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October 3, 2006

Mr. Giuseppa Bentivegna
Alberta Energy and Utilities Board
640 – 5th Avenue S.W.
Calgary, AB T2P 3G4

Dear Mr. Bentivegna:

Re: AEUB Board Staff Information Request - Sep 19, 2006
Applications 1394112 and 1409180
Cold Lake Oil Sands Area - Clearwater Deposit

Attached are Imperial Oil's responses to your information request dated September 19, 2006.

Yours truly,

ORIGINAL COPY SIGNED

Susan C. Stark, Manager
In-Situ Development Planning

SCS/ry

Attachments

cc: EL Lui, TJ Boone, SR Maxwell, MD Taylor, E. Smith (AEUB)

* an Alberta limited partnership

Board Staff Information Request (September 19, 2006)

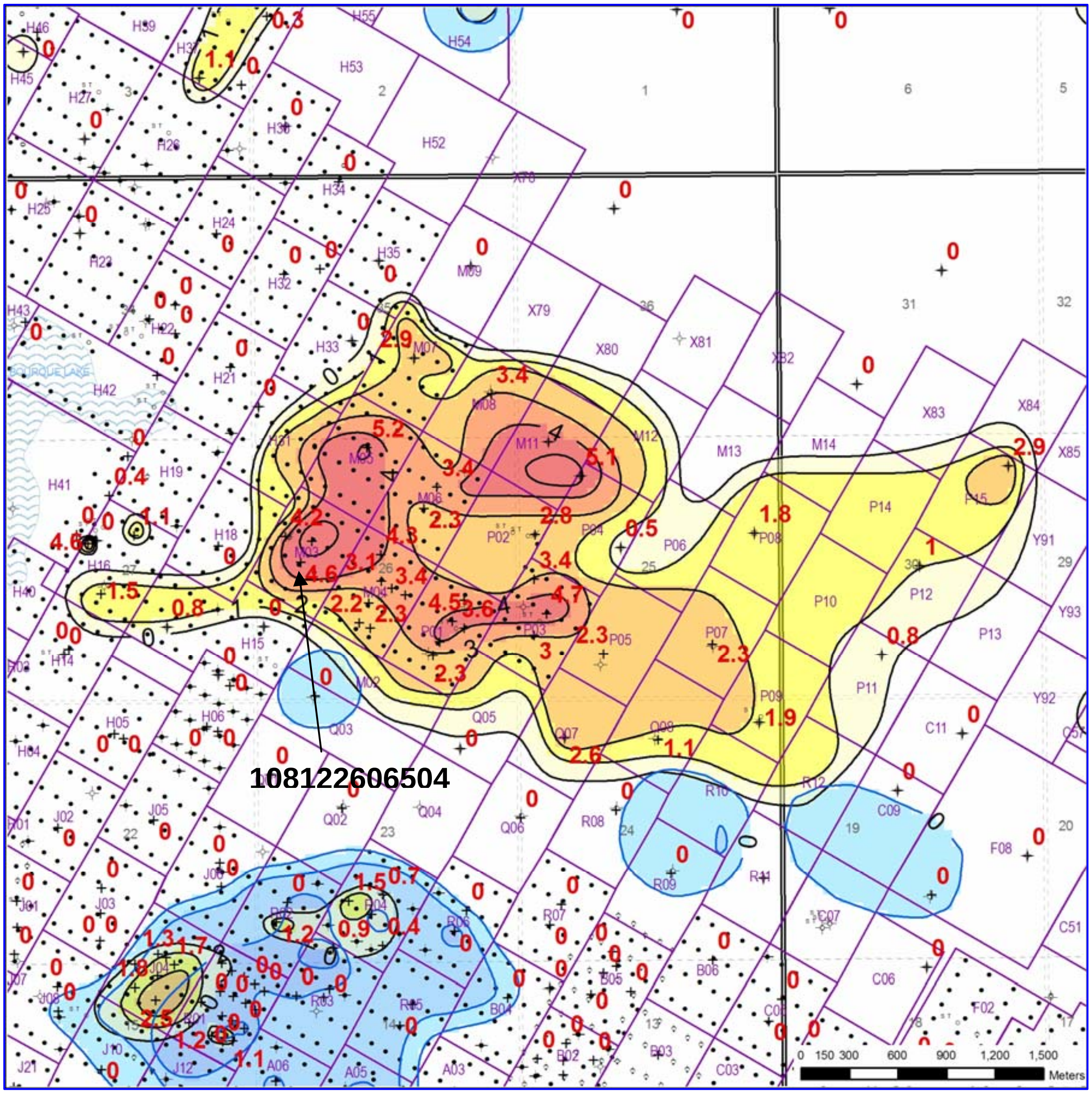
1. ***On the first page of its submission Imperial Oil states that with respect to four Clearwater gas pools at Cold Lake, the cumulative gas production has exceeded the volumetric gas in place (GIP) and this indicates that gas production was being supported by degassing of the bitumen.***

   ***Provide details of Imperial Oil's determination of the volumetric GIP for the four pools, including the parameters used (ie. porosity, water saturation, and gas formation volume factor) and the basis for these parameters*.**

   The reservoir parameters are based on log analysis (Sg, porosity) and analogue values (Bg) used in the area of interest. Sg calculated from gas effect on each neutron and density logs were screened for invasion effects and a gas cap of sufficient thickness (~2m). Volumes were determined from isopach maps of the pools (attached).

