ALBERTA ENERGY AND UTILITIES BOARD

IN THE MATTER OF the *Alberta Energy and Utilities Board Act*, R.S.A. 2000, c. A-17 (the "EUB Act"), and the regulations made thereunder; and

IN THE MATTER OF section 40(1) of the *Energy Resources Conservation Act,* R.S.A. 2000, c. E-10, (the "ERC Act") and the regulations made thereunder; and

IN THE MATTER OF Part 2 of Proceeding No. 1457147, Bearspaw Petroleum Ltd. ("Bearspaw"), Carbon Development Partnership (Successor in Interest to Prairie Mines and Royalties Ltd., Formerly Luscar Ltd.) ("CDP"), Devon Canada Corporation ("Devon"), EnCana Corporation ("EnCana"), and Fairborne Energy Ltd. ("Fairborne"), in relation to the Clive, Ewing Lake, Stettler and Wimborne Fields; and

IN THE MATTER OF Alberta Energy and Utilities Board ("EUB" or "Board") Bulletin 2006-19 ("Bulletin 2006-19"); and

IN THE MATTER OF EUB Notice of Hearing dated June 23, 2006 ("Notice of Hearing"); and

IN THE MATTER OF EUB letter to Legal Counsel dated July 27, 2006 ("Letter to Counsel").

JOINT ARGUMENT OF CONOCOPHILLIPS CANADA RESOURCES CORP. ("ConocoPhillips Canada"), DEVON CANADA CORPORATION ("Devon"), FAIRBORNE ENERGY LTD. ("Fairborne"), QUICKSILVER RESOURCES CANADA INC. ("Quicksilver"), CANPAR HOLDINGS LTD. ("Canpar"), and CENTRICA CANADA LIMITED ("Centrica")

November 15, 2006

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JOINT ARGUMENT OF
THE NATURAL GAS RIGHTS HOLDERS

I. INTRODUCTION AND SUMMARY

1. In accordance with the Board's directions, ConocoPhillips Canada, Devon, Fairborne, Quicksilver, Canpar, and Centrica (collectively referred to as the "Natural Gas Rights Holders") provide this joint written argument (the "Joint Argument") on technical and scientific issues pertaining to coal and gas stored in coal[1] raised in Part 2 of Proceeding No. 1457147 ("Proceeding No. 1457147").[2]

2. From a technical and scientific perspective, gas stored in coal is in a gaseous state at the *in situ* temperature and pressure conditions of Alberta's coal seams. When the reservoir is disturbed by the drilling of a gas well into the coal seam, the gas remains in a gaseous state as it escapes through the wellbore to the point where it is recovered by processing, at which time its volume is measured as natural gas. As such, gas stored in coal is natural gas. It is not coal, which is the rock that serves as its container.

3. The most commonly known and understood states of matter are solid, liquid and gas. This understanding has been adopted by the Supreme Court of Canada in its decision in *Anderson v. Amoco.*[3] Gas stored in coal, which exists as both free gas and in a highly condensed state attracted to the coal by weak physical forces, is clearly not a "solid".

4. Given the temperature at which gas stored in coal is found in Alberta coal reservoirs, it is impossible for it to be a "liquid". The temperature and pressure conditions of gas stored in coal *in situ*, the flow mechanics of gas stored in coal, the ease of separation of gas stored in

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[1] The terms coalbed gas, gas in coal, gas from coal, coalbed methane or "CBM" within the context of Proceeding No. 1457147 are all intended to refer to and describe natural gas stored in coal.
[2] Proceeding No. 1457147 involves a review, at the request of EnCana and CDP, of the Board's previous decisions on Bearspaw, Devon and Fairborne applications for well licenses, special gas well spacing and compulsory pooling orders. As part of that review a substantial amount of evidence has been led concerning the characteristics of coal and gas in coal.
[3] *Anderson v. Amoco Canada Oil and Gas,* (SCC) 241 D.L.R. (4th) 193, at 195, para. 2.

coal from the coal matrix and the absence of any phase change occurring during production, all lead to a conclusion that gas stored in coal is in a gaseous state both before and after disturbance by man.

