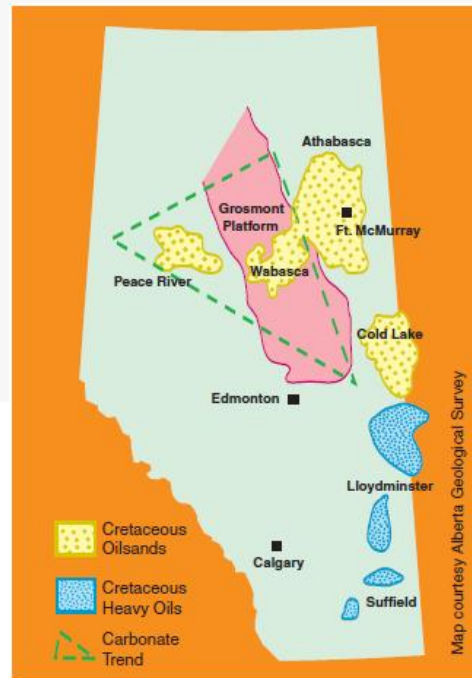
# Canadian Oil Sands

More than 40 years  
evaluation experience

Evaluating oil sands  
since the mid 80's



Source: Alberta Geological Survey



We evaluate nearly 100%  
of the currently  
operational oil sands  
mining projects

We have completed  
projects for  
approximately 85% of  
the in situ oil sands  
operators

We have evaluated more  
than 200 individual oil  
sands assets in Alberta  
and Saskatchewan in the  
last 12 months alone

# Recent In Situ Evaluations

## Operational Projects

- CNRL - Tangleflags
- Connacher - Great Divide, Algar
- ConocoPhillips - Surmont
- JACOS - Hangingstone (Demonstration)
- Laricina - Saleski (Pilot)
- Laricina - Germain Grand Rapids (Demonstration)
- MEG - Christina Lake
- OPTI - Long Lake
- Pengrowth - Lindbergh
- Penn West - Seal
- Petrobank - Conklin (Pilot)
- Shell - Orion
- Southern Pacific - Senlac, McKay
- Statoil Kai Kos Dehseh - Leismer (Demonstration)
- Suncor - Firebag, MacKay River

# Recent In Situ Evaluations

## Planned Projects

- Alberta Oilsands - Clearwater West
- Athabasca Oil - Birch, Dover, Dover West, Dover West Devonian, Hangingstone
- Birchwood - Sage
- Cavalier - Saleski
- Cenovus - Leismer, Telephone Lake
- ConocoPhillips - Clyden, Crow Lake, McMillan Lake, Saleski, Thornbury
- Dover Operating Corp. - Dover
- Enerplus - Kirby
- Grizzly - Algar Lake, May River, Thickwood
- Harvest - Black Gold
- Husky - Caribou, McMullen, Saleski
- Ivanhoe - Tamarack
- Koch - Gemini
- Laricina - Germain, Saleski
- MacKay Operating Corp. - MacKay
- MEG - Surmont
- Marathon - Birchwood
- One Earth - Gift
- OPTI - Kinosis, Cottonwood, Leismer
- Oak Point - Lewis
- Oilsands Quest - Axe Lake, Raven's Ridge, Wallace Creek
- OSUM - Saleski, Taiga-Cold Lake
- Statoil - Corner, Greater Leismer, Hangingstone, Thornbury
- Suncor - Chard, Kirby, Lewis, Meadow, Steepbank
- Sunshine - Harper, Legend Lake, Thickwood, West Ells
- Surmont - Wildwood
- Total - Asphalt Creek, Emerillon, Griffon
- Value Creation - Terre de Grace

... plus a long list of emerging assets

# Technological Currency

We internally review all operational projects in the Canadian Oil Sands Region annually, commissioned evaluation projects aside

Expertise includes SAGD, CSS, cold production & CHOPs, polymer & ASP flooding, spacing sensitivities & SAGD infill drilling, solvent assisted processes, NCG injection, low pressure operations, unconventional caprock and conformance enhancement strategies

We were the first IQRE to recognize contingent resources in carbonates (technology under development)

Our evaluations span a multitude of formations including the McMurray, Wabiskaw, Clearwater & Grand Rapids sandstones (and their equivalents) plus the Grosmont, Ireton, Leduc & Nisku carbonates



# Typical 5 Step Evaluation Process

Determine Bitumen Initially In Place (BIIP)