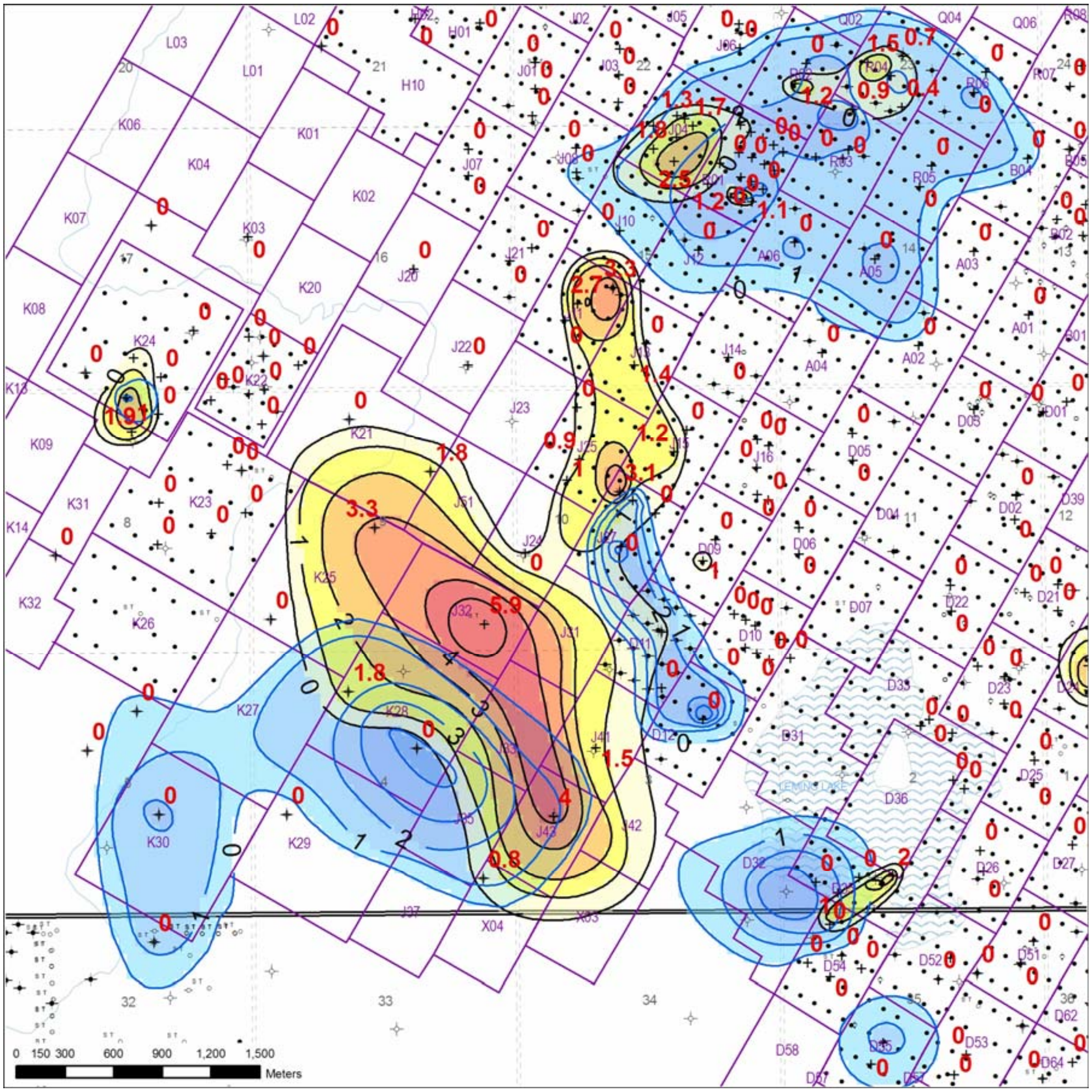
Gas Pool	Sg	Porosity	Pore Volume 1e6 m3	1/Bg sm3/m3	Volumetric OGIP 1e6 sm3
A	0.75	0.34	19.9	32.5	165
B	0.62	0.34	10.7	32.5	73
C	0.62	0.34	1.8	32.5	13
E	0.75	0.34	29.7	32.5	246

   Also provide isopach maps for the pools that show the net gas values for each well posted on the maps and the well control used to determine the zero edge of the isopach maps.



