# analora Energy corporation

Sawn Lake Single SAGD Wellpair Demonstration Project Peace River Oil Sands Region Scheme Approval 11341A Alberta Energy Regulator (AER) Annual D54 Performance Presentation Craig Pichach, VP Operations, June 14, 2016

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#### Agenda (Subsurface)

 1 Introduction and Sawn Lake Single Wellpair SAGD Demonstration Project Overview

#### 2 Geology / Geoscience

Subsection 3.1.1 (2) Geology and Geophysics

#### 3 Drilling and Completions

- Subsection 3.1.1 (3) Drilling and Completions
- Subsection 3.1.1 (4) Artificial Lift
- Subsection 3.1.1 (5) Instrumentation In Wells

#### 4 Scheme Performance - Subsurface

Subsection 3.1.1 (7) Scheme Performance

#### 5 Future Plans - Subsurface

Subsection 3.1.1 (8) Future Plans



#### Agenda (Surface Operations)

#### 6 Facilities

- Subsection 3.1.2 (1) Facilities
- Subsection 3.1.2 (2) Facility Performance

#### 7 Measurement and Reporting

Subsection 3.1.2 (3) Measurement and Reporting

#### 8 Water Source and Disposal

 Subsection 3.1.2 (4) Water Production, Injection and Use

#### 9 Environmental

- Subsection 3.1.2 (5) Sulphur Production
- Subsection 3.1.2 (6) Environmental Issues

#### 10 Compliance Statement

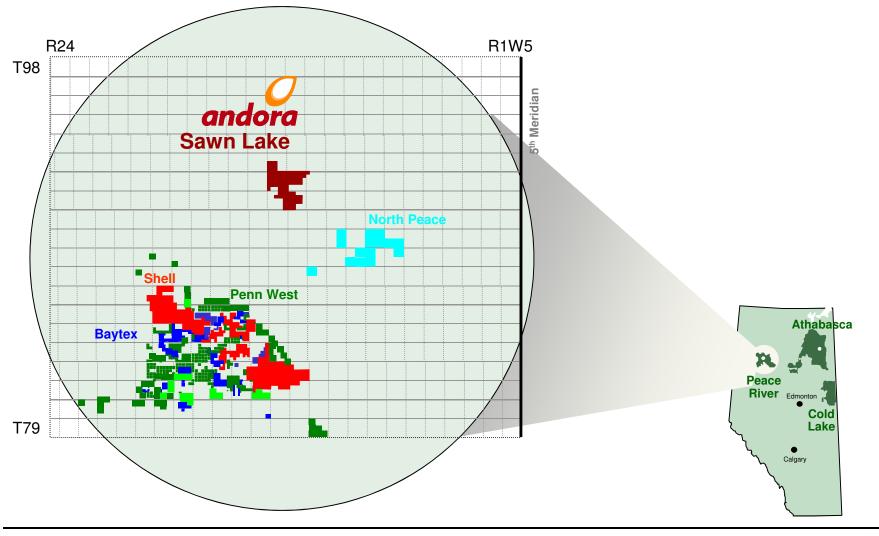
- Subsection 3.1.2 (7/8) Compliance
- 11 Future Plans Facilities
- Subsection 3.1.2 (9) Future Plans

#### Introduction and Overview



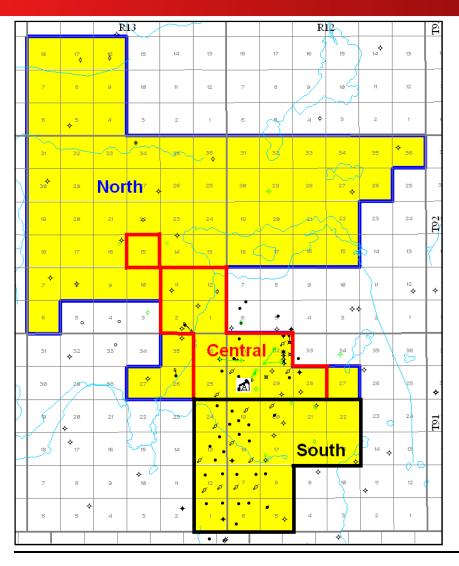


## Sawn Lake Location Map





# Sawn Lake – Land (Andora)





- Sawn Lake North
  - 10% of 51 sections (non-operated)
  - 100% of 9 sections
- Sawn Lake Central
  - 50% of 12 sections
  - Designated Operator;
  - Approved Commercial SAGD Site

#### Sawn Lake South

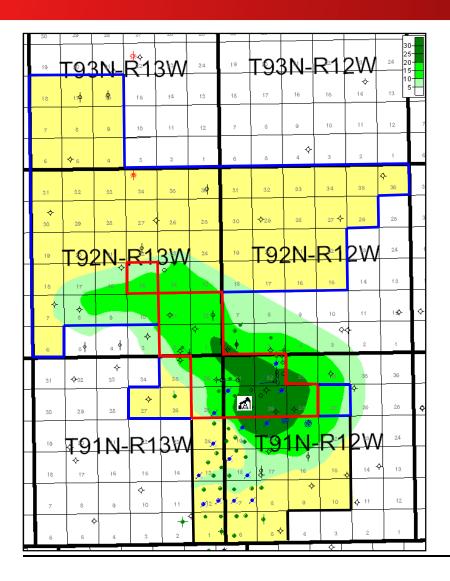
• 100% of 16 sections

(Gross 100%)	SAGD Contingent Resource Estimate (MMbbl)		
	High	Best	Low
Sawn Lake	428.5	366.9	333.2

#### **▲** SAGD Project Location



# Sawn Lake Single WP Pilot Overview



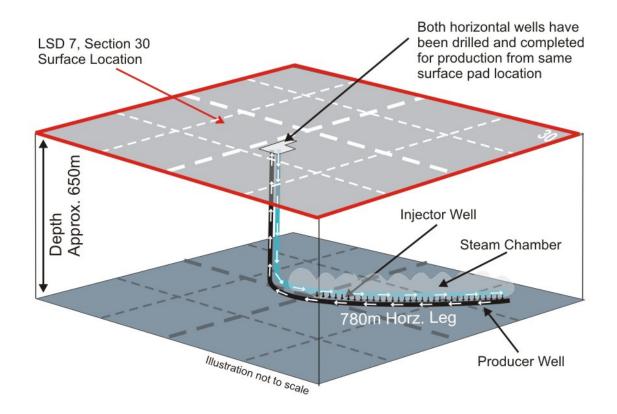


AER Scheme Approval: **11341A** One (1) SAGD wellpair Pilot Facility at 7-30-91-12W5 Target formation is the Bluesky Traditional SAGD recovery process Andora Energy is Operator.

Dark Green Area >20m pay Green 15-20m pay Light Green <15m pay



#### Single SAGD Wellpair Project Overview



Using Steam Assisted Gravity Drainage (SAGD) to recover bitumen from the Bluesky formation.

10 degree subcool based on the lesser of:

- Reservoir Subcool
- Toe Subcool
- Heel Subcool

Heel subcool was the dominant well control mechanism.'

Future use Echo meter for additional subcool control.

# Sawn Lake Project Background



- Andora has working interests in 88 sections of Oil Sands Leases all in primary term
- Andora's Focus Operated Leases 740307A365, 7403070363 & 7408030779
- 2005 2007 Resource Evaluation and Asset Consolidation
  - > 100 Legacy wells, Sawn Lake Slave Point Exploration & Development
  - 3 Andora (Signet) Horizontal Wells
  - 9 Andora (Signet) Vertical Wells
  - ~ 200km 2D seismic
  - Andora Acquired 18km<sup>2</sup> 3D Seismic over SAGD Project Location
- 2008 2009 Application to ERCB for SAGD Demonstration in Sawn Lake
- August 2009, ERCB Commercial Scheme Approval for SAGD demonstration project in South Sawn Lake
- 2009 2010 build all season access road and pipeline right of way into 15-21 site (disposal well, source water well)



# **Demonstration Project Applications**



#### Single Wellpair SAGD Demonstration Project Application Timeline

- 2008 Sawn Lake SAGD Demonstration Project Application to the ERCB
- 2008 Sawn Lake SAGD Demonstration Project Supplemental Information Request #1
- 2008 Sawn Lake SAGD Demonstration Project Supplemental Information Request #2
- 2012 Sawn Lake SAGD Demonstration Project D78 Project Amendment (7-30 Application)
- 2013 Sawn Lake SAGD Demonstration Project D78 Project Amendment Supplemental Information Request
- 2013 Sawn Lake Measurement, Accounting and Reporting Plan (MARP)

#### **Future Applications (Not Implemented)**

- 2014 D78 Category 2 2U/2L SAGD Wellpair; Approved
- 2015 D78 Category 1 Produced Water Boiler (PWB) Trial.; Approved



# Future Applications / Approvals

#### Single Wellpair SAGD Demonstration Project Approvals and Licences

- AER Approval 11341A (7-30) 2013
- AER Approval of MARP (2013)
- AER Approval for Disposal Well (D51) 1775897; well W0420620
- AER Approval for Class II Disposal Well (D65) 12169
- Approved Fuel Gas P/L Licence 55565
- Approved Source Well P/L Licence 55566
- Approved Disposal Well P/L Licence 55567
- Approved 1U/16-30-91-12W5 (Injector) Licence 0457964
- Approved 1L/16-30-91-12W5 (Producer) Licence 0457960
- Approved F46733 Bitumen Battery Facility Licence
- EPEA Approval 00247729-00-01
- Approved Plan 1076969MS-2013-10-08
- Water Act Approval Licence 00361158-00-00

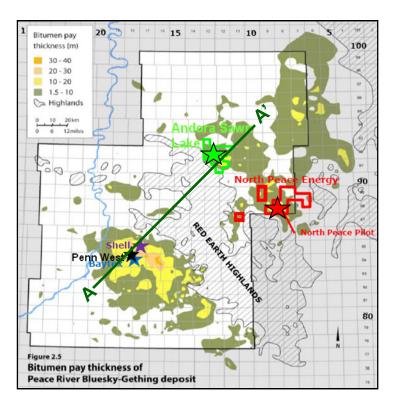


#### Subsurface – Geology and Geophysics





# Sawn Lake – Geological Setting

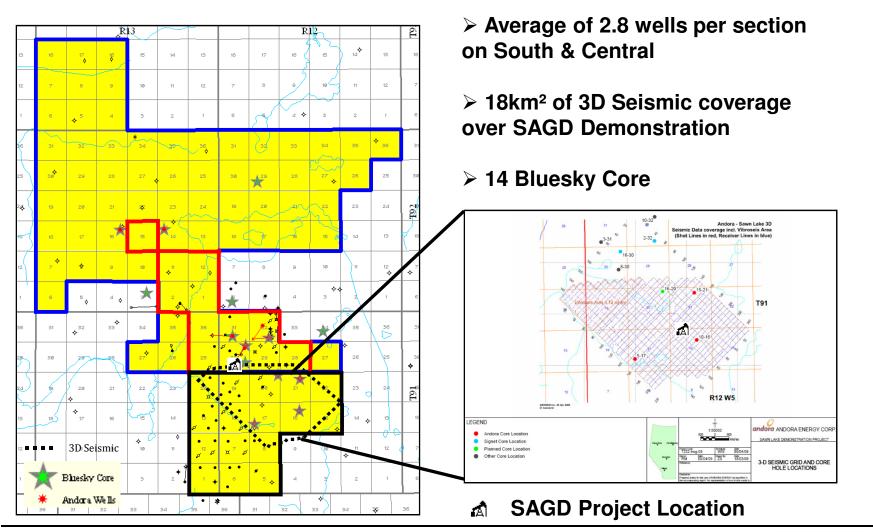


Peace River Region – Oil Sands Deposits & Major Projects Peace River Region – Oil Sands Geological Schematic Cross Section

Pre Cretaceous Unconformity



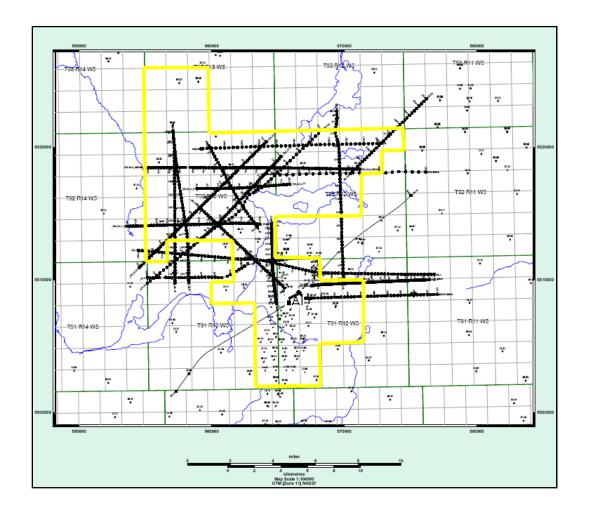
#### Sawn Lake – Core & 3D Seismic Data





#### Sawn Lake – 2D Seismic Data





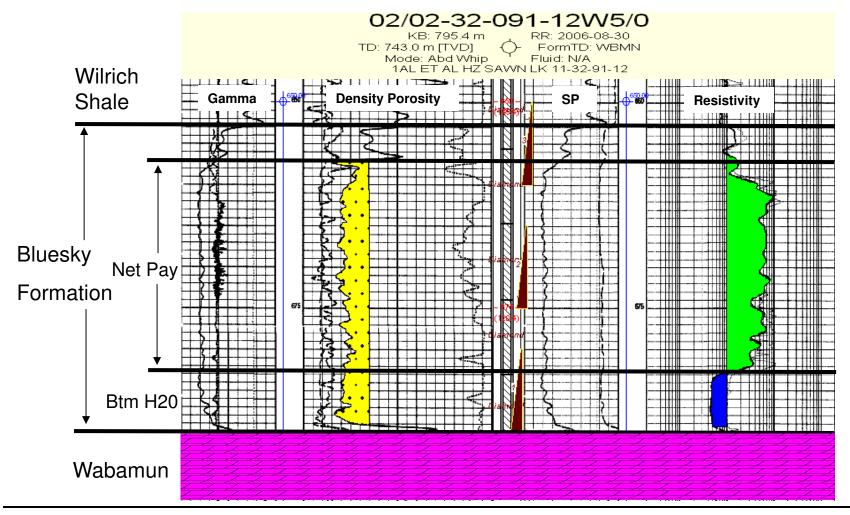
> +200 km 2D seismic data

Ճ SAGD Project Location



# Sawn Lake – Type Well

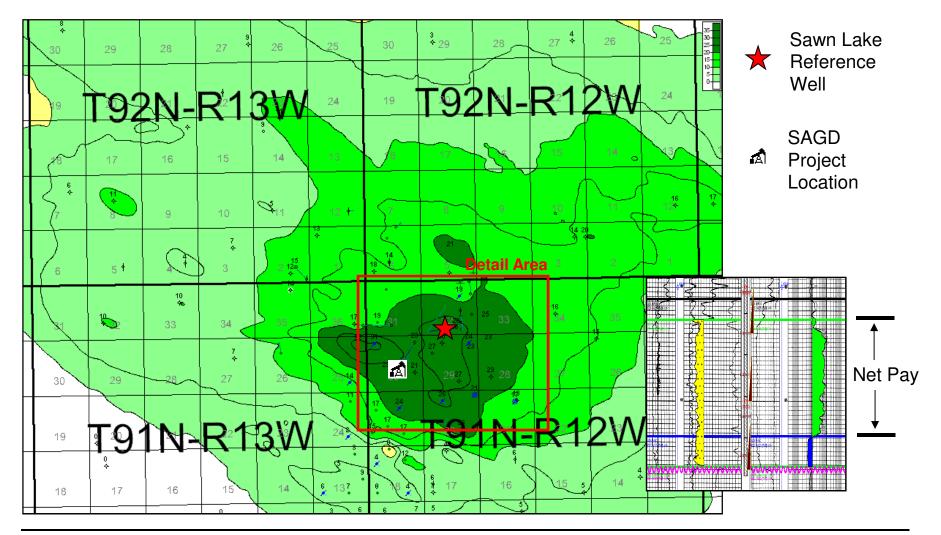






## Sawn Lake - Bluesky Net Pay

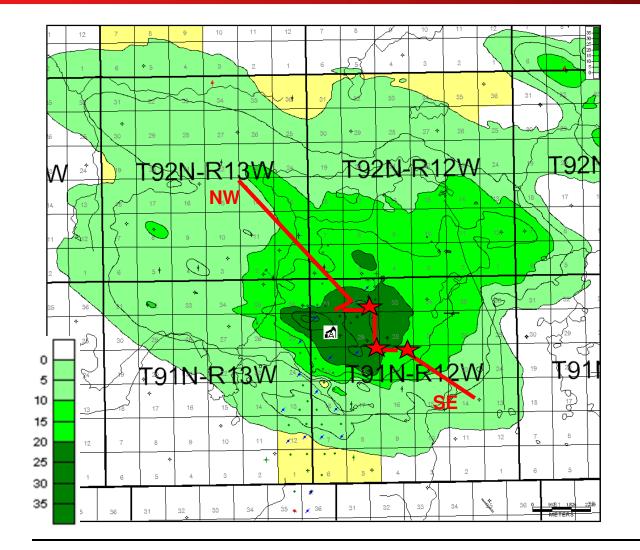






## Sawn Lake - Regional Cross Section



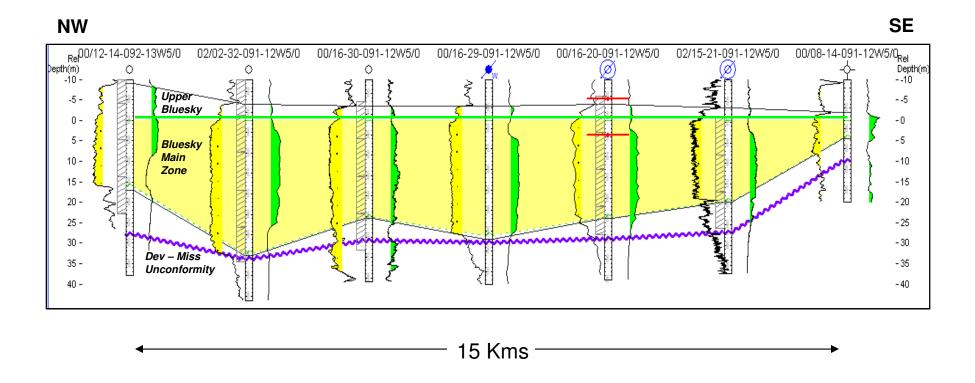


Regional Cross Section
 NW – SE through the
 "Tide Dominated Delta"