Estimate Recovery Factors

Estimate Type Well Production Profiles

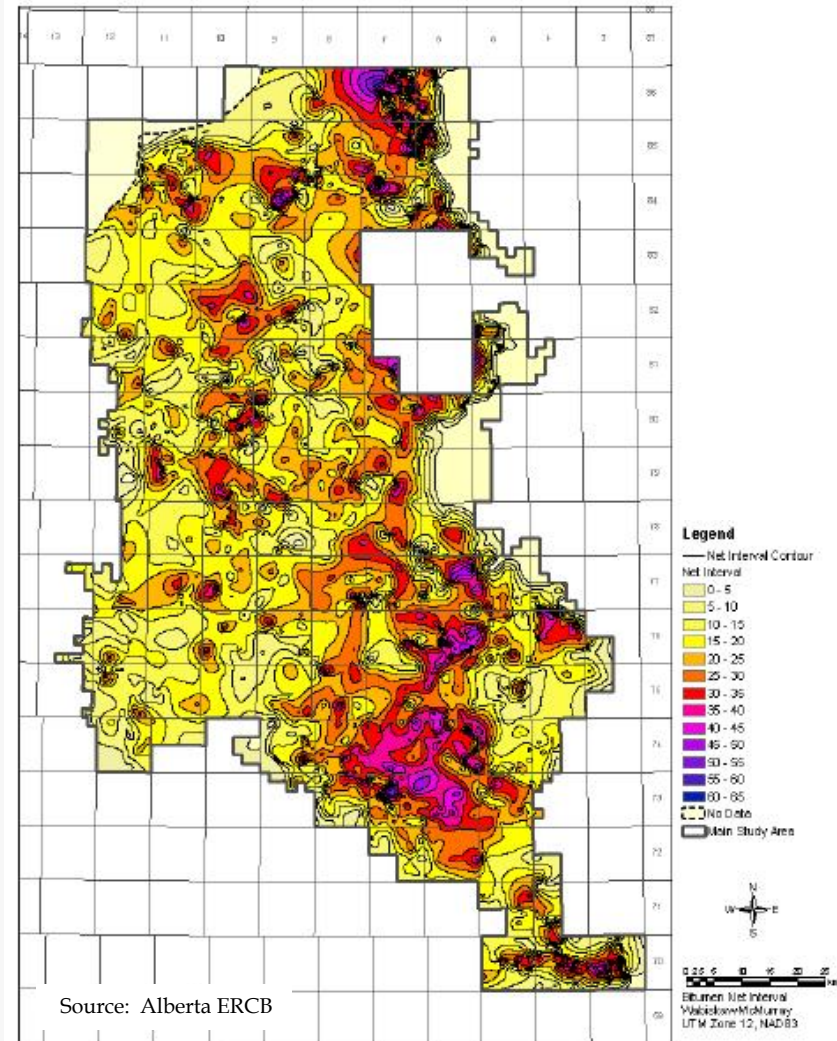
Estimate Type Well Production Efficiency

Build Economic Forecasts

Volumetric estimations are tuned to analogue performance and technical studies including laboratory testing and simulation

# SAGD BIIP

- Map net continuous bitumen pay using well logs, core analyses and core photos
- Determine porosity, initial oil saturation & permeability from core and petrophysics
- Quantify impairments & quality variations; map if significant
- Assess caprock integrity & water source and disposal



# Recovery Factor

$$\text{Recovery Factor} = E_d * E_v * E_h * E_c$$

$$E_d = \text{Displacement Efficiency} = (S_{oi} - S_{or}) / S_{oi}$$

$$E_v = \text{Vertical Efficiency} = \text{Effective H} / H$$

$$E_h = \text{Horizontal Efficiency} = (\text{Effective H} - D * S / 4) / (\text{Effective H})$$