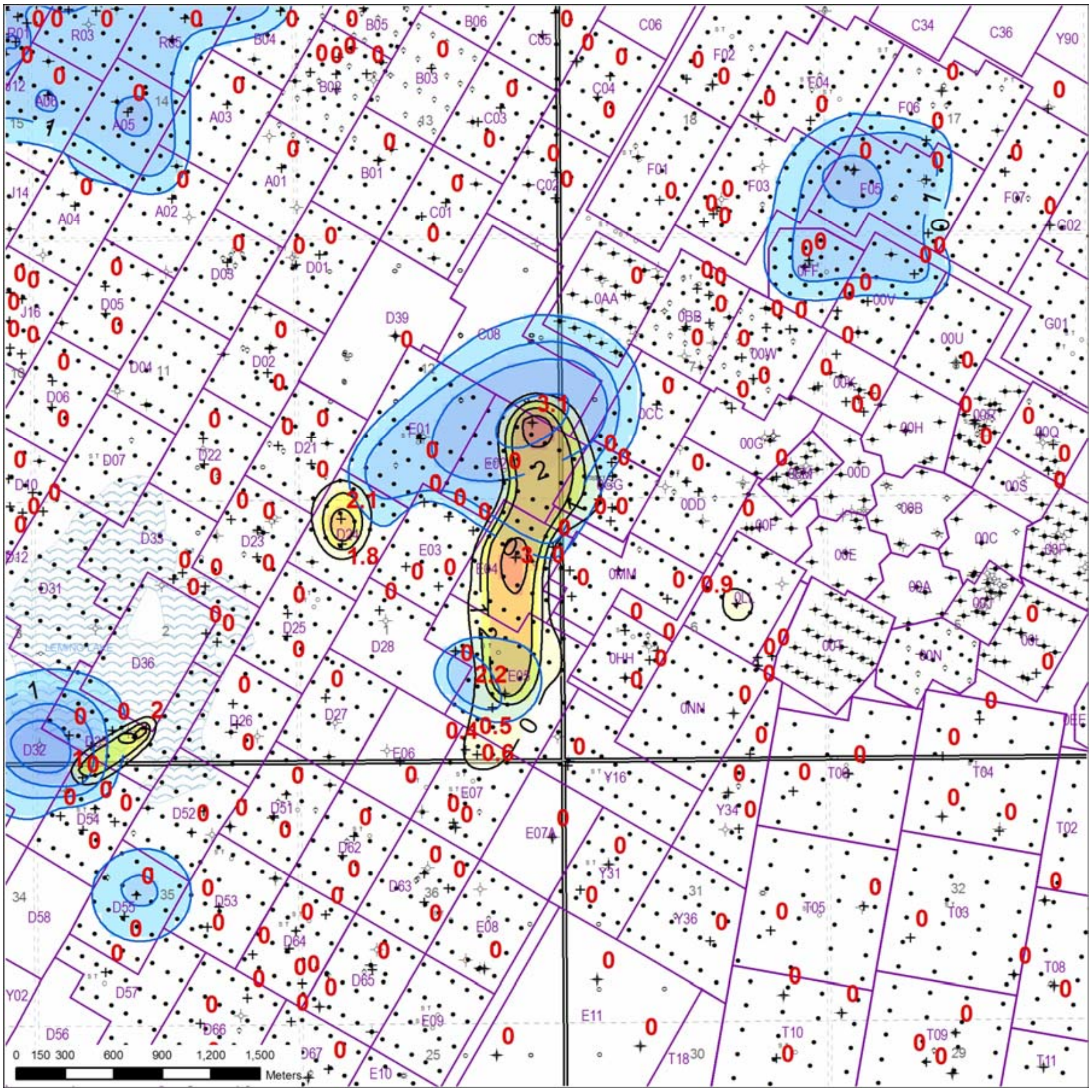
Net Gas Pay Map from "A" Gas Pool (M&P Trunk)

Clearwater Gas Cap	Clearwater Top Water
Thickness (m)	Thickness (m)
-1 - 0	-1 - 0
0 - 1	0 - 1
1 - 2	1 - 2
2 - 3	2 - 3
3 - 4	3 - 4
4 - 5	4 - 5