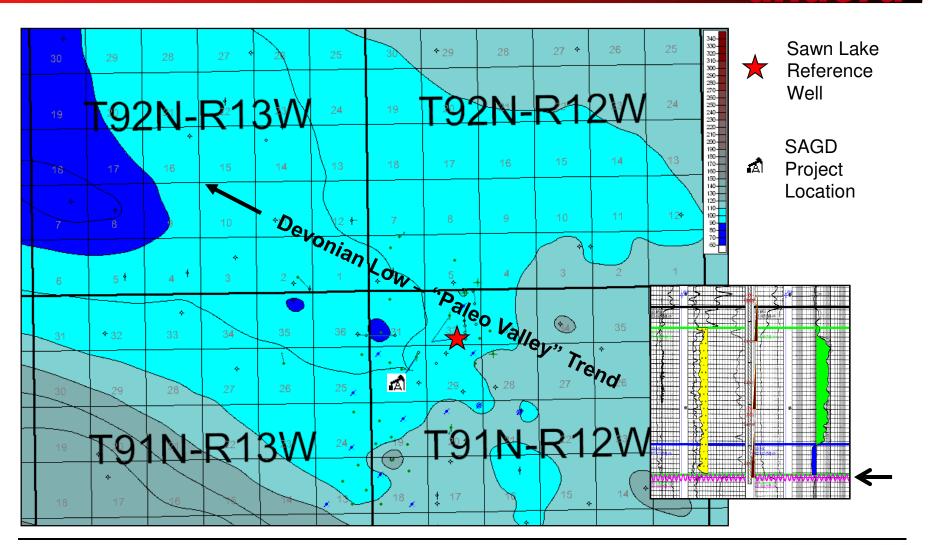
# Sawn Lake – Regional Cross Section NW-SE



#### > Thick continuous Oil Sands Reservoir within the "Paleo Valley"

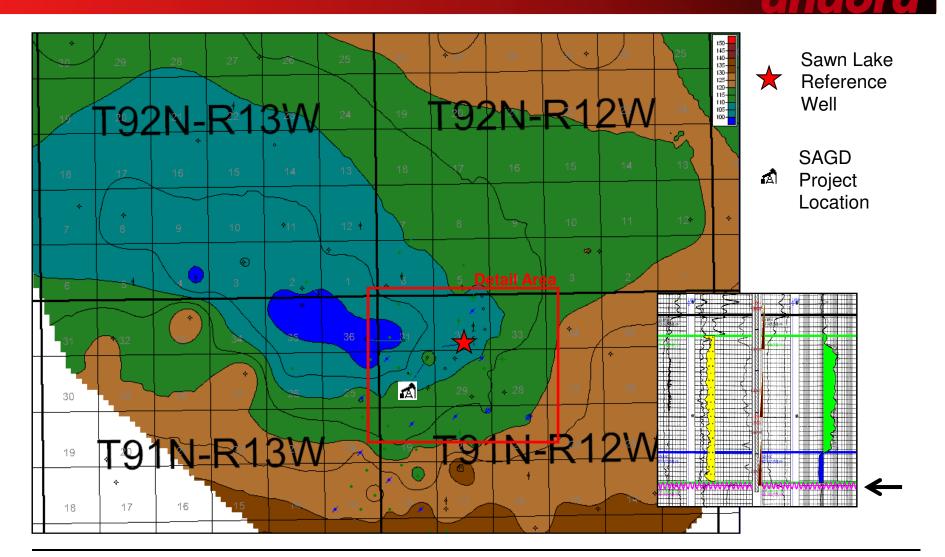


## Sawn Lake – Devonian Structure

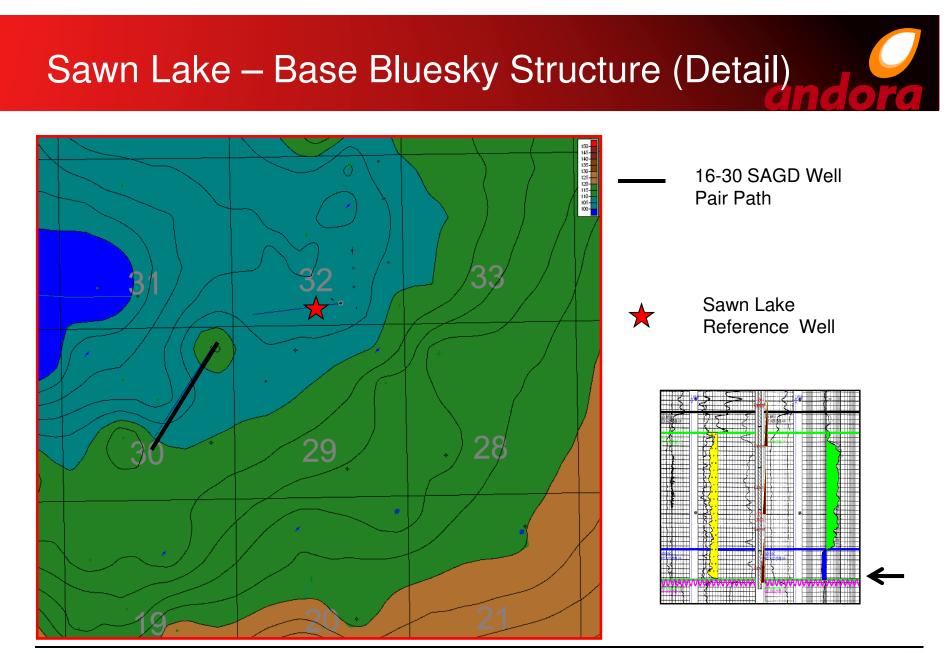




## Sawn Lake – Base Bluesky Structure

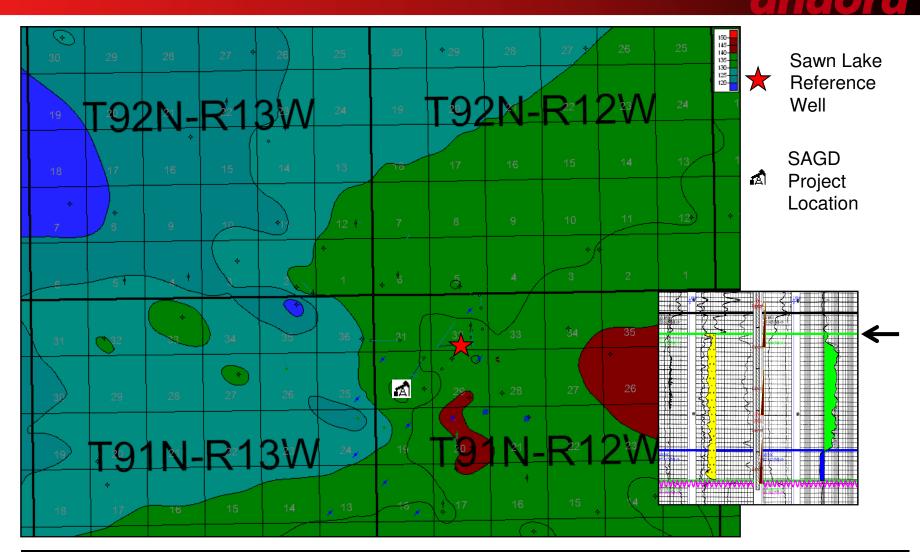






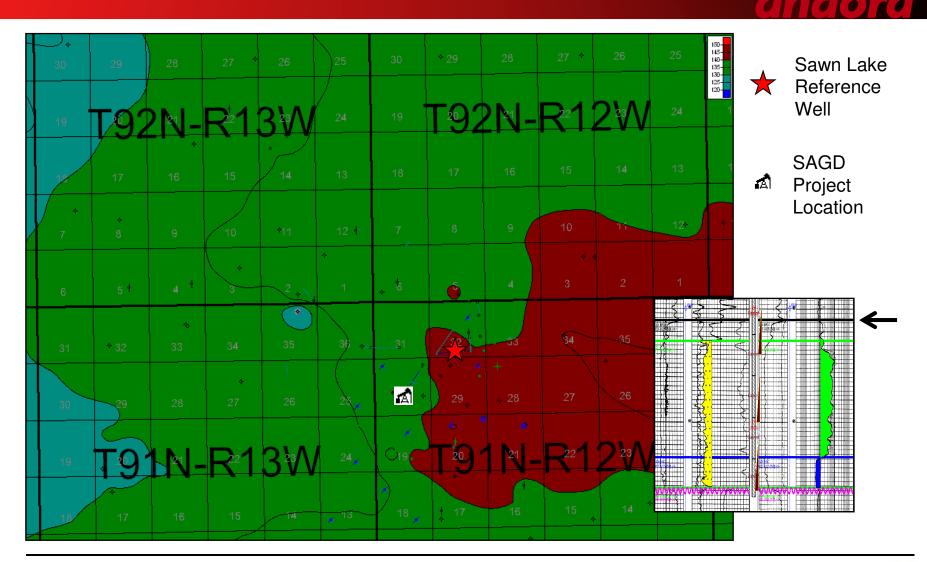


## Sawn Lake – Top Bluesky Pay Structure





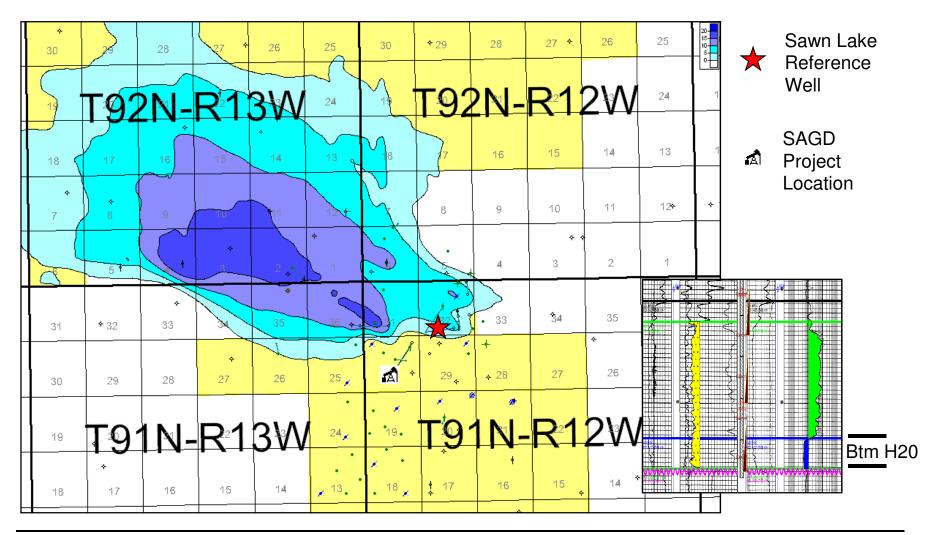
# Sawn Lake – Top Bluesky Structure





# Sawn Lake – Bottom Water

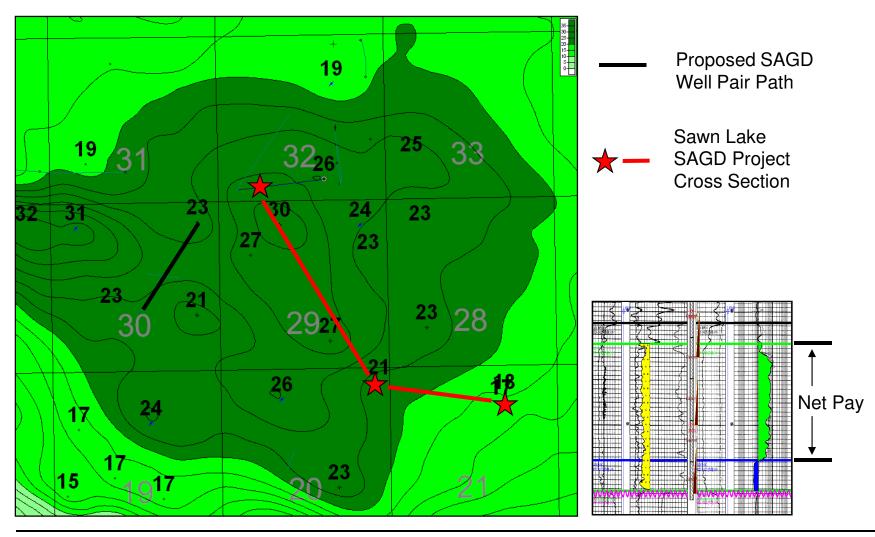






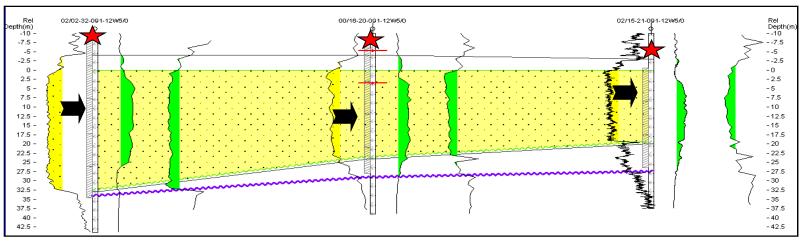
# Sawn Lake - Bluesky Net Pay



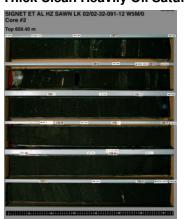




# Sawn Lake – SAGD Test Key Zones



**Thick Clean Heavily Oil Saturated** 



\* Dominant Zone Type





\* Thin & aerially constrained Zone Type



# 1U/1L Wellpair



Bottom Hole

L.S.16

30.18m Theoretical S Government Road Allowance

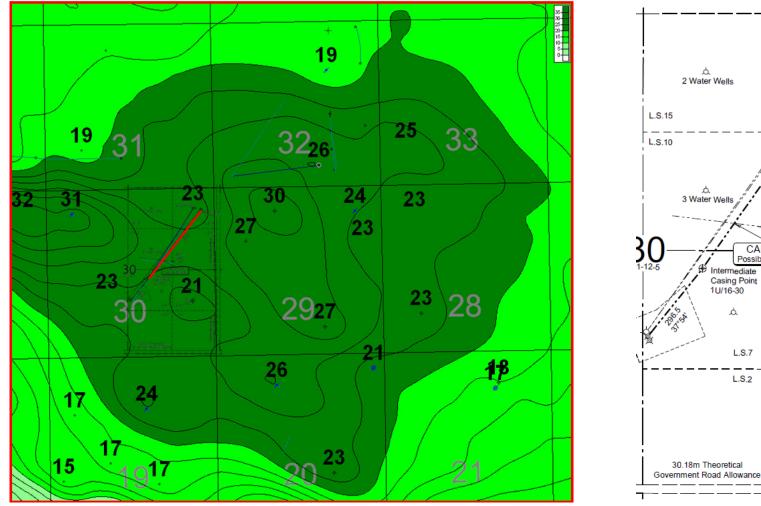
1U/16-30

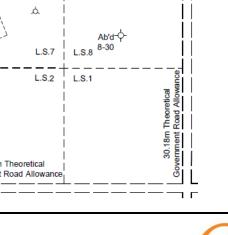
4 Water Wells

Penn West

-0-10-30

CAUTION Possible Collision

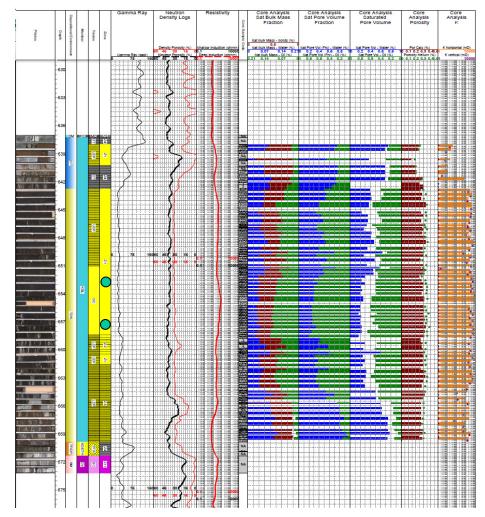






# Sawn Lake – 1U/1L Wellpair





#### 1U/1L wellpair

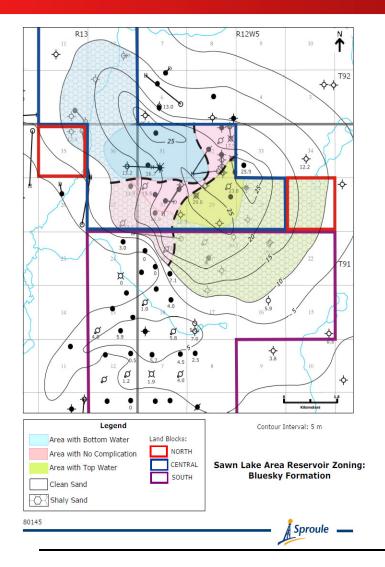
- Wellpair 50m SE of existing horizontal core well.7-30-91-12W5 core summary shown to left.
- Producer landed at 657.5-658m (base of Z1) to avoid potential complications and give pilot best chance of success. Injector 5m higher at 652m
- Base Temp 17degC, Base Reservoir Pressure: 2280kPag Average So = 0.6 Average H = 18m Average  $\theta_1$  = 0.29 Average Kh = 4.3D Average Kv = 3.6D

