PETRO-CANADA

Reply Submission and Errata of Petro-Canada

Bitumen Conservation Requirements

EUB General Bulletin GB 2003-28

Phase 3 Final Proceeding

May 27, 2005

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PETRO-CANADA

May 27, 2005

Mr. Gary D. Perkins
Alberta Energy and Utilities Board
640-5th Avenue SW
Calgary, Alberta T2P 3G4

Dear Sir:

Re: General Bulletin 2003-28, Bitumen Conservation Requirements, Athabasca Wabiskaw-McMurray, Phase 3 Final Proceeding, Proceeding No. 1347905, Errata to Petro-Canada Reply Submission

Petro-Canada has identified an error in its Reply Submission filed with the Alberta Energy and Utilities Board (the "Board") on May 20th, 2005. Petro-Canada hereby requests leave from the Board to file the following errata to its Reply Submission.

On page 36 of the Reply Submission, in the first full paragraph, it currently reads:

> …The weakest point of a sealing surface is what determines whether there is an effective seal. At Chard, the weakest point is the thin nature of the regional mudstones. This is important as the mudstone is the sole barrier because the permeable coarsening up beds overlie the mudstones with no intervening layers of contingent sealing surfaces…

This excerpt is clearly not comprehensible. In order to avoid confusion and clarify its meaning, the foregoing excerpt should be replaced with the following:

> …The weakest point of a sealing surface is what determines whether there is an effective seal. The thin nature of the regional mudstones is important because permeable coarsening up beds overlie the mudstones with no intervening layers of contingent sealing surfaces…

Petro-Canada respectfully submits that the filing of this errata to clarify the meaning of the foregoing excerpt will not prejudice any of the parties. We apologize for any confusion this may have caused and have enclosed a revised copy of our submission in CD format to replace the version filed with the Board and served on interested parties on May 20th, 2005.

Please do not hesitate to contact the undersigned should you have any questions concerning this errata.

Yours sincerely,

PETRO-CANADA

Rachel Kolber
Legal Counsel

cc: Interested Parties

Reply Submission of Petro-Canada

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Reply Submission of Petro-Canada

Bitumen Conservation Requirements
Alberta Energy and Utilities Board General Bulletin GB 2003-28
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1.0 Introduction

On May 9th, 2005 Canadian Natural Resources Limited ("CNRL") filed a Response Submission to Petro-Canada's submission of February 14th, 2005. Petro-Canada is providing this further submission to reply and to clarify matters raised by CNRL.

A central claim by CNRL is that the evidence submitted by Petro-Canada has been presented and considered by the Board in previous hearings, and that no new data is presented that warrants a change to the Board's earlier findings. Petro-Canada objects to this characterization of its evidence. Over the past three years since the issuance of Decision 2003-23 (the "Chard-Leismer Decision"), Petro-Canada has gathered new field data to obtain a better history and address various issues identified by the Board in that decision. Since the Chard-Leismer hearing, Petro-Canada has drilled and equipped two new observation wells in the Chard area with piezometer gauges. In addition, new static gradient and build-up data has been obtained in the gas sands that provide evidence to augment and update the Board's rulings pertaining to the production status of gas wells in the area.

Contrary to CNRL's assertion, Petro-Canada's submission in these proceedings presents new and more comprehensive evidence including:

1. Three years of piezometer data which adds to the initial two years of data reviewed by the Board at the Chard-Leismer hearing, more than doubling the time span of the dataset;

2. A new format and enhanced data density to the ConocoPhillips 10-26-81-7W4 well dataset, facilitated by implementation of a new field SCADA system, confirming reservoir continuity between associated gas and bitumen;

3. A new well piezometer dataset in the 10-14-79-7W4 well evidencing pressure communication across the regional A2 mudstone;

4. A new case study evidencing communication across the A2 mudstone from conventional pressure data alone between the 11-33-79-7W4 and the 12-35-79-7W4 wells;

5. New insights into the vertical reservoir continuity of the 9-24-80-7W4 well dataset arising out of the incremental data gathered since the Board last reviewed the case study, supported by new off-setting conventional pressure data; and,

6. An indication of the time scale of pressure equilibration at the 9-24 well site.

This new evidence was gathered to build upon the previous dataset in response to questions raised by the Board in the Chard-Leismer Decision.

In addition, a more comprehensive review of the pressure response within the McMurray formation has been provided in the 2003 and 2004 Resource Management Reports submitted by Petro-Canada in compliance with the Board's requirement for the Chard lease area.

Building on past data and evaluations, Petro-Canada's findings from recent pressure evidence reveal that the sealing capacity of the regional mudstones within the Chard lease area cannot be relied upon. Petro-Canada presented two case studies providing direct evidence of pressure communication within the interior of the mapped mudstones in the Athabasca Wabiskaw-McMurray Regional Geologic Study, Report 2003-A ("RGS"). As such, Petro-Canada has requested the shut-in of nine additional identified wells, including the 6-22-80-6W4 well within the Wabiskaw McMurray A pool. All of the evidence presented by Petro-Canada directly relates to the wells Petro-Canada seeks to have shut-in. More specifically, excepting the 6-22 well, the wells lie on the erosional edge of the A2 mudstone where the risk of a breach to the sealing capacity of this shale is highest.

In its Response Submission, CNRL advances three reasons why Petro-Canada's request for shut-in should be denied. First, CNRL states that none of the pressure arguments support the contention that regional McMurray mudstones are not pressure barriers (page 16, CNRL Response Submission). Contrary to this assertion, Petro-Canada presented two pressure datasets that prove the lack of sealing integrity of the regional mudstones. The 11-33 and 12-35 wells demonstrate a case where, despite sparse pressure measurements within the gas sands, continuity across the A2 mudstone between the A sequence and B sequence sands is evident. Given the small pressure dataset available across the sands within the Chard lease, the presence of such an example raises serious concerns regarding the continuity of the regional mudstone sequence over large areas with sparse well control. One must ask how many more examples would be realized if a larger and better dataset were available? Furthermore, Petro-Canada presents the new 10-14-79-7W4 piezometer dataset which demonstrates both significant initial pressure depletion across the A2 mudstone, plus a declining pressure trend indicating continuing depletion and/or pressure equilibration across the A2 mudstone. These examples were not available at the Chard-Leismer hearing and constitute new evidence. Both datasets support the position that regional McMurray mudstones may not always act as pressure barriers, placing bitumen resources at risk from top gas pressure depletion.

The second reason CNRL states that Petro-Canada's request should be denied is because the geologic material presented is "general in nature and has already been repeatedly argued and ruled on by the Board at the previous Chard hearing" (page 16, CNRL Response Submission). CNRL argues that "no new data is presented which warrants a change to the Board's findings" (page 16, CNRL Response Submission). Having regard to the new pressure evidence summarized above, the geological discussion also provides a framework for the basis upon which the regional mudstones may be breached beyond the characterization from existing well control. New evidence in consideration of seal properties was presented that had not been considered by the Board at the Chard-Leismer hearing.

And finally, CNRL contends that Petro-Canada's shut-in request should be denied because Petro-Canada "provides no evidence which indicates that continued production from the 9 specified wells is impacting potentially recoverable bitumen" (page 16, CNRL Response Submission). Again, contrary to CNRL's contention, Petro-Canada has provided a mapping of bitumen throughout the Chard lease area in the Chard-Leismer hearing, to which the nine overlying wells impact potentially recoverable bitumen (see Figure 1).

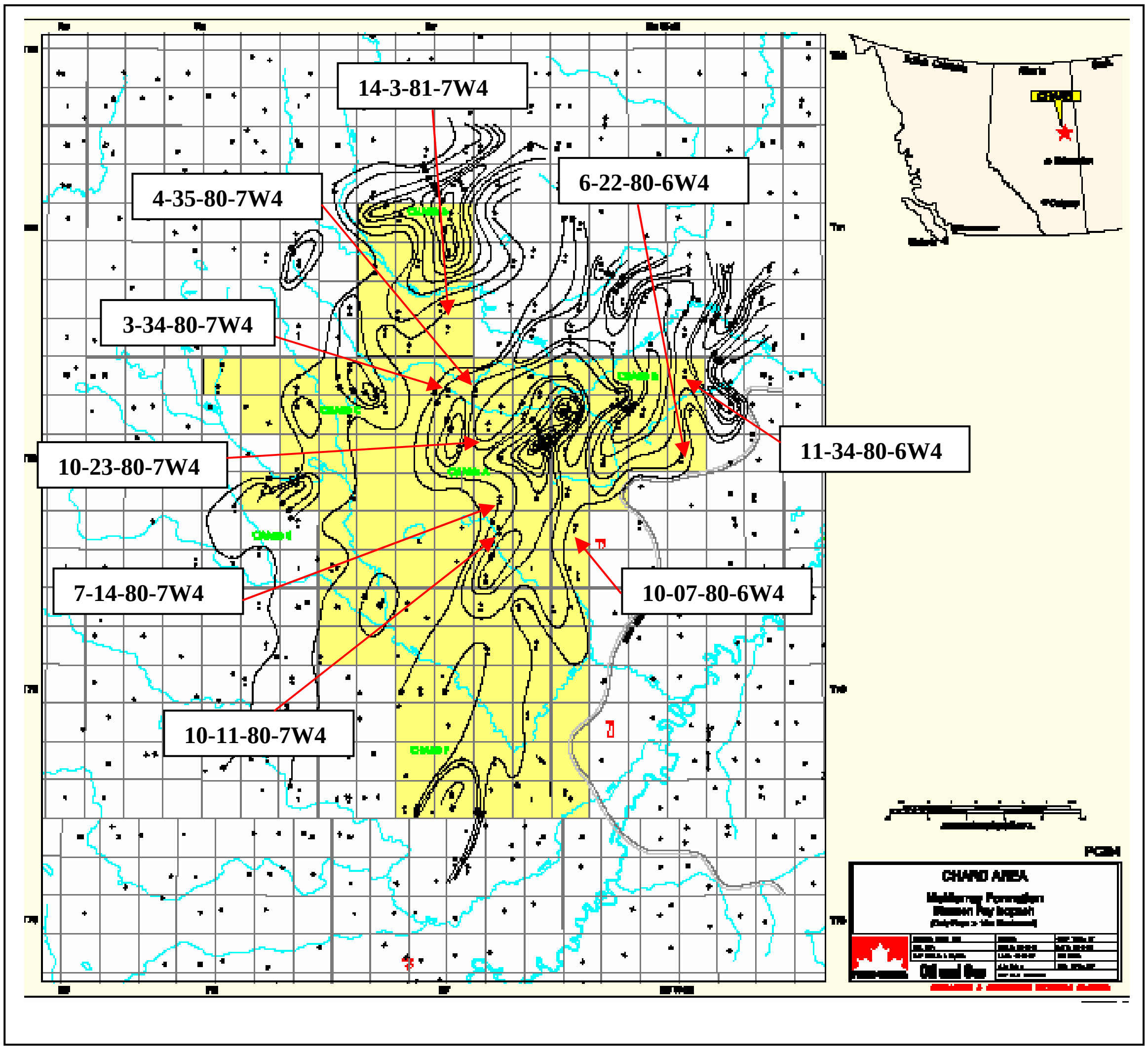

Figure 1 – Location of the Nine Producing Gas Wells Overlying Prospectively Commercial Bitumen Deposits as Currently Mapped