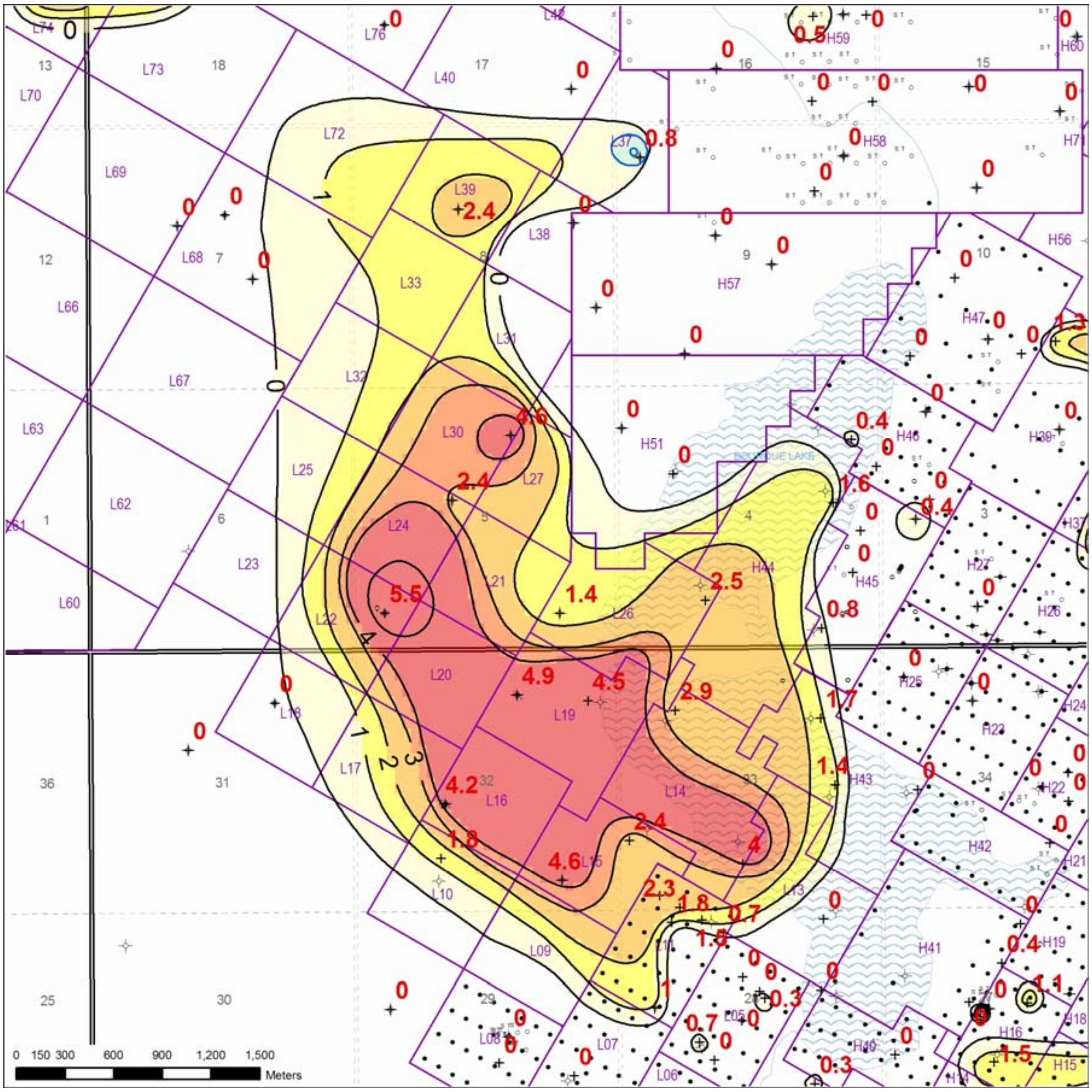
Net Gas Pay Map from "B" Gas Pool (J Trunk)

Clearwater Gas Cap Thickness (m)	Clearwater Top Water Thickness (m)
-1 - 0	-1 - 0
0 - 1	0 - 1
1 - 2	1 - 2
2 - 3	2 - 3
3 - 4	3 - 4
4 - 5	4 - 5



Net Gas Pay Map from "C" Gas Pool (E Trunk)

Clearwater Gas Cap	Clearwater Top Water
Thickness (m)	Thickness (m)
-1 - 0	-1 - 0
0 - 1	0 - 1
1 - 2	1 - 2
2 - 3	2 - 3
3 - 4	3 - 4
4 - 5	4 - 5



Net Gas Pay Map from "E" Gas Pool (Bourque)

Clearwater Gas Cap	Clearwater Top Water
Thickness (m)	Thickness (m)
-1 - 0	-1 - 0
0 - 1	0 - 1
1 - 2	1 - 2
2 - 3	2 - 3
3 - 4	3 - 4
4 - 5	4 - 5

Elaborate why Imperial Oil believes its volumetric GIP estimates are accurate enough to allow Imperial Oil to conclude that gas production was being supported by degassing of the bitumen because the cumulative gas production exceeded the volumetric GIP.

The following Table summarizes:

- The volumetric GIP estimate for the pools at their discovery pressure;
- The remaining GIP at the pool shut-in pressure;
- By difference, the GIP theoretically produced at the shut-in pressure; and
- The cumulative gas produced at the time of shut-in.