Bitumen in Place (OBIP)

$$\begin{split} OBIP &= A \times h_1 \times S_{o_1} \times \theta_1 \times B_o \\ &= (100m \times 805m) \times 18m \times 0.6 \times 0.29 \times 1 \\ &= 252,126m^3 \end{split}$$



# Sawn Lake - Bluesky Net Pay



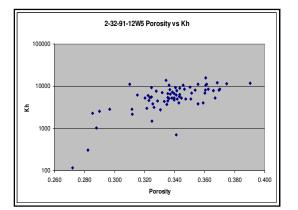
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- Sawn Lake Field
  - 39 contiguous sections with > 10 meters of pay and excess of 2 Billion Gross Barrels of Bitumen in Place
  - 6.5 sections with > 20 meters of pay and ~
     0.5 Billion Gross Barrels of Bitumen in Place, ~ 30% Porosity, ~70% Oil Saturation
  - Areas with no complication, bottom water, top lean zones identified; strategy is Low Pressure SAGD (LP SAGD) operating with steam chamber pressure close to base reservoir pressure
  - Base Reservoir Pressure identified as ~2280kPag at ~650m TVD.
  - Pilot Placed at 7-30-91-12W5 drilled to BH 16-30-91-12W5 (no complications)

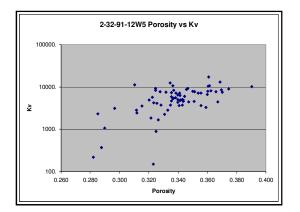


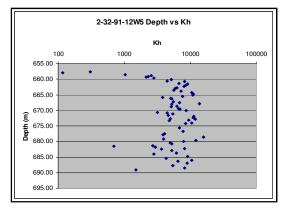
## Sawn Lake - 2-32-91-12W5 Core

#### ≻ 2-32-91-12W5

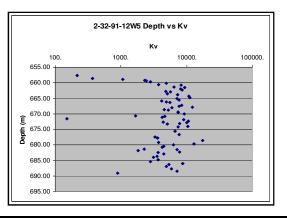


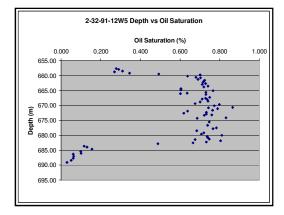
Porosity vs. Permeability





#### Depth vs. Permeability



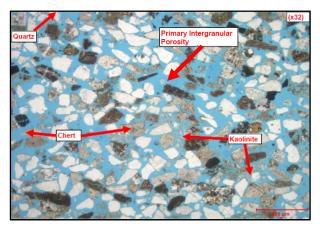


#### Depth vs. Oil Saturation

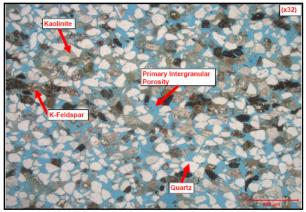


# Sawn Lake – Petrography





#### > 16-20-91-12W5 (673.5 m)



#### > XRD Analysis

	2-32-91-12W5	16-20-91-12W5	
Depth Interval (m)	677.5	673.5	
Mineral	Whole Rock Weight %		
Quartz	91	80	
K-Feldspar	1	2	
Plagioclase	0	0	
Anhydrite	0	0	
Calcite	0	0	
Dolomite	Trace	3	
Halite	0	0	
Siderite	0	0	
Pyrite	Trace	Trace	
Total Clay	8	15	
Total	100	100	

Clay Mineral	Relative Clay %		
Smectite	0	0	
Illite / Smectite	0	0	
Illite / Mica	14	14	
Kaolinite	86	86	
Chlorite	0	0	
Total	100	100	

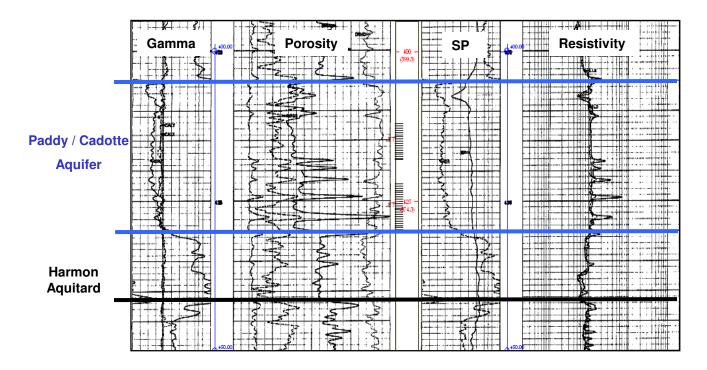


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## Sawn Lake – Surface Operations



#### Water Source Well 00/16-20-91-12W5



- Paddy / Cadotte
   Aquifer, 420 mKb
- Fresh Water, ~ 3600
   ppm

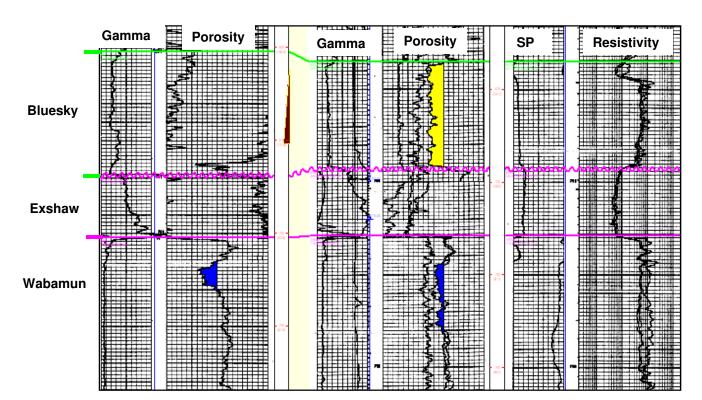


## Sawn Lake – Surface Operations

> Water Disposal Well 15-21-91-12W5

00/15-21-91-12W5

00/16-29-91-12W5



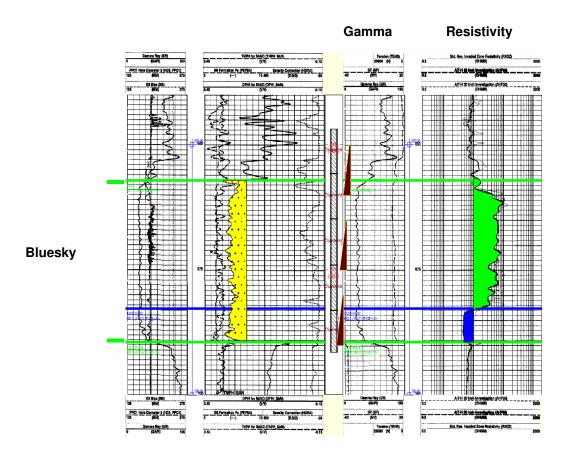
- Disposal Well located on facility site
- Disposing to the Wabamun



## Sawn Lake – Surface Operations

Future Potential Saline Source – Bluesky

02/02-32-091-12W5/0



Potential source water is the Bluesky.

Measured/laboratory samples in T091 and T092 R13 suggest the TDS is 14,906 and 23,352 mg/L, respectively.

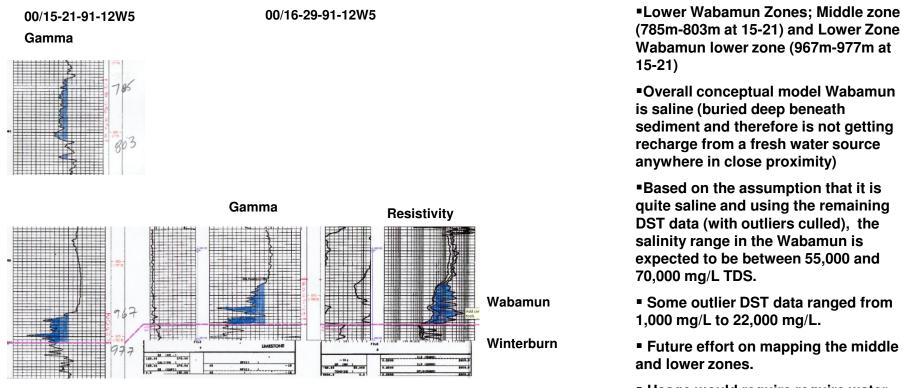
A DST sample in T091
R13 suggests a TDS of 19,786 mg/L.

 Would require water treatment plant capable of handling saline water (such as PWB).



## Sawn Lake – Surface Operations

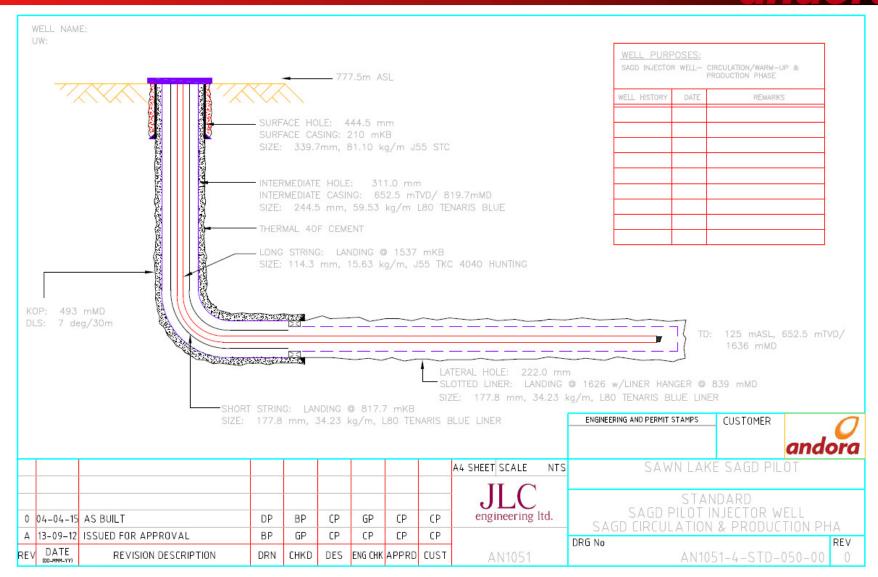
### Future Potential Saline Source – Lower Wabamun Zones



 Usage would require require water treatment plant capable of handling saline water (such as PWB).

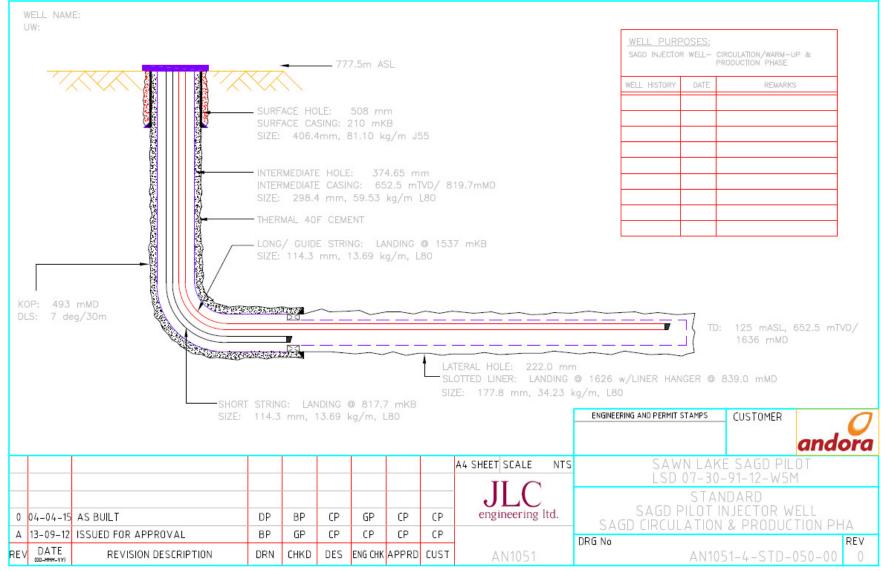


# **Drilling and Completions - Injector**



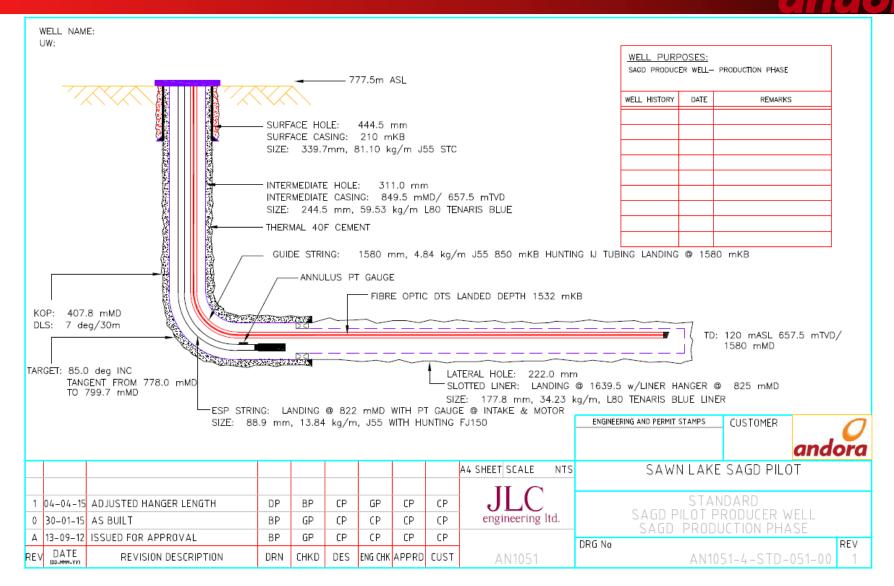
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# Drilling and Completions – Producer (Circ)



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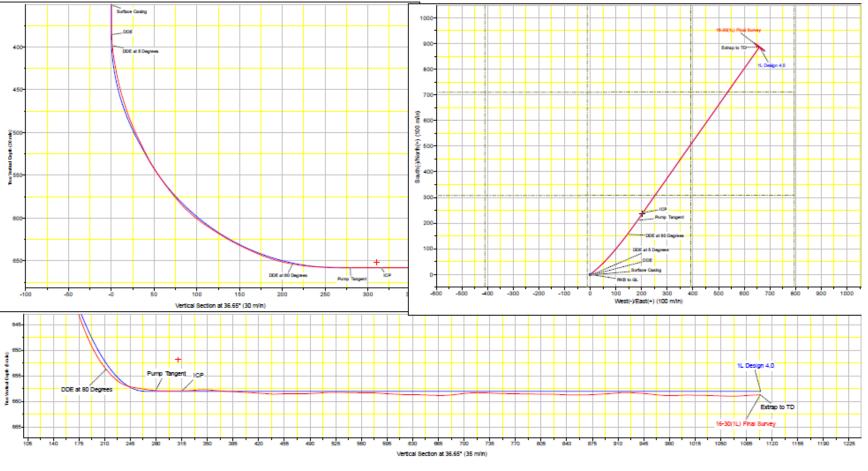
# **Drilling and Completions - Producer (SAGD)**



# **Drilling and Completions – Well Survey**

### HALLIBURTON

Project: Sawn Lake (Nad 83) Site: 30-91-12W5M Well: Andora 1L Sawn Lake 7-30/16-30-91-12W5M 16-30(1L) Final Survey





# Instrumentation



### Injector

Blanket gas for downhole pressure measurement

### **Producer**

- Fiberoptic DTS temperature profile
- X2 P/T Gauge on ESP Suction (heel)
- P/T Gauge on ESP Motor
- X 1 Pressure gauge at Toe
- Casing Gas pressure at surface