5. The technical evidence of CDP and EnCana (collectively the "Coal Owners") pushes the limits of science. With respect, Dr. Levine's theories on natural gas in coal seams are imprecise and indiscriminate and are not in accordance with the mainstream science and understanding of coal. In his testimony, Dr. Levine was ambiguous on phase behaviour, incorrect on liquid methane density and uncertain about porosity. While perhaps interesting, the Coal Owners' scientific evidence was more advocacy than scholarship. It provides no reasonable foundation to guide the Board in administering the regulatory regime that governs the exploitation of mineral resources in the Province of Alberta.

6. It is respectfully submitted that the evidence of Mr. Mavor should be preferred as representing the established and mainstream of scientific opinion on gas stored in coal.

7. The key facts established by the technical and scientific evidence adduced in Proceeding No. 1457147 include:

    - coal is a rock and therefore a solid substance;
    - gas stored in coal is gaseous at the *in situ* temperature and pressure conditions of Alberta's coal seams; and
    - coal is a container for natural gas in coal. The two substances are easily separated.

8. The Natural Gas Rights Holders file this Joint Argument concurrently with separate and individual company submissions on all other matters at issue in Proceeding No. 1457147 including, but not limited to, EUB procedure, jurisdiction, rights under leases and impacts of delay on development of gas in coal.

9. In this Joint Argument, the Natural Gas Rights Holders provide an introduction and summary at Section I and describe the nature of coal and gas stored in coal at Section II. Section III

sets out detailed submissions on why the production of gas from coal does not involve a phase change. Conclusions are provided at Section IV.

II. THE NATURE OF COAL AND NATURAL GAS STORED IN COAL

A. Coal is a Solid Rock

10. Dr. Levine characterizes coal as very complex in order to suggest that an accurate understanding of it is impossible.[4] His approach may suit the purposes of his clients but it is certainly unhelpful to the Board. In fact, scientifically and chemically, coal is not nearly as complicated as Dr. Levine would have us believe.

11. The Bates and Jackson *Glossary of Geology*[5] defines coal as a rock.[6] It is worth noting that Dr. Levine considers the Bates and Jackson definition to be both useful and comparatively well thought out and accurate in describing the general characteristics of coal.[7] Dr. Levine also agrees that coal is a rock.[8]

12. Terminology such as "quasi-solid rock",[9] while symptomatic of Dr. Levine's rather haphazard use of language, is both unsupported by science and misleading.

13. A solid is "a substance that deforms when a shear stress is applied but it does not continue to deform."[10] Coal is a solid at the subsurface conditions found in commercial coal seams[11]

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[4] See, for example, Tr. Vol. 6, page 789, lines 19-22.
[5] Bates R.L. and Jackson, J.A. (editors): *Glossary of Geology,* American Geological Institute, Falls Church Virginia (1980), page 120.
[6] [Exhibit 18-001-2006-08-25] Mavor Expert Report, August 25, 2006, Glossary Appendix I, page 6; see also Tr. Vol. 2, page 228, lines 17-25.
[7] Tr. Vol. 6, page 868, line 23 to p. 869, line 15.
[8] Tr. Vol. 6, page 867, line 23 to p. 867 line 1.
[9] [Exhibit 19-001-2006-09-15] Levine Expert Report, September 15, 2006, page 4.
[10] Fox, R.W. and MacDonald A.T. *Introduction to Fluid Dynamics*. John Wiley and Sons Inc., New York (1973) pages 1-2; see also [Exhibit 18-001-2006-08-25], Mavor Expert Report, August 25, 2006, page. 5
[11] As an Alberta example, Mannville coal at an Alberta Research Council research location withstood the stress due to the weight of 1.26 km of overburden rock while retaining the ability to allow fluid flow through natural fractures. If coal were able to deform continuously, as for a non-solid substance, the Mannville coal would have lost all ability to transmit fluids. [Exhibit 18-001-2006-08-25] Mavor Expert Report, August 25, 2006, page. 2

and serves as the container for natural gas stored in coal both before and after the reservoir has been disturbed by man.[12]

B. Natural Gas Stored in Coal is Gaseous in Undisturbed Coal Reservoirs

14. It is submitted that, for the reasons that follow, the only reasonable conclusion available to the Board is that natural gas stored in coal exists in a gaseous state both before and after disturbance by man.

