In Situ Pad Discussion

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Well Pad Program Director, Major Projects.

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In Situ Pad Discussion

The format that your In Situ development takes depends on may factors that may be unique for your Company, Reserve, Facility, Philosophy and core Competencies.

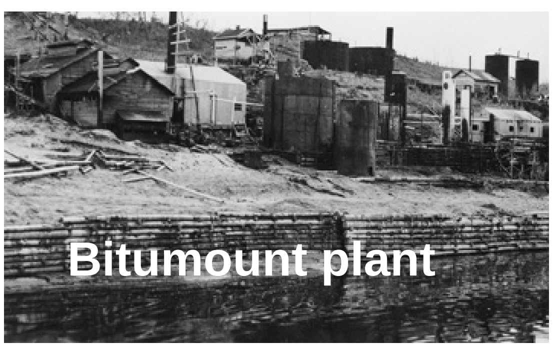
Where is the industry heading and why?

Who is driving the change?

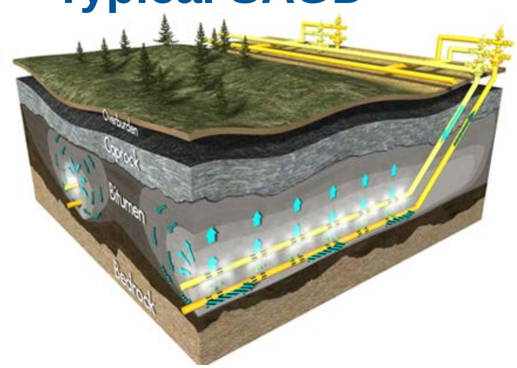
Is the industry heading in a common direction in spite of these unique aspects?

What are some of the high level items that should be considered when developing a strategic direction?

Lets have an open discussion to understand the variables and our options.



Typical SAGD



Why is the Bitumen here?

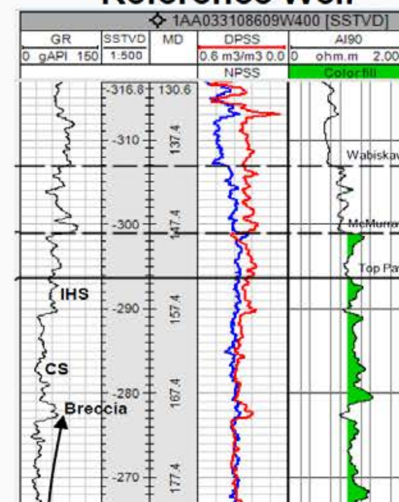
Hangingstone Project - Subsurface
Depositional Environment of Middle McMurray

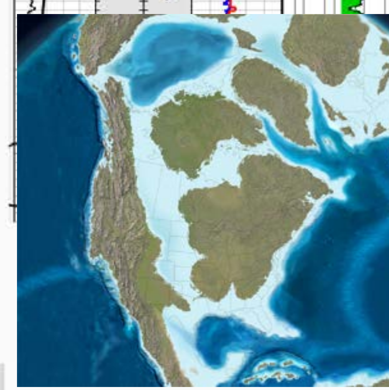
Modern Analog – Estuarine Environment
(Digul River Estuary, Papua New Guinea)

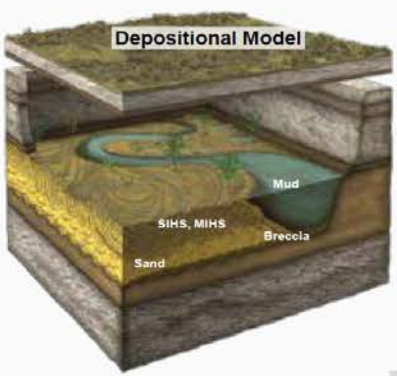
Middle McMurray Deposits

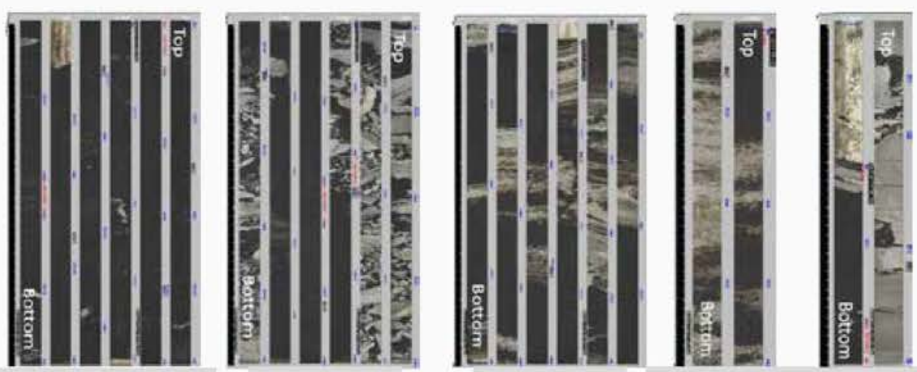
- Formed dominantly in a mixed tide and wave dominated estuary system.
- Reservoir is composed of amalgamated point bar deposits dominated by fine-medium grained, channel sand. Mud clast breccia is commonly found near the base of the reservoir. The reservoir fines upwards into interbedded sand and mud (sandy and muddy IHS). Thin mud layers are typical towards the top of the reservoir.

Reference Well









Channel Sand (CS) | Breccia | SIHS (IHS) | MIHS | Mudstone

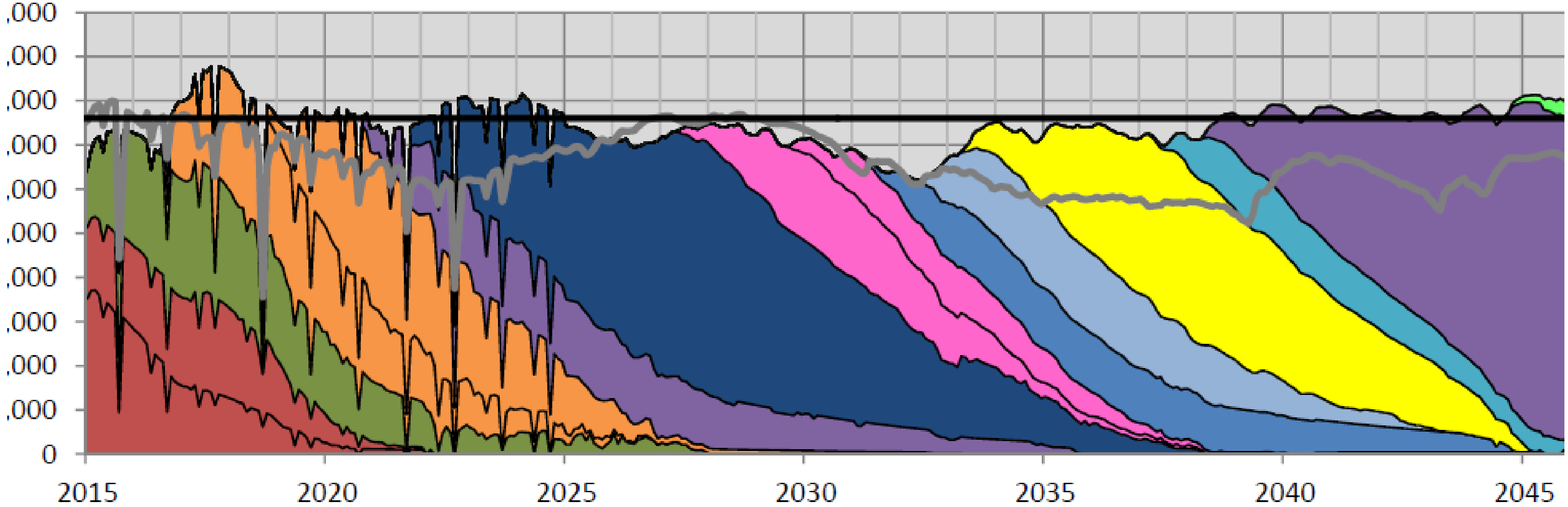
Choosing an Alberta Oil & Gas Mega Projects

- Mine
  - Environmental pressure, Capital intensive, Labour intensive, Risk/Reward
- In Situ
  - Variable capital intensity, Lower capital/barrel, Lower energy intensity, Fungible production
- Upgraders
  - Capital intensive, Global bitumen production change, Limited local market

