### Air injection and displacement for recovery with oil horizontal (AIDROH) project Approval #11618 Performance presentation

Alberta Energy Regulator offices Calgary

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## Advisory

This document contains forward-looking information prepared and submitted pursuant to the Alberta Energy Regulator's requirements and is not intended to be relied upon for the purpose of making investment decisions, including without limitation, to purchase, hold or sell any securities of Cenovus Energy Inc. Additional information regarding Cenovus Energy Inc. is available at <u>cenovus.com</u>.



## Advisory

<u>Total bitumen initially-in-place (BIIP) estimates</u>, and all subcategories thereof, including the definitions associated with the categories and estimates, are disclosed and discussed in our July 24, 2013 news release, available on SEDAR at sedar.com and at cenovus.com. BIIP estimates include unrecoverable volumes and are not an estimate of the volume of the substances that will ultimately be recovered. Cumulative production, reserves and contingent resources are disclosed on a before royalties basis. All estimates are best estimate, billion barrels (Bbbls). *Total BIIP* (143 Bbbls); *discovered BIIP* (93 Bbbls); *commercial discovered BIIP* equals the *cumulative production* (0.1 Bbbls) plus reserves (2.4 Bbbls); *sub-commercial discovered BIIP* (50 Bbbls); *prospective resources* (9.6 Bbbls) plus the *unrecoverable portion of discovered BIIP* (42 Bbbls). Any contingent resources as at December 31, 2012 that are sub-economic or that are classified as being subject to technology under development have been grouped into the unrecoverable portion of discovered BIIP. <u>Petroleum initially-in-place (PIIP) estimates for Pelican Lake</u> are effective December 31, 2012 and were prepared by McDaniel. All estimates are best estimate discovered PIIP volumes as follows: *Mobile Wabiskaw* total PIIP (2.11 Bbbls); unrecoverable discovered PIIP (0.13 Bbbls); cumulative production (0.11 Bbbls); reserves (0.25 Bbbls); contingent resources (0.03 Bbbls); unrecoverable discovered PIIP (1.62 Bbbls); undiscovered PIIP (0 Bbbls). *Immobile Wabiskaw* total PIIP (1.33 Bbbls); undiscovered PIIP (0 Bbbls). *Immobile Wabiskaw* total PIIP (1.33 Bbbls); undiscovered PIIP (0 Bbbls).

Certain natural gas volumes have been converted to barrels of oil equivalent (BOE) on the basis of one barrel (bbl) to six thousand cubic feet (Mcf). BOE may be misleading, particularly if used in isolation. A conversion ratio of one bbl to six Mcf is based on an energy equivalency conversion method primarily applicable at the burner tip and does not represent value equivalency at the well head.

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## AIDROH\* introduction and overview

This presentation was prepared in accordance with AER Directive 054 - Performance presentations, auditing, and surveillance of in situ oil sands schemes

Subsurface issues related to resource evaluation and recovery

Directive 054, Section 3.1.1

Surface operations, compliance, and issues not related to resource evaluation and recovery

Directive 054, Section 3.1.2

\* Canadian patent CA2594413

### AER Directive 054 Section 3.1.1

Subsurface issues related to resource evaluation and recovery





## Subsurface issues: table of contents

- Background
- Geology/geoscience
- Drilling and completion
- Artificial lift
- Instrumentation
- Scheme performance
- Future plans



## Scheme background

### Subsurface section 1







The AIDROH project uses gravity drainage as a bitumen recovery process to recover bitumen that has been passively heated by the Cenovus EnCAID combustion project





## Geological/geoscience

Directive 54 Subsurface section 2





## Summary of reservoir properties

Depth	465m TVD
Thickness	25-30m
Average porosity	35%
Average bitumen saturation	65%
Average permeability	1,350mD
OBIP (project area)	3,302 e <sup>3</sup> m <sup>3</sup>
Oil viscosity @ 13C @ 60C	~25,000 cP ~600 cP
API oil gravity	10.3 - 10.8



## Wabiskaw bitumen thickness



Type log cut offs:-

-<75 api gamma ray</li>>20 ohm resistivity>27% porosity

**OBIP** under gas cap = 159,000 e<sup>3</sup>m<sup>3</sup>

AIDROH



## Wabiskaw structural map





## Wabiskaw stratigraphic cross-section



## Horizontal production well 104/5-10



Drilled in 2011 east of injector well at surface location 6-10 300m of horizontal leg landed 30m north of injector well and ~15m into heated zone

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## Drilling and completion

Directive 54 Subsurface section 3





## Well layout

## Drilled 103/5-10-73-6W4 post burn vertical well September 2011

- Drilled 11m northwest of 102/5-10-73-6W4
- Successfully cored 44m from top Wabiskaw to top of McMurray – no lot core
  - extensive core ad oil analysis program completed
  - core routine core analysis, SEM, XRD
  - oil API, viscosity, composition

## Drilled 104/5-10-73-6W4 horizontal producer well September 2011

- Drilled 300m east-west horizontal section, landed 30m north of 100/5-10-73-6W4 injector well and 15m below Wabiskaw gas/bitumen interface
- Well equipped with 20 thermocouples in horizontal length