Petro-Canada is concerned about the increased risk of communication with underlying bitumen as essentially all of these wells are located at or near the erosional edge of the mapped regional mudstones, where the sealing capacity of the mudstones is most questionable.

2.0 Conventional Pressure Data Evidence

In response to CNRL's first concern, Petro-Canada will address in this and the following section the new pressure datasets demonstrating continuity across the regional A2 mudstone.

The 11-33-79-7W4 and 12-35-79-7W4 case study from Petro-Canada's evidence is an example using conventional pressure data to indicate communication across the A2 mudstone between an A sequence sand completed in the 11-33 observation well and B and C sequence gas sands three kilometres to the east completed in the 12-35 well. These wells are well within the confines of the regionally mapped A2 mudstone, yet demonstrate that broad regional communication across the A2 mudstone exists. Ignoring evidence to the contrary, CNRL claims that the uncontested depletion in the 11-33 well arises from the offsetting 10-36-79-8W4 well to the west in the same A sequence.

Figure 2 presents the wells with gas pools as originally mapped by Petro-Canada (see page 52 of the 2004 Chard Resource Management Report).

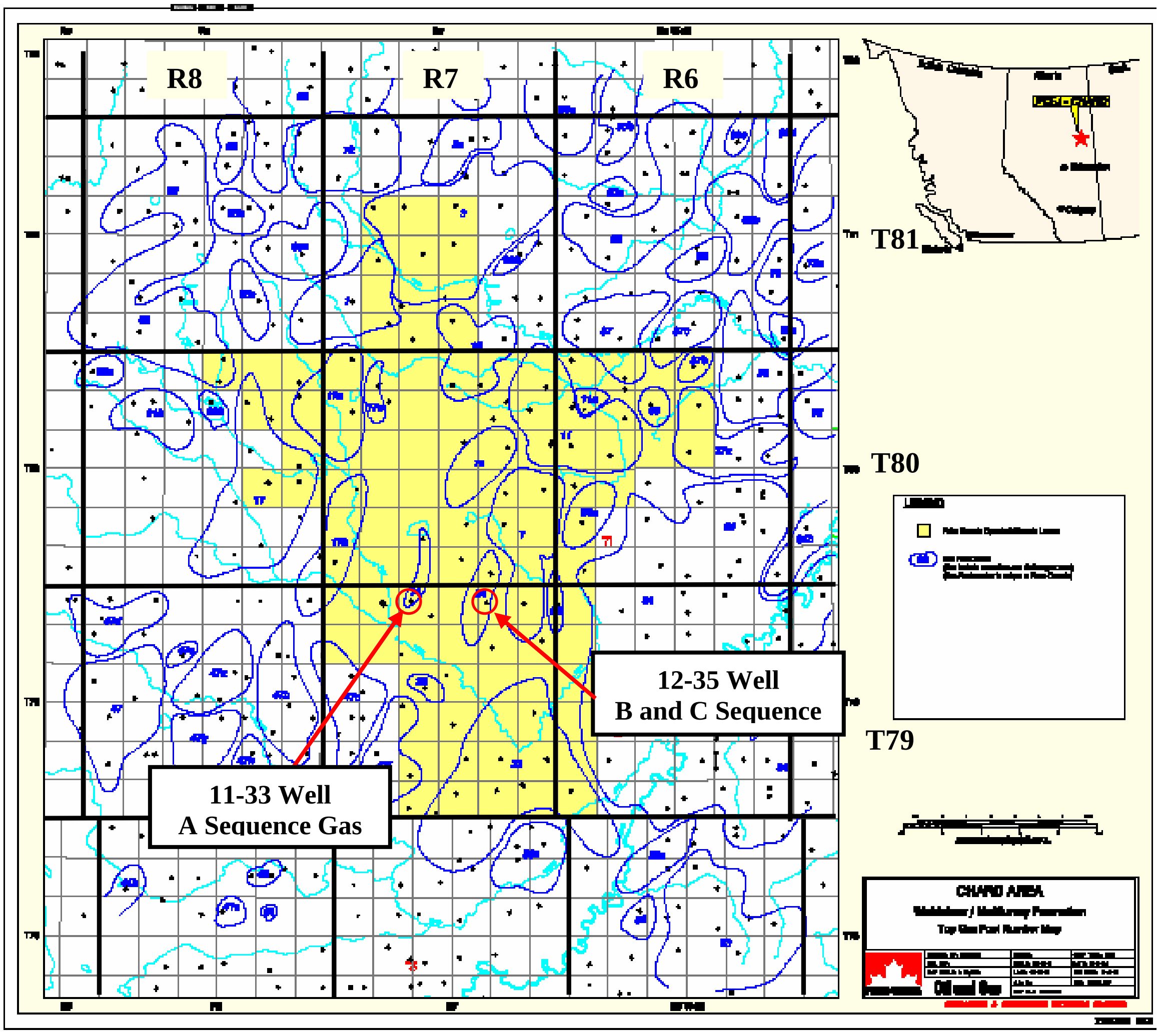

Figure 2 – Case Study for Pressure Communication across A2 Mudstone

Petro-Canada agrees that the 11-33 well consists of gas over water over bitumen fluid regime in the A sequence. Petro-Canada also agrees that the McMurray B gas in the 12-35 well lies approximately 18 metres below the top of the bitumen in the 11-33 well. Petro-Canada disagrees, however, with CNRL's assertion (page 17, CNRL Response Submission) that, if these two wells were in communication through the A2 regional mudstone, the 12-35 should be entirely charged with bitumen or water. While this may be a valid preliminary observation, Petro-Canada notes that it is not supported geologically and that the evidence shows that the 11-33 and 12-35 wells are in pressure communication. In support of its position, Petro-Canada notes the following:

1. The CNRL cross section of Figure 21 in its Response Submission does not extend the A sequence water in the 11-33 well to the 12-35 well. Consequently, the extent of the top water aquifer is limited moving two miles east to the 12-35 well. Between the 11-33 and 12-35 wells, Petro-Canada interprets the A sequence 11-33 gas to extend beyond the top water aquifer, as commonly mapped in pools in the RGS, while the B sequence gas extends westward below the eastern development of the A gas. Furthermore, some undefined geological feature not evident due to the low drilling density such as a cross cutting channel or fault, could readily bring both sands in communication over the two mile distance, as evidenced by the pressure data. Therefore, it is not a compelling geological argument to suggest that the 12-35 gas sand should be entirely charged with bitumen or water. A model for communication between the two sands is shown in Figure 3. It should be noted that communication resulting from late time faulting between the wells can act independently of initial fluid saturation distributions. Such a model explains why there is water in one well but not in the other.

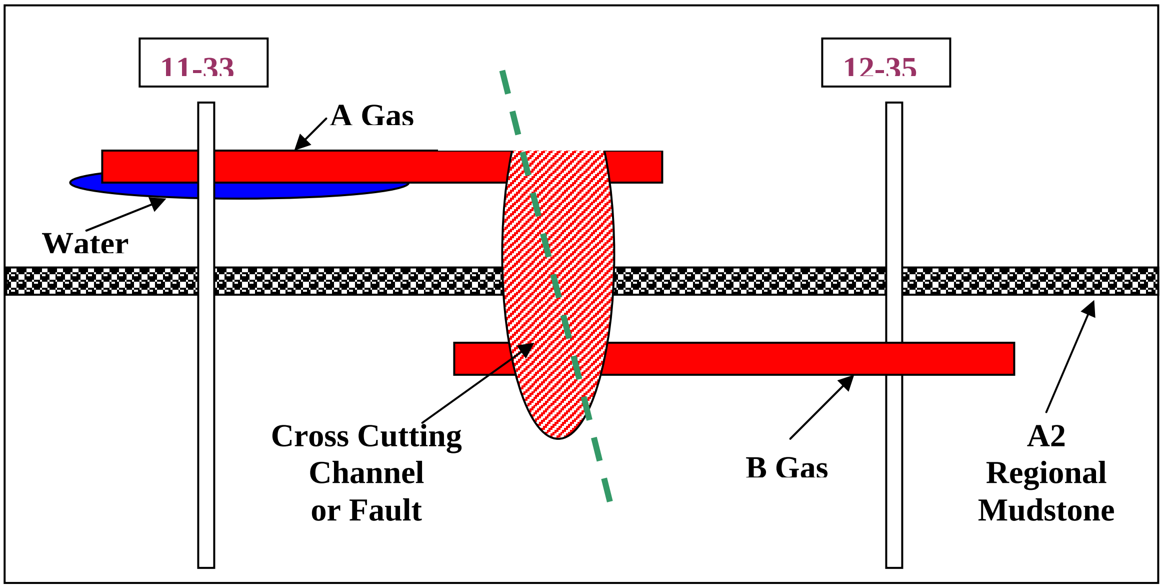

Figure 3 - Schematic for Communication Between 11-33 and 12-35 Gas Zones

2. CNRL interprets the March, 1999, dead weight gauge pressure point as an "…understatement of the downhole calculated pressure when extrapolated from the surface readings" (page 17, CNRL Response Submission) as there may have been water in the wellbore, therefore the pressure reading may have been at virgin pressure.