In Situ project cost breakdown

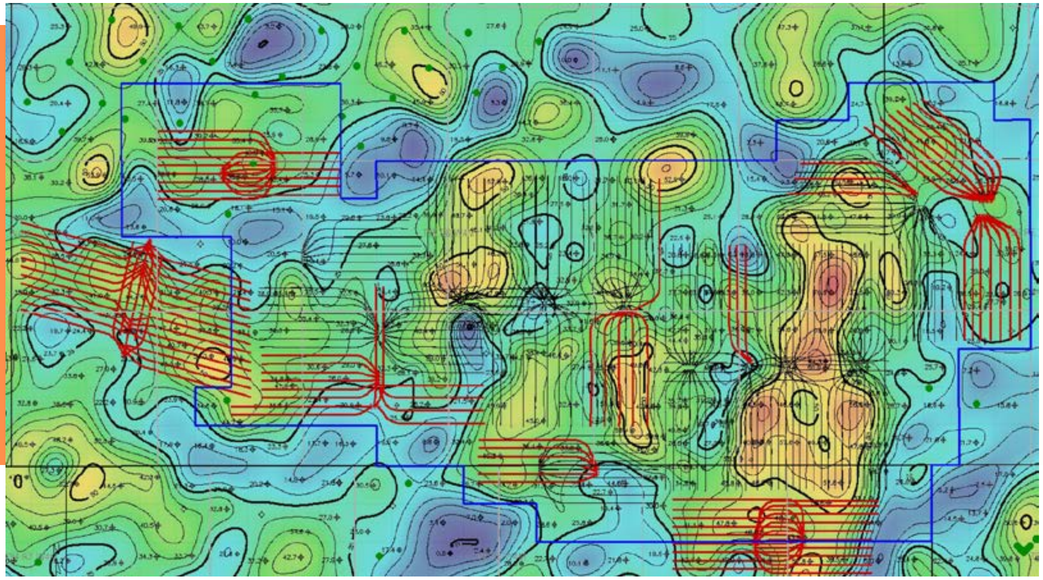
- 30% Central processing facility / 70% Pad costs
  - 40% Drilling and completions / 60% Pad facility costs
    - 40 to 45% of In Situ project costs are related to pad facilities.

Continuous well pad development



In Situ Well Pad Development

- 10 to 15 year reservoir depletion
- Reservoir characteristics
- Well Spacing and in fill wells
- Technology development



How do we compare?

	Suncor Firebag	Suncor MacKay River	Cenovus Foster Creek	ConocoPhillips Surmont	Devon Jackfish	MEG Energy Christina Lake
Approximate Reservoir Depth *approx from logs	275-325	95-130	180-225m	305-425m	400m	345-400m
Well pairs per pad Well Spacing	12-22 10 m	9-14 10 m	12-13 10 m	12 10 m	7 10 m	6-9 10 m
Artificial Lift	ESP	ESP	ESP, Rod Pumps, PCP's	ESP, PCP's	none	ESP
Gas Lift		x	x	X	x	X
Start Up Method	Circulation Bullhead	Circulation	Circulation Solvent Soak	Circulation Dilation	Circulation	Circulation

Well Pad Costs

A SAGD operation at the Cenovus Christina Lake facility near Lac La Biche, Alta

Pad facility project costs breakdown

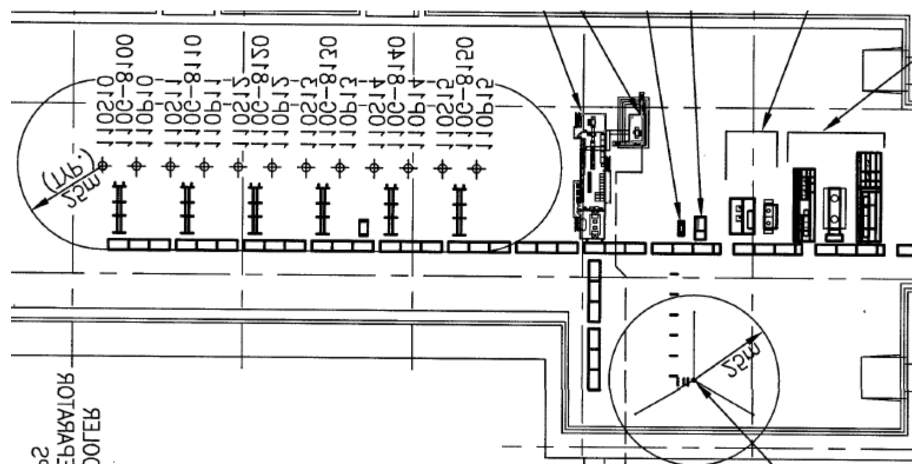
- 10% Engineering
- 30% Material
- 50% Labour
- 10% Overhead, other

A SAGD well pad at Suncor's Firebag development helped boost thermal oilsands output to a record in April.

Suncor

Scope development

- Stage of facility; New, Sustaining production, Technology development
- Life cycle plan; Abandon, Relocate, Reuse
- Reservoir characteristics and Technology selection
- Technology centric or Repetitive efficiencies
- Repeatable design philosophy Whole facility or Module components
- Size, Configuration, Components, Complexity



Cenovus

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Christina Lake

A typical Foster Creek multiwell pad
includes nine well pairs.
Photo from O&G J 9/6/2010 from Cenovus

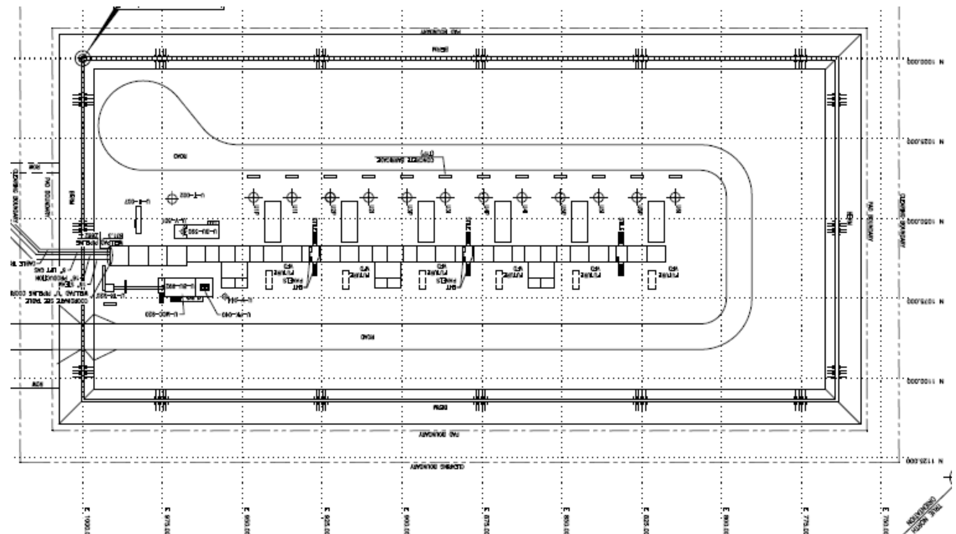
cenovus ENERGY

Starting off with the end in mind

Contracting strategy

- **E,P,C / EP, CM / EPC / others**
  - Project structure and contracting strategy to align with corporate capabilities and structure

Starting off with the end in mind



Engineering development

- EP's size and capability match to owner requirements
- Desired speed of development and project phase overlap
- Industry knowledge, Local capabilities, High values center
- 100% Off shore, what does it look like
- Continuous improvement or Productivity efficiency