(i) Temperatures of the Reservoirs

15. Given the temperatures that prevail in Alberta coal reservoirs, it is impossible for natural gas stored in coal to be a liquid. The critical temperature of methane is minus 82.6 degrees C[13] and methane simply cannot exist as a liquid at temperatures that exceed its critical temperature.[14] Dr. Levine agrees.[15]

16. Although Dr. Levine seems to suggest otherwise[16], the same concept applies to mixtures of substances – where the cricondentherm, rather than the critical temperature, is the maximum temperature at which the mixture can exist as a liquid.

17. Exhibit 20-045 ("Phase Diagram of Methane-Ethane Mixture") depicts the temperature and pressure conditions in which the gas and liquid phases of a methane-ethane mixture can co-exist. As Dr. Levine confirmed in reference to Exhibit 20-045, for a mixture of 70% methane and 30% ethane (as represented by curve 5 on the Exhibit) the maximum temperature at which the mixture can exist as both a liquid and a gas is approximately minus 28 degrees C.[17] Dr. Levine further agreed that Exhibit 20-045 provides the maximum

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[12] [Exhibit 18-001-2006-08-25] Mavor Expert Report, August 25, 2006, page 20.
[13] Tr. Vol. 6. page 894, lines 14 to 15.
[14] [Exhibit 20-013] Mavor Direct Testimony, page 2.
[15] Tr. Vol. 6, page 920, line 20 to page 921, line 1.
[16] For example, Dr. Levine stated "[w]hen you start dealing with mixtures, than [sic] the critical point doesn't become a point. It can become a line…". Tr. Vol. 6, page 896, lines 20-21.
[17] Tr. Vol. 7, page 986, line 20 to page 987, line 3.

temperature at which the liquid phase could exist for the various other mixtures that it depicted.[18] For example, a mixture of roughly 85% methane and 15% ethane, as represented by curve 4 on Exhibit 20-045, has a cricondentherm of approximately minus 58 degrees C.[19] A mixture of roughly 92.5% methane and 7.5% ethane, as represented by curve 3 on Exhibit 20-045, has a cricondentherm of approximately minus 66 degrees C.[20]

18. The natural gas stored in Alberta's Mannville[21] and Horseshoe Canyon[22] coals is comprised of mostly methane – above 80% and 90% methane respectively by Dr. Levine's own estimates – with the remainder being mostly ethane.[23] Therefore, as demonstrated by Exhibit 20-045, it would be necessary for the Mannville and Horseshoe Canyon coals to exhibit temperatures ranging from minus 58 to minus 66 degrees C in order for the gas stored in coal that is produced from them to exist as a liquid *in situ.*

19. The temperatures observed in Alberta's Ardley and Mannville coals range from 16 to 47 degrees C.[24] Horseshoe Canyon coal seams in Alberta have temperatures between these two temperatures. It is obvious that these temperatures are much higher than either the critical temperature of methane or the cricondentherms of the relevant mixtures.

(ii) Natural Gas Can Be Easily Separated From Coal

20. Natural gas can be easily separated, and thus clearly distinguished, from the coal in which it is stored. The ease of separation allows gas stored in coal to be produced with industry-wide natural gas drilling and completion techniques.

21. The ease with which natural gas can be separated from coal – as can natural gas stored in conventional reservoirs – implies that natural gas from coal seams is the same as natural gas

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[18] Tr. Vol. 7, page 988, line 20 to page 989, line 3.
[19] [Exhibit 20-045] Figure 2.4 Phase Diagram of Methane-Ethane Mixture.
[20] [Exhibit 20-045] Figure 2.4 Phase Diagram of Methane-Ethane Mixture.
[21] Tr. Vol. 7, page 983, line 25 to page 984, line 3.
[22] Tr. Vol. 7, page 983 lines 21-24.
[23] Tr. Vol. 7, page 983, line 21 to page 984, line 6.
[24] Tr. Vol. 2, page 151, line 24 to page 152, line 3.

from other reservoir types. The organic material, inorganic material, and inherent moisture in coal cannot be separated *in situ*. Rather, in order to separate these materials, one must remove the coal from the reservoir by mining or coring and move the coal to the surface where it can be crushed, treated with chemicals, exposed to the atmosphere, or otherwise altered.[25] The natural gas production industry is able to extract gas stored in coal using procedures that are little modified from those developed for use in conventional gas and oil reservoirs.[26]

(iii) The Flow of Gas Through Reservoirs

22. The flow mechanisms of gas in a coal reservoir are the same as those for gas in conventional gas reservoirs. The modern theory of flow through gas reservoirs considers mass transfer from greater density regions to lesser density regions.[27] The theory is also applicable to gas stored in coal.