Pool	Volumetric OGIP 1e6 sm3	Shut-in Pressure MPa	Shut-in 1/Bg sm3/m3	Remaining GIP 1e6 m3	Theoretical Produced GIP 1e6 m3	Cum Gas Production 1e6 sm3	Cum Gas Production % of Theoretical
A	165	1.1	11.9	61	104	180	170%
B	73	1.1	11.9	27	46	101	220%
C	13	1.0	10.8	4	9	37	420%
E	246	0.9	9.7	73	173	307	180%

Notes: Theoretical Produced GIP = OGIP - Remaining GIP (at shut-in pressure)
% of Theoretical = Cum Gas Produced/Theoretical Prosuced GIP

For the gas produced from these pools to be entirely free gas, it would be necessary for each of the gas pools to be 70% to 320% larger than the size of the currently mapped pools. Given the current level of delineation drilling, this is unlikely for a single gas pool, let alone all four gas pools.

Imperial Oil also states on the first page of its submission that with respect to the E Pool, after a lengthy shut-in period of approximately 2.5 years, the gas pool pressure increased by 50% which indicates that the pressure was being supported by the partial degassing of the associated bitumen column. Comment on whether the increase in pool pressure could be due to pressure equalization with less depleted edges of the pool rather than due to the degassing of the underlying bitumen.

Permeabilties in the Clearwater formation are typically in the range of 0.5 to 4 Darcy. As a result, it is expected that the pressure gradients across the pool during production operations should be small and the gas pool pressure should equilibrate in less than a few days. To create the increase in pressure observed at the E gas pool it would be necessary to postulate that an extensive volume of "tight gas" is located at the edges of the gas pool.

As identified above, the cumulative gas production from the E pool has been 80% percent more than should have been produced - based on the volumetric GIP data - at the shut-in pressure. Given the currently level of delineation drilling, it is unlikely that a large area of (conventional) tight gas could exist. It is much more plausible to view the associated bitumen column as being the (unconventional) "tight gas" source that is recharging the pool.

2. ***On the second page of the submission Imperial Oil suggests that as it has been demonstrated that degassing is occurring within the bitumen column directly under the gas cap, it is logical to believe that degassing will extend beyond laterally in the bitumen column beyond the zero edge of the gas cap. Provide a discussion of the mechanism by which degassing of the bitumen column beyond the zero edge of the gas cap would occur.***

   Well 108122606504W400 is a CSS well located under the A Gas Pool. This well (Common Name M03-13) was drilled in 1988, seven years after gas production started. Its location is highlighted on the A Gas Pool map included in the response to Question 1. This well helps highlight the degassing mechanism for bitumen resource located directly beneath the gas cap.

   The complete dataset for 108122606504W400 (core plus resistivity, density, neutron, and sonic logs) across top of Clearwater illustrates two distinct situations and signatures. Because porosity in the Clearwater is noticeably constant, gas saturation can be estimated from the neutron and density logs independently by comparing gas-affected measurements to commonly expected values (common values are determined from average or best fit lines on the well log).

   Over the top 3 m (413-416m TVD) is an example of the classic neutron-density gas effect with gas-interpreted crossover. Over the next 6 metres (416-423m TVD) the effect is more subtle; the neutron porosity decreases somewhat and the density porosity increases. The sonic tool also responds to gas. However, it is a very shallow reading device so may only see gas at residual saturation to invasion in the first couple of inches of the formation but also does not resolve between high and low gas saturations. So, the sonic can corroborate gas presence and may even, without other evidence, still strongly indicate its presence but cannot differentiate between free gas cap and a small gas saturation caused by gas exsolving with pressure depletion in an otherwise bitumen saturated interval.

   This well is interpreted as a free gas cap in the upper 3 m (higher gas saturation determined from neutron and density curves) above a longer interval of low gas saturation interpreted to be caused by gas coming out of solution as pressure has depleted in the gas cap.