- **Design once and build many… What does that feel like?**

MEG ENERGY

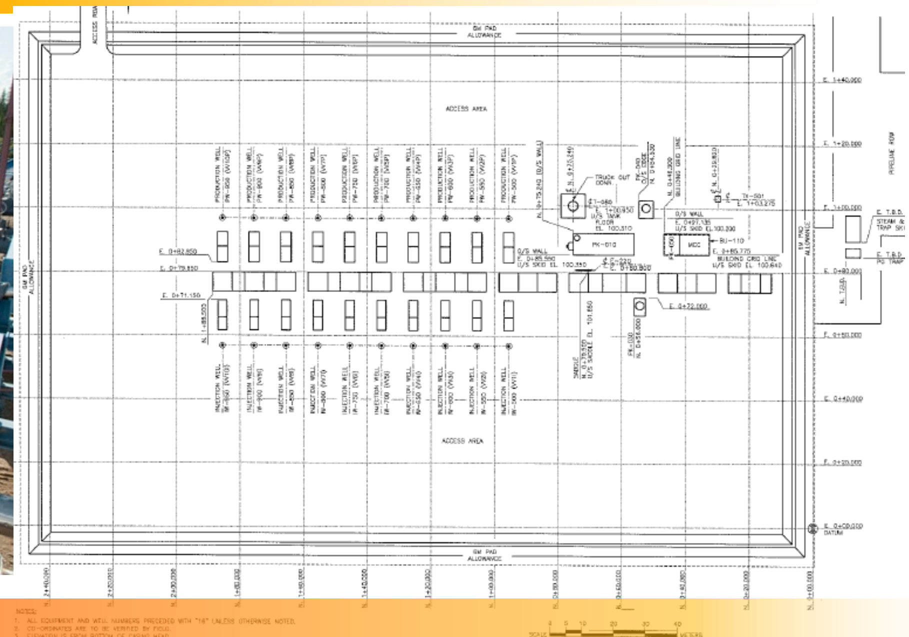
How do we compare? – Benchmarking Well Pad Design

	Suncor						
	FB 116	FB 115	MR 750/751	Cenovus	Conoco Phillips	Devon	MEG
Group Separator	V	☒	V	H	H	H	☒
Group Transfer Pump	✓	☒	✓	✓	✓	✓	☒
Group Separator Booster Pump	☒	☒	☒	✓	☒	☒	☒
Test Separator	☒	☒	V	H	H	V	V
Test Separator Transfer Pump	☒	☒	✓	✓	✓	✓	☒
Test Separator Booster Pump	☒	☒	☒	✓	☒	☒	☒
Lift/Fuel Gas Heater:	E	E	E	G/FG	☒	S	FG
Produced Gas Exchanger:	✓	✓	☒	✓	☒	☒	☒
Produced Gas Cooler/Separator	✓	✓	☒	✓	☒	☒	☒
Annulus Gas Cooler/Separator	☒	✓	☒	☒	☒	☒	☒
Condensate Pump	✓	✓	☒	✓	☒	☒	☒
Ethylene Glycol Pump/Glycol Heater	☒	☒	☒	✓	☒	☒	☒
Flare K.O. Drum	✓	✓	☒	✓	✓	☒	☒
Pop Tank	☒	☒	✓	✓	☒	✓	✓
Flare Stack	✓	✓	☒	✓	✓	☒	☒
Instrument Air Package	✓	✓	✓	☒	☒	✓	✓
Chemical Injection	☒	☒	D/RD/C	☒	M/D/C	D	D/RD
Flush Water Pump	☒	☒	☒	✓	☒	☒	☒
Start-Up Skid	☒	✓	☒	☒	☒	☒	☒

Legend:
C = corrosion
D = demulsifier
E = electrical
FG = fuel gas
G = glycol
H = horizontal
M = methanol
RD = reverse demulsifier
S = steam

What are the controllable

A well-pad at the Devon Jackfish In Situ mine site
St Albert Gazette Jul 2010.



Material

- Major components and Tagged items
  - Consistency or low cost option
  - Commercial agreements
  - Design considerations
  - Operations and Maintenance impact
  - Technology development

Where to get the work done

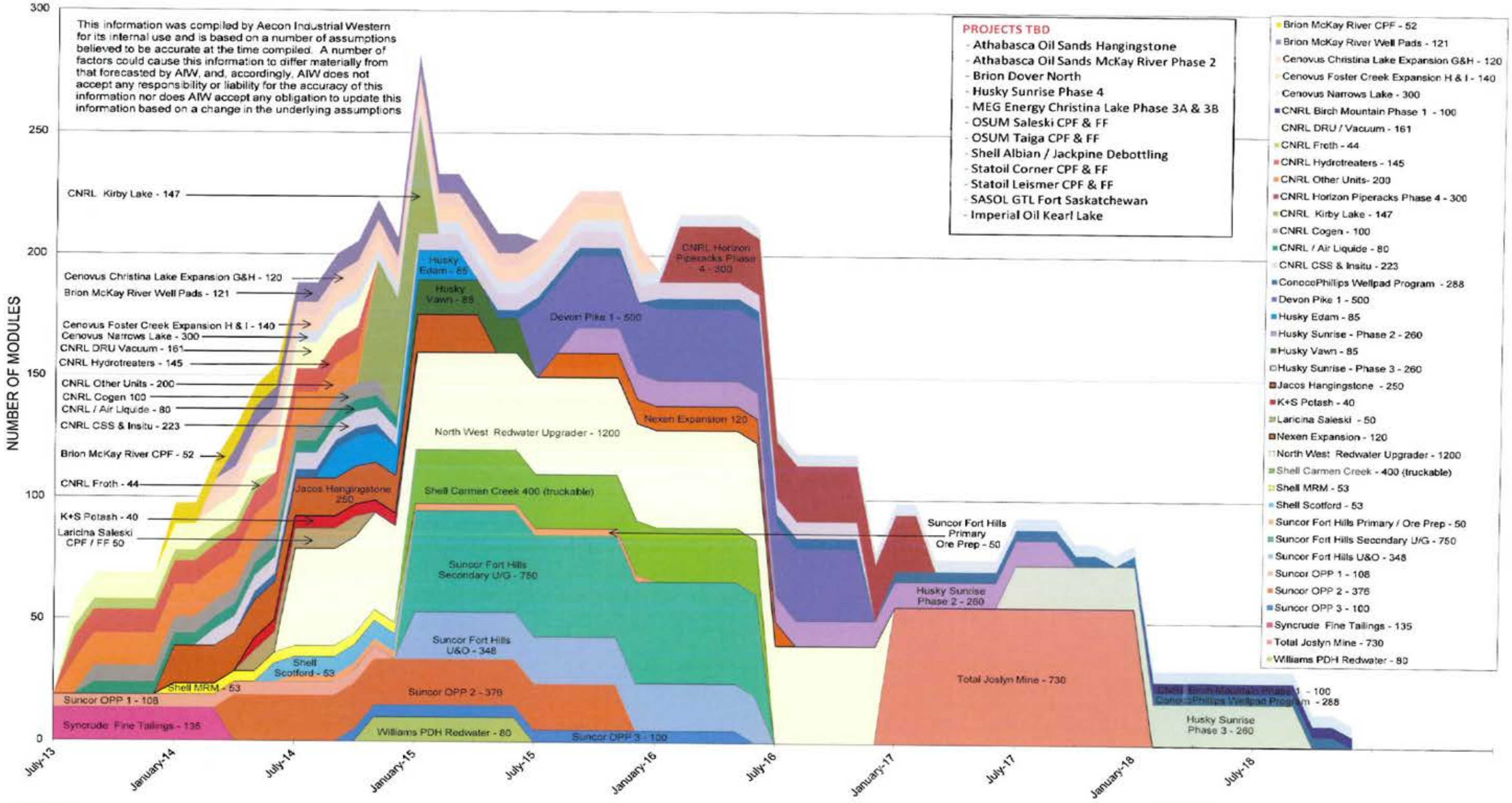
Modulation

- Percentage of modularization
- Location of work
  - Fabrication
  - Assembly
  - Transportation
- Alberta size or Truckable
- Owner managed, Industry capability, 3rd Generation