23. Mr. Mavor[28] and Dr. Levine[29] generally agree upon the mechanisms for gas flow through reservoirs. In coal reservoirs, gas flows from the greater density adsorbed region to the lower density region in wellbores. Flow through the unfractured portions of coal seams is driven by concentration gradients during diffusion. Flow through the natural fracture systems is described by Darcy's Law in terms of pressure differences. Pressure differences and density differences are equivalent because gas density is directly related to pressure.[30]

(iv) The Storage of Natural Gas in Coal

24. In general, and specifically in Alberta, the majority of gas stored in coal in commercial reservoirs is adsorbed within the solid organic material. The adsorption results from weak

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[25] [Exhibit 20-013] Mavor Direct Testimony, page 3.
[26] [Exhibit 18-001-2006-08-25] Mavor Expert Report, August 25, 2006, pages 14-19.
[27] [Exhibit 18-001-2006-08-25] Mavor Expert Report, August 25, 2006, page 8.
[28]See generally [Exhibit 18-001-2006-08-25] Mavor Expert Report, August 25, 2006, pages 6-10.
[29] Tr. Vol. 6, page 808, line 18 to page 810 line 4.
[30] [Exhibit 18-001-2006-08-25] Mavor Expert Report, August 25, 2006, page 8. See also page 7 of the Mavor Expert Report for a discussion of diffusion concerning "CBM Primary Porosity Characteristics".

intermolecular physical attraction between gas and the organic material. This physical bond implies that there are two separate substances, gas and coal.[31]

25. At page 1, paragraph 3 of Dr. Levine's Expert Report he stated that ". . . CBM interacts physically and chemically with other coal constituents".[32] In his evidence in chief, Dr. Levine amended his report to say "simply physical".[33] This was no small error on Dr. Levine's part and is but one illustration of the fact that he is not nearly as careful in his use of language as he claims.[34]

26. The evidence in this proceeding suggests that for the Horseshoe Canyon, Mannville, and Ardley coals, the interaction between the coal and the gas stored in it can best be described as an interaction between a gas and a solid surface. Adsorption isotherm data conform to a non-linear gas storage, versus pressure, relationship as described by Mr. Mavor.[35] This relationship differs significantly from the linear relationship during absorption (solution) of methane in organic liquids described by Dr. Levine.[36] Mr. Mavor testified that the shape of the diagrams contained in Exhibit 40-043 indicates that "solubility is known to be different from absorption".[37]

27. In support of his view that gas stored in coal is partially absorbed in coal, Dr. Levine places great reliance on a paper by Dr. John Larsen entitled "The Effects of Dissolved CO_2 on Coal Structure and Properties".[38] In fact, Dr. Levine suggests that Dr. Larsen's interpretations of laboratory data and the underlying theory must be given ". . . the highest level of

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[31] Indeed, Dr. Levine indicated, the bonds are so weak, they have a duration "on the order of a millionth to a billionth of a second" [Tr. Vol. 6, page 919, lines 4-6] further suggesting that methane is not an inherent constituent of coal.
[32] [Exhibit 19-002-2006-09-15] Levine Expert Report, September 15, 2006.
[33] Tr. Vol. 6, page 783, lines 5-6.
[34] Tr. Vol. 6, page 920, lines 22-23.
[35] [Exhibit 18-001-2006-08-25] Mavor Expert Report, August 25, 2006, page 14, Figure 5.
[36] [Exhibit 20-043] Solubility of CH_4 in Various Solvents.
[37] Tr. Vol. 3, page 417, lines 21-22.
[38] [Exhibit 20-044] Larsen, J.W.: "The Effects of Dissolved CO_2 on Coal Structure and Properties," *International Journal of Coal Geology*, Vol. 57 (2004) pp. 63-70 ("Larsen Paper").

consideration".[39] In light of this, it is rather curious that Dr. Levine made no mention of the Larsen Paper in his report.[40]

28. There are two observations to be made concerning the Larsen Paper. First, whatever it may say about how CO_2 may interact with coal, the Larsen Paper makes it clear that:

> . . . No matter what the explanation, the data demonstrate that CO_2 and hydrocarbons behave very differently in their interactions with coal.[41]

29. Despite this unambiguous statement, Dr. Levine persists in extending Dr. Larsen's findings to natural gas in coal – with the supposed explanation being that Dr. Larsen told Dr. Levine that he was of the view that methane behaves similarly to CO_2 in coal.[42] With all due respect to Dr. Levine, this is simply far too convenient – especially since it would mean that Dr. Larsen has completely reversed his stated position. It is submitted that, in light of the plain words of the Larsen Paper, the Board cannot reasonably conclude that such is the case.