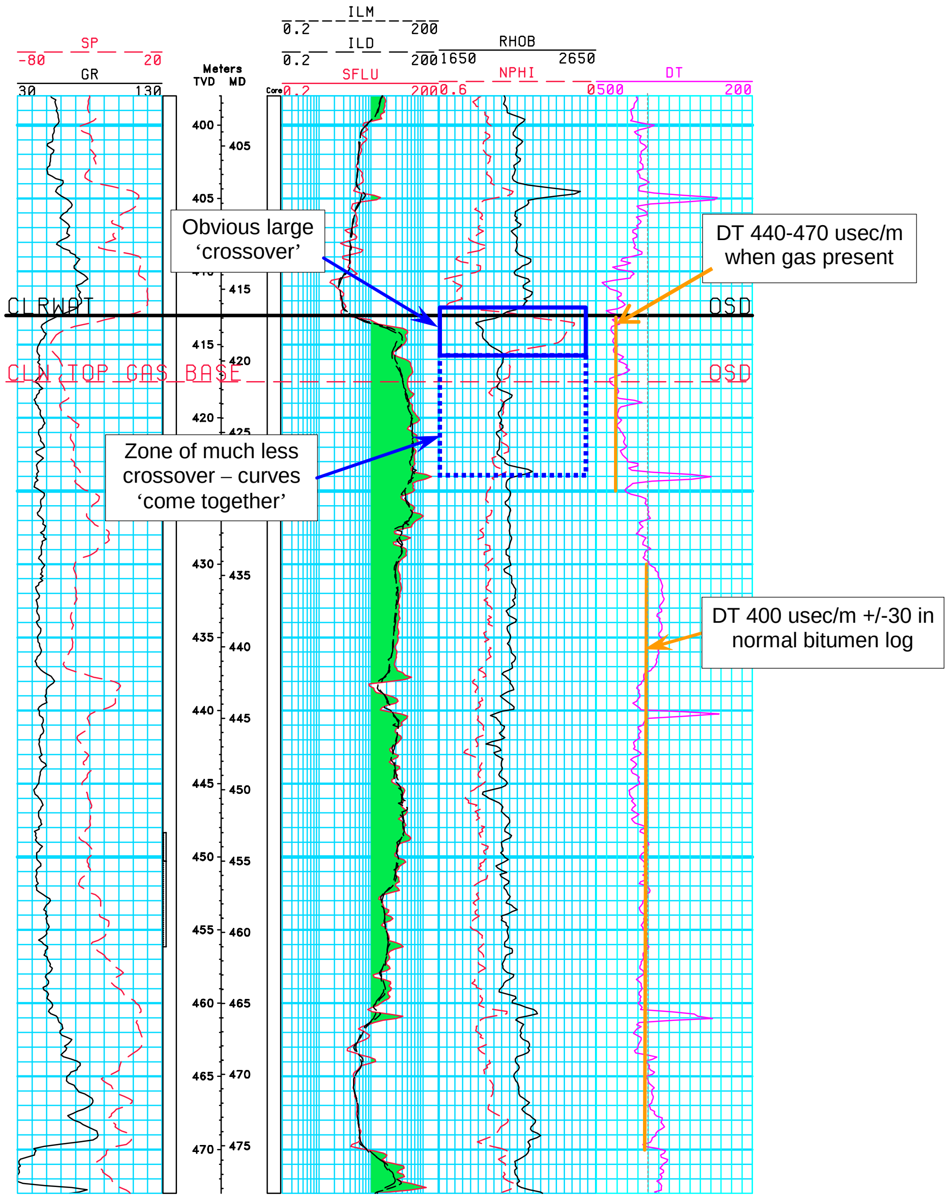
   The core, both in photos and analysis, shows the gas cap clearly. The low gas saturation zone or interpreted exsolved gas zone is not so obvious in core photos and analysis. However, the low gas saturation zone has a lower Dean-Stark bitumen volume than the interval immediately below it (with no gas saturation) for approximately the same resistivity. The difference is approximately 12% in saturation units. This would be consistent with the log data.

UWI: 108122606504W400

Name: M03-13 #: 08/12-26

ELEV: KB 616.1 METERS

TD: 488.3 METERS TVD



This "foamy oil" log signature is not observed at all delineation wells drilled under gas pools that have previously been put on production. It is speculated that when there is sufficient mobile water saturation present, the evolved gas displaces the mobile water and slowly leaks-off into the gas cap.

In this situation, the evolved gas that remains with the bitumen is too small to be observed by the open hole logs.

The same mechanism that allows the bitumen located directly below the gas pool to be partially degassed will also allow the bitumen adjacent to the gas pool to be degassed. The lateral growth rate for the zone being influenced by the bitumen degassing phenomena will be higher than observed vertically due to the more uniform reservoir quality/permeabilities that are present horizontally. In the case of well 108122606504W400, an interval with increased shale located at 424-429m TVD is present directly beneath the base of the foamy oil log signature. This interval of reduced vertical permeability has significantly impeded the degassing of the remainder of the bitumen column.

On the third page of its submission Imperial Oil states that with respect to CSS wells located adjacent to, but outside the zero edge of the M&P and Bourque gas pools, the fraction of the solution gas removed from the associated bitumen column as a result of the Clearwater gas production is expected to be small. What is the basis for this statement?

The following Table summarizes the gas pool areas, bitumen pay, OBIPs and associated solution gas for the resource directly under the gas pools.

The exsolved solution gas shown in this Table represents the difference between the cum gas produced from the gas pools and the volume of gas that should have been produced based on the volumetric OGIP and shut-in pressure data.

For the two largest gas pools (A and E), a maximum of 10 - 12% of the solution gas would need to be produced to support the excess gas production observed. Extending the region of influence by only 500-m beyond the zero edge of the gas pool reduces the solution gas removal to 7 - 8%.