Where to get the work done

AECON

FORECAST - MODULES UNDER CONSTRUCTION



NOTE: Data assumes 12 week construction schedule

Where to get the work done

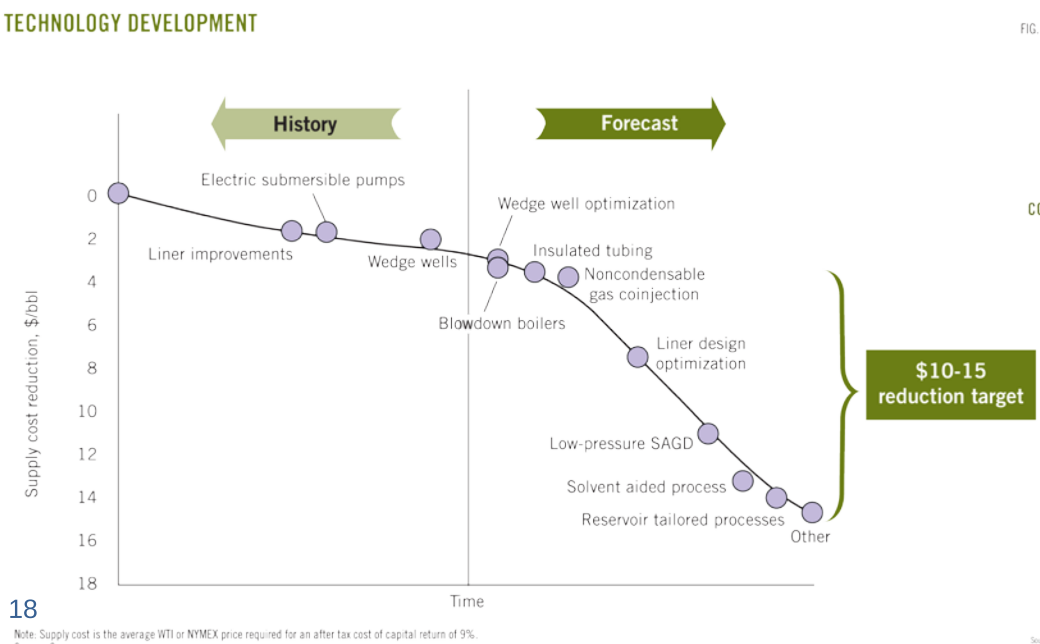
Labour

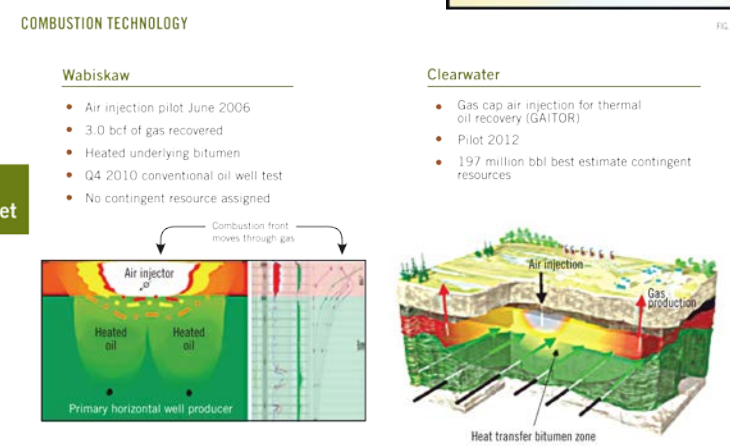
- Field Construction
  - Owner managed, General contractor, Turn key
  - Labour capacity, Travel cards, Temporary foreign workers
  - 3 bids and a buy, Long term relationships,
  - Lump Sum, Time & material, Unit rate
  - Performance and Incentives

Other considerations

- Corporate considerations
  - Standards and Specifications
  - Class of Plant
  - Project Governance

  - Technology development, How and when to incorporate
    - ESEIEH - Enhanced Solvent Extraction Incorporating Electromagnetic Heating
    - Co-Injection Direct Stimulation
    - Gas Lift vs. Mechanical lift End of reservoir life





Additional information

http://www.aer.ca/data-and-publications/activity-and-data/in-situ-performance-presentations

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In Situ Progress Presentations

DATA & PUBLICATIONS

Activity & Data

- Commingling
- Confidential Well List
- Control Well Requirements
- Core & Drill Cutting Material Sampling
- Drilling Activity
- Facility Approvals Daily List
- Horizontal Well List
- In Situ Progress Presentations
- Pipeline Approval and Disposition Daily List
- Pipeline Construction Notification List
- Reference Codes
- Thermal In Situ (TIS) Water Publication

In Situ Progress Presentations

Operators of in situ oil sands schemes are required to present regular performance reviews to the AER. Resource management reports are required from some operators and, if nonconfidential, are provided here as a separate submission or are incorporated into the performance presentations. Presentations older than what is displayed in the table below, continue to be available through the Information Product Services Section at infoservices@aer.ca.

- Directive 054: Performance Presentations, Auditing, and Surveillance of In Situ Oil Sands Schemes
- Directive 081: Water Disposal Limits and Reporting Requirements for Thermal In Situ Oil Sands Schemes
- Thermal In Situ (TIS) Water Publication

** File size > 50 MB*

Andora Energy Corporation		2013	2012	2011	2010	2009	2008
Sawn Lake SAGD 11341	Presentations				PDF		

Athabasca Oil Corporation		2013	2012	2011	2010	2009	2008
Hangingstone SAGD 11888	Presentations	PDF					

Historical commercial development

The first attempts to develop the Athabasca Oil Sands commercially were made under the assumption that the bitumen in the area must be coming from pools of oil deep beneath the surface. In an attempt to locate these pools, Alfred von Hammerstein drilled the first wells in the region, north of Fort McMurray. Altogether, between 1906 and 1917, about 24 wells were sunk in the search for the mother-lode of oil. None were successful at finding oil, but they did discover salt which became a major industry in the Fort McMurray area for 50 years.

In 1913, Sidney Ells, a young engineer employed by the federal Department of Mines, began his work in the oil sands, which was to last until 1945. Ells was an early advocate of the hot water flotation method of separating bitumen from sand and he conducted a number of experiments to test this technique. He was the first to bring out samples from the area for laboratory testing. As a result, oil sand was shipped to Edmonton to be tested as road paving material. While the paving was successful, oil sand could not compete economically with imported asphalt and the project was dropped.

In the 1920s, entrepreneur R.C. Fitzsimmons used the same hot water flotation process to produce bitumen for roofing and road surfacing at a plant near Bitumount, 80 kilometres north of Fort McMurray. By 1942, however, financial difficulties forced him to sell the operation. In 1948, the plant was taken over by the Alberta Government to investigate extraction methods with large scale equipment.

By 1949, the plant was processing 450 tonnes of oil sand a day, but it was closed because the government was not interested in launching a commercial venture. Data from the experiments was used as the basis for a major study of the viability of commercial production.

Dr. Karl Clark, a scientist with the Alberta Research Council in the 1920s, pioneered experiments with a hot water flotation process which involved mixing oil sand with hot water and aerating the resultant slurry. This would then separate into a floating froth of bitumen and a clean layer of sand which would settle to the bottom of the tank. The hot water flotation method pioneered by Ells, Fitzsimmons and Clark proved, over the years, to be the most viable method of extracting oil from the sand.

In 1936, another developer, Max Ball, founded Abasand Oils Ltd. His plant west of Fort McMurray produced diesel oil from the oil sands. There was a brief flurry of interest in his project, especially during World War II. When the plant burned down after being purchased by the federal government, the project died with the buildings.

The 1950s saw another upsurge of interest in the oil sands when the publication of an Alberta Government report indicated that production from the sand could be a profitable venture.