30. Second, Dr. Levine is quite adamant in his assertion that the results of studies performed on dry coal samples may lead to incorrect conclusions about the nature of coal and its properties *in situ*. In fact, Dr. Levine substantially discounted the work of Van Krevelen on that basis.[43] What Dr. Levine apparently failed to recognize was that much of the work upon which Dr. Larsen relied involved analysis of dried coal samples.[44,45,46]

(v) Dr. Levine's Density Estimates Lack Credibility

31. Dr. Levine asserts that:

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[39] [Exhibit 20-041] Levine Direct Evidence, Item 28 a, page 7.
[40] Tr. Vol. 7, page 989, lines 18-24.
[41] Larsen Paper, pages 68-69.
[42] Tr. Vol. 9, page 1309, line 23 to p. 1310, line 10.
[43] Tr. Vol. 7, page 976, line 25 to page 977, line 13; see also Tr. Vol. 6, page 872, line 23 to page 873, line 1.
[44] Tr. Vol. 7, page 993, lines 1-4.
[45] Tr. Vol. 7, page 995, lines 1-4.
[46] Tr. Vol. 7, page 997, lines 3-6.

> While Mr. Mavor is correct that in the supercritical region there is a continuum in phase characteristics, the transition from free methane to sorbed methane entails an order-of-magnitude change in density. Free (supercritical) methane has a density of approximately 0.025 to 0.100 g/cm^3, whereas the density of sorbed methane is variously estimated as ranging from 0.425 to 1.0 g/cm^3. Referring to both the free and sorbed methane as a vapour minimizes the significance of this transition.[47]

32. Two observations are warranted. First, Dr. Levine was unable to say whether an interface would exist between the "sorbed" methane and the free methane in the sense that there is an interface between two phases of matter.[48] Dr. Levine recognizes the existence of an interface as an essential condition for a substance to exist in two phases simultaneously.[49]

33. Second, although there were no estimates of the density of "sorbed" methane mentioned in Dr. Levine's report, he chose to provide such estimates in his Direct Evidence.[50] This is more than a little surprising given the importance that Dr. Levine apparently attaches to the estimates. In any event, it is submitted that they are entirely lacking in credibility.

34. Dr. Levine's 0.59 g/cm^3 estimate of "sorbed" methane in coal is said to be based on research – that Dr. Levine says he conducted jointly with an unnamed colleague.[51] Dr. Levine admitted that the research has not been peer reviewed.[52]

35. Further, it is apparent that the 0.59 g/cm^3 density estimate represents a mere straight-line extrapolation from data that were described as representing the quantities of methane that could be dissolved in various hydrocarbon solvents rather than coal.[53] Dr. Levine's 1.0

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[47] [Exhibit 20-041] Levine Direct Evidence, paragraph 26(d).
[48] Tr. Vol. 7, page 942, line 19 to page 943, line 16.
[49] Tr. Vol. 6, page 914, lines 12 to 22.
[50] Tr. Vol. 7, page 952, line 21-25; See also [Exhibit 19-002-2006-09-15] Levine Expert Report, September 15, 2006.
[51] Tr. Vol. 7 page 953, lines 12-19
[52] Tr. Vol. 7, page 954, lines 5-7.
[53] [Exhibit 20-041] Levine Direct Evidence, October 23, 2006, PowerPoint Presentation, page 10, lower figure "A Method for Estimating the Apparent Density of Sorbed Methane."

g/cm^3 estimate of the density of "sorbed" methane in coal was said to be derived from discussions with another unnamed colleague and a "white paper" that is not a refereed source.[54]

36. These estimates of the density of "sorbed" methane in coal are not only remarkable for their lack of scientific rigour but also for the fact that they exceed the greatest possible density of liquid methane which is 0.4515 g/cm^3 as measured at the "triple point".[55] The fact is that if "sorbed" methane in coal were to have a density as high as 0.59 g/cm^3 – let alone 1.0 g/cm^3 – it could not be liquid or even "liquid like" as Dr. Levine claims. This is a remarkable error and not the least because it was made by someone who claims to be an "unusually fastidious and careful researcher".[56]