Petro-Canada notes that the well was shut-in for 45 hours before the March 1999 pressure was taken, following a short flow test. Prior tests did not record water in the wellbore. The subsequent static gradient pressure of February 2002, despite further depletion, demonstrated a fluid level below the base of gas with a depleted pressure of 1617 kPaa. It is more likely that the March 1999 data point was also without a water column. Therefore, CNRL has no evidence to support a fluid level existing within the well or that the March 1999 pressure does not represent a depleted pressure of 1753 kPaa, well below the virgin top gas pressure of 1880 kPaa in the 11-33 well. That CNRL accepted this pressure as adequate is supported by the omission of a fluid level shot with the pressure point. Petro-Canada therefore reasonably interprets the March 1999 pressure point as indicating depletion (see Figure 4).

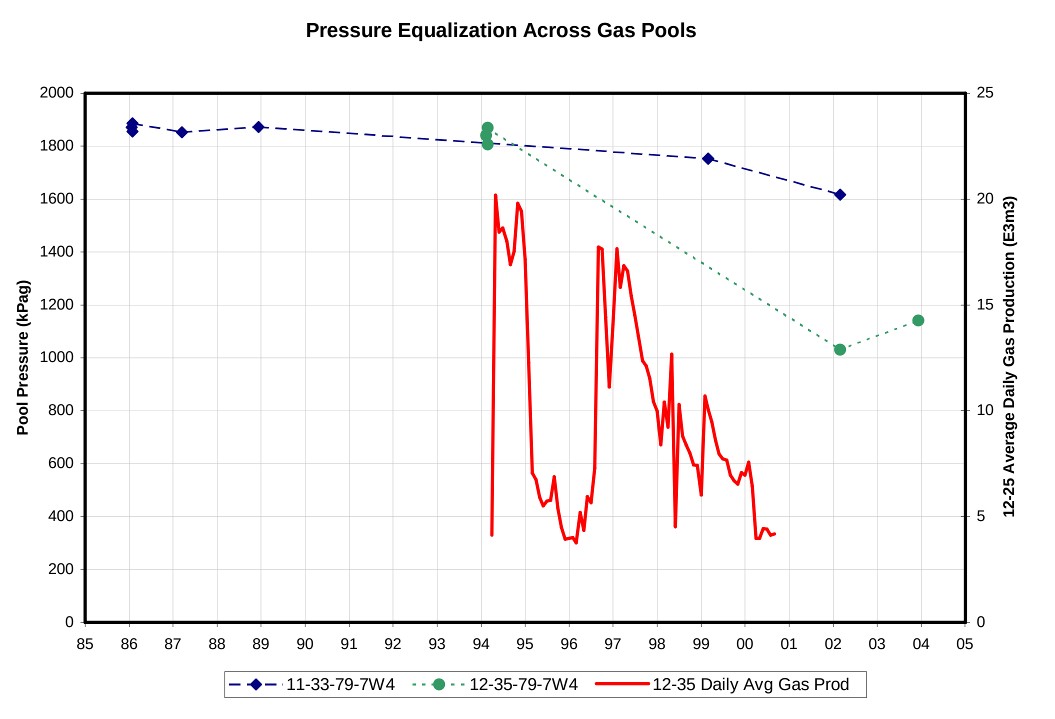

Figure 4 – Pressure/Production History for the 11-33 and 12-35 Wells

3. To explain the depletion and communication with the 11-33 well through the A2 regional mudstone, CNRL claims that the recorded depletion at 11-33 has been developed from off-setting production from the western 10-36-79-8W4 well, with a recorded pressure of 1400 kPaa in June, 2001.

Petro-Canada notes that the DST in the adjacent 10-32-79-7W4 well between the 11-33 and 10-36 recovered 88 metres of water and no gas. Therefore, the two gas pools are not continuous between the wells that CNRL claims communication. Alternately, CNRL may be arguing that this is a case for communication across an underlying aquifer joining two segregated gas pools over a distance of two miles. Although interesting, this contradicts the gas pool mapping by the Chard Gas Producers ("CGP") group in the Chard-Leismer hearing that did not recognize gas-on-gas communication through a regionally extensive top water aquifer (CGP-FAI 16). Rio Alto Exploration, a predecessor company to CNRL, was a member of the CGP group.

Petro-Canada notes that the CGP group in the Chard-Leismer hearing maps the 10-36 gas pool and 11-33 gas pool in isolation as two separate pools in the same A sequence sand, presumably on the basis of initial pressure differences (CGP Submission, June 2001, page 8 and Figure CGP-FAI 12) (see Figure 5). Furthermore, the CGP model for the mapped aquifer extending slightly beyond the limits of each gas pool is contradictory to these pools being in communication through a common aquifer, given the CGP group gas pool mapping in Figure 5 where a distance of one mile separates the 10-36 and 11-33 mapped pools.

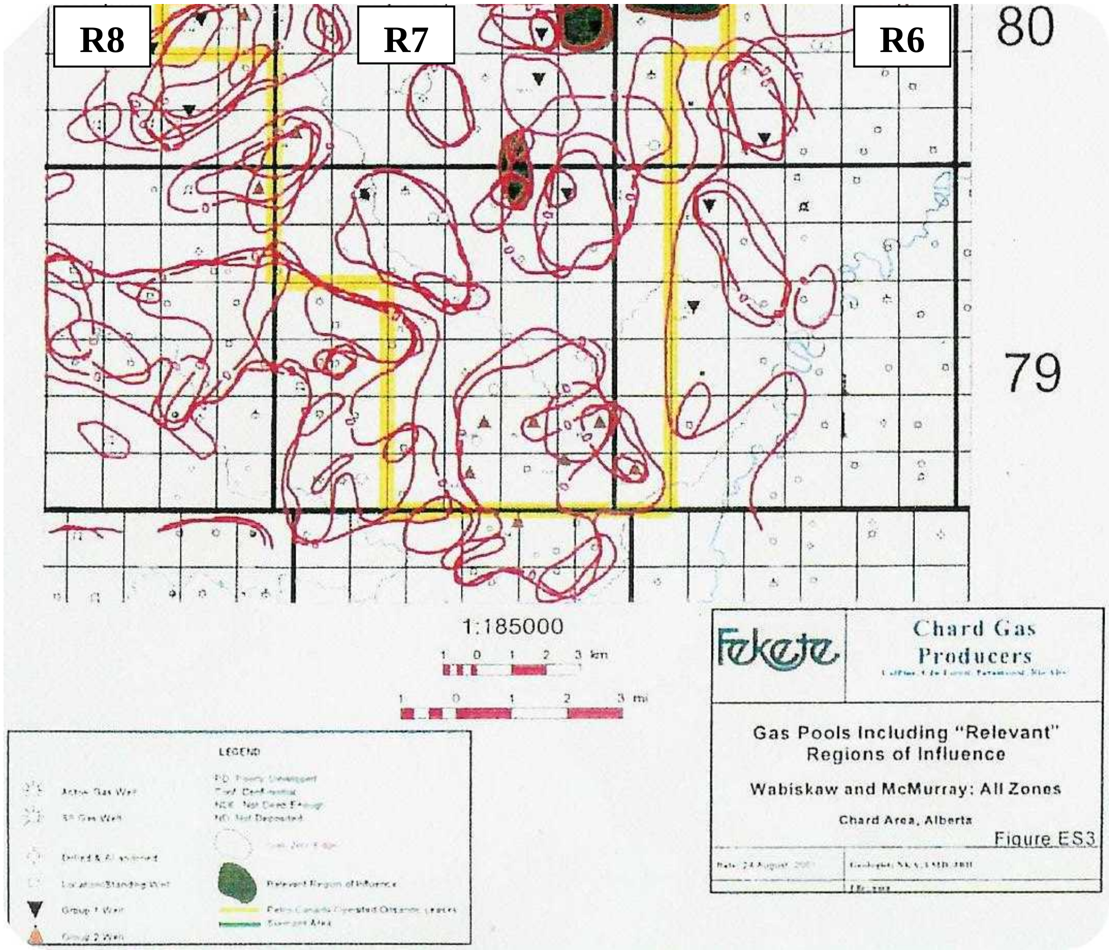

Figure 5 – CGP-FAI 12 Gas Pool Mapping

To claim an influence of a pressure drop of 263 kPa to the 11-33 well over a distance of two miles across an intervening aquifer is unlikely given that, by March 1999, the pressure depletion was 117 kPa at the 11-33 well while the 10-36 well had only come on production in the previous month. At the time of the recording of the depleted February 2002 pressure at the 11-33 well of 1617 kPaa, the 10-36 well had produced 8.5 million m^3 (0.3 Bscf). Petro-Canada also notes that the initial pressure for the 10-36 well is 1827 kPaa, while the DST pressure for the 10-32 well is 1932 kPaa.

Consequently, CNRL's claim of a pressure link between the 10-36 and the 11-33 wells to explain the depletion is contradictory to

- the principles of the CGP group's own previous gas pool mapping;
- the CGP group's previous aquifer model with associated top gas;
- the evidence of lack of gas-to-gas continuity between the wells;
- the measured pressure record between the wells;
- the timing of gas production influencing the March 1999 pressure depletion; and,
- any evidence provided of the 10-36 pressure equalizing with the 11-33 pressure.