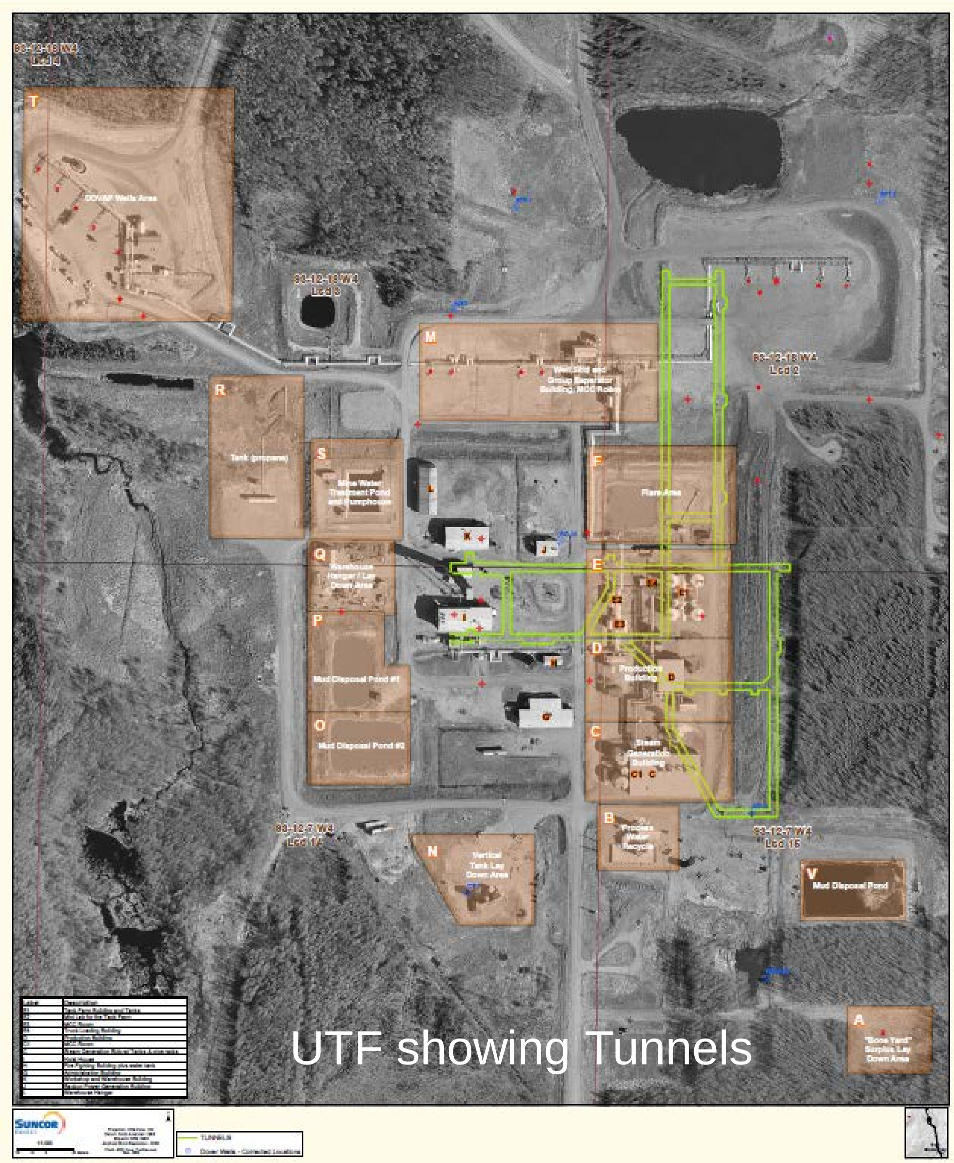
In 1962, the Government of Alberta announced an oil sands policy to provide for the orderly development of oil sands in such a manner that it would supplement, but not displace, conventional crude oil policy.

The first project off the mark was the Great Canadian Oil Sands (GCOS) Project. GCOS went through a number of ownership changes after its incorporation but, by 1963, prior to the construction decision, ownership rested with the Sun Oil Company (later Suncor Energy). The Suncor project came on stream in 1967 and became the world's first oil sands operation.

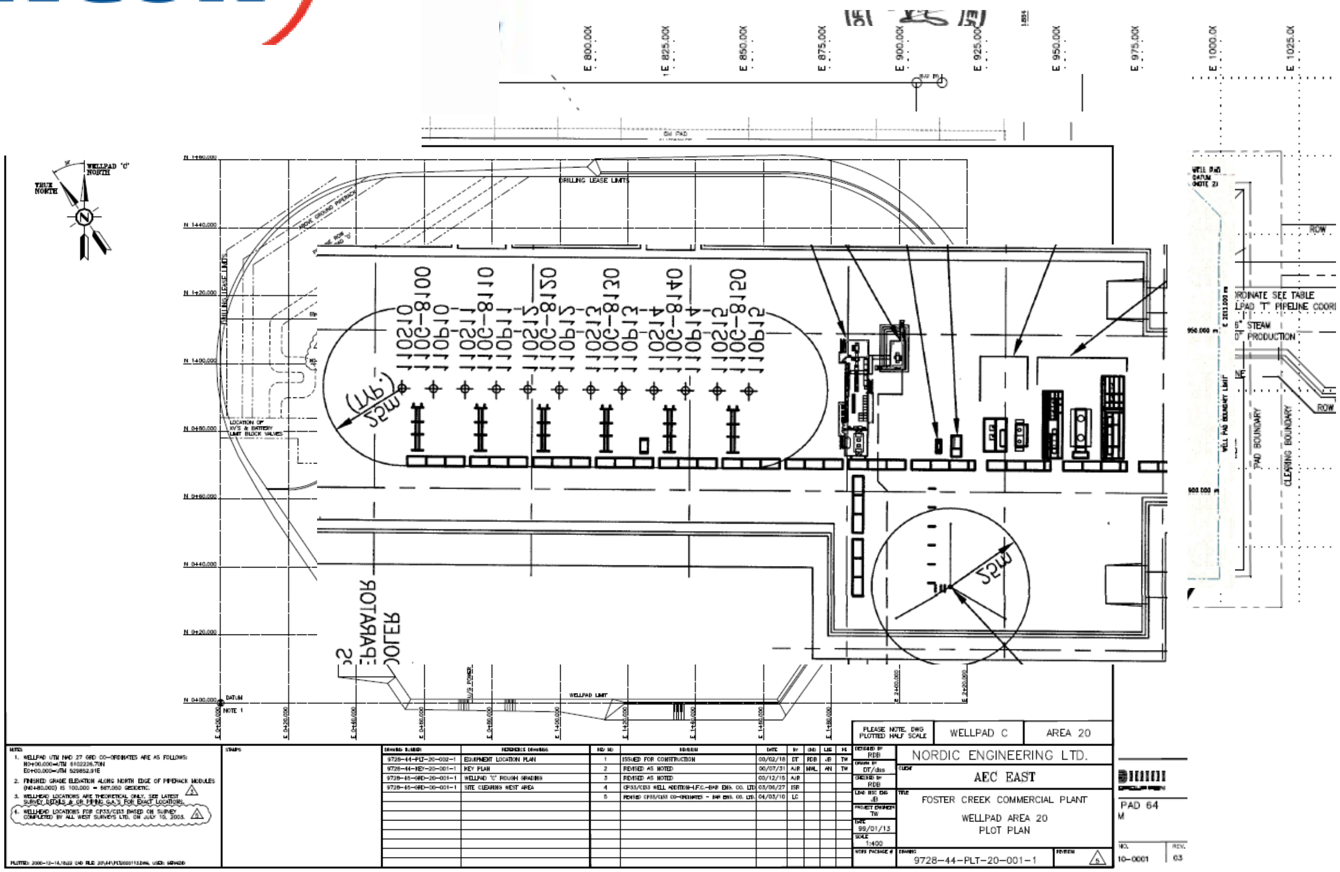
In the meantime, the Syncrude consortium was formed in 1964. Syncrude's initial objective was research on the economic and technical feasibility of mining oil from the Athabasca oil sands. Syncrude's proposal for a production facility was finally approved in 1969.

In 1973, construction began on the Syncrude site and, after five years of construction, the first barrel was shipped on July 30, 1978. The official opening of the Syncrude Project was on September 15, 1978. Production steadily increased in the ensuing years and, on April 16, 1998, the billionth barrel was sent down the pipeline, five years ahead of schedule.

Dover Mine Site



Pad Design

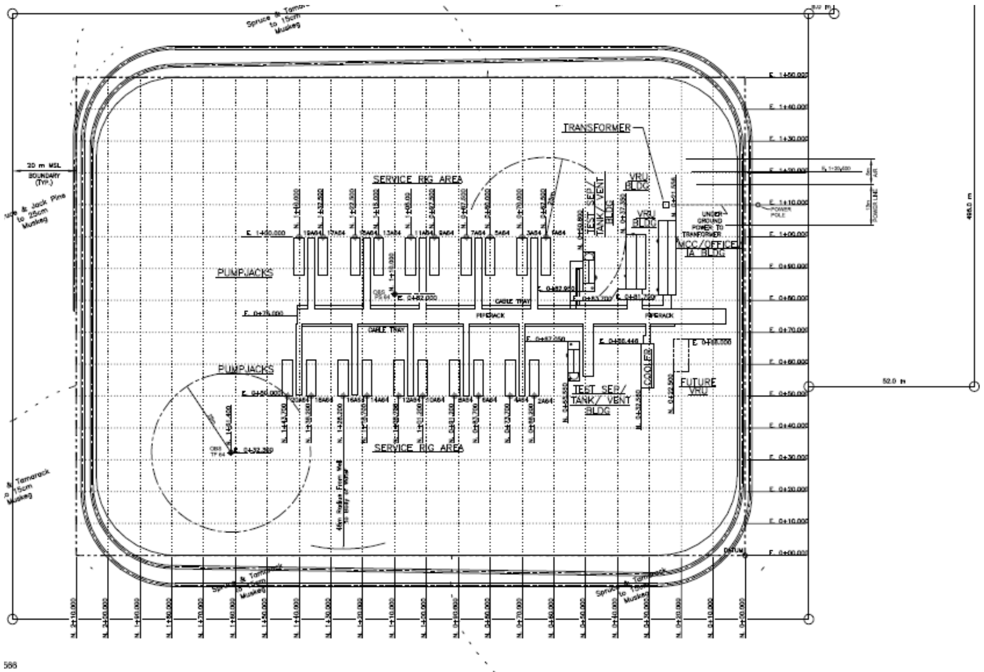

WELLPAD "C" NORTH
TRUE NORTH
DRILLING LEASE LIMITS
WELLPAD LIMIT
PLEASE NOTE, DWG PLOTTED HALF SCALE
WELLPAD C
AREA 20
NORDIC ENGINEERING LTD.
AEC EAST
FOSTER CREEK COMMERCIAL PLANT
WELLPAD AREA 20
PLOT PLAN
9728-44-PLT-20-001-1
ROW
PAD BOUNDARY
CLEARING BOUNDARY