37. It must also be noted that Dr. Levine's estimates of the density of "sorbed" methane in coal are substantially greater than the value (0.42 g/cm^3) recommended by Dr. Dan Yee – whom Dr. Levine described as "an extremely bright fellow" and upon whose paper Dr. Levine relies – for the important purpose of adjusting isotherm calculations.[57,58]

III. THE PRODUCTION OF GAS FROM COAL DOES NOT INVOLVE A PHASE CHANGE

38. In this Joint Argument the term "phase" is used with clear, consistent meanings. With respect to science "phase" means:

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[54] Tr. Vol. 7, page 955, line 21 to page 956, line 8.

[55] Tr. Vol. 7, page 960, lines 18-21; Tr. Vol. 7, page 965, lines 6-7. The "triple point" is the temperature (-182.456 degrees C) and pressure (11.7 kPa) at which solid and liquid methane can coexist.

[56] Tr. Vol. 7, page 955, lines 22-23.

[57] Tr. Vol. 7, page 958, line 4. As to the importance of using a correct value for the density of "sorbed" methane in coal to adjust isotherm calculations see the testimony of Dr. Levine at Tr. Vol. 7, page 956, line 23 to page 957, line 5.

[58] Tr. Vol. 7, page 958, lines 13-17. See also, Tr. Vol. 9, page 1301, lines 20-24 where Dr. Levine refers to a paper entitled "Gas Sorption on Coal and Measurement of Gas Content" authored by Dan Yee, John Seidle and William Hanson, all of Amoco Production (the "Yee Paper"). The Yee Paper recommends a value for the adsorbed methane density of 0.421 g/cm^3 on page 209, paragraph 2 under equation 11. The Yee Paper also goes on to say in the same paragraph that the density could be a lesser value, 0.375 g/cm^3 not the greater values reported by Dr. Levine.

> a homogeneous, **physically distinct** and possibly mechanically separable portion of matter in an inhomogeneous physical-chemical system.[59]

With respect to law, the Supreme Court of Canada understands "phase" to mean:

> **a distinct physical state of matter**, all matter exists in one or more of three physical states: gas, liquid or solid.[60]

39. The Natural Gas Rights Holders use the forgoing definitions of "phase" to demonstrate two fundamental conclusions. First, a "unique thermodynamic" or "liquid-like" state is not a distinct physical state of matter. Second, a change from a "liquid-like" or "unique thermodynamic state" to gas does not constitute a phase change and, in any event, has not been proven on the evidence presented in this Proceeding.

40. One of the terms that Dr. Levine uses repeatedly is "unique thermodynamic state"[61] when discussing the state of adsorbed methane or gas stored in coal. This phrase is ambiguous, because thermodynamic states are dependent upon the internal energy of the matter of interest. The internal energy is dependent upon pressure and temperature, among other items. Matter at any pressure and temperature condition has its own unique thermodynamic state or internal energy. There is energy associated with adsorption and gas stored in coal that is adsorbed will have different internal energy than gas stored in coal that is not adsorbed. However, different thermodynamic states do not imply different phases such as solid, liquid, or vapour.

41. Furthermore, a change in internal energy does not indicate a change in phase. For example, Dr. Levine attempted to make a point that the change in internal energy of methane associated with adsorption in Fruitland Formation coal was approximately 5 kcal/mole.[62] The change in energy is proportional to the surface area of the adsorbing material, in this

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[59] [Exhibit 18-001-2006-08-25] Mavor Expert Report, August 25, 2006, Appendix 1, page 5.
[60] *Anderson v. Amoco Canada Oil and Gas,* 241 D.L.R. (4th) 193, at 195, para. 2 (SCC).
[61] Tr. Vol. 6, page 830, line 9.
[62] [Exhibit 20-041] Levine Direct Testimony, page 6, paragraph 26(f).

case, the coal organic material. The change in internal energy does not imply a change of phase.[63]

42. Mr. Mavor was clear and forthright in expressing his opinion that natural gas stored in coal as a gas. Dr. Levine was unequivocal in his disagreement with Mr. Mavor on that point. However, when it came to discussing the question of the state of matter in which he considers coalbed methane to exist in an undisturbed reservoir, he was anything but.