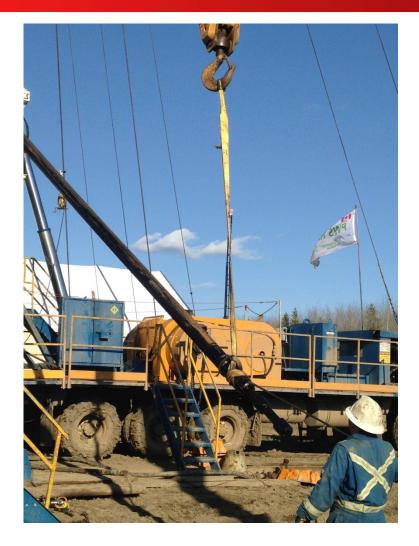
### **Discussion**

- Toe Pressure gauge reading lower (~400kPa+) than heel pressure gauges; and has trended down below base reservoir pressure; believed to have failed.
- DTS fiberoptic temperatures were trending with surface temperatures; surface compensation corrected
- Primary subcool on heel pressure, temperature and DTS Avg/High at heel pressure.
- Future consideration; using Echometer to see fluid level for more aggressive subcool operation



# Artificial Lift



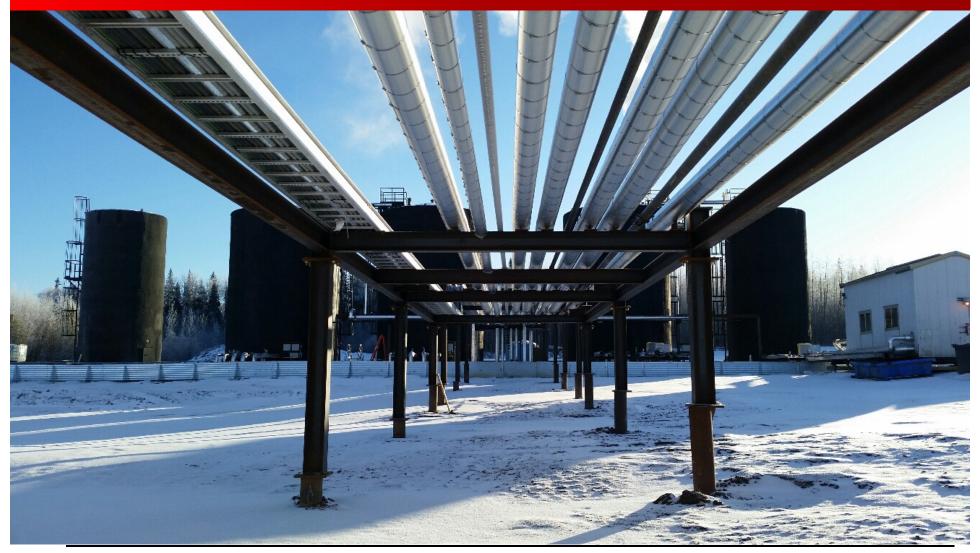


Artificial Lift provided by Electric Submersible Pump (ESP) due to depth (650m TVD) with low base reservoir pressure (3200kPag)
First ESP lasted from Sept 2015 to May 2015; (9 months); motor failure due to manufacturing fault. Pump showed no sign of sand, well integrity good. Some sign of up-thrust damage from low start up rates (on edge of pump curve).
New ESP downsized to avoid future upthrust potential.





### Scheme Performance





## **Operations Time line**







May 19, 2014 First Sustained OTSG firing

May 21, 2014 Commenced steam injection on injector and producer (First Steam) at 25-30tpd/wellpair

May 23, 2014 Offloading of liquids in producer and injector

May 23 – Aug 29 2014 SAGD Circulation

Aug 29, 2014 Plant Shut down / Cool down

**Sept 9 – 11 2014** Service Rig for ESP and fiberoptic install

Sept 12 2014 Plant Start Up on SAGD mode



## **Operations Timeline (Continued)**





May 11 – May 29 2015 Loss of ESP; ESP replacement

August 11 – August 15 2015 Boiler Inspection

September – December 2015 Avg steam for 209tpd Avg Production 615bopd Avg SOR 2.13

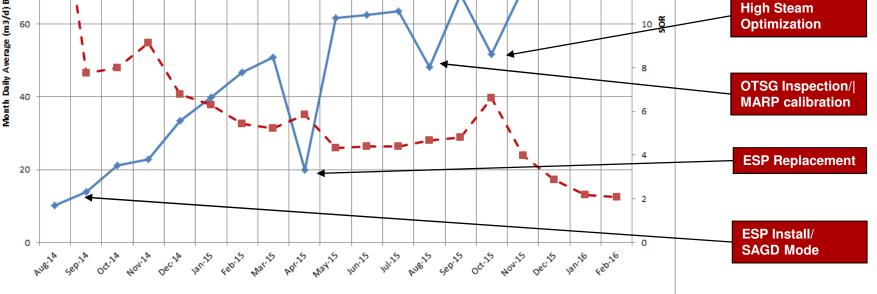
March 1, 2016 Steam to SAGD wellpair discontinued; ESP shut down.

March 1 – April 1, 2016 Plant and P/Ls under nitrogen purge; Heat to MCC HMI/PLCs removed

April 1, 2016 Site suspended and dark.

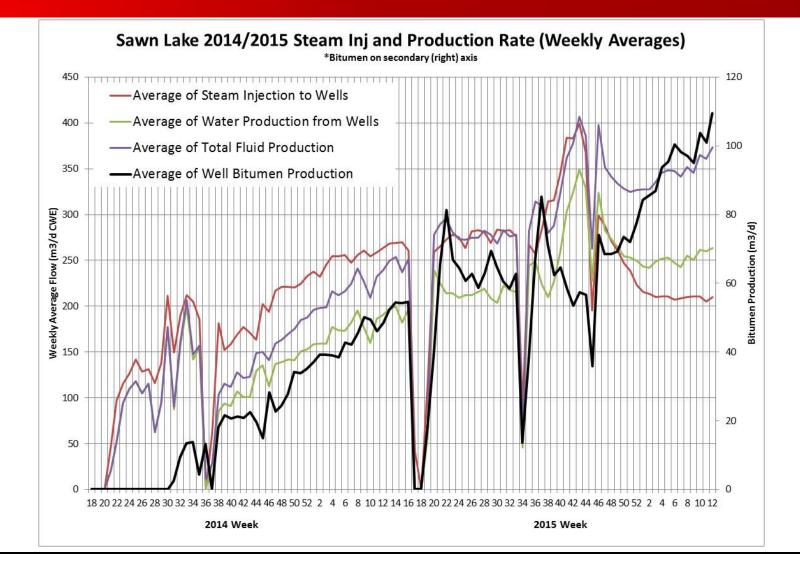


#### Performance Data (Month Cal. Day Avg) To Sept 30 2015 Mth Daily AVG Bitumen Production ų Mth Daily Avg SOR Month Daily Average (m3/d) Bitumen Production Low Steam Optimization **High Steam** 10 8 Optimization

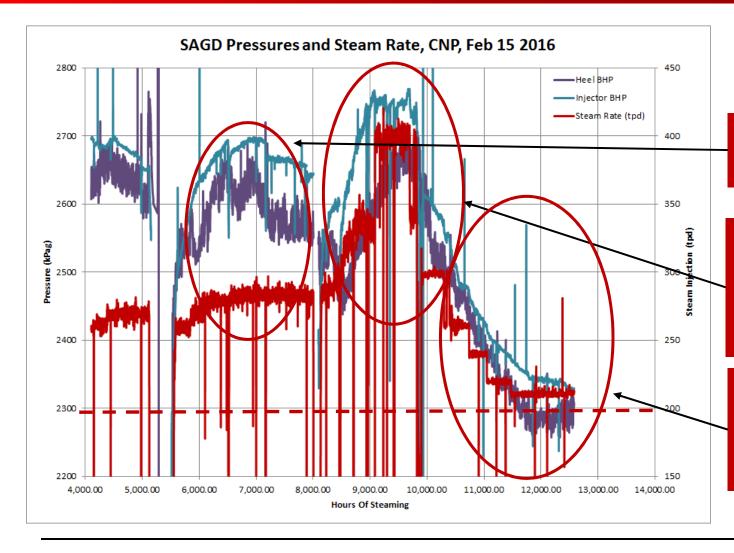




## Pilot Production; Steam (Wk Avg)



## BH Pressures – Step Changes



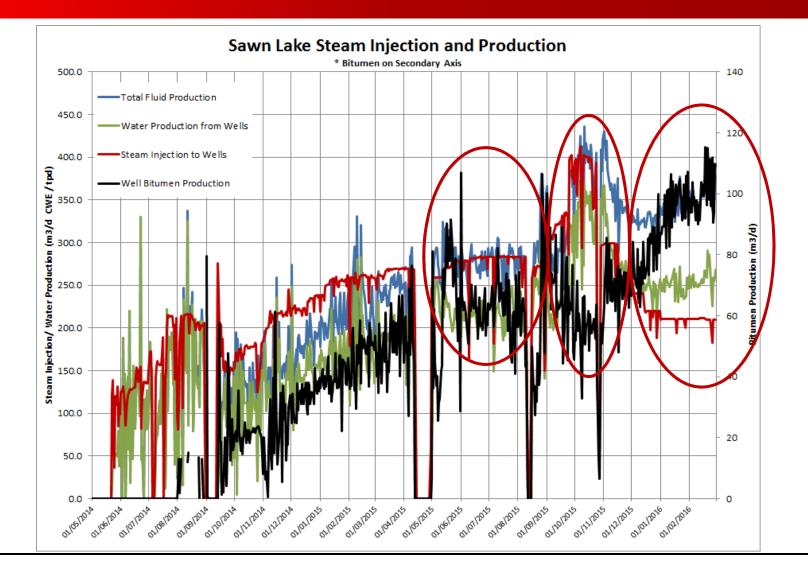
Operation of well within 500kPa of base reservoir pressure at all steam injection rates.

Estimated Caprock plateau Reservoir stabilizes than slight depressurization at constant steam

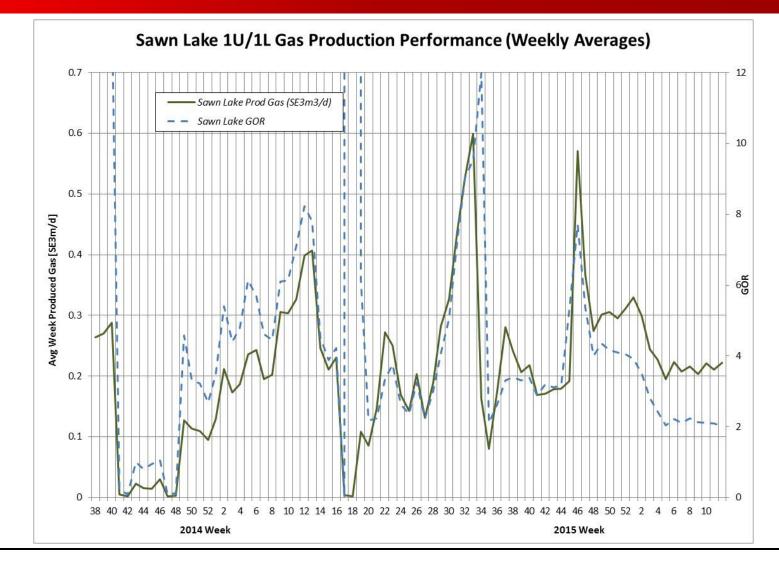
High Steam Trial Operations attempts to repressurize; able to reach 400tpd steam injection without exceeding 2800kPag. Ops Holds for a month to determine if steam is productive.

Low Steam Trials Operations lowers steam injection in step changes until producer at base reservoir pressure and experiences production boost

## Pilot Production; Steam (Daily)

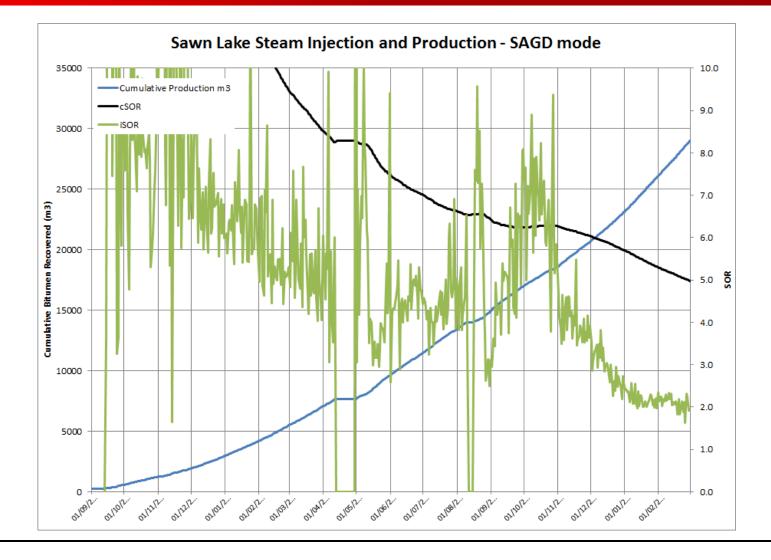


# GOR

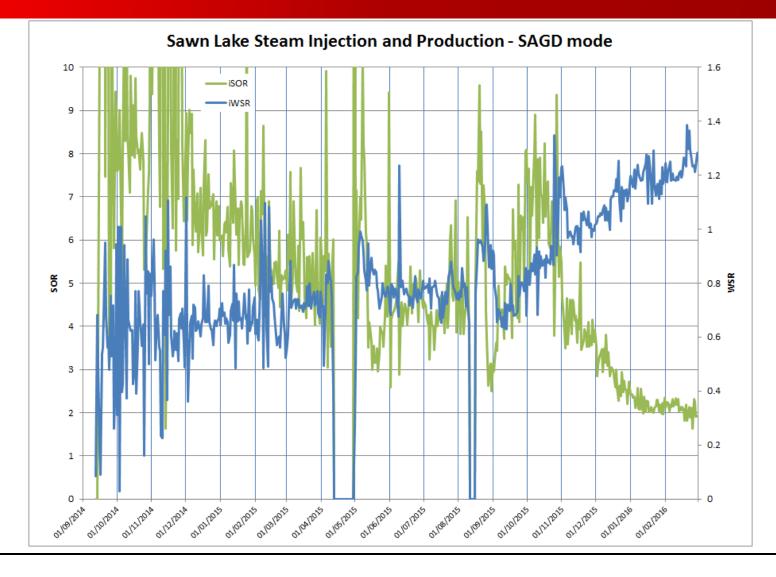


GOR low 2-4 vs. expected 8.

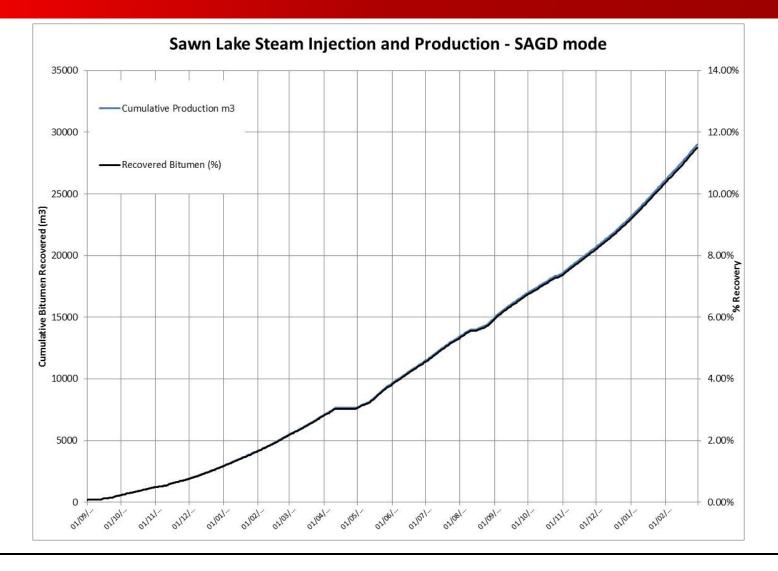
## Production, iSOR, cSOR



# iSOR, iWSR

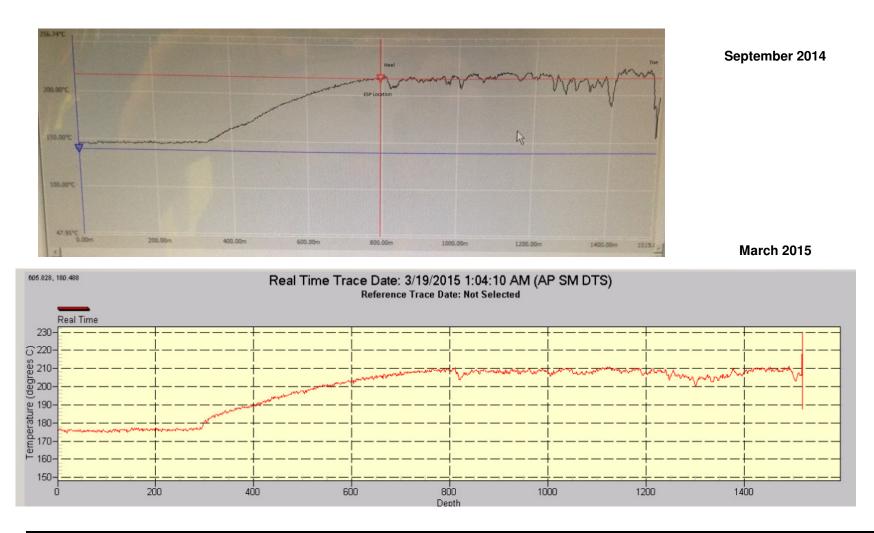


# iSOR, iWSR



## Conformance





andora

### Sproule (Andora) Expectations Dec31-2014

- Exceeding Sproule "LOW" case [121 bopd @ SOR 8 for 2015; 242 bopd @ SOR 5.7 for 2016 & 2017]
- Exceeding Sproule "BEST" case [173 bopd @ SOR 5.6 for 2015; 345 bopd @ SOR 4 for 2016 & 2017]
- Aiming to exceed "HIGH" case of [224 bopd @ SOR 4.3 for 2015; 449 bopd @ SOR 3.1 for 2016 & 2017]
- Can inject more steam than predicted by Sproule [>380 tpd actual vs. 208 tpd Sproule] which could mean more production.