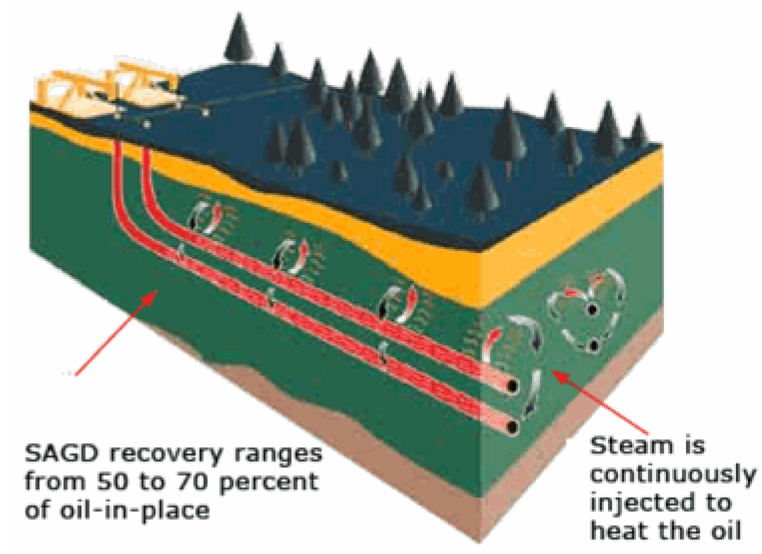
Cenovus

A SAGD operation at the Cenovus Christina Lake facility near Lac La Biche, Alta

Some Foster Creek wedge wells have electrically driven overhead hydraulic pumping units (Weatherford VSH-2 100 hp) while other wedge wells have ESPs.
Photo from O&G J 9/6/2010 from Cenovus

CNRL

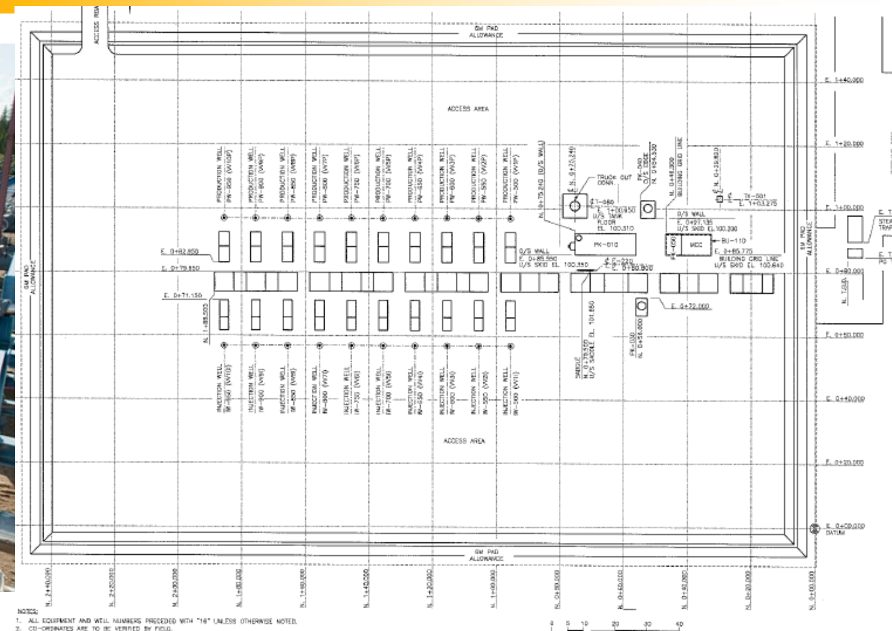


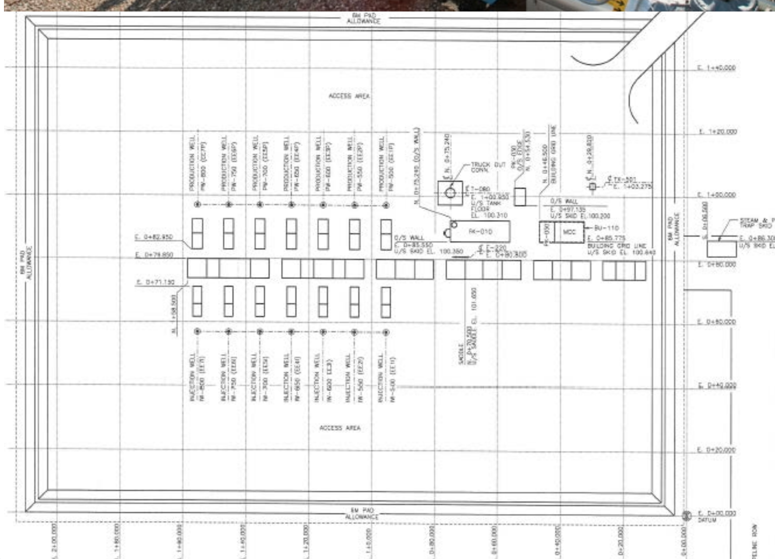


Canadian Natural

Devon

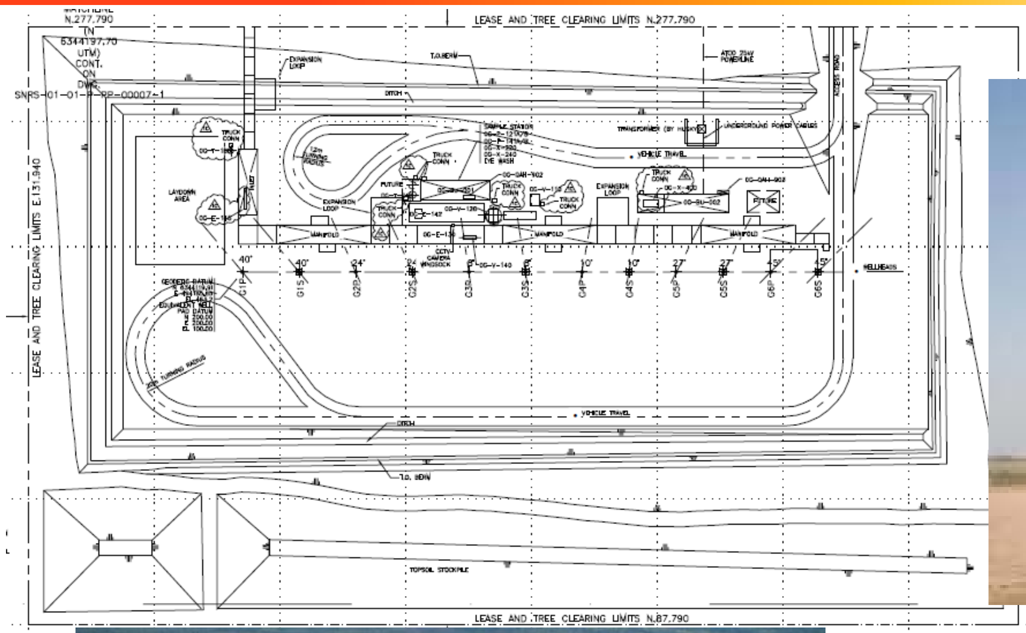
A well-pad at the Devon Jackfish In Situ mine site
St Albert Gazette Jul 2010.