Pool	Area	Bitumen Gross Pay	OBIP Under Gas Pool	Solution Gas	Solution Gas Exsolved		If Area is Gas Pool + 500-m
	1e6 m2	m	1e6 m3	1e6 m3	1e6 m3	%	%
A	9.8	39	81.0	673	76	11%	7%
B	5.5	43	48.4	402	55	14%	7%
C	1.1	48	11.0	91	28	31%	9%
E	13.2	50	129.9	1078	134	12%	8%

Notes: OBIP and Gross Pay are based on a 6wt% cut-off
Solution Gas dissolved in bitumen under the gas pool is based on 8.3 m3/m3 bitumen.
Solution Gas Exsolved = Cum Gas Produced - Theoretical Produced GIP
Gas Pool + 500-m: assumes no change in pay thickness, gas pool and gas pool + 500-m areas represented as circles to simplify math

For the gas pools identified, the fraction of the solution gas removed has been small and thus the expected impact this gas removal would have on CSS performance is also small. For example, if removal of 100% of the solution gas were to cause a 20% reduction in CSS recovery, a 10% reduction in solution gas would cause a 2% reduction. Using the cumulative OSR as a representative for recovery, a 2% reduction in a 0.32 OSR would be 0.0064. This level of change in OSR can not be reliably measured the field.

Does this mean that in Imperial Oil's view, gas production is not a concern for CSS wells that are adjacent to but outside the zero edge of a depleted gas pool? Explain your answer.

In light of the piezometer data submitted by CNRL and Husky to the AEUB as part of this process, Imperial Oil believes that gas production is a concern for CSS wells that are adjacent to but outside the zero edge of a gas pool that has been partially (or fully) depleted.

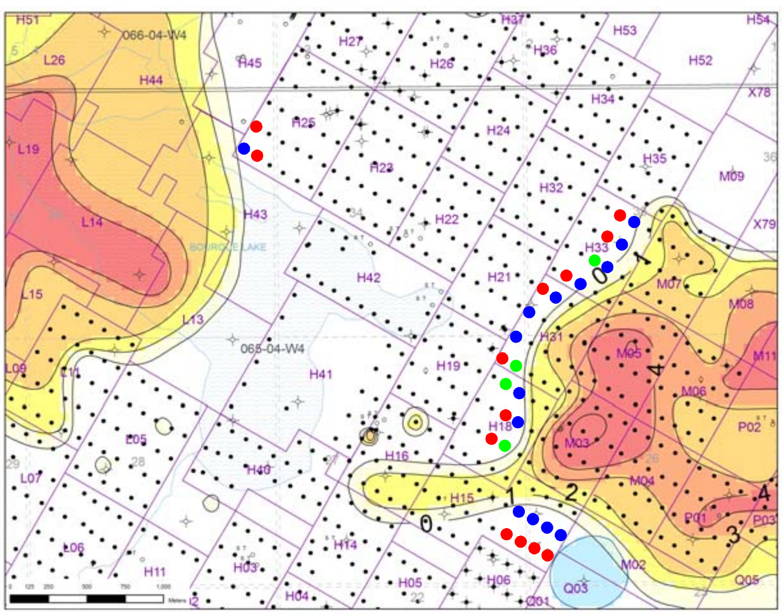
Currently there is no definitive field data to prove - or disprove - this concern. This is in part due to none of the wells included in Imperial's analysis having reached their economic limit. On an intuitive level, given that solution gas drive is a key recovery mechanism for CSS, any removal of the dissolved solution gas will result in a reduction in recovery. This belief is reinforced by the SPE paper included as part of our original submission.

Also on the third page, Imperial indicates that no material change in cumulative SOR performance were noted between wells located adjacent to the gas pools and wells located one additional spacing unit from the gas pools. Provide the performance plots and a tabulation of the performance of the two groups of wells.

A copy of the analysis and a well location map is included below. Overall, a 0.01 OSR (oil steam ratio) reduction was noted for the wells adjacent to the gas pools. This variation is within the field data measurement error.

Of more significance is the 0.11 WSR (water steam ratio) reduction observed at the well adjacent to the gas pools. This indicates that the presence of the gas pool has influenced the performance of these wells.