In support of pressure communication between the 12-35 well and the 11-33 well across the A2 mudstone, Petro-Canada notes that the virgin pressure in the off-setting 12-35 gas of 1870 kPaa is essentially the same as the 1880 kPaa 11-33 pressure. As indicated in Petro-Canada's February 14, 2005 submission, production from the 12-35 well began in early 1994 and had produced 22.3 million m^3 (0.79 Bscf) prior to the February 2002 depleted pressure and had produced for five years prior to the depleted March 1999 11-33 pressure. Consequently, the timing and volume of gas production from the 12-35 well is more consistent with the pressure record of the 11-33 well, as illustrated in Figure 4.

The 12-35 B and C sand pools are comparatively smaller than the A sequence pools and have demonstrated a strong pressure increase continuing three years after shut-in of gas production, consistent with a small pool being recharged by a larger, offsetting gas volume. In a direct comparison of the 10-36 well or the 12-35 well providing drainage to the 11-33 well, the physics of the 12-35 well as a source of depletion is consistent, while the 10-36 option is strained and contradictory. CNRL claims that a tie to the 10-36 well is "a far more reasonable explanation as the depletion comes from the same zone" (page 18, CNRL Response Submission). This logic is self-serving and ignores direct evidence to the contrary.

Petro-Canada reasserts that the reasonable conclusion from the evidence is that the 12-35 well and the 11-33 well are in pressure communication across the A2 mudstones. This is significant given that the time sequence record of conventional pressure data from producing gas sands across regional mudstone sequences is limited. Therefore, to find clear evidence of the communication example provided by the 11-33 and the 12-35 case study within the limited range of case studies available raises a serious concern over the regional sealing capacity of the mudstone. This places bitumen recovery at risk throughout the coverage area of the regionally mapped mudstones.

3.0 Piezometer Data Cases

Over the history of the production of top gas within the Chard-Leismer area, conventional gas pressures have been acquired for the purposes of gas production operations. The pressures taken in the gas sands provide no information on the reservoir continuity of these sands with underlying strata and bitumen. To address this concern, Petro-Canada drilled and equipped four wells in the Chard lease area with piezometer gauges for permanent downhole pressure monitoring across the vertical column crossing fluid saturation and stratigraphy changes within the McMurray. The time series data provided by the piezometer record provides a better record than the sparsely collected conventional pressure dataset to evidence reservoir continuity issues across all McMurray fluids and lithologies. In many cases, the piezometer record has established reservoir-induced effects that would not have been captured by conventional pressures.

Despite extensive evidence of vertical pressure continuity through the McMurray, CNRL continues to contest the validity of piezometer data (page 20, CNRL Response Submission). Hundreds of piezometer gauges have been installed to monitor SAGD performance and numerous long-standing companies offer this technology to the industry. In addition, at page 24 of Decision 2003-23, the Board accepted this data:

> The Board accepts that piezometers in the upper part of the McMurray at the 02/9-24080-7W4/0 and the 5-16 and 6C-16-76-6W4/0 wells are reading pressures that are less in magnitude than a reasonable estimate of virgin pressures.

The Board accepts that there is evidence of pressure depletion in the lower zones from the piezometer record. The Board was also seeking further and better information. At page 24, it stated:

> With regard to the nature of the declining pressure trends observed over time, the Board agrees with EnCana that <u>in the absence of any other information</u>, these changes in pressure over time are as likely to represent 1) instrument drift of an unknown origin, 2) the decaying remnant of drilling-induced pressure pulses around the borehole, or 3) the transmittal of pressure decline down the borehole, as they are to be due to the effects of overlying gas production being transmitted vertically through the formation away from the borehole. [Emphasis added].

In response to this concern, Petro-Canada provided new evidence from the longer trend data of the piezometers. This data provides additional information not available at the Chard-Leismer hearing.

CNRL contends that the three piezometer data cases provided by Petro-Canada are similar to those presented at the first interim hearing for the Chard area (page 18, CNRL Response Submission). Petro-Canada notes that the original evaluation of the 10-26-81-7W4 well and the 9-24-80-7W4 well are now supported by three years of additional data that confirms Petro-Canada's original conclusions. The third case for the 10-14-79-7W4 well presents new data that was not available at the first interim hearing.

3.1 Case 1: The 10-26-81-7W4 Well

Prior to the installation of a field SCADA system in November 2002, data from the 10-26 well was collected by a field operator. The early data from the 10-26 well is comparable to a frequent sequence of conventional pressure measurements. The data shows a pronounced drop in underlying bottom water pressure from off-setting top gas depletion in the adjacent section through an extensive 60 metre mud plug and bitumen column, which reverses to exceed initial recorded pressures after off-setting gas production is shut-in.

Referring to page 24 of the Chard-Leismer Decision, CNRL states at page 18 of its Response Submission:

> At that time the Board could not make such a correlation primarily because:
>
> > "*…unlike the other piezometer data entered as evidence, these pressure data were collected at discrete time intervals rather than continuously. Moreover, the pressure appears to begin to rise prior to the shut-in order" (Decision 2003-23, pg. 24).*

CNRL suggests that the collection of the piezometer data at discrete time intervals was considered problematic by the Board. Petro-Canada interprets the Board's concern to rest with the single pressure point that appeared to indicate a pressure rise immediately before the Surmont gas shut-in order. New data acquired since the installation of the field SCADA system in November 2002 now addresses this matter (see Figure 6).

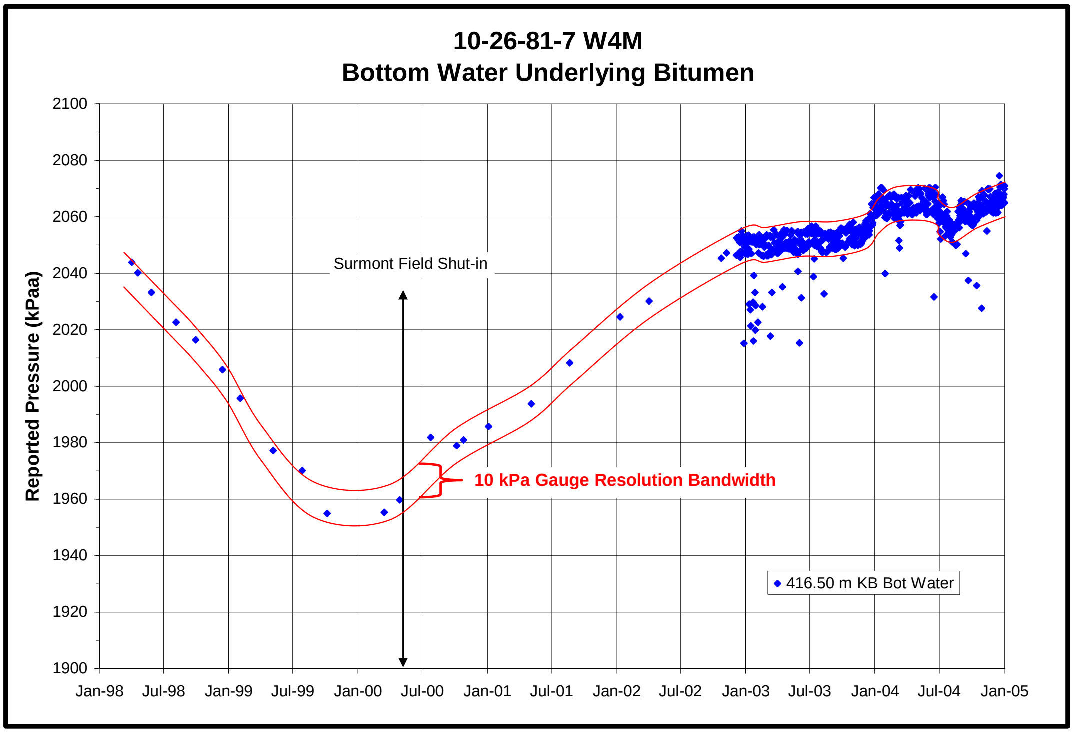

Figure 6 – Pressure History for the 10-26-81-7W4 Bottom Water Piezometer

In Petro-Canada's submission of February 14, 2005, the observed trend is compelling evidence of pressure rebound after the Board-ordered shut-in and shows the interconnected nature of these pools. CNRL attempts to discredit such a conclusion through its interpretation of an error band analysis for the 10-26 pressure record, illustrated on Figure 22 of the CNRL Response Submission. The claim is that the dataset carries an 80 kPa "error band". In reply, Petro-Canada notes the following.

As noted in Petro-Canada's submission of February 14, 2005, the gauge resolution at +/-5 kPa is demonstrated by the SCADA data period, consistent with manufacturer specifications. The resolution bandwidth defines the outer bounds of error for any measured data point defining a time series trend of the data. Consequently, any trend of data that moves beyond a +/- 5 kPa window to an initial series of data points is exceeding the limitations of the gauge resolution and therefore demonstrating a reservoir-induced effect. The SCADA data also illustrates some limited, infrequent noise beyond the range of gauge resolution. Such effects are commonly artifacts of the telemetry and surface data logging technology as discussed in the Chard-Leismer hearing.

With respect to the issue of communication, Petro-Canada notes the following:

1. The declining pressure tend prior to field gas shut-in of 100 kPa presents a significant decrease beyond considerations of gauge resolution and "error band" interpretation. Even CNRL's attempts to illustrate an "80 kPa Potential Error Band" demonstrate the same <u>declining trend prior to gas shut-in and then a following pressure restoration trend after gas shut-in.</u>

2. The data collected at discrete intervals prior to the SCADA installation shows a smooth curve with minimal scatter contained within the +/- 5 kPa resolution bandwidth of the data demonstrated.

3. The absolute value of the measured pressure points demonstrates an initially depleted pressure at the onset of data collection. However, the significance of the data arises from the trends established straddling the date of the field production shut-in.

4. The Board had previously noted that there was no explanation for the pressure rise in the 10-26 dataset recorded prior to gas shut-in. Specifically, at page 24 of the Chard-Leismer Decision, the Board wrote:

> The lack of continuous data and the suggestion of a pre-shut-in pressure rise makes it difficult to determine whether the pressure reversal was indeed linked to a cessation of overlying gas production or was due to some other cause.