### 16-30-091-12W5 Pilot Well Forecasts

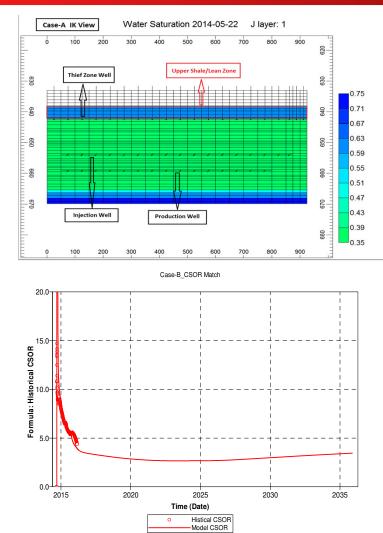
Low Estimate Contingent Resources					Best Estimate Contingent Resources						High Estimate Contingent Resources								
Year	Bitumen Rate bbl/d	Water Rate bbl/d	Steam 100% Quality bbl/d	SOR	CSOR	-	Year	Bitumen Rate bbl/d	Water Rate bbl/d	Steam 100% Quality bbl/d	SOR	CSOR	_	Year	Bitumen Rate bbl/d	Water Rate bbl/d	Steam 100% Quality bbl/d	SOR	CSOR
2015	121	918	966	8.0	8.0		2015	173	918	966	5.6	5.6	1.1	2015	224	918	966	4.3	4.
2016	242	1,311	1,380	5.7	6.5	-	2016	345	1,311	1,380	4.0	4.5		2016	449	1,311	1,380	3.1	3
2017	242	1,311	1,380	5.7	6.2		2017	345	1,311	1,380	4.0	4.3		2017	449	1,311	1,380	3.1	3.
2018	242	1,382	1,455	6.0	6.1		2018	345	1,382	1,455	4.2	4.3	_	2018	449	1,382	1,455	3.2	3.
2019	242	1,453	1,529	6.3	6.2		2019	345	1,453	1,529	4.4	4.3		2019	449	1,453	1,529	3.4	3.
2020	242	1,524	1,604	6.6	6.3		2020	345	1,524	1,604	4.6	4.4	_	2020	449	1,524	1,604	3.6	3
2021	242	1,594	1,678	6.9	6.4		2021	345	1,594	1,678	4.9	4.5		2021	449	1,594	1,678	3.7	3
2022	173	1,194	1,257	7.3	6.5		2022	247	1,194	1,257	5.1	4.5		2022	322	1,194	1,257	3.9	3
2023	124	893	940	7.6	6.5		2023	178	893	940	5.3	4.6		2023	231	893	940	4.1	3
2024	89	667	702	7.9	6.6		2024	127	667	702	5.5	4.6		2024	166	667	702	4.2	3
2025	64	497	523	8.2	6.6		2025	91	497	523	5.7	4.6		2025	119	497	523	4.4	3
2026	46	370	390	8.5	6.7		2026	66	370	390	5.9	4.7		2026	85	370	390	4.6	3
2027	33	275	290	8.8	6.7	_	2027	47	275	290	6.2	4.7		2027	61	275	290	4.7	3
2028	-	-	-	-	-		2028	-	-	-	-	-		2028	-	-	-	-	-
2029	-	-	-	-	-		2029	-	-	-	-	-		2029	-	-	-	-	-
2030	-	-	-	-	-		2030		-	-	-	-		2030		-	-	-	-
tal [Mbbl]	767	4,890	5,148	CSOR	6.71		Total [Mbbl]	1,095	4,890	5,148	CSOR	4.70	1	Total [Mbbl]	1,424	4,890	5,148	CSOR	3.62



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# 1U/1L Simulation Matching





Wellpair 1U/1L performed as expected until reaching plateau where three dissonances with early models were evident:

• The upper reservoir is somehow more permeable than believed that operations was able to inject 400tpd steam without pressuring up the reservoir and that this team somehow displaces bitumen and water production

When the producer is at base reservoir pressure (at 210tpd steam injection) production is boosted and the iSOR lowers to 2.2

• For some reason after shut downs the displaced emulsion does not all flow to the producer (i.e. the displaced bitumen did not flow back on shut downs).

History matching to model for accounting of these three production trends has been best done through adding a highly permeable thief zone near the caprock at the paleogas cap with high compressibility. When downhole pressure is above base reservoir dilation occurs and emulsion is displaced. When downhole pressure is at base reservoir pressure dialation does not occur and displaced emulsion does not flow to the producer. Modelling on-going, currently showing High recovery (70-75%) expected with lower pressures, cSOR of 2.7 at 2030.



# Sawn Lake Analyticals



#### SAWN LAKE ANALYTICALS

#### Bitumen

Last Analysis September 2015 – 1021kg/m3 density; 7.0API ; generally 7.8API. Sawn Lake bitumen is consistent with a McMurray formation bitumen 7-8API

#### **Produced Gas**

Typical SAGD casing gas; small production; 54% methane, 40% CO2, 2% Hydrogen, 1.4% H2S remainder C2+ hydrocarbons.

#### **Produced Water**

TDS: 2100mg/L by evaporation, 352mg/L calculated P-Alkalinity 0ppm, M Alkalinity 287ppm, Total Alkalinity 287mg/L Total Hardness: 5mg/L as CaCO3 Silica: 125-141mg/L

#### Non-Saline Make Up Water

TDS: 3530mg/L by evaporation P-alkalinity 0ppm, M Alkalinity 1648mg/L, Total 1648mg/L Total Hardness: 49mg/L Silica: 3-8mg/L



#### OIL ANALYSIS

441 - 1						52136-20	015-6657
CONTAINER IDENTITY		METER ID	WELL LICEN	SE NUMBER		LABORATORY	FILE NUMBER
	Andora E	Energy Corporation					1
		OPERATOR					PAGE
07-30-091-12W6		Sawn Lake 7-30 Battery	/				
LOCATION (UWI	)	WELL NAME				KB ELEV (r	n) GR ELEV (m)
Sawn Lake					Core Lab -	GP	
FIELD OR AR	EA	POOL OR	ZONE			SAMPLER	
TEST TYPE AND NO.			TEST RECOVER	Y			
Sales Bitumen							
	POINT OF S	AMPLE			:	SAMPLE POINT ID	
	PUMPING	FLOWING		GAS LIFT		SWAB	
	WATER	m*/d	OIL		m³/d GA	s	m³/d
TEST INTERVAL or PERFS (metric SEPARATOR RESERVO at 13:26 hrs F 2015 09 10 DATE SAMPLED (YIMD)		CONTAINER WHEN SAMPLED e) 2015 09 18 DATE ANALYZED (Y/M/D)	@ CONTAINER WHEN RECEIVED	<u>.</u>	SEPARATOR Ten	nperatures, °	OTHER °C
· · ·	SAMPLE PROPERT	TES					
Dark Brown APPEARANCE OF CLEAN OIL	WATER	BS TOTA	AL BS & W	FRACTION DISTILLED	°C	METHOD	BAROM PRESS
ABSOLUTE DENSIT kg/m³ @15°C 1.02		API GRAVITY @15	.6°C 7.0			°C ROOM TEMP	°C INITIAL BOIL PT
SRECEIVED AFTER C			CLEANING			DISTILLATION	I SUMMARY
49.9 grams/kg kg/n	n* wt. %	A.S.T.M.			204	4 °C NAPHTHA	274 °C KEROSENE

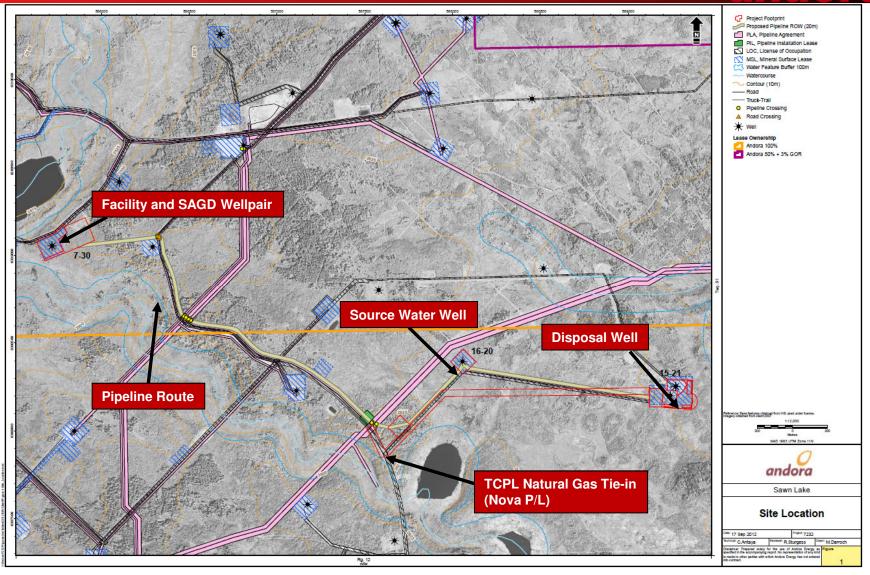


### Surface and Facilities





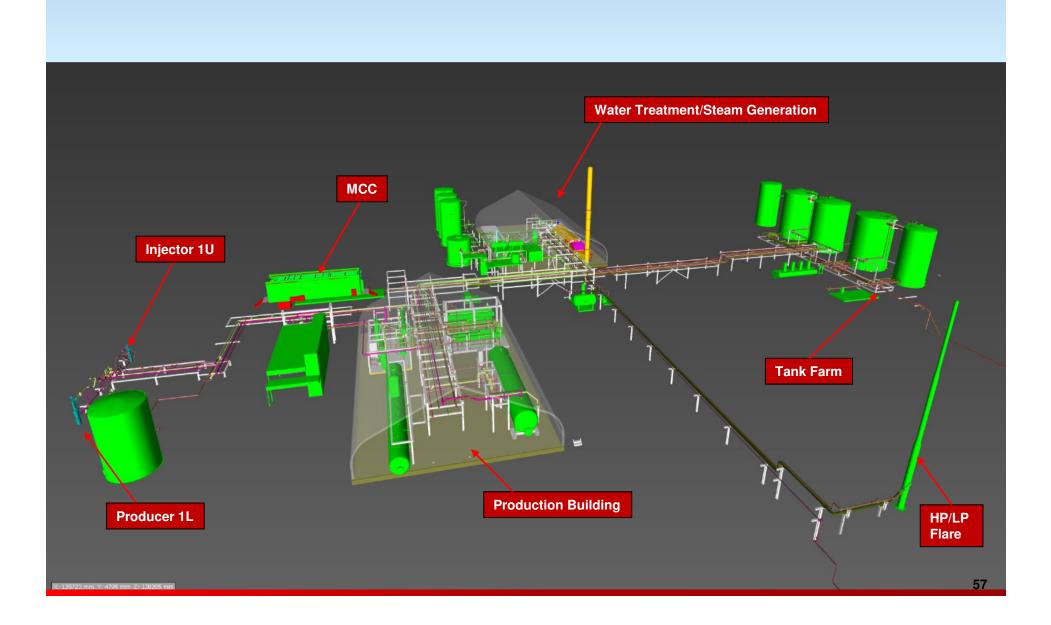
# Project Overview- Facility, Wells, Pipeline



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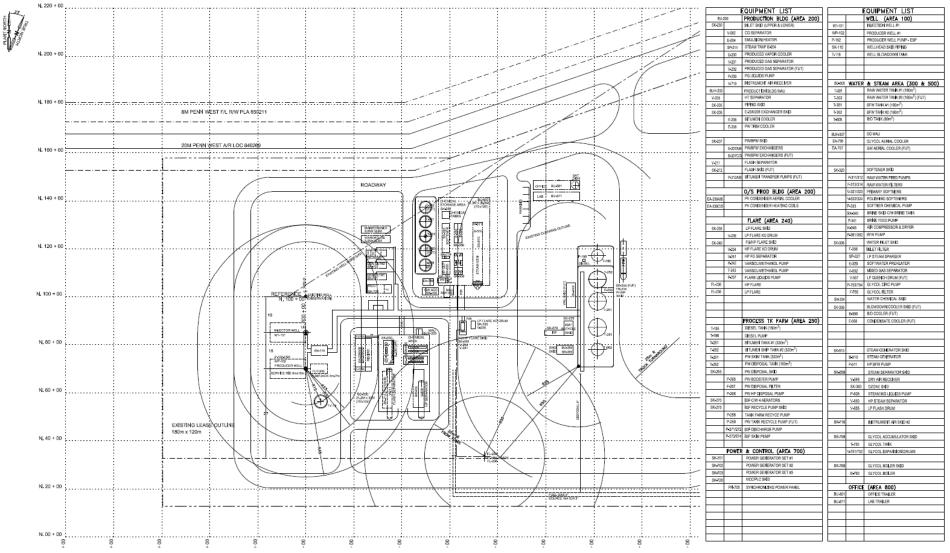
# Sawn Lake SAGD Facility





## **Project Overview**– Facility Plot Plan



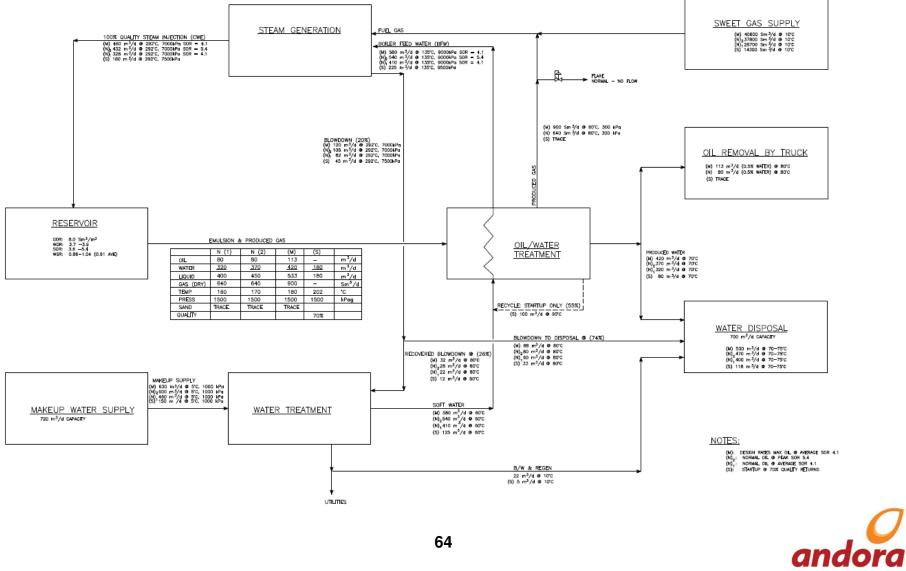


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#### **Project Overview– Facility (Equipment)** 0 Ð ROADWAY OFFICE BU-801 LAB BU-811 N.140+00 BU-500 .3M x 36.6M (70'x120') CHEMICAL STORAGE AREA 2/ \$-J. PARK 23 CENTRONIN HUNCHLINOTH SK 334 CHEMICAL Ì TANKS EXISTING OLEARING OUTLINE P-511 MAINTENANCE 3.0Mx12.2M SOFTENER E 356 B-510 Ð SK-510 WAREHOUSE 3.0Mx12.2M SK 356 N.120+00 Ð SK 716 0,0 10 000 5K-308 GEN P-196 SK 70 J-399 NIN. GEN SET#2 SR-702 HP SEP SK-550 **-195** STEAM ( T#1 SK 760 EA-756 DUCT DUCT SKID (FUT) SK-255 (FUT) TRUCK PUMP SKID мсс SK-XXX MAU BUH-507 REFERENCE EXISTING WELL N. 100 + 00 (OBSERVATION) PL R GW ACC SK-750 P-255 SK-72 N,100+00 VRU 8 **-**25 + 00 15 SK-275 LP FLARE KO DRUM SK-235 V-235 SK-270 RECYCLE ù 닏 INJECTOR WELL W1-101 ́т\_26 SK-230 (UP) SK-230 (UP) SK-230 (UP) FG/HP SK-240 V-234 V-241 LARE SKID N.80+00 SWD BU-265 SKID SK-265 RECIRC T 26 SK-110 15 P-102-ESP WP-102 PRODUCER WELL ĽЪ FUTURE SERVICE RIG 8mx15m JMPJACK 4mx7 SEPARATOR B) 23 SK-205 V-205 PARAT N.60+00 / BU 200 21.3M x 32M SK-212 ( ⊁ 40° (70'x105') DISPOSAL 4 г-IJ JNE POL SON N.40+00 FL-238 FLARE FL-236 8 8 8; i 00-00 <u>8</u>, 1 ġ. 8 /ģ 63

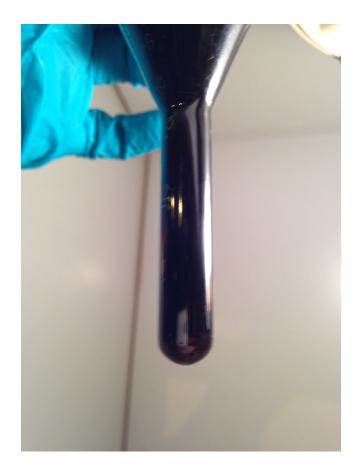
## **Block Flow Diagram**





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### **Facility Performance**



### Facility Overview:

- Oil/Water Separation train 3200bopd AOSTRA/Devon/Suncor facility relocated to Sawn. No condensate on site.
- New Conventional SAC/OTSG
- Refurbished natgas gensets for power

### Key Learnings:

- High Temperature Separator; effective with proper chemical program; making on-spec (less than 0.5% BS&W oil).
- Pressure; Only need 3000kPag steam for injector; 600ANSI design at wellhead.
- Hot Bitumen Trucking; effective up to 6 hours. Facility exporting to Bitutainers could extend range
- Roads gravel ineffective without geoweb.
- Operations Multi disciplined team,; 10 operators 14 on/14 off [3 days, 2 nights]; Alpha and Omega shift. Effective; could operate larger battery. No condensate reduced environmental and safety risks.