devon

Husky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LEASE AND TREE CLEARING LIMITS E.131.940
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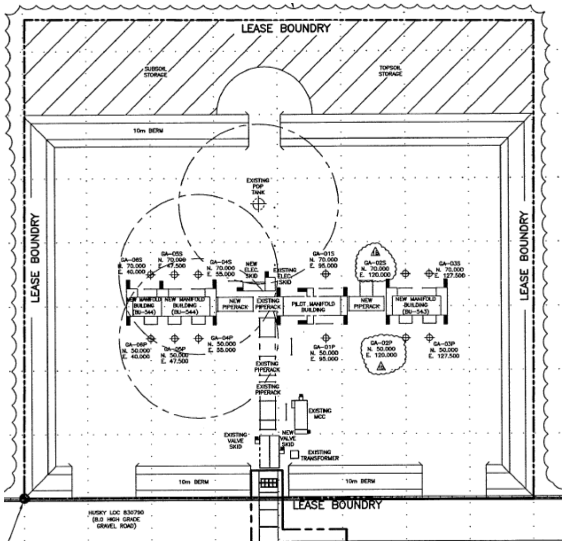
DITCH
T.O. BERM
TOPSOIL STOCKPILE
LEASE AND TREE CLEARING LIMITS N.87.790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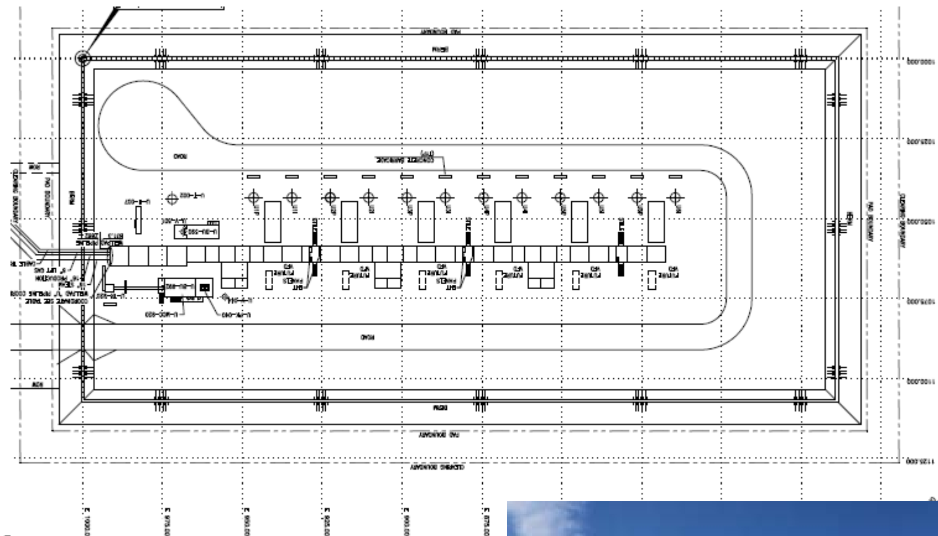
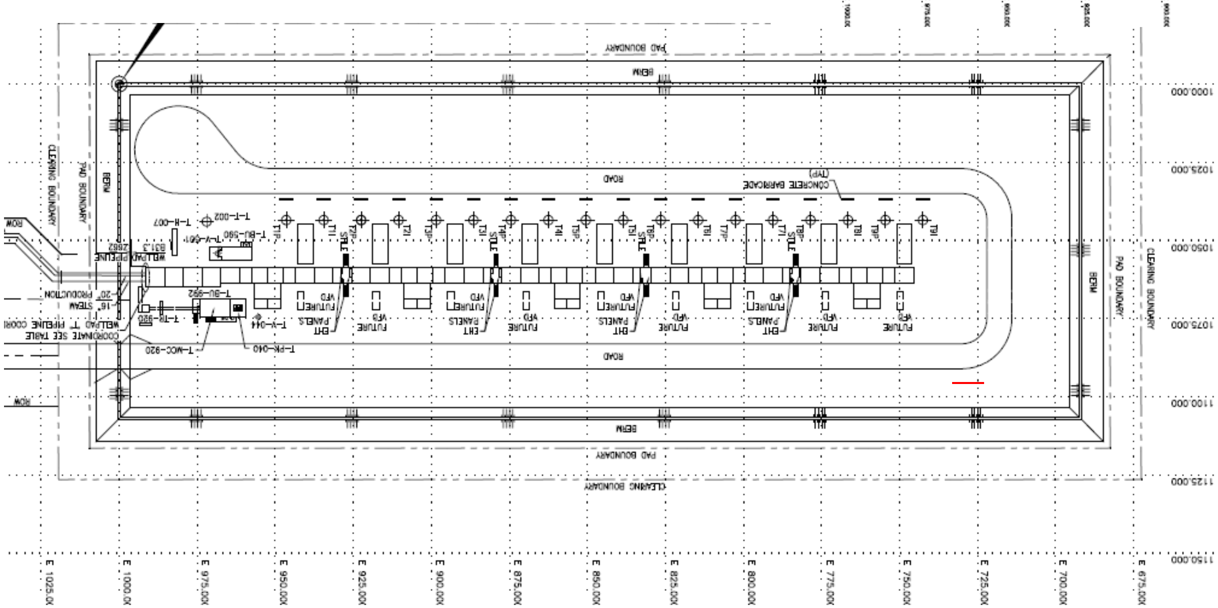
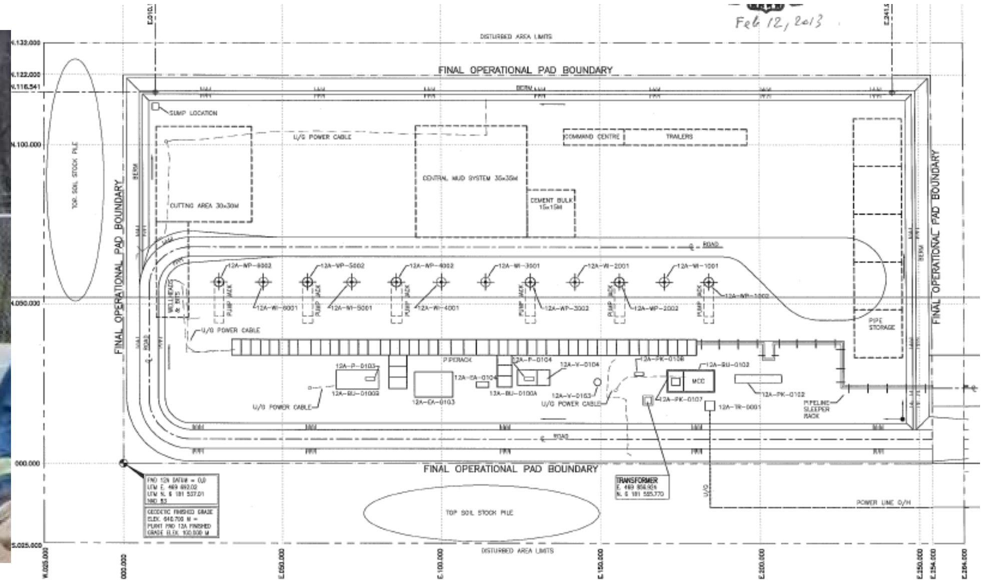
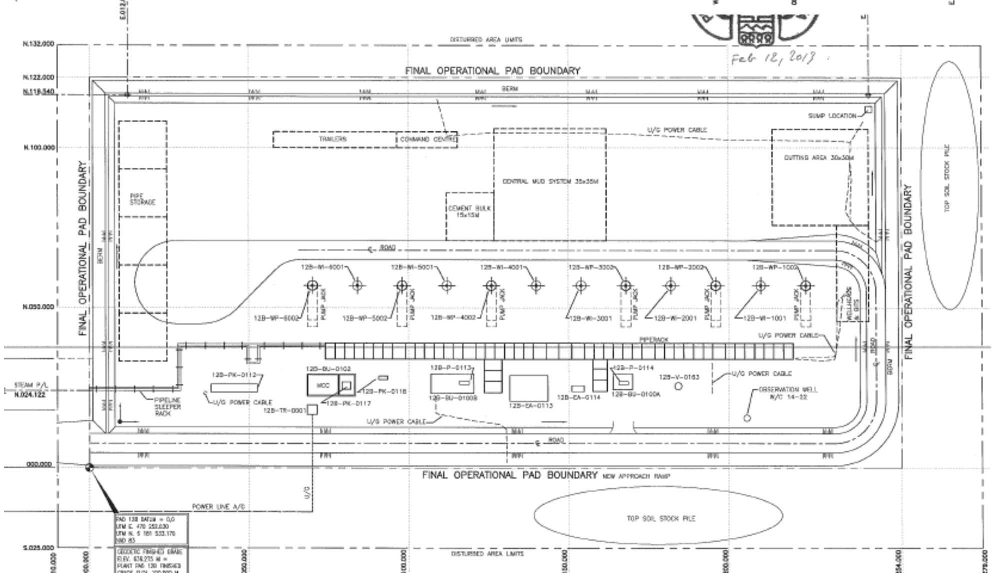