New continuous SCADA data now provides a reasonable explanation for the minor change as falling within gauge resolution, thereby supporting the pressure depletion trend. This dataset is more thoroughly reviewed in the 2004 Chard Resource Management Report.

5. The significance of the 10-26 case study is that strong communication pathways can exist across the vertical McMurray column and across extensive mud plugs and bitumen, which can directly tie bitumen deposits to overlying gas. Direct and compelling new evidence has now been provided to enable the Board to further refine its conclusions.

3.2 Case 2: The 10-14-79-7W4 Well

Petro-Canada recommended a pressure monitoring program as a part of the Chard-Leismer hearing. Petro-Canada advanced a proposal for the testing of the integrity of the regional shale in Township 79-7W4 and elsewhere. Petro-Canada asked that producing wells be completed in permeable zones below the regional shales and equipped with pressure recorders while top gas was being produced. Where direct evidence did not demonstrate underlying depletion, the parties could agree on the local sealing integrity of the mudstone. However, this proposal was not adopted at the time.

To refine this proposal, in April of 2003, Petro-Canada drilled and installed the piezometer set in the 10-14 well to provide a direct measure of the pressure response across the A2 mudstone in an overlying gas pool that had been depleted to within 500 kPaa (see Figures 2 and 7).

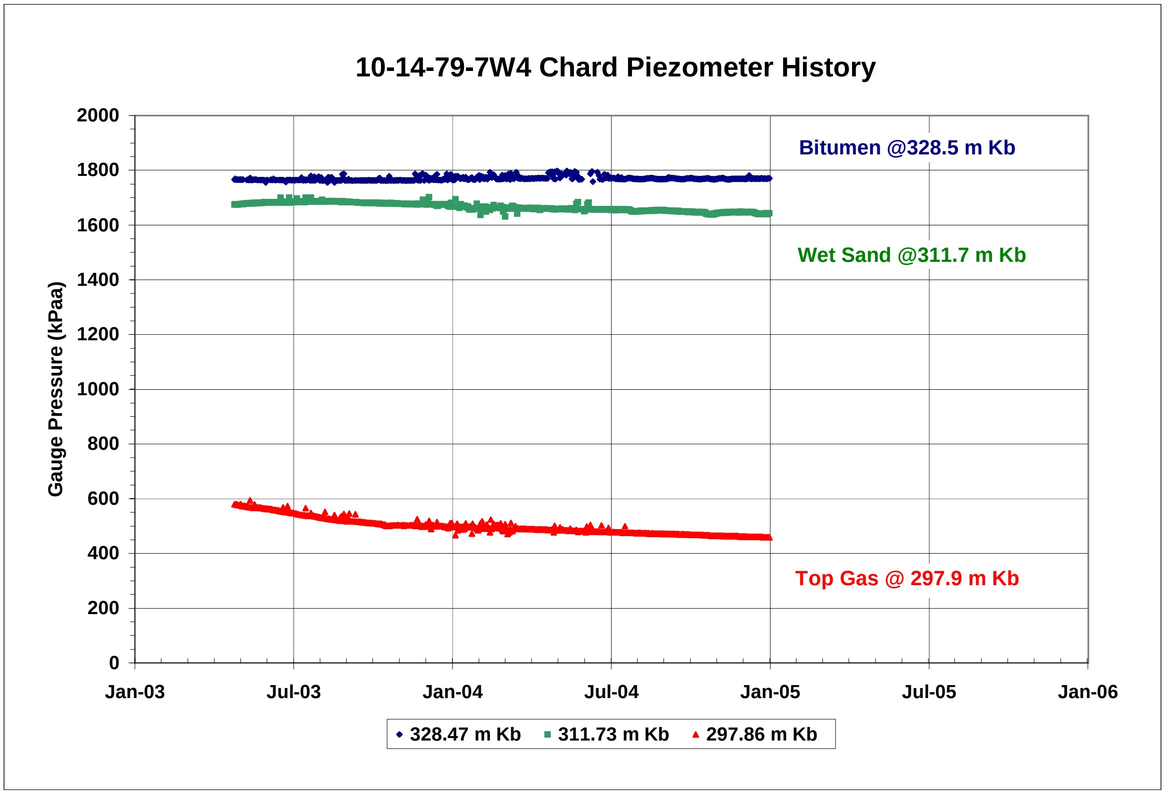

Figure 7 – 10-14 Piezometer Pressure History

What has been determined is evidence of initial depletion and a trend of continuing depletion across the A2 mudstone, at a point source in the centre of the regionally mapped mudstone across the entire township. This evidence questions the sealing capacity of the regional mudstone and the mudstone's characterization as a laterally continuous unit above bitumen.

The evidence for pressure communication across the A2 mudstone is reflected in the middle piezometer record in the permeable, wet sand below the regional mudstone (see Figure 8) which shows initial and continuing pressure depletion across the mudstone.

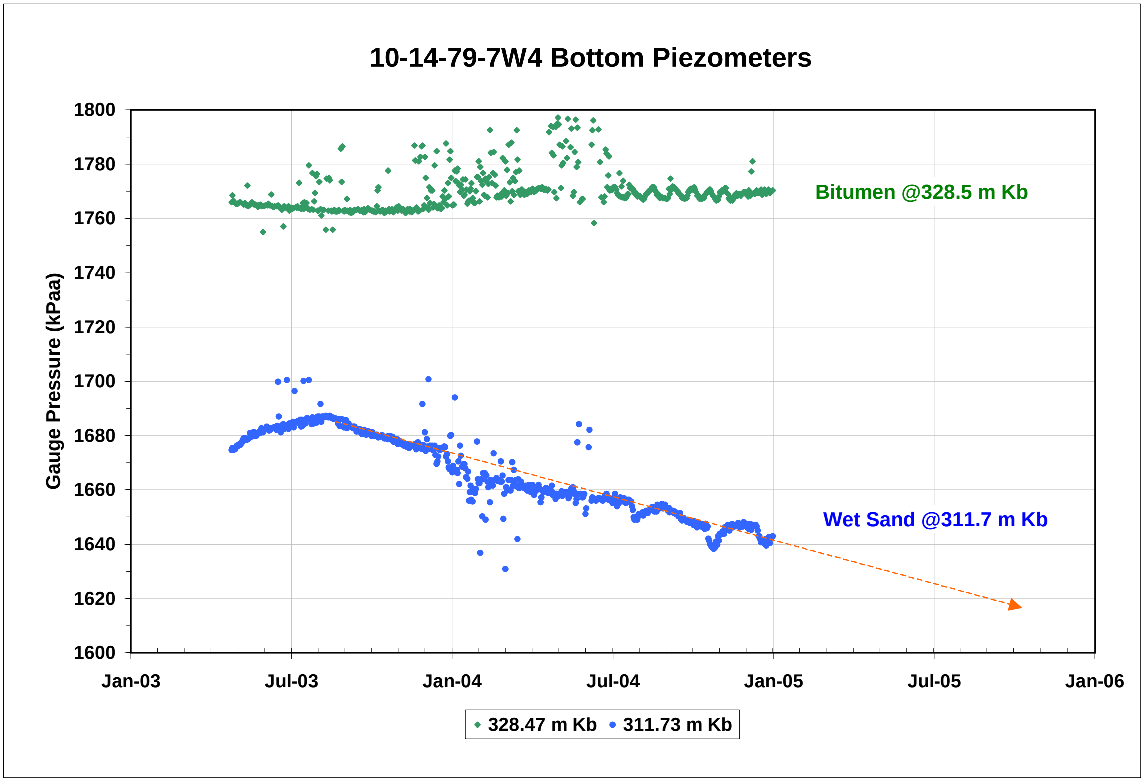

Figure 8 – Bottom Piezometers in 10-14

CNRL attempts to question this evidence through speculative propositions on recorder drift and noise that do not take into consideration either the reservoir physics or the integrated dataset with conventional pressure data in off-setting wells, which confirm the presence of a reservoir-induced response. CNRL takes the position that risk factors to data interpretation with the 10-14 dataset should favour the extended production of gas. Petro-Canada submits that, due to the significant consequences of bitumen sterilization due to the pressure depletion, risk factors to data interpretation should favour the protection of bitumen.

In its review of the 10-14 pressure dataset, CNRL speculates on the potential effects of drift and scatter. CNRL concludes that "it is far more likely that this decline (if it is real) is due to pressure transmission via borehole pathways (behind pipe)" (page 20, CNRL Response Submission). Petro-Canada notes the following:

1. Referencing the 10-14 piezometer dataset (see Figure 8) it is clear that the pressure reading, at 1640 kPaa in December 2004, is now considerably below the virgin top gas pressure of 1780 kPaa. Top gas pressure recorded in the upper gas piezometer at the same time is 460 kPaa, consistent with static gradient pressures from surrounding wells. Therefore, the piezometer dataset underlying the A2 "regional" mudstone is experiencing direct depletion from top gas production, irrespective of the developed trend. This 140 kPa of depletion, without consideration to hydraulic head differences between the top gas and underlying piezometer, represents a less than reasonable estimate of virgin pressure at the water bearing sand underlying the A2 mudstone. To suggest that the underlying water was originally at a virgin pressure below the under-pressured virgin top gas pressure is unreasonable. Consequently, prior to any consideration of recorder drift and scatter, the 10-14 piezometer evidences established depletion below the A2 mudstone.

2. The fact that the wet sand piezometer at 311.7 metre Kb is displaying a four month pressure incline after installation rules out the possibility that the two piezometers are connected by a microannulus to the high permeability underlying wet sand below the A2 mudstone (see Figure 9). For the top gas piezometer to be recording a 60 kPa pressure drop over this period, while the underlying wet sand piezometer is recording a 10 kPa build-up, discounts the theory of the two being directly in communication via borehole pathways. Rather, the four month stabilization build-up seen in the wet sand piezometer is a common feature among many accurate piezometers. For example, the 9-24 well in the top gas or bottom water experiences similar effects. More likely, this small pressure rise is due to temperature effects from cementing being dissipated.

