



D79 Abandoned Well Methane Toxicity Assessment
Preliminary Analysis
DRAFT – NOT FOR DISTRIBUTION

VERSION 2.0

November 2016

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3. A process be developed by AER using a decision support tool and data management system to allow for data entry, integration of data, data QA/QC, automated comparison of data to AH thresholds and to identify the high risk wells with methane leaks requiring notification of AH. Tracking of these notifications and any follow-up activities will also be important to ensure AER due diligence in assessment, reporting and notification. 16

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1. Background

The Alberta Energy Regulator (AER) developed *Directive 079: Surface Development in Proximity to Abandoned Wells* (D079) (AER, 2014) in response to the Alberta Municipal Affairs' Alberta Regulation 160/2012; *Subdivision and Development Regulation* (SDR) (Government of Alberta, 2012). The SDR requires developers applying for subdivision or development permits to identify the location of abandoned wells during planning and to appropriately incorporate them into a proposed development.

Directive 079 was prepared in support of the SDR and provides;

- information for municipal officials, planners, development officers, and applicants for subdivision or development approval (applicants) about abandoned oil and gas wells licensed by the AER,
- instructions on obtaining the necessary abandoned well information from the AER,
- guidance for municipalities in ensuring that abandoned wells are identified and appropriately situated within subdivisions and developments,
- the AER requirements for oil and gas industry stakeholders to locate and test abandoned wells;
 - where potential conflicts with proposed surface structures may exist, and
 - Where abandoned wells already exist in proximity to surface structures.
- the minimum setback requirements from abandoned wells to surface structures, and
- The protocol for locating and testing abandoned wells.

To further support abandoned and operating well regulation the requirements and equipment specifications in relation to methane emission detection are outlined in:

Directive 020: Well Abandonment (D020) (AER, 2016)- details the minimum requirements for well abandonments, casing removal, zonal abandonments, and plug backs as required under Sections 3.013 of the *Oil and Gas Conservation Act*; and

Interim Directive 2003-01 (ID 2003-01) (AER, 2003) - includes requirements for surface casing vent flow/gas migration testing, reporting, and repair requirement.

Information on abandoned wells in Alberta can be accessed through the following links which were released at the same time as D079 and indicates the location of AER licensed abandoned wells within the province.

The AER's Abandoned Well Viewer;

(<http://mapviewer.aer.ca/Html5/Index.html?viewer=aerabnwells>)

Government of Alberta's GeoDiscover System;

(<https://geodiscover.alberta.ca/geoportal/catalog/main/home.page>)

While D079 addresses future surface developments near abandoned wells, the AER and Alberta Energy have identified existing surface developments that may be in conflict with abandoned wells, as per the ADR and D079.

The AER has identified that there are approximately 1,500 abandoned wells (including license status of Abandoned, Reclamation Certified and Reclamation Exempt) in urban centers (Cities, Towns, Villages and Summer Villages) and approximately 170,000 abandoned wells in rural areas. Locations and current status of these abandoned wells are planned to be confirmed in two phases using the leak detection testing described below.

a) Phase I – Urban Wells

Phase I is in progress and is designed to locate and determine the current status of the abandoned wells in urban centres. Of the 1,500 abandoned wells in urban centres, 388 abandoned wells have been located and tested. Phase 1 incorporate three distinct programs as follows:

Phase IA

Alberta Energy identified 335 abandoned wells out of the 1500 that were believed to be in close proximity to surface developments (houses, airports, business, etc.). AER directed licensees to locate and leak test (see below for testing methods) these wells. The testing has been completed in Phase 1A, however follow-up risk assessment and mitigation work is still underway on several wells identified to be leaking. Most of the wells highlighted in this paper are from the Phase 1A program.

Phase IB

The AER identified an additional 53 abandoned wells of the 1500 that are deemed to be of higher risk (i.e. critical sour product, acid gas injection well and Class 1A disposal). Licensees were directed to locate and test these wells. This phase has been completed.