Pad	Group	Common Name	UWI	Cum Steam m3	Cum Bitumen m3	Cum Water m3	Cum OSR	Cum WSR
H15	Adjacent to Gas Pool	H15-12	109082706504W400	51,981	19,277	35,637	0.37	0.69
	Adjacent to Gas Pool	H15-13	112052606504W400	54,219	24,823	43,440	0.46	0.80
	Adjacent to Gas Pool	H15-14	103042606504W400	51,735	19,567	35,356	0.38	0.68
	Adjacent to Gas Pool	H15-15	104042606504W400	52,079	18,519	35,993	0.36	0.69
	Adjacent to Gas Pool						**0.39**	**0.72**
	One Spacing Away	H15-22	108012706504W400	52,115	15,951	40,652	0.31	0.78
	One Spacing Away	H15-23	109012706504W400	53,902	17,276	46,907	0.32	0.87
	One Spacing Away	H15-24	105042606504W400	53,290	16,647	44,925	0.31	0.84
	One Spacing Away	H15-25	106042606504W400	54,096	13,863	43,626	0.26	0.81
	One Spacing Away						**0.30**	**0.83**
H18	Adjacent to Gas Pool	H18-03	107162706504W400	96,360	27,161	66,597	0.28	0.69
	Adjacent to Gas Pool	H18-09	107092706504W400	99,695	35,010	61,805	0.35	0.62
	Adjacent to Gas Pool						**0.32**	**0.65**
	One Spacing Away	H18-08	106092706504W400	77,367	29,948	75,217	0.39	0.97
	One Spacing Away	H18-13	100092706504W400	95,659	35,274	71,479	0.37	0.75
	One Spacing Away						**0.38**	**0.85**
H25	Adjacent to Gas Pool	H25-25	104163306504W400	87,796	26,904	48,456	0.31	0.55
	Adjacent to Gas Pool						**0.31**	**0.55**
	One Spacing Away	H25-19	102163306504W400	90,652	29,002	67,426	0.32	0.74
	One Spacing Away	H25-26	100093306504W400	92,040	31,705	68,656	0.34	0.75
	One Spacing Away						**0.33**	**0.74**
H31	Adjacent to Gas Pool	H31-02	102043506504W400	95,962	34,171	68,216	0.36	0.71
	Adjacent to Gas Pool	H31-06	105043506504W400	97,557	35,275	76,460	0.36	0.78
	Adjacent to Gas Pool	H31-11	111162706504W400	96,499	32,684	72,928	0.34	0.76
	Adjacent to Gas Pool						**0.35**	**0.75**
	One Spacing Away	H31-01	100043506504W400	95,510	33,434	67,539	0.35	0.71
	One Spacing Away	H31-16	108162706504W400	99,248	37,870	81,558	0.38	0.82
	One Spacing Away						**0.37**	**0.77**
H33	Adjacent to Gas Pool	H33-04	102063506504W400	88,345	18,708	51,779	0.21	0.59
	Adjacent to Gas Pool	H33-09	106063506504W400	96,502	19,707	51,271	0.20	0.53
	Adjacent to Gas Pool	H33-14	109063506504W400	97,234	24,558	47,829	0.25	0.49
	Adjacent to Gas Pool	H33-18	111043506504W400	96,986	27,705	53,988	0.29	0.56
	Adjacent to Gas Pool						**0.24**	**0.54**
	One Spacing Away	H33-03	100063506504W400	80,441	17,532	45,421	0.22	0.56
	One Spacing Away	H33-08	105063506504W400	95,864	25,458	67,185	0.27	0.70
	One Spacing Away	H33-17	110043506504W400	98,896	29,438	60,004	0.30	0.61
	One Spacing Away						**0.26**	**0.63**
Overall	Adjacent to Gas Pool						**0.31**	**0.64**
	One Spacing Away						**0.32**	**0.75**



Wells adjacent to gas pool

Wells one spacing from gas pool

Wells excluded due to missed cycles

3. ***On the first page of its submission Imperial Oil states that it has shut-in the gas wells in four Clearwater gas pools at Cold Lake. On the second page of its submission Imperial states that the presence of a large depleted gas cap is expected to reduce the recovery performance of CSS by 25%, but that Imperial Oil does not have any experience with the presence of a large undepleted gas zone which overlies CSS operations. Why did Imperial Oil decide to shut-in gas production when it only has experience with the presence of a depleted gas zone, but not an undepleted gas zone?***

   Imperial's word selection for describing the recovery state of the gas pool was not clear in its original submission. In the original submission:

   - An "undepleted" gas pool is one in which no gas production has occurred. (ie. the gas pool is still at discovery pressure)
   - A "depleted" gas pool is one in which gas production has reduced its current pressure to less than half its discovery pressure, versus being at its abandonment pressure. In hindsight, this situation should have been referred to a being a "partially depleted" gas pool.

   Imperial's CSS field experience is with large partially depleted gas pools. Imperial does not have operating experience with large gas pools that are either at their discovery pressure or at their abandonment pressure.

   Also, provide an explanation of why the presence of a depleted gas zone is expected to reduce the recovery performance of CSS by 25%?

   The CSS recovery process relies on fracturing to areally distribute the steam during injection. Once connection is achieved with the top gas, the fluids in the gas cap need to be compressed before the injection pressures can be increased sufficiently high to allow fracturing to continue. The cycling of steam/water through the gas cap reduces the thermal efficiency of the recovery process (increased overburden heat losses and steam being consumed to heat reservoir that contains minimal bitumen) and thus lowers the ultimate recovery achievable with CSS.

4. ***Discuss whether Imperial Oil believes that the effect of the production of gas cap gas on CSS performance could be different for horizontal wellbore CSS than for vertical wellbore CSS.***

   "Vertical" well CSS is undertaken using deviated wells, with some of the wells being landed at angles of 80 to 85 degrees (nearly horizontal). Imperial Oil has operated CSS using both vertical (deviated) and horizontal wells at Cold Lake. Both well types have been used where gas caps have - and have not - been present. No material differences in performance related to well type have been noted.