3. The noise in the wet sand piezometer is consistent with the noise within the top gas piezometer, which is providing an accurate reading of top gas pressure as confirmed by static gradient tests in offsetting wells in the gas, notably the adjacent 10-11 well immediately to the south (see Figure 9). Therefore, the piezometer signal noise in the wet sand piezometer is not a factor influencing accuracy or the trend of the data.

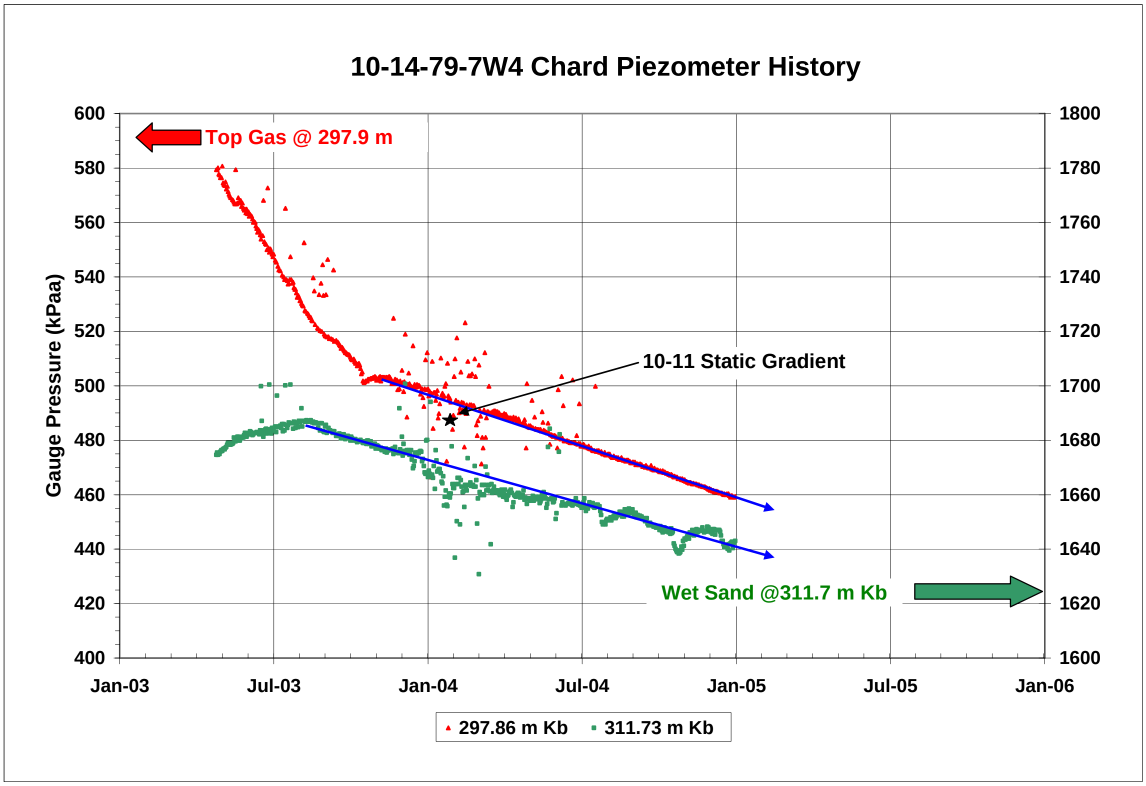

Figure 9 – Piezometer Record Straddling the A2 Regional Mudstone

4. The rate of decline in the wet sand piezometer (35 kPa/year) is consistent with the rate of decline in the upper gas piezometer (40 kPa/year). The upper gas piezometer can be shown to be responding to off-setting depletion due to continuing gas production in the adjacent eastern township. The rate of annual depletion in both gauges is larger than can be accounted for by drift and can be tied to field operations.

5. CNRL attempts to evaluate differing decline slopes on the overall 10-14 wet sand decline trend (Figure 24, CNRL Response Submission). The purported changes in slope are minor and inconsequential. Note that the wet sand piezometer is reading the net balance of influences from top gas

depletion and the aquifer water at the 311.7 metre depth. That there should be some character within the data in not unreasonable, due to two competing and counteracting forces of pressure depletion and pressure restoration from within the aquifer. Overall, the decline trend of the wet sand piezometer is comparatively linear. Such effects are not evident in the top gas piezometer where competitive pressure transients are dampened.

Contrary to CNRL's view, a direct examination of the piezometer record demonstrates that:

1. The two piezometer gauges straddling the A2 mudstone are providing accurate readings of formation pressures as confirmed by the off-setting 10-11 static gradient pressure of February, 2004;

2. The potential for effects of pressure transmission down a microannulus can be discounted based upon the contrasting character of the early time gauge response;

3. An effect of the decaying remnant of drilling induced pressure pulses can be discounted; and,

4. Parallel instrument drift in both recorders can be discounted as the annual rate of decline is well beyond considerations of recorder drift.

In support of its conclusion that the piezometer data should not be relied upon, CNRL references the Board's following conclusion at page 20 of Decision 2003-23 that McMurray A and B mudstones act as pressure barriers:

> This conclusion is based on the areal extent of the McMurray A and B mudstones relative to the size of the overlying gas pools and top water zones, the distribution of reservoir fluids within the sands, and pressure data from segregated gas zones.

In fact, the Board does not conclude that the McMurray A and B mudstones create a comprehensive barrier everywhere. The more relevant quotation from Decision 2003-23, also at page 20, is: "…where present, the McMurray A and B mudstones act as barriers to vertical pressure transmission …" (emphasis added).

The central question to be addressed is the confidence that can be taken in the areal continuity of the mudstones with limited well control. Petro-Canada submits that, where pressure data indicates a potential risk to bitumen, the bitumen resource should be protected.

The 10-14 case study presents new evidence of direct pressure communication across the A2 mudstone and demonstrates the incapacity of this regional mudstone to act as a seal to underlying bitumen.

3.3 Case 3: The 9-24-80-7W4 Well

CNRL claims that the 02/9-24 case study is an example of pressure transmission via borehole pathways. Petro-Canada maintains that new data from the piezometer record indicates that this cannot be the case and that pressure transmission throughout the McMurray formation is the most likely explanation for the observed pressure trend.

Petro-Canada notes that:

1. The 9-24 well does not contain a regional shale, but rather is in the fluvial-estuarine trend of the Chard lease. Consequently, vertical isolation is not anticipated from geological arguments.

2. The increasing trend and accuracy of the rising pressure in the top gas is confirmed by the off-setting static gradient data from the 11-19 well (see Figure 10), as discussed in the Chard 2004 Resource Management Report.

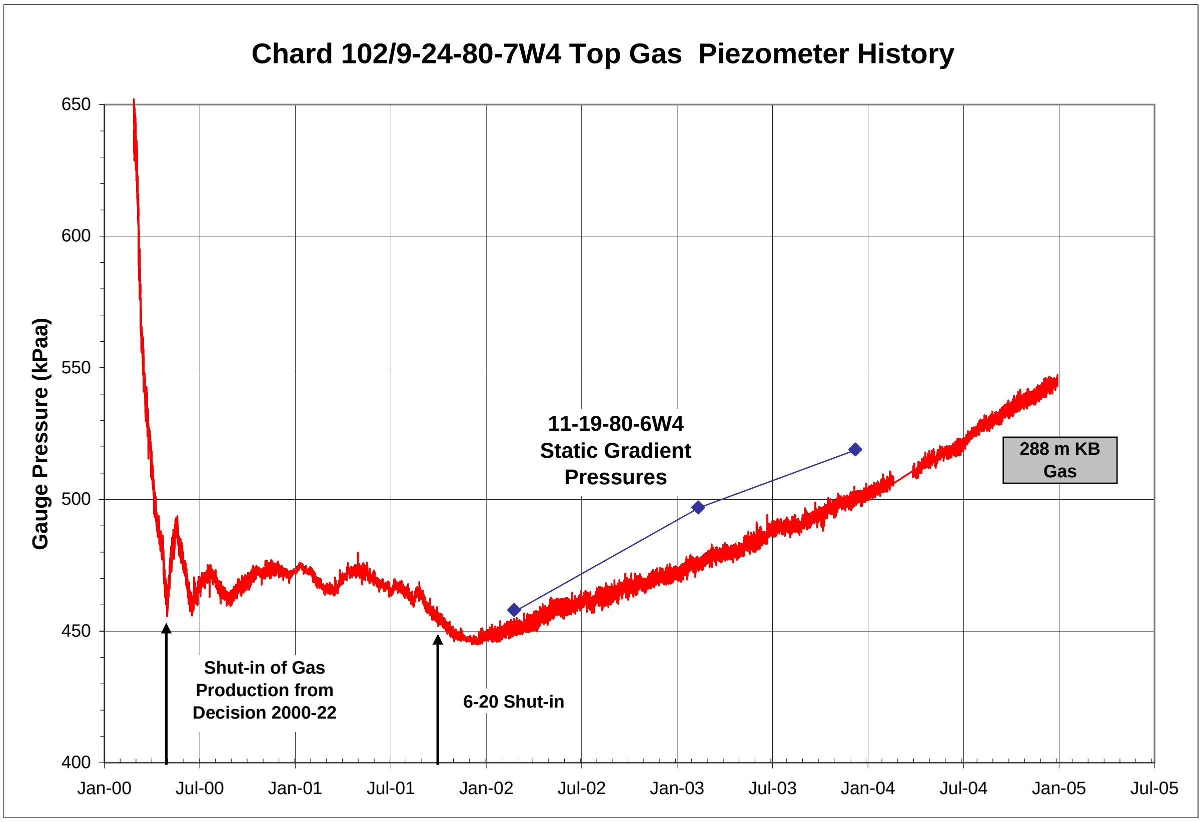

Figure 10 – Corresponding Static Gradient and Piezometer Pressure Response

3. The Board recognizes that the pressures underlying top gas in the 9-24 well are lower than any reasonable estimate of virgin pressures, indicating depletion due to top gas production.