### Learnings – Bitumen Export



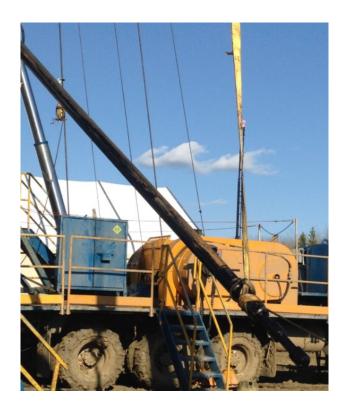


### **Emulsion Treating**

- Facility on circulation/SAGD start up was unable to meet water content requirement. Following ramp up good success with chemical treatment and high temperature separator. Meeting Tervita/Pembina sales spec 0.5%BS&W and Shell Peace River complex sales spec of 0.35% BS&W.
- Also was exporting to Murphy 1-26; battery shut down early 2016.
- Early start up issues with HTS resulted in excess produced water trucking especially on start up steam circulation required trucking to Custom Treating stations (Gibsons Valleyview, NewAlta Peace River, Secure Judy Creek).
- Plains Midstream Nipisi terminal has been unable to blend (too heavy at 7-8API). Currently exporting to Shell Peace River Complex, Murphy 1-26, Tervita High Prairie.
- Able to meet spec with single High Temperature Separator (HTS) train. Flash Treater in building, not yet hooked up.
- Decision made to proceed with Recycle pumps; should allow for off-spec bitumen from off-spec tank to be recycled through the high temp separator to be brought on-spec.



### **Facility Performance**



### Steam Requirements / Plant Pressure Rating

- 50MMBTU/hr OTSG is good for x 2 SAGD wellpairs.
- Less than 3000kPag bottom hole pressures, plant could be designed for #600ANSI

### Road / Geomembrane Trial

• Issues with truck turn around required improvement project with geomembrane/gravel appears to be a success; trouble free since road improvement project.

### **ESP Sizing/Scaling**

- No sand generation; liner slot size strategy seems to have been
   successful
- During ESP replacement silica scaling on the production tubing at liquid/steam interface.
- New wells should have a start up ESP as opposed to full-rate ESP to avoid up-thrust damage or use 6 month run-time for first ESP.

### **Power Generators**

 Gensets (x 3 270kW gensets) have issues with respect to switchgear / load sheding causing plant trips. Issues resolved in Jan 2016.

### Natural Gas

Hydrate issues at nat gas let down; methanol injection commenced.



### Facility Performance - Gas



#### Gas Volumes E3m3

- Note Most Produced Gas is recovered and consumed in the OTSG
- Tank vapors to LP Flare

	Purchased Gas	Produced Gas	Flared Gas
May-14	364.9	0.0	0
Jun-14	688.1	0.0	0
Jul-14	636.3	0.0	5.0
Aug-14	620.6	0.0	3.1
Sep-14	453.2	5.4	1.2
Oct-14	678.0	0.9	0.2
Nov-14	746.4	0.4	0.2
Dec-14	809.8	3.6	2.5
Jan-15	891.5	6.5	6.4
Feb-15	836.0	7.0	7.0
Mar-15	943.7	10.3	10.3
Apr-15	418.6	3.0	2.9
May-15	916.6	5.8	3.9
Jun-15	856.3	4.8	3.9
Jul-15	880.0	11.3	4.0
Aug-15	768.4	8.3	3.3
Sep-15	987.8	6.7	4.0
Oct-15	929.9	5.6	3.6
Nov-15	776.6	11.2	4.2
Dec-15	686.3	9.6	6.4
Jan-16	654.8	6.7	6.4
Feb-16	619.0	6.2	5.9
Mar-16	77.5	0.4	0.4



## Facility Performance – Greenhouse Gas Emissions

GREENHOUSE	GAS EMISSIONS - S	AWN LAKE (May 2	.014 to March 2016)
	CO2 (tonnes)	N2O (tonnes)	CO2e (tonnes)
May-14	868.5	0.012	872.05
Jun-14	1637.7	0.023	1644.44
Jul-14	1514.4	0.021	1520.65
Aug-14	1477.0	0.020	1483.13
Sep-14	1088.0	0.015	1092.48
Oct-14	1615.3	0.022	1621.93
Nov-14	1777.1	0.025	1784.40
Dec-14	1933.6	0.027	1941.61
Jan-15	2133.1	0.030	2141.92
Feb-15	2002.0	0.028	2010.24
Mar-15	2264.0	0.031	2273.34
Apr-15	1001.4	0.014	1005.58
May-15	2191.6	0.030	2200.60
Jun-15	2046.3	0.028	2054.78
Jul-15	2114.1	0.029	2122.78
Aug-15	1843.2	0.026	1850.85
Sep-15	2362.7	0.033	2372.45
Oct-15	2222.9	0.031	2232.09
Nov-15	1867.8	0.026	1875.49
Dec-15	1650.2	0.023	1656.98
Jan-16	1570.1	0.022	1576.54
Feb-16	1484.1	0.021	1490.20
Mar-16	185.2	0.003	185.99

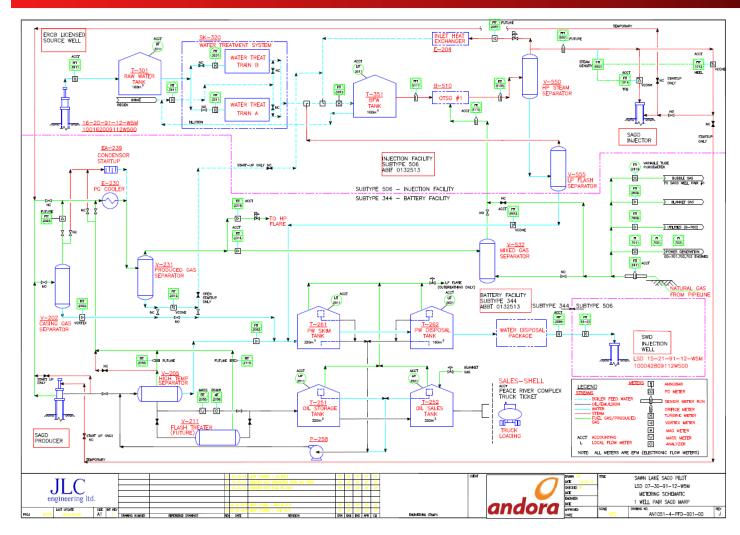


## Measurement and Reporting





### MARP





MARP Approved – October 23, 2013

MARP Calibrations on-going; complete account meter recalibrations for 2015 completed

#### **Reporting Codes:**

SAGD Production Facility ABBT 0132513

SAGD injection Facility ABIF 0132513

Water source is 16-20-91-12W5 100162009112W500

Water injection (disposal) is 15-21-091-12W5/100 100042809112W500

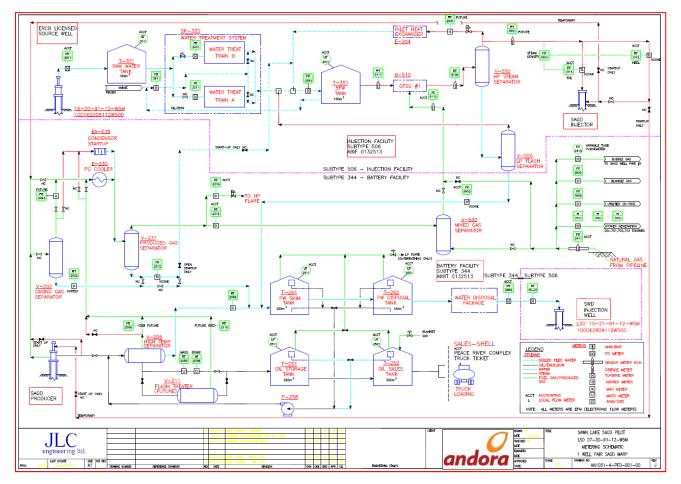
SAGD Wellpair Injector: BH 103/16-30-091-12W5/0

SAGD Wellpair Producer: BH 102/16-30-091-12W5/0









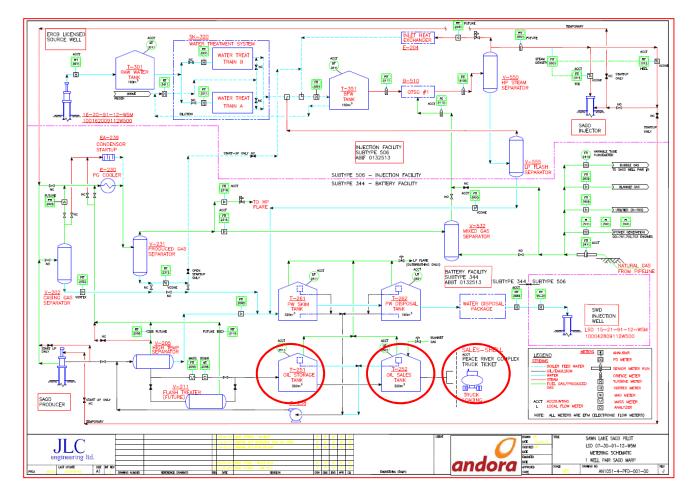
MARP Approved - October 23, 2013

MARP Calibrations on-going; complete account meter recalibrations for 2015 completed



### MARP



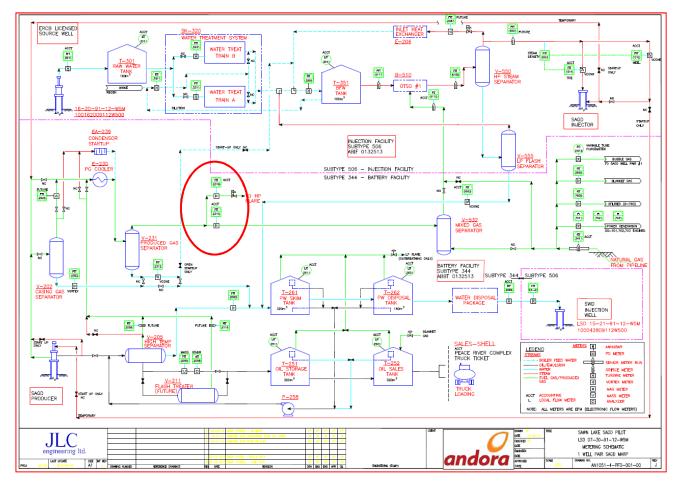


Bitumen Production = Truck receipts (Std Conditions)+ Daily delta LT-2511 (T-251) + Daily delta LT-2521 (T-252) Required adjustment on water cut on start up until chemical program produced on-spec bitumen.



### MARP



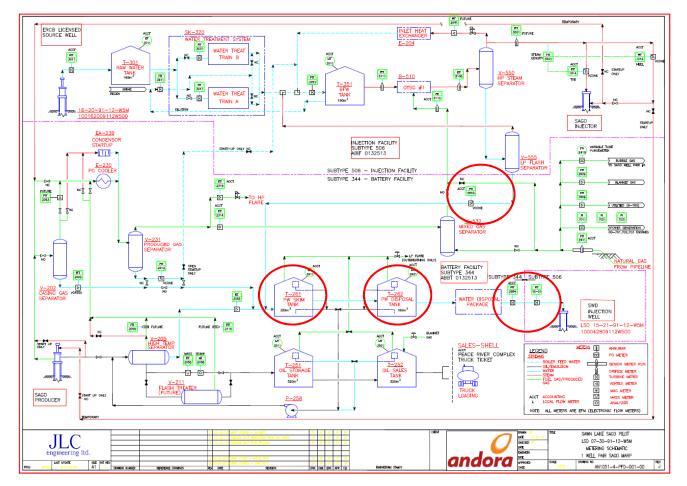


Gas Production (Battery Facility) = FIT-2314+ FIT-2316 + Estimated solution gas vapors (See Section 6.4). Use of Hysys is permitted in CAPP guide "Estimation of Venting Volumes from Upstream Oil and Gas Facilities". For initial operation of the plant Andora will report low pressure flaring of 2 Sm3 per m3 of bitumen produced.







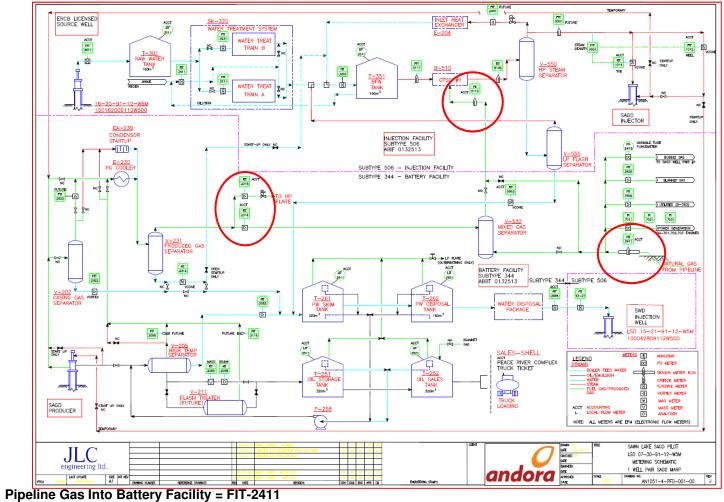


Water Production = FIT-2684 (Disposal Meter) + Daily Delta LT-2611 (T-261) + Daily Delta LT-2621 (T-262) – FIT-5553 (Blowdown) Note – Due to flashing across FIT-5553 / scaling; better calc blowdown Blowdown = FIT-3911 – FIT-1014 – FIT-1012



### MARP





Pipeline Gas Into Battery Facility = FIT-2411 Fuel Gas Consumed by Battery Facility = FIT-2411+ FIT-2314 - FE-5110 Fuel Gas Disposition from Battery to Injector Facility (Consumed by Injector Facility) = FE-5110



### Water Production and Usage





## Source Water Well



#### Source Water Well

- Water Act Approval Licence 00361158-00-00
- Non Saline Source Water Well at 16-20-91-12W5 TDS: 3530mg/L by evaporation P-alkalinity 0ppm, M Alkalinity 1648mg/L, Total 1648mg/L Total Hardness: 49mg/L Silica: 3-8mg/L
- Water from the Paddy/Cadotte

#### Water Recycle

 Andora pilot uses less than 500,000m3 per year of make up water and does not recycle the produced water as per allowance in Directive 081, Section 5.