43. The following excerpt from Dr. Levine's testimony provides but one example which illustrates this point:

> A. DR. LEVINE: … So if I had, if you forced me, if you said, Dr. Levine, I'm going to constrain you to putting this sorbed methane into one of these bins, it would be liquid.
> If you said that you can -- you can't put it in liquid, you can put it in liquid or solid, I would put it in solid.[64]

44. Again, with all due respect to Dr. Levine, it is irresponsible of him to be so cavalier about such an important matter and his apparent willingness to fundamentally alter his opinion when convenient - or if "forced" - means that it ought to be given very little, if any, weight.

45. Dr. Levine was similarly cavalier in his references to Steam Assisted Gravity Drainage ("SAGD"), describing it as an analogy for phase changes. In fact, the SAGD oil recovery mechanism is viscosity reduction of bitumen.[65]

46. Dr. Levine's SAGD analogy epitomizes his equivocation and is captured in the following exchange:

> Q. The analogy might be useful if there were in fact a phase change but there isn't, is there, sir? The produced resource that is

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[63] [Exhibit 18-003a-2006-09-29] Mavor Response to Levine Report, September 29, 2006, page 4, item 6.
[64] Tr. Vol. 6, page 922, line 21 to page 923, line 1.
[65] Tr. Vol. 6, page 883, line 21 to page 889, line 12.

> of interest, you called it the liquids themselves, that's the resource of interest and there isn't a phase change. Rather it is heated to reduce its viscosity so that it will flow to the lower well and be produced; isn't that the case?
> A. DR. LEVINE: I would like to at this point to step off into a topic that --
> Q. Let's not step off into any topics. Could you answer my question, sir?
> A. DR. LEVINE: *The phases of the materials we're describing are not so easily defined as you might wish.*
> Q. Which material are we talking about?
> A. DR. LEVINE: The bitumen. It can be described as a solid.
> Q. Is it a solid, sir?
> A. DR. LEVINE: I'm in the process of discussing that topic.
> Q. Well, is it a solid in your professional opinion?
> A. DR. LEVINE: It has some of the characteristics of a solid and it has some of the characteristics of a liquid.
> Q. Is it a solid, in your professional opinion?
> A. DR. LEVINE: It's neither one or nor the other; it is both. *We like to put the things in nature into discrete little bins. Sometimes they don't fit so nicely.*
> Bitumen, like coal, is a heterogeneous material.[66]

IV. CONCLUSIONS

47. Coal is not such a chemically complex substance that it defines classification. It is simply a solid rock that serves as a container for gas stored in it.

48. Gas stored in coal is separate and distinct both from the coal rock matrix itself and from the other coal materials that may be contained within it, including water, oil, organic matter, and inorganic (mineral) matter. Gas stored in coal is in the gaseous phase at *in situ* temperature and pressure conditions in Alberta coal seams.

49. It is impossible for gas stored in coal in Alberta commercial coal seams to exist as a liquid, because the reservoir temperatures are substantially higher than the critical temperature of methane and the cricondentherms of the relevant methane-rich natural gas mixtures. This fact is not changed by interactions between the gas stored in coal and the coal itself.

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[66] Tr. Vol. 6, page 887, line 11, to page 888, line 15 (emphasis added).

50. Gas stored in coal is a gas before and after disturbance by man. Pressure reduction during production does not cause coal, a rock, to change to a gas. There is no phase change that occurs when drilling disturbs the coal bed and both "free gas" and the greater density "adsorbed gas" flow to the lower density region in the wellbore. These are the same flow mechanics that prevail in conventional natural gas reservoirs. The ease of separation of natural gas from coal allows gas stored in coal to be produced with virtually the same industry-wide natural gas drilling and completion techniques used for conventional reservoirs.

ALL OF WHICH IS RESPECTFULLY SUBMITTED OF BEHALF OF THE NATURAL GAS RIGHTS HOLDERS THIS 15TH DAY OF NOVEMBER, 2006

CONOCOPHILLIPS CANADA RESOURCES CORP., DEVON CANADA CORPORATION, FAIRBORNE ENERGY LTD., QUICKSILVER RESOURCES CANADA INC., CANPAR HOLDINGS LTD., and CENTRICA CANADA LIMITED

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