4. The trends in the underlying gas and bitumen are decreasing in pressure at different rates while the overlying gauges demonstrate pressure increases. Even the trends within the underlying bitumen and bottom water within the 9-24 well follow different slopes, indicating differing rates. Over 2002, the bitumen piezometer demonstrates a flat, stable pressure response, while the underlying bottom water continues to decrease. This is the opposite effect that would be anticipated for pressure transmission via borehole pathways (see Figure 11) (see also the 2004 Chard Resource Management Report, page 28).

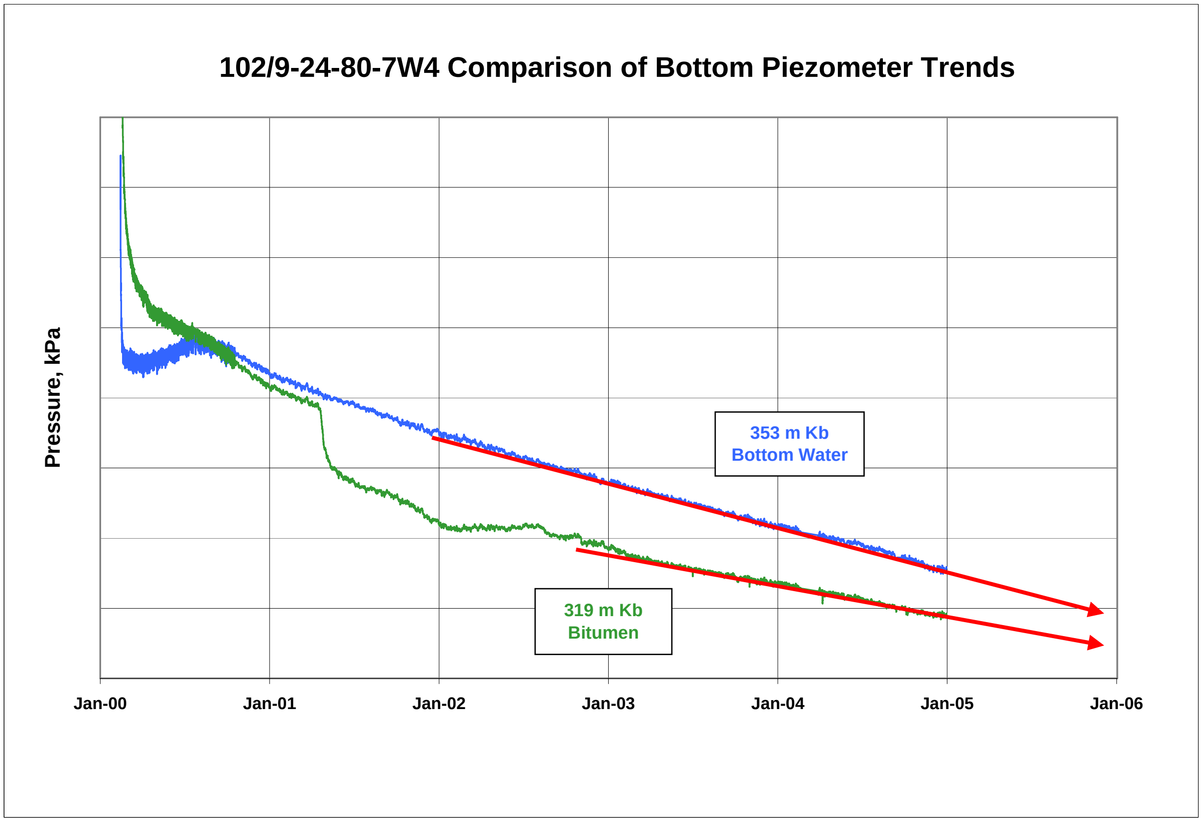

Figure 11 – Comparison of Bottom Water and Bitumen Piezometer Trends

5. Figure 25 of the CNRL Response Submission suggests that the depleted upper sand pressure is demonstrating a pronounced re-pressuring, while the lower two gauges in bitumen and bottom water are demonstrating a pronounced de-pressuring. The argument for gauge drift is repeatedly put forward by CNRL when physically consistent trends supporting vertical pressure transmission through the formation exist. In fact, the 9-24 dataset shows a pronounced vertical equalization of pressure, which current trends indicate will be achieved within an engineering time scale.

The extended piezometer record Petro-Canada has introduced in this proceeding supports the view that the pressure response in the 9-24 well demonstrates a reservoir-induced effect.

4.0 Paramount's Acceptance of Piezometer Data Evidencing Bitumen Depletion

CNRL states that "piezometric data on its own is at best ambiguous, and does not allow any substantive conclusions to be made" (page 20, CNRL Response Submission). Petro-Canada submits that the piezometer data is conclusive and can be supported by conventional pressure data and correspondence with field operational events which provide direct evidence of vertical reservoir continuity across regional mudstones and fluid regimes.

It is interesting to note that Paramount accepts that piezometer data within the Corner McMurray C pool is evidencing depletion in underlying interbedded mudstones and bitumen within the 02/3-34-80-10W4 well. Observation of the rates of pressure decline within the interbedded mudstone piezometer and bitumen piezometer within the 3-34 well are less than the levels of depletion evidenced in the 10-14 and 9-24 wells that CNRL would otherwise ascribe to drift, yet Paramount supports as evidencing pressure decline from reservoir induced communication with overlying top gas depletion (see Figure 12).

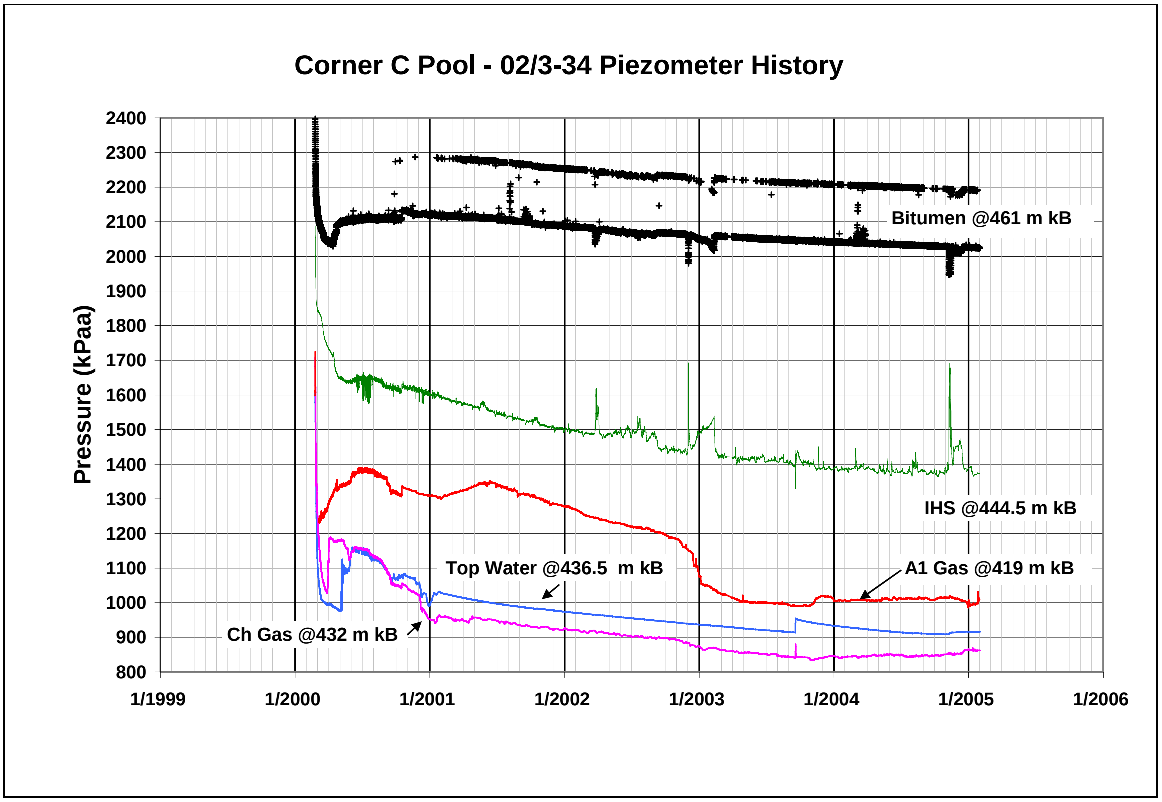

Figure 12 – Corner 02/3-34-80-10W4 Piezometer Data

5.0 Conclusion – Pressure Evidence

In its submission of February 14, 2005, Petro-Canada requested an order from the Board to shut-in nine producing gas wells on the basis that the evidence questions the sealing capacity of the regional mudstones within the Chard lease area. In addition, the risk of the regional mudstones being breached is highest near the erosional edge where those identified wells are located.

The evidence provided by Petro-Canada demonstrates that the current drilling density within the Chard lease area is insufficient to identify variations within the regional mudstones on the short scale of heterogeneity at which they can occur. In addition, the conventional pressure record is too sparse to resolve the issues of communication across existing gas pools and underlying strata through bitumen. Consequently, the four well piezometer datasets obtained by Petro-Canada constitute the most conclusive and reliable data available demonstrating that there is lateral and vertical communication within the McMurray.

Throughout the Chard lease area, the piezometer dataset reveals evidence of pressure communication from top gas depletion to underlying bitumen. Evidence of pressure transmission through the A2 mudstone can be found from conventional pressure data as well as piezometer data, which raises a concern regarding the sealing capacity of the regional shales. Considerations for artifacts of piezometer drift, communication across borehole pathways and drilling-induced effects unresolved in the initial hearing can now be dismissed having regard to the trends and absolute pressure differences highlighted by the addition of the past three years of pressure history.

As recently as the first interim hearing (Decision 2004-45, page 7), the Board stated:

> …at this time the Board sees no need to shut in intervals where, based on existing data, the pool has a mudstone/shale unit meeting the RGS criteria separating the gas from potentially recoverable bitumen throughout the entire region of influence. [Emphasis added].