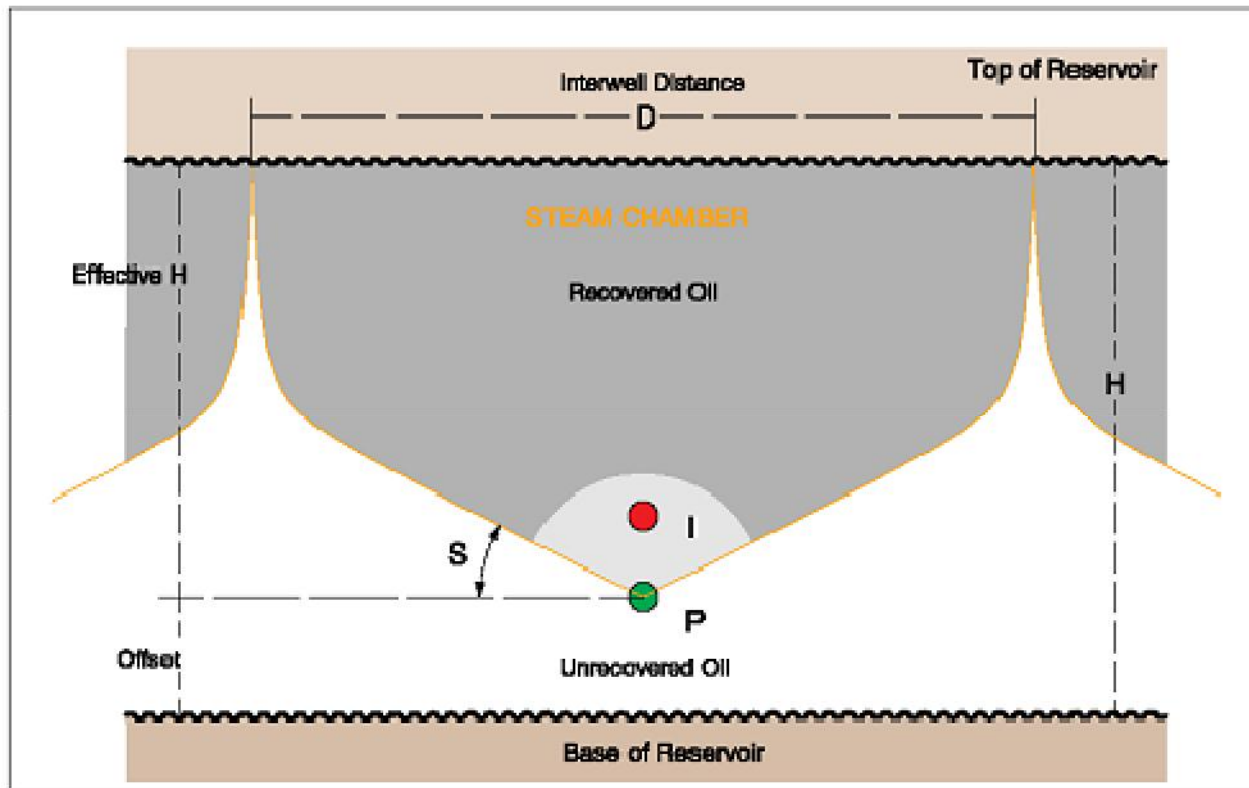
$$E_c = \text{Conformance Efficiency}$$

which includes sweep inefficiencies due to (i) local permeability barriers and reservoir heterogeneities along the length of the well pair, (ii) geographical inaccessibility, (iii) operational impacts and (iv) other perceived uncertainties/risks

**Recovery factors and economically recoverable volumes  
are determined on an lsd by lsd basis  
incorporating lateral variations in reservoir quality and impairments**



# Recovery Factor



# Production Rates

## Rate increases with

- Well Length
- Square root of  
Effective H  
Permeability  
Porosity  
Change in oil saturation  
1/viscosity

## Controllable Factors

- Higher operating temperature/pressure
- Longer well length
- Lower well standoff

Viscosity improves as steam temperature increases  
Steam temperature increases with operating pressure

# Steam Oil Ratio

Steam oil ratio (SOR) is a measure of production efficiency; how many barrels of steam are required to produce a barrel of bitumen?

While heating the bitumen, heat will be lost to reservoir rock, other reservoir fluids, overburden & underburden and impairment zones including bottom water, top gas, top water and lean zones

Everything else being equal, cumulative SOR increases for

- thinner pay
- higher operating pressure
- lower porosity
- lower initial oil saturation
- longer time to depletion (lower effective permeability, operational issues, wider spacing)
- more extensive and thicker impairment zones

# Economic Forecasts

## Operating and Capital Cost Models

- based on historical actual costs, client costs studies and/or GLJ's knowledge of similar projects
- operating costs are forecast as fuel and non-fuel (variable, fixed well month and fixed annual) costs
- capital costs are sub-divided into delineation, drill & complete, pumps, pad, facility, co-gen, infrastructure and maintenance costs

## Development Forecast

- type wells are forecast on-stream up to facility design capacities with allowances for operational downtime

## Commodity Sales Prices

- based upon the saleable product, typically bitumen or synthetic crude oil
- net wellhead bitumen price takes into account the type of diluent, blend ratio, quality differentials and transportation arrangements (trucking, rail, pipeline) to various markets

# Resource Classifications

## Discovered versus Undiscovered BIIP

- sufficient data (core, log and fluid data) to confirm the likelihood of economically viable production for the defined development technology
- core data confirms fluid saturations, reservoir quality and facies
- fluid analyses confirm fluid density and viscosity
- well density requirement will depend on depositional environment, reservoir variability and analogues in the vicinity

## Reserves Booking Requirements

- established technology or successful pilot results
- positive project economics (based on good quality cost estimates and reasonable forecast pricing ie GLJ's in house price deck)
- high likelihood of regulatory approvals, corporate sanctioning
- development within a reasonable time frame, first major capital within 2-5 years



# Questions?

## Contact our Team

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