MEG ENERGY

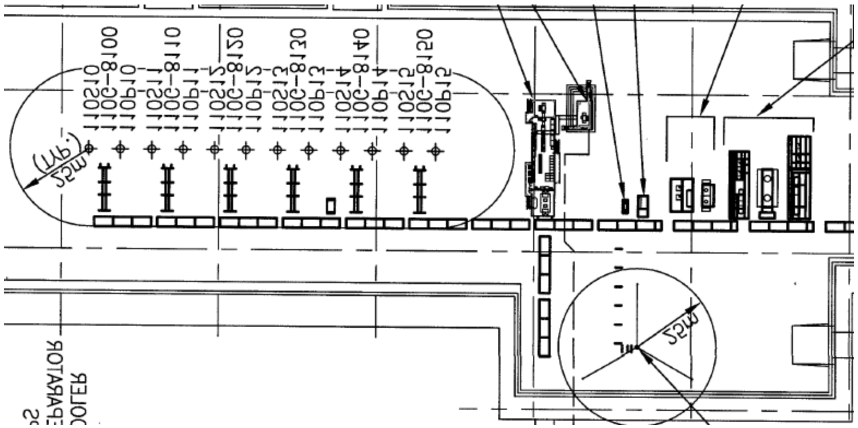
StatOil





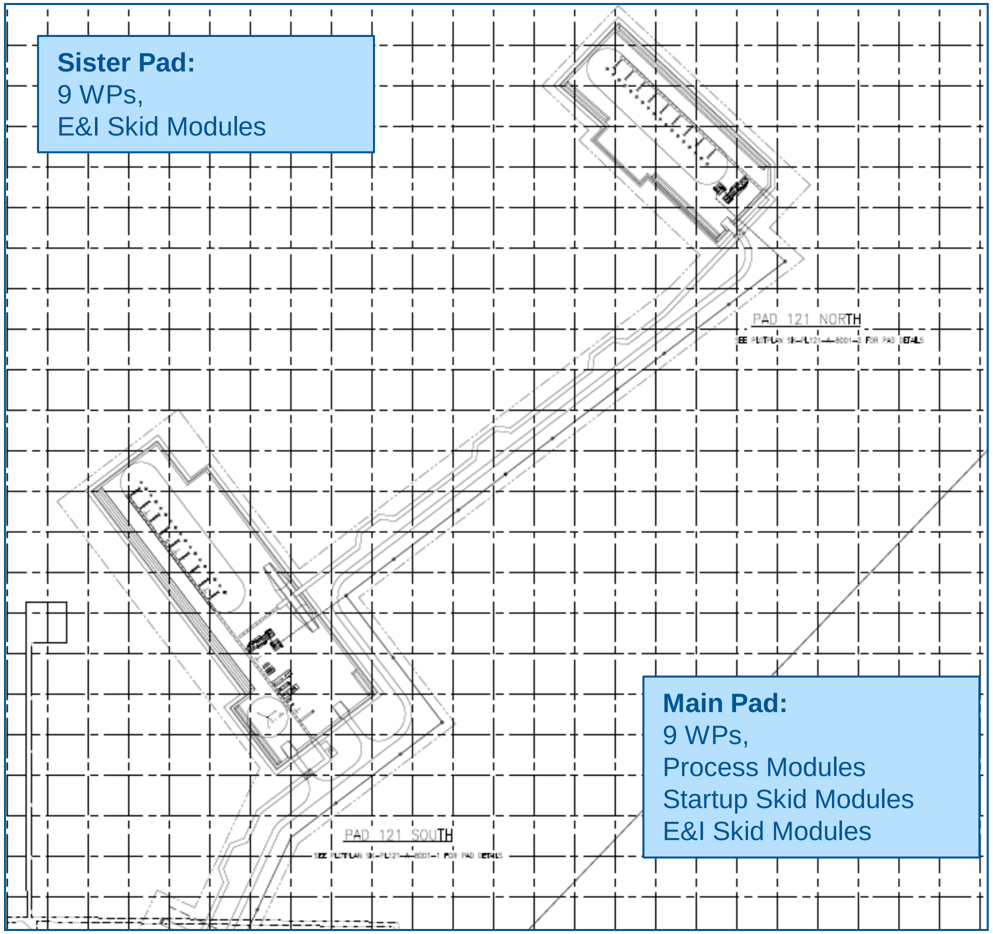
A Statoil field worker looks at oil well heads on a well pad at the company's oil sands operation near Conklin, Alta

Suncor

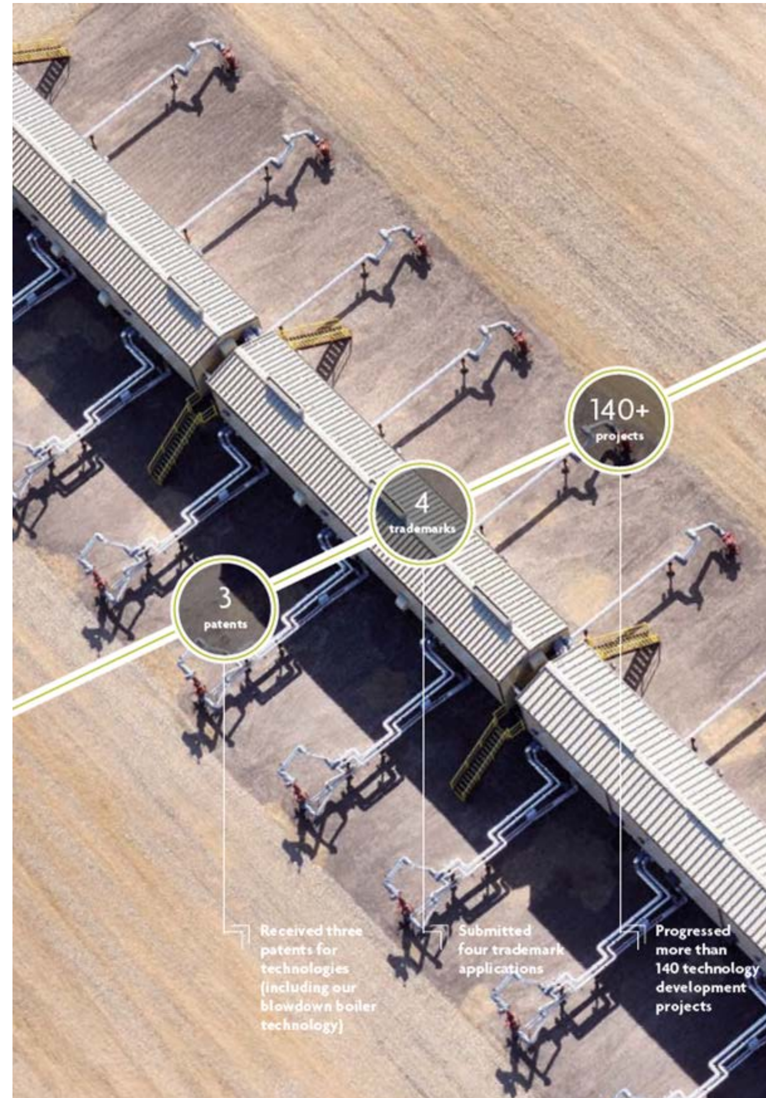


A SAGD well pad at Suncor's Firebag development helped boost thermal oilsands output to a record in April.

Suncor, MacKay River Phase 1



Sister Pad:
9 WPs,
E&I Skid Modules
PAD 121 NORTH
PAD 121 SOUTH
Main Pad:
9 WPs,
Process Modules
Startup Skid Modules
E&I Skid Modules



140+
projects
4
trademarks
3
patents
Received three patents for technologies (including our blowdown boiler technology)
Submitted four trademark applications
Progressed more than 140 technology development projects