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## Completion

#### Installed tail pipe to toe

- divert hot crude to toe
- encourage warming near toe



Requirements under subsection 3.1.1 3c – wellbore schematics are included in the appendix



## Artificial lift

Directive 54 Subsurface section 4





## Artificial lift

### Artificial lift technology information

- Progressive cavity pump (PCP), temperature tolerance of elastomer 150°C
- Lift capacity range: 34-50 m3/D
- Operating temperature range 44°C to 108°C



## Artificial lift performance

### No production activity during 2016 reporting period

• Well suspended on February 13, 2015



## Instrumentation

Directive 54 Subsurface section 5





## Instrumentation in wells

### 104/05-10-73-6W4/00

Equipped with 10 thermocouples

Requirements under subsection 3.1.1 5a – wellbore schematics 5c and 5d are included in the appendix



## Thermocouple temperature vs. depth





## Scheme performance

Directive 54 Subsurface section 7





## Production history





## Heated oil volume

Calculated using analytical geometry-based method

Combustion front heats bitumen by conduction in the shape of a sphere cap

Thermally affected radius ~ 270m
 Chemically affected

- 57,000m<sup>3</sup>
  Thermal affected\*
  - 665,000m<sup>3</sup>
- \* Based on horizontal well depth 15m below gas/bitumen interface



## Historical oil quality

Original oil ~45,000 cP at reservoir conditions (dead)

No oil quality analysis undertaken during 2016 reporting period

	viscosity	C)		
No.	25C	35C	50C	
1	6469	2608	781	
2	7510	2111	853	
3	5006	2103	652	
4	9073	2483	925 844	
5	8013	2185		
6	7994	2112	1022	
7	7763	2971	860	
8	8276	3050	884	
9	8271	2410	923	
10	5389	1646	662	
11	8442	2338	894	
12	7180	2449	926	
13	6270	1583	737	
14	10250	2922	1130	
15	10955	3038	1153	
16	10457	2919	1103	
17	10267	2780	1091	
18	9962	2813	1077	

		SARA, %		
Sample No.	Asphaltene (C5 insoluble)	Saturates	Resins	Aromatics
1	13	26	11	50
2	14	25	13	49
3	14	26	13	47
4	14	24	13	49
5	15	25	13	47
6	12	25	11	52
7	13	28	8	52
8	15	23	16	46
9	16	24	11	49
10	13	24	9	54
11	13	24	13	50
12	14	24	13	49
13	14	23	10	53
	No analysis	conducted in 20	15	



## BS&W

### No production activity during 2016 reporting period

2016	BS&W
Q1	-
Q2	-
Q3	-
Q4	-



## Subsurface key learnings

No production activity during 2016 reporting period

## EnCAID conductive heating effects observed following suspension of well operations from 2015

- TC 1-5 ~6°C temperature increase
- TC 6-11 ~12°C temperature increase
- TC 12-15 ~5°C temperature increase



## Future plans

Directive 54 Subsurface section 8





## Future plans

### **Continue the following:**

- Monitor downhole temperatures
- Continued suspension of AIDROH well operations



# AER Directive 54 Section 3.1.2

Surface operations, compliance and issues not related to resource evaluation and recovery





## Surface operations: table of contents

- Facility overview/modifications
- Measurement and reporting
- Water, water disposal well and landfill waste
- Sulphur production
- Environmental issues
- Compliance statement
- Non-compliance discussion
- Future plans



## Facility overview/modifications

**Directive 54** Surface operations section 1











## Process flow schematic

No changes to facility or process undertaken during 2016 reporting period





## Facility performance 2016

### No production activity during 2016 reporting period

Suspended facility February, 2015



## Gas usage

No gas usage activity during 2016 reporting period



## Greenhouse gas emissions

### No production operations or gas usage activity during 2016 reporting period

Month	2016 (tonnes)	2015 (tonnes)	2014 (tonnes)
January	-	29	46
February	-	12	64
March	-	-	91
April	-	-	101
Мау	-	-	109
June	-	-	112
July	-	-	115
August	-	-	78
September	-	-	23
October	-	1	11
November	-	7	22
December	-	4	30



## Measurement and reporting

Directive 54 Surface operations section 2





## Measurement reporting





Water, water disposal wells and landfill waste

Directive 54 Surface operations section 5





## Water and waste disposal

### No production operations during 2016 reporting period

- No processing occurred at the site
- No produced water



## Sulphur production

Directive 54 Surface operations section 6





## Sulphur production

## No production operations during 2016 reporting period

2016	Sulphur Emission, Kg
Q1	-
Q2	-
Q3	_
Q4	-



## **Environmental issues**

Directive 54 Surface operations section 7





## Environmental issues

No environmental issues related to the AIDROH occurred in 2016



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## Compliance statement

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## **Compliance confirmation**

No non-compliance events related to the AIDROH occurred in 2016



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## Non-compliance discussion

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## Non-compliance confirmation