The Board now has new data to consider which extends and clarifies the previous data considered by with the Board. This information shows that the sealing capacity of the mudstone/shale units cannot be relied upon to isolate overlying gas from underlying strata. Petro-Canada has consistently submitted that, where risks to the recovery of bitumen by SAGD are present, the Board should act without delay to preserve the bitumen resource.

6.0 Geologic Evidence

CNRL submits that Petro-Canada's geologic arguments have been presented in past hearings and that no new substantive information has been presented to warrant a review of the Board's previous findings. Petro-Canada disagrees. In its Response Submission, CNRL challenges Petro-Canada's decision to discuss the relevant geologic criteria to determine seal effectiveness and reliability. The purpose of Petro-Canada's evidence was to facilitate the Board's consideration of the scientific criteria relevant to an effective and reliable seal. Petro-Canada presented the geologic characteristics of an effective seal based on an investigation of referenced geologic papers that addressed the basic requirements of a seal from a broad perspective. The published opinions of recognized authorities on seals, including M.W. Downey, P.A. Allen, and H.R. Grunau, were investigated and this evidence highlighted the importance of understanding the three criteria of a reliable seal, namely, seal capacity, seal geometry and seal integrity.

Seal capacity is the fundamental quality of a seal. In the Chard-Leismer Decision, the Board noted that "[c]ore and log data indicate that both the McMurray A and B regional mudstones are typically about 1 m thick in the Chard-Leismer area" (page 22). The RGS description of the base of the A2 mudstone states that it is characterized by a 5 to 20 cm thick, condensed section of bitumen stained sands and muds (page 17). Bitumen in the condensed section of the one-metre thick A2 mudstone indicates that the seal capacity of the lower 5 to 20 cm has been compromised. The Board's reliance on the A2 mudstone as a regional pressure barrier is only valid if there is uninterrupted lateral continuity of the remaining mudstone above the bitumen stained condensed section.

The second criterion for an effective seal, seal geometry, considers geological factors affecting thickness and lateral extent of a seal. The thin nature of the regional mudstones (one metre) makes it unlikely that they will maintain a uniform character over a large area. The weakest point of a sealing surface is what determines whether there is an effective seal. The thin nature of the regional mudstones is important because permeable coarsening up beds overlie the mudstones with no intervening layers of contingent sealing surfaces. Consideration of seal geometry also includes assessment of factors concerning geological setting that affect the lateral extent of a seal. Factors that compromise the lateral extent of the regional mudstones in the Chard area include the following: (i) non-fully marine depositional environments, (ii) channel erosion, and (iii) insufficient well control. Petro-Canada's review of geologic factors that affect seal geometry is warranted because Petro-Canada's new evidence of pressure communication across the regional mudstones confirms that they are not laterally continuous and supports Petro-Canada's concern regarding undue reliance on the thin regional mudstones as pervasive seals.

The third criterion highlighted for the Board was seal integrity, which considers the propensity of a sealing layer to fail or fracture. The seal integrity of an effective sealing surface is compromised when the seal is broken due to geomechanical disturbance. In the Chard area, the seal integrity of the one-metre regional mudstones is compromised through disturbance by structural collapse due to post McMurray and Wabiskaw dissolution of Devonian salt. Seal integrity is also at risk due to tectonic geomechanical disturbance introduced to the McMurray in the Laramide orogeny.

Petro-Canada discussed the documented criteria of seal capacity, seal geometry and seal integrity to assist the Board in its assessment of the A2 and B2 mudstones as tenuous pressure seals given the pressure evidence that confirms pressure communication.

Petro-Canada is concerned with CNRL's out-of-context reference to Petro-Canada's evidence. Specifically, in support of its position, CNRL referenced Petro-Canada's statement that, "[t]hereotically, a few centimeters of shale may be capable of trapping a large column of hydrocarbons" (page 21, CNRL Response Submission). In doing so, CNRL omitted the context for the quote, which addressed the importance of thickness and lateral extent to the criterion of seal geometry. The sentence following the above excerpt in Petro-Canada's submission properly addressed the context, stating: "This perspective does not, however, address the necessary lateral homogeneity and continuity of lithologic properties of an effective seal" (pages 11-12, Petro-Canada Submission of February 14, 2005).

Also, in response to Petro-Canada's concerns with seal geometry limiting reliability of the A2 and B2 mudstones to act as seals, CNRL submits that these factors (i.e. channel cutting, non fully marine environment, and insufficient drilling density) are "theoretical" (page 21, CNRL Response Submission). Quite the contrary, as recognized in the RGS (pages 9 and 167) and the Chard-Leismer Decision (page 15), channel cutting, non fully marine environments, and insufficient drilling density are matters of fact that impact the oil sand resource of the McMurray. The generally accepted understanding of the stratigraphic framework, the depositional environment and the paucity of well control in the McMurray oil sands should not be marginalized by being labeled "theoretical". Petro-Canada brought these geologic factors to the Board's attention because new pressure data from the Chard area confirms communication through the mudstones and supports Petro-Canada's concern with the inadequate seal geometry of the A2 and B2 mudstones that compromise their effectiveness as regional seals.

CNRL also questions Petro-Canada's concern regarding the loss of seal integrity of the one-metre thick A2 and B2 mudstones at Chard because of structural shift due to salt solution. CNRL's statement that "[t]he fact that the McMurray oil sands have undergone salt solution driven structuring has been recognized for decades" (page 21, CNRL Response Submission) is correct. However, CNRL is incorrect in stating that Petro-Canada has submitted no evidence of structural shift that directly pertains to the nine wells listed by Petro-Canada in the Chard area. CNRL apparently has overlooked Petro-Canada's response to an information request from the Board Staff (I.R. No. 2). Petro-Canada provided the Board Staff and other participants with strong evidence of laterally abrupt, post McMurray structural disturbances that are attributable to dissolution of the Devonian Prairie Evaporite in the Chard area. Petro-Canada submitted:

- A regional structure map of the Wabiskaw T-21 surface published by AOSTRA that showed a south westerly dip of 1.5 to 2.0 metres per kilometer excepting the eastern "Main Valley" trend where reversals in dip of up to 60 metres coincides with salt dissolution (Tab 1, Board Staff I.R. No. 2);

- A Wabiskaw structure map of the T-21 surface in the Chard area that illustrates local structural disturbance related to post Wabiskaw salt solution (Tab 4, Board Staff I.R. No. 2); and,

- Four structural cross sections that show the laterally abrupt vertical differences between wells ranging from 1 to 2.5 km apart. The wells, 6-2-80-7W4, AA/10-26-80-7W4, and 6-4-81-7W4 show significant structural drop. Elevation differences between nearby wells range from eight to almost eighteen meters and greatly exceed the difference expected from a consistent dip of 1.5 to 2.0 metres per kilometre in undisturbed Wabiskaw.

These abrupt vertical differences between the salt solution collapse wells and adjacent wells indicates post Wabiskaw collapse associated with salt-solution sufficient to breach the seal integrity of the one-metre thick regional mudstones and create pathways for pressure communication.

In its February 14, 2005 submission, Petro-Canada listed five disposition wells in its Summary of Requested Disposition, Table 1. The disposition wells and off-setting salt solution collapse wells show differences in Wabiskaw structure of 9.6 to 14.5 metres between wells ranging from 1.3 to 2.5 km apart. The structural differences are predominantly attributable to post Wabiskaw, salt dissolution collapse and is of a magnitude sufficient to breach the seal integrity of the regional mudstones in the Chard area.

Salt Solution Collapse Well	**Disposition Well**	**Inter-well Distance**	**Vertical Difference**	**Requested Shut-In**	**IR Figure Reference**
AA/10-26-80-7W4	4-35-80-7W4	1.3 km SE	9.6 m	A & B Gas	X-Section, Tab 5
AA/10-26-80-7W4	10-23-80-7w4	1.9 km N	11.7 m	A Gas	WBSK Structure Map, Tab 4
6-4-81-7W4	3-34-80-7W4	2.5 km NW	12.8 m	A & B Gas	X-Section, Tab 6
6-4-81-7W4	14-3-81-7W4	1.8 km SW	14.5 m	A & B Gas	X-Section, Tab 7
6-2-80-7W4	10-11-80-7W4	2.1 km S	13.6 m	A Gas	WBSK Structure Map, Tab 4

The regional A2 and/or B2 mudstones in five of the nine wells for which Petro-Canada sought relief are at direct risk of seal integrity breach due to structural displacement attributable to post Wabiskaw salt dissolution.

With respect to thermal effects on seal competency, CNRL challenges the relevance of two papers referenced in Petro-Canada's February 14, 2005 submission that address mudstone competence in a thermal environment on the basis that they are unpublished. Petro-Canada confirms that some of the information discussed in the referenced literature is so current that it is not yet published in technical journals. However, as an update, P. Li and R. Chalaknyk's paper, *Permeability Variations Associated with Shearing and Isotropic Unloading During the SAGD Process*, has been approved for publication in early 2006 by the Journal of Canadian Petroleum Technology. Their other paper, entitled *Gas-Over-Bitumen Geometry and its SAGD Performance Analysis with Coupled Reservoir Geomechanical Simulation*, has passed prescreening and has proceeded to referee by peer review for publication in the same journal. These papers were available as pre-prints at the referenced conferences.

7.0 Conclusion

In response to CNRL's Response Submission, the additional evidence adduced by Petro-Canada in this proceeding demonstrates that:

- The observed pressure depletion confirms that the McMurray mudstones cannot be relied upon to act as effective regional seals;
- The geological interpretation explains the various pathways for the observed pressure depletion; and
- The continuing pressure depletion will adversely and directly affect the ability to produce the bitumen identified to be in association with the nine producing gas wells requested by Petro-Canada to be shut-in.

8.0 Transmittal

This response submission was prepared under the direction, supervision and control of Mr. Ken Wilde, Senior Staff Geologist, Petro-Canada, Mr. Gordon Stabb, P.Geol., Durando Resources Corporation, and Mr. Mauro Cimolai , Reservoir Modeling Advisor**.**

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All of which is respectively submitted this 20th day of May, 2005.

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