## Water and Waste Well

#### Produced Water Disposal Well

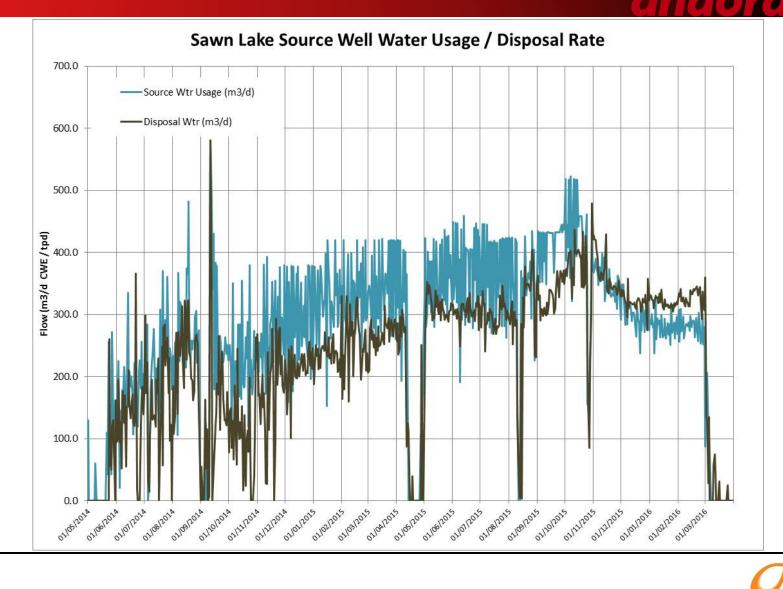
- AER Approval for Disposal Well (D51) 1775897; well W0420620
- AER Approval for Class II Disposal Well (D65) 12169
- Disposal into Upper Wabamum zone at 15-21-91-12W5
- Well remains near vacuum; injection pressure less than 500kPag

#### <u>Other</u>

- Tervita High Prairie ABWP0093970
- Tervita Peace River ABWP0090327
- Gibsons Mayerthorpe ABWP0000556;
- NewAlta Peace River (11-07-082-W5M) AB WP 0097804
- NewAlta Red Earth AB WP 0000663
- Secure Fox 11-36 ABWL0730091



### Sawn Lake Source / Disposal Rates



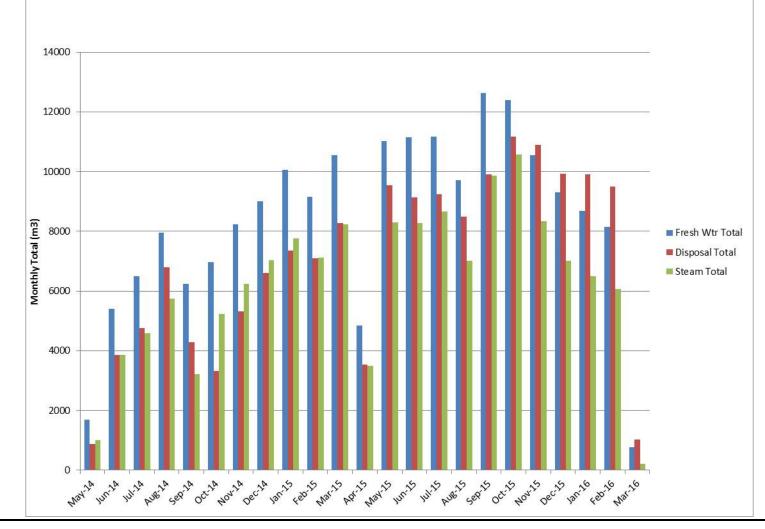
andora



Withdrawal 620m3

Disposal 700m3

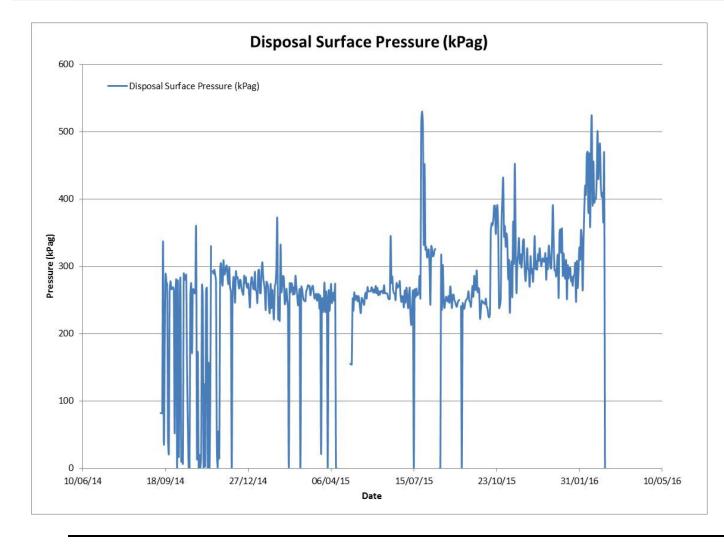
### Sawn Lake Monthly Water / Steam Totals





### **Disposal Well Pressure**





Disposal Well approved (D51) for Maximum Wellhead Injection Pressure of 7000kPag; no issues with wellhead injection pressures typically less than 500kPag.



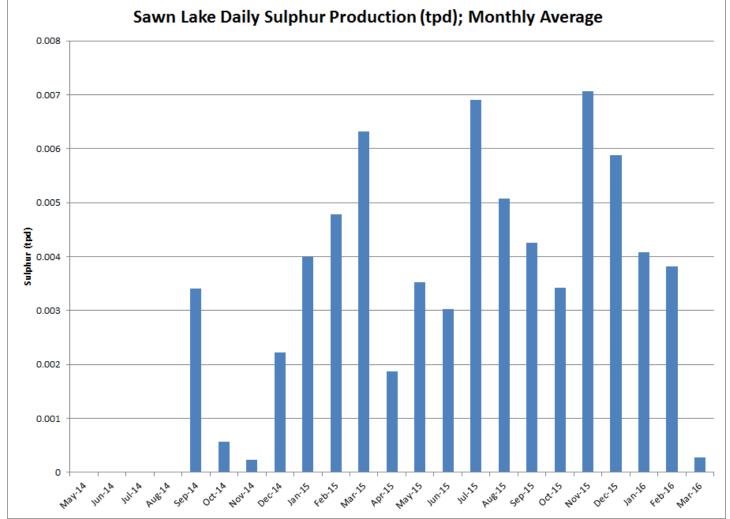
### Sulphur Production and Environmental





## **Sulphur Production**

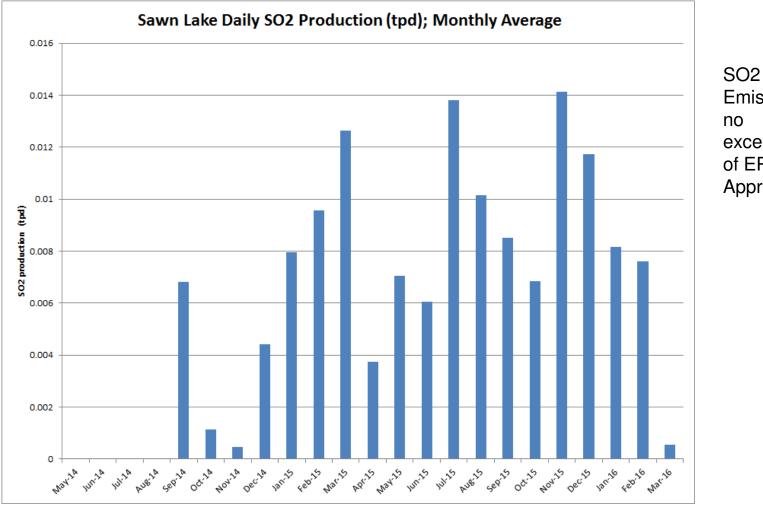






### **SO2** Production





SO2 Emissions: no exceedances of EPEA Approval Limit.



## **Regulatory Summary**



#### **Emissions**

No exceedances on NO2, SO2, H2S

#### Soil and Groundwater Monitoring

Soil monitoring program on-going; samples taken 2015.

### Spills and Clean Up

October 5, 2015: Andora reported an onsite disposal (produced) water spill – 5m3. Area remediated and confirmed via third party; berm reinforced as requested.

#### **Reclamation Programs**

No reclamation programs in 2014/2015



## Ground Water Monitoring Program



- The groundwater monitoring program has been designed to monitor for potential impacts to roundwater quality due to operations at the central processing facility (CPF) and thermal-related effects to non-saline potential domestic use aquifers. The program was developed in consideration of the existing draft Alberta Environment and Sustainable Resource Development Groundwater Monitoring Directive (ESRD 2012).
- On March 9, 2015 a deficiency letter was received by Andora Energy from the AER noting that "The thermal effects groundwater monitoring program must include groundwater monitoring wells completed within the deeper non-saline aquifers beneath the site. There are nearby water wells completed within sand and gravel aquifers at approximately 25 mbgl and 150 mbgl that must be protected. Confirm that Andora Energy will install groundwater monitoring wells within these aquifers and provide proposed locations and completion intervals on maps and crosssections."
- Letter sent to AER April 2015 that nearby wellcores show no deeper intervals; May 28, 2015 AER noted that they wanted confirmation no Dunvegan or Wapiti at 7-30-91-12W5.
- September/October 2015 Andora Drilled ground water test hole to 149.5m and drilled and completed 11 proposed shallow ground water wells at 7-30-91-12W5. Shallow Wells complete.
- Hole drilled; no apparent aquifers within the bedrock from cuttings return and drilling response; confirmed by geophysical logging; there are no apparent deep aquifers, just the shallow sand already noted above bedrock roughly around the 17-20m mark.
- Compiling and will submit information to the AER and document baseline measurements.



## Compliance, Monitoring and Reclamation

#### IWCP – Low Risk Non-Compliance

- Inactive IWCP (core wells) suspended without downhole isolation per D13
- Remedial Action: Will bring 1 noncompliant inactive well into compliance per year; wells to be used as future in-field and/or observation wells. 02/15-21 core was to be suspended per D13 however 01/15-21 came up on the list (old well, converted to source). Andora is in communication with AER through Crest Consultants to fix this list and then will suspend 02/15-21 in 2016. Also 0/7-30 on the IWCP list is an observation well, attempting to have removed from list.
- Wish to suspend wells with service rig to do late 2016/early 2017 core well to north.



# Compliance, Monitoring and Reclamation

#### 2015 Site Inspection

Detailed site inspection Dec 10, 2015 which went through the entire Sawn Lake operation. Action items noted as follows:

#### P/L Corrosion Monitoring and Mitigation – High Risk Non Compliance

**Concern:** Field did not have copies of pipeline cathodic assays required within 1 year of operating P/L per CSA. Disposal line is Fiberspar (no cathodic protection required), fresh water and natural gas lines however are protected by anodes. NG line also set up to receive cathodic protection from TCPL station.

*Mitigation:* The Andora P/L Operations manual requires annual corrosion reviews. Andora has scheduled corrosion assays to occur Jan of every year. Jan 2016 assay found additional anodes on fresh water line required; these were installed Feb 2016. NG line shown to be protected. Copies of the cathodic protection assays are to be available on-side when the plant is in operation.

*Outstanding:* AER inspectors wish for Andora to confirm anodes can provide good protection in lieu of TCPL CA system; Andora to install isolation kit for next testing and confirm anode adequacy. Andora wishes to then remove the isolation kit to ensure double protection is provided.

#### Ground Water Pump-Off Tests

*Concern:* Rain water pump off testing done by ops on-site lab with Baker, not third party ISO accredited lab. ISO laboratory must be used,

*Mitigation:* All samples now sent to third party (Corelab) for analysis; validating on-site lab.



## **Compliance**, Monitoring and Reclamation

#### P/L Right of Way Surveillance – High Risk Non Compliance

*Concern:* No formal documentation regarding P/L RoW inspections in field.

*Mitigation:* Andora P/L operations manual mandates a pipeline patrol per CSA every 14 days (shift) and a formal annual inspection. These pipeline patrols however had no documentation noting that the RoW patrol had taken place. Andora now has added a formal sign off that a P/L RoW patrol has taken place every shift with the operators name and time of inspection noted on the operator round sheets.

#### Source/Disposal Water Casing Vent within Shed – Low Risk Non Compliance

*Concern:* 15-21 disposal and 16-20 source well casing vents open but within shed; casing vents must be open to atmosphere.

*Mitigation:* In January 2016 Andora added extensions to the casing vents that they now vent outside of the well sheds.

#### Source/Disposal Signage at entrance of well pad – Low Risk Non Compliance

*Concern:* 15-21 disposal and 16-20 source well had a sign on the road to the wells but not at the wellpads *Mitigation:* Signs placed at entrance to wellpads.



### Future Plans





## Regulatory

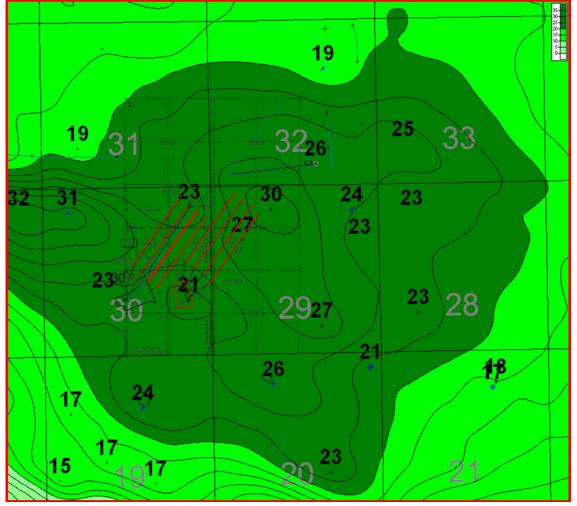


	2015	2016		2017		2018		2019		2020		
	Q1 Q2 Q3 Q4	Q1   Q2   Q	3 Q4	Q1 Q2	Q3 Q4	Q1 Q2	Q3 Q4	Q1 Q2	Q3  Q4	Q1	Q2 Q3	3 Q4
2U/2LWELLPAIR ADDITION TO EXISTING SITE [+400bopd to 800bopd]	AER Approval											
PRODUCED WATER BOIL PILOT AND TRIAL	AER ap AER submission	proval <del>-</del>										
ADD x2 WELLPAIR TO EXISTING SITE [+800bopd to 1600bopd]	FEED		proval	Period								
ADD x 4 WELLPAIRS AT NEW 8-30 LEASE [+1600bopd to 3200bopd]	AER sub				approva	I						



## 490m3/d Regulatory Application



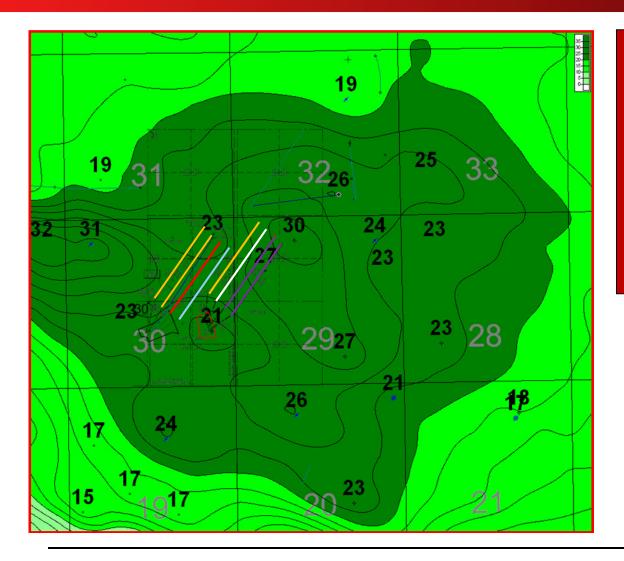


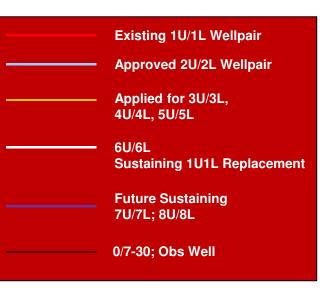
#### **Application Includes:**

- Use of existing oil/water production facility (3200bopd), natural gas line, disposal well and in field well.
- Three (3) additional wellpairs for a total of five (5) operating SAGD wellpairs. Design work for up to 8 SAGD wellpairs is presented (was prepared prior to pilot results);
   6U/6L backup for 1U/1L; 7 and 8 moved to sustaining wellpairs.
- Three (3) Produced Water Boilers (PWB), Vapor-Recovery-Unit (VRU)
- Additional back up source water well at 8-30-91-12W5.