No non-compliance events related to the AIDROH occurred in 2016



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## Future plans

### Directive 54 Surface operations section 10





## Future plans

Continue suspension of AIDROH well and facilities



## Appendix



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## Wellbore schematic

Well Name:	CVE FO	CCL 6-10 KIRBY	5-10-73-6	Schem	atic - Currer	nt (Landsca	pe Layout)			се	ηογμ
ottom Hole UWI	000000	Surface Legal Location	Pad	Profile Type	Sour Class(Lic)	Sour Status Date	Orig KB Elev (m)	Working GLE (m)	KB-CF (m)	KB-TH (m)	Total Depth (mKB)
04/05-10-0/3-0	06774/00	LSD 6-10-73-6W4	6P-10-736 W4 FILE	SIG HORIZONTA	LUNKNOWN	-	694.40	689.50	2.91		1905.00
ib Category		Type		Job Sta	rt Date	J	ob End Date		-		
VORKOVER		OPTIN	MIZATION	2	2014-09-1	4			e.		
100 ( 100)				HORIZC	INTAL - ORIGINAL	. HOLE, 2014-09-	22 8:30:00 PM				
MD (MKB)		KB) Incl (*)	DLS (920m)				vertical schem	latic (actual)			
-0.7	- <mark>0.7</mark>	0.0	0-20	- ú		CROSS OVER;	CTION; 508.0; -4. 244.5; 224.4; -0.7	90-0.00; 4.90 5-0.00; 0.75			
1.1 -	1.1	0.0	-								
2.8	2.8	0.1	-		4-1	TUBING HANG	ER; 0.0; 2.71-2.86	0.15			
4.1	4.1	0.2			4-2	; PUP JOINT; 88.	9; 2.86-4.12; 1.26				
4.9	4.9	0.2			2-3	CASING JOINT CROSS OVER;	S; 508.0; 475.7; 0. 339.7; 320.4; 4.90	00-20.00; 20.00 -17.18; 12.55			
12.7 -	12.7	0.5									
17.2 -	17.2	0.7	Ļ 🛛	2	2-4	CASING JOINT	S; 339.7; 320.4; 17	7.18-303.40; 286.2	2		
303.4 -	297.2	2 - 22.1	1		2-5	FLOAT COLLAR	R; 339.7; 320.4; 30	3.40-303.85; 0.45			
303.9	297.7	22.1			2-6	CASING JOINT	S; 339.7; 320.4; 30	03.85-316.61; 12.7	6		
317.0	309.8	3 23.1			-3-3	CASING JOINT	5: 244 5: 224 4: 0	00-638 48: 638 48			
321.4	313.8	3 23.4	5		-3-1	COILED TUBIN	G; 31.8; 0.00-880.	00; 880.00			
534.0	456.6	5 72.8			-4-5	TUBING; 88.9; 1	6.0; 534.01-580.6	8; 46.67			
557.9	462.2	2 79.8			/-4-6 /-4-7	CROSS OVER; PCP - STATOR	88.9; 580.68-580. 76.2: 580.82-585	B2; 0.14 .45: 4.63			
580.8	465.7	82.4	-		-4-8	TAG BAR; 76.2;	585.45-585.53; 0.	08			
585.8	466.3	82.8	1L		4-1	0; CROSS OVER	; 88.9; 585.80-586	.39; 0.59			
609.0	467.7	7 89.9	17		-4-3	DEPTH CORRE	CTION; 177.8; 60	9.40-630.49; 21.0	9		
630.5	467.3	91.3			-3-4	FLOAT COLLAR	R: 244.5: 224.4: 63	8.48-639.00; 0.52			
638.5	467.2	90.6			<b>1</b> /-4-5	CASING JOINT	S; 177.8; 161.7; 63	33.03-657.83; 24.8	0		
000.0	407.2				-3-5	CASING JOINT	S; 244.5; 22 <mark>4</mark> .4; 63	39.00-651.94; 12.9	4		
651.9	467.2	2 - 90.3			/-3-6	CASING JOINT	244.5; 224.4; 651.9	94-652.45; 0.51 57 83 723 33: 65 5	n		
657.8	467.1	90.3	- Į		-4-1	1; TUBING; 88.9;	69.8; 586.39-866.	82; 280.43			
734.8	466.8	89.4	2		4-4-/	CASING JOINT	S; 177.8; 161.7; 72 S; 177.8; 159.4; 73	23.33-734.76; 11.4 34.76-799.23; 64.4	3 7		
810.5	467.8	89.2	}		4-9	CASING JOINT	S; 177.8; 161.7; 79 TS: 177.8: 159.4: 8	99.23-810.49; 11.2 310.49-876.40; 65.	6 91		
876.4	467.2	90.9			4-1	2; MULE SHOE T	UBING JOINT; 88	3.9; 866.82-876.87	; 10.05		
880.0	467.2	2 90.9			4.1	1; CASING JOIN	TS; 177.8; 161.7; 8	37 <mark>6.40-890.00;</mark> 13.	60		
905.0	466.8	8 - 91.0			•						
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## Thank you