## 490m3/d Regulatory Application Wellpairs

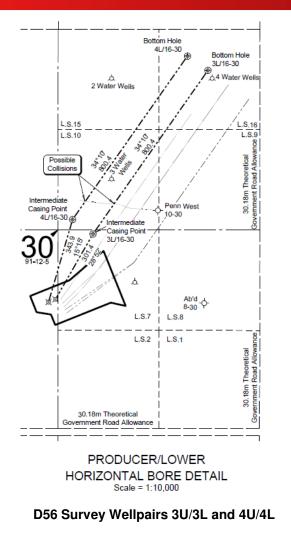


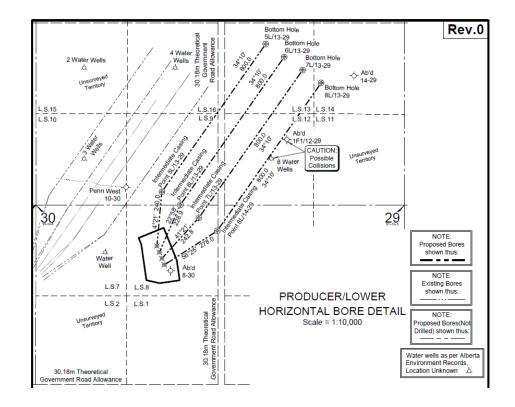


Well Spacing – 100m



## 490m3/d Regulatory Application Wellpairs



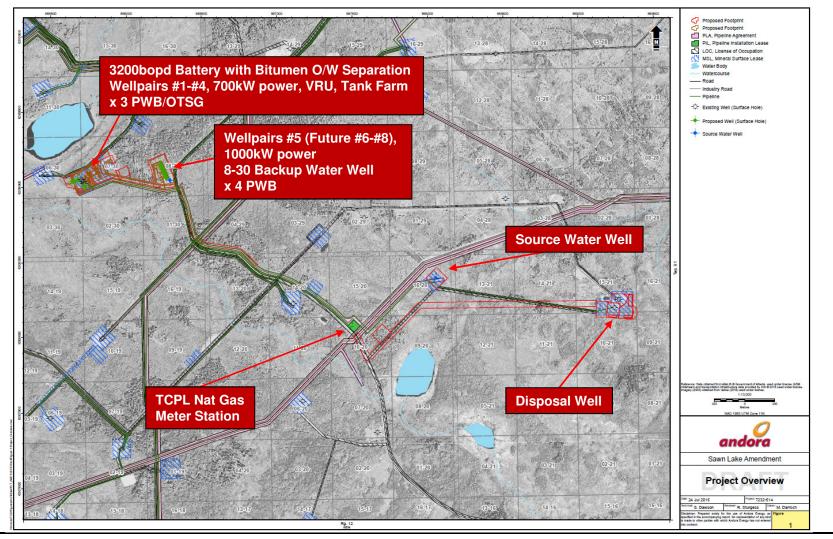


D56 Survey Wellpairs 5U/5L, 6U/6L, 7U/7L, 8U/8L



### 490m3/d Project Overview

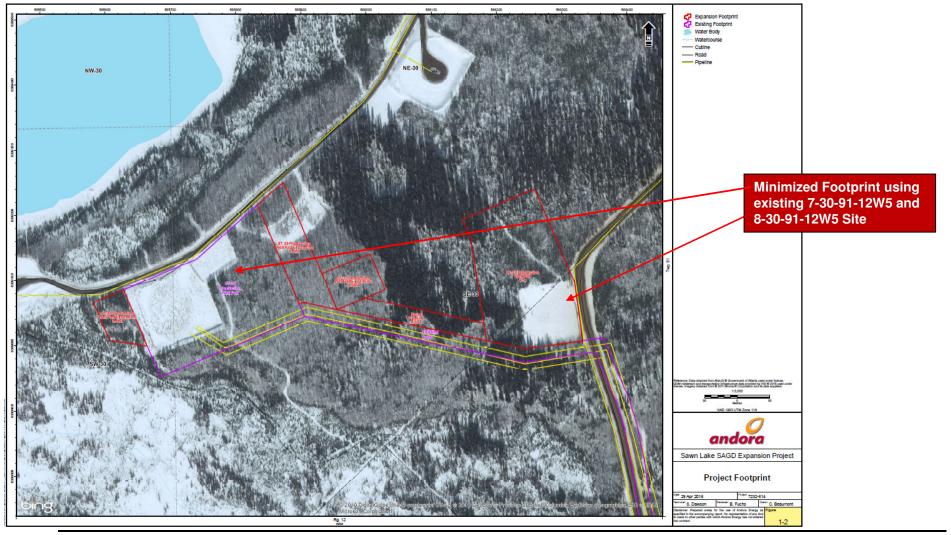






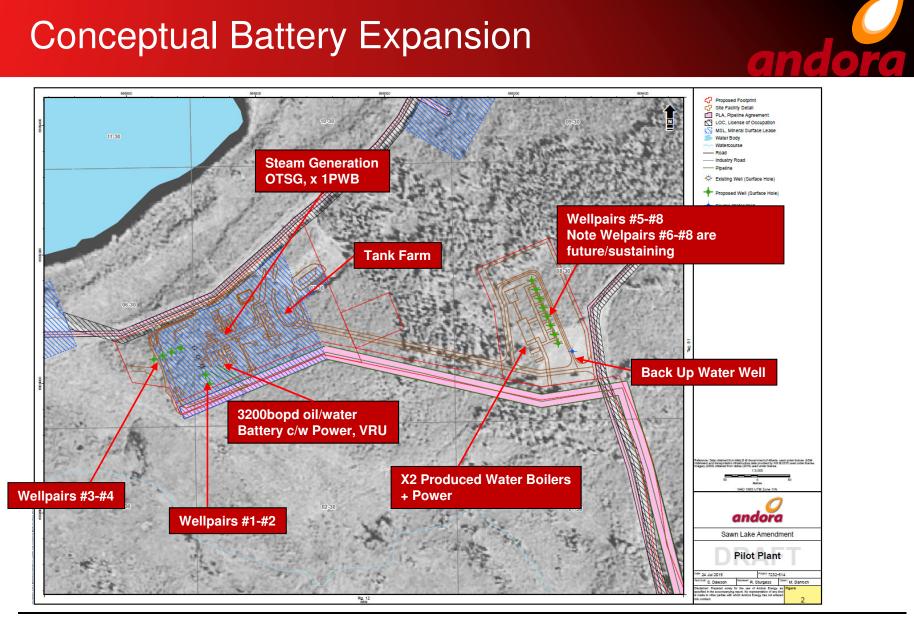
## 490m3/d Battery Expansion







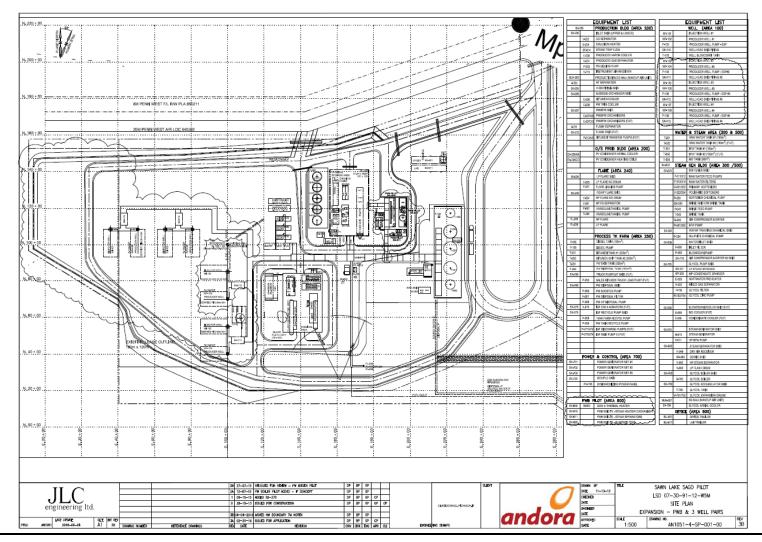
## **Conceptual Battery Expansion**





## **Battery Expansion**

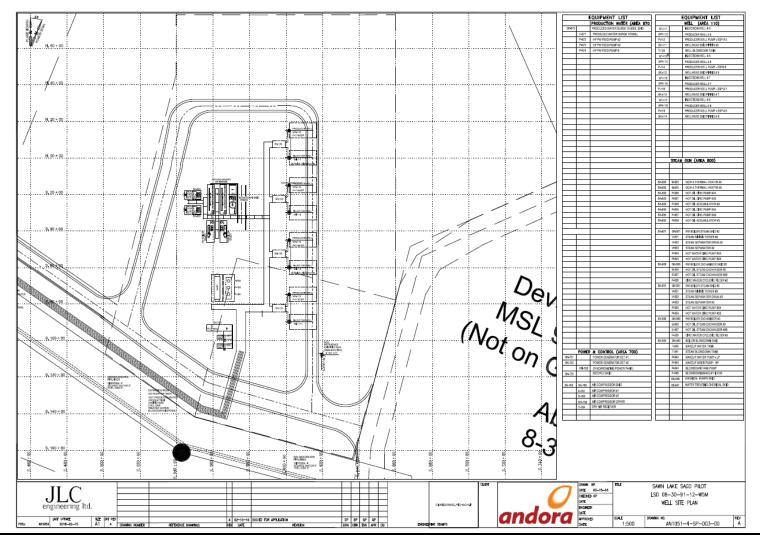






### **Battery Expansion**







### Andora PWB Technology



Concept boilers

#### **TYPICAL RANGE OF FEEDWATERS \***

Constituent	Parts per Million (mg/L)					
Total Oil	0-250					
Total Dissolved Solids (TDS)	1,000-20,000					
Total Hardness (Ca+Mg)	100-2,000 (eg CaCO3)					
Silica (SiO2)	10-300					
Sulfate (SO4)	10-1,000					
Suspended Matter (Turbidity)	10-1,000					

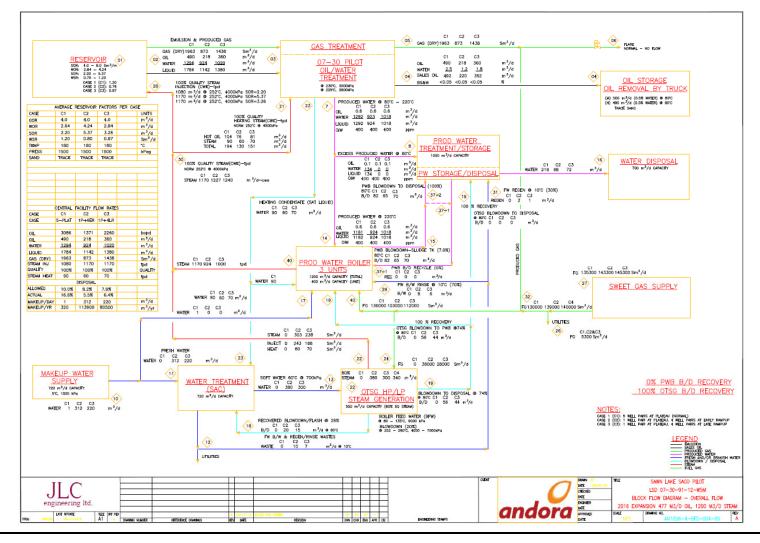
\* Figures used are not necessarily the maximum values that the PWB can handle

- Produced Water Boiler a patented improvement on the an older boiler process. Unit can fire on oilfield produced water, brackish water, sea water or fresh water greatly simplifying SAGD plant strategies while meeting AER D81 water recycle requirements. Allows D81 PW recycle at small scale; combines boiler function with water treatment function in a single 30 or 50 MMBTU/hr package.
- Lower pressure steam at the wellheads; eliminate steam transmission lines/pressures.
- Based on commercially available units in 60-70s; patented improvements by Andora for sustained operation based on lessons learned and current technologies.



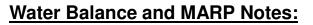
### **Battery Expansion**







## 490m3/d Regulatory Application

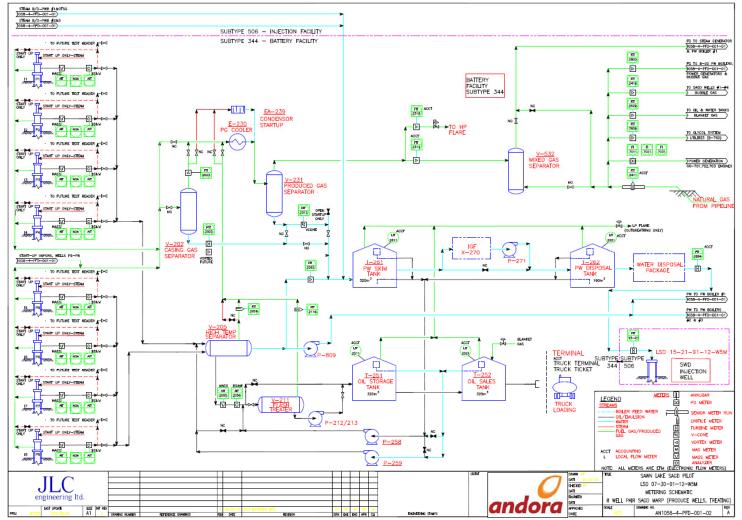


- The Expansion Project will utilize high efficiency water treating technology described previously, which will convert more than 92% of the fed produced water to 100% quality steam.
- All cases where the WSR is less than 1.1 the existing facility meets D81.
- In the event the WSR is greater than 1.1 even if 100% of the produced water was converted to 100% quality steam D-81 calculated allowed limits cannot be achieved as excess produced water would need to be disposed of. A WSR of 1.2 was achieved by the Sawn Lake 1U/1L wellpair in January and February 2016. This case is noted in the application to ensure the AER is aware and approves of facility operation with WSR above 1.1 given that 93%+ of the produced water is converted to 100% quality steam, no make up water would be required and the existing SAC/OTSG steam generation train would be shut down (all steam would be from the PWBs).
- Preliminary MARP diagrams included; wellhead emulsion proration based on flows and water cut test heater, produced gas proration based on orifice meters at wellheads. Export volumes and accumulation used for ultimate production values.



### **Battery Expansion**

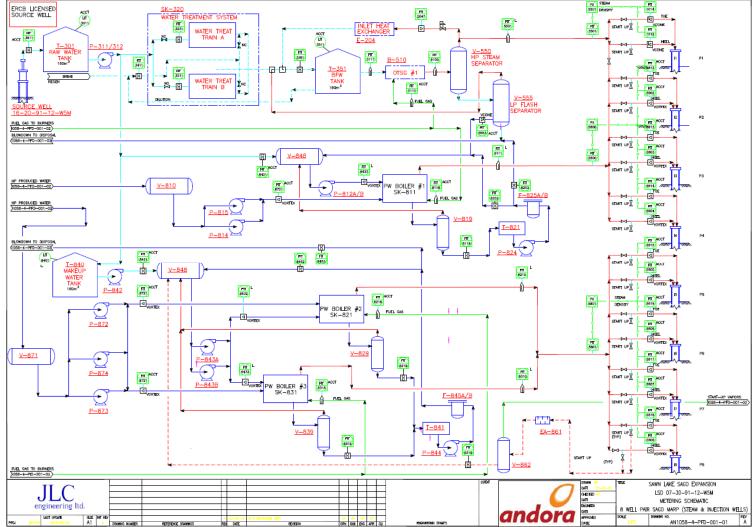






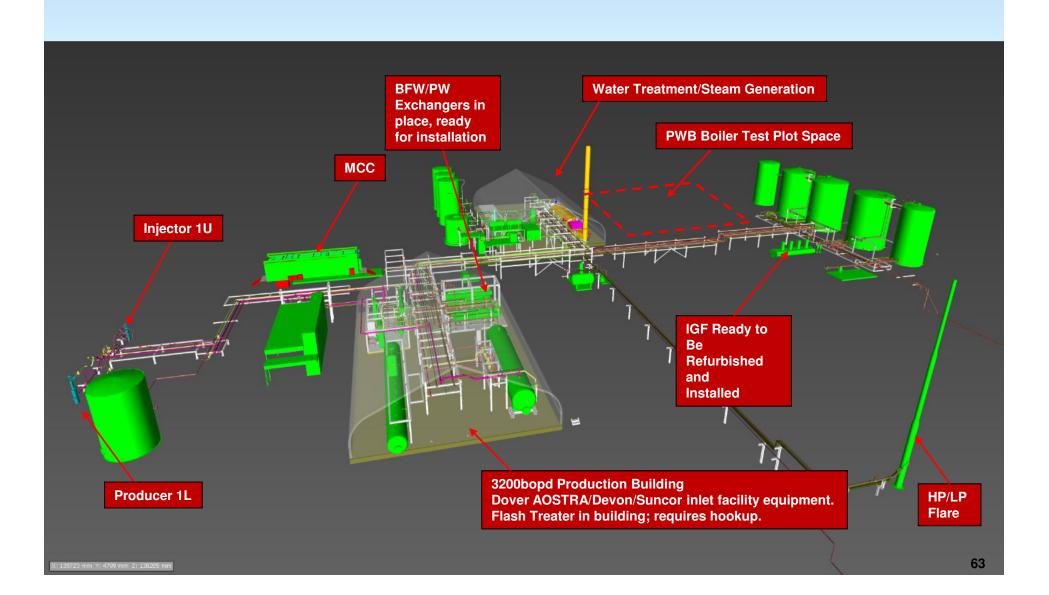
## **Battery Expansion**







## **Pre-invested Emulsion Treating Equipment**

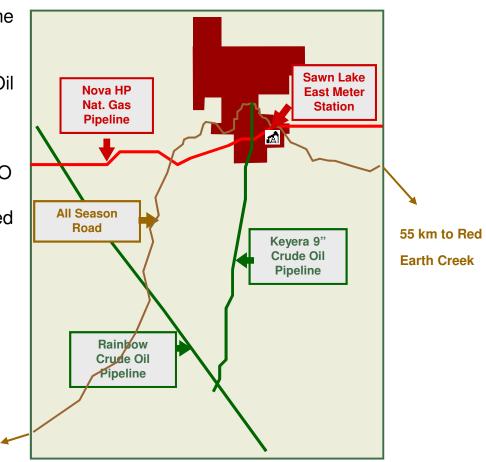


## **Blending / Marketing**



- Current plans to export by truck to Shell Peace River and Murphy batteries along Rainbow Pipeline (Plains Nipisi unable to blend)
- Exploring utilizing Keyera crude / Mount Bastion Oil and Gas facilities to blend closer to facility and at less cost.
- Andora Sawn Lake is "bitutainer" export ready; ISO rated containers capable of transporting on-spec (less than 0.05%BS&W); bitumen can be re-heated with internal coils at destination (steam or thermal oil).





130 km to the town of Peace River







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