Phase IC

Of the original 1,500 abandoned wells in urban centres, approximately 1100 abandoned wells still need to be located and tested for leakage. This phase has not started.

Phase I Results

Based on the leak test results from Phase IA and IB, 36 wells or approximately 10% were found to have methane anomalies (i.e. leaking natural gas). Of the 36 wells with noted anomalies, 27 were not included in this report as they were repaired or are under the threshold values provided for methane and are being monitored further. The remaining nine wells are not yet repaired and exceed one of the published methane threshold values. The methane threshold values to evaluate potential human health implications were provided by Alberta Health. Methane levels were compared to these thresholds at the request of Alberta Health to determine if further engagement with them for risk assessment was necessary.

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b) Phase II – Rural Wells

Phase II was developed to identify and assess the approximately 170,000 abandoned wells in rural Alberta. It is unknown how many surface developments may be in proximity to abandoned wells throughout the province in rural areas. After Phase 1 is complete, Phase II will begin.

c) Leak Detection Testing Method

As specified in D020 referenced above, the threshold for well leakage is low. Any gas flow above one bubble in 10 minutes measured with a passive system (Section 7.3 of Directive 20: Well Abandonment) is considered leaking and must be repaired. This flow equates to approximately 0.000001 m³/day. However, based on site specific conditions, Directive 079 provides the AER the authority to allow for a methane anomaly identified from a leaking well to be monitored and managed rather than repaired as required by D020 and ID 2003-01.

Methane is the primary component measured and reported as per the testing described above. As a result there is a potential gap in characterization of non-methane gases from leaking wells. In addition to methane, leaking wells may emit volatile organic compounds (VOCs) such as benzene, toluene, ethylbenzene, and xylene, hydrogen sulfide (H₂S), and other organic gases. As such, the assessment conducted here identified potential risks to human health from methane exposure. Due to data constraints, the assessment below may underestimate the source gas impacts to acute and short term risks to human health due to the presence of other gaseous chemicals.

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A gas detection survey is one of the requirements for D079. The majority of the gas samples collected for D079, D020 or ID 2003-01 purposes have been performed using an active methane detection system for gas migration sampling. The testing device has a pump that creates a vacuum to draw the sample into the device. The device then outputs methane readings in ppm, % by volume or %LEL. The testing system does not account for gas migration influencing factors such as: soil gas pressure, barometric pressure, soil geology, natural and man-made pathways, wind speed and direction, moisture, groundwater levels, temperature and seasonal flow path changes (frozen ground versus summer ground conditions). The gas detection survey performed as described above may overestimate methane concentrations due to the concentration of methane caused by the vacuum.

The data from the gas detection surveys is presented as subsurface or surface methane readings. The subsurface readings are typically taken at a minimum depth of 30 centimeters into the ground using a vacuum system to collect a soil gas sample. There are two types of surface readings that can be taken: at the ground/air interface and at the surface casing vent assembly after a wellhead has been installed. A vacuum or passive system can be utilized at the ground/air interface while passive

system is typically used at the vent assembly. Examples of passive systems include flame ionization, photo ionization, laser detection or positive displacement flowmeters.

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2. Screening Level Assessment

The Environmental Sciences Branch has conducted a screening level assessment of potential risks to human health from wells leaking methane in urban centres based on Alberta Health thresholds provided. Based on the respective mandates of Alberta Health and the AER, AER assesses industry emission and environmental information relative to health benchmarks but assessment of human health risks themselves falls to the mandate and discretion of Alberta Health. Exceedance of thresholds is an indication of potential human health risk requiring further review by Alberta Health; it is not a conclusion of impact to human health.

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The screening level assessment was completed in 4 steps.

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a) Problem Formulation

Is there the potential for exposure of community members to methane leaking from abandoned wells in urban centres?

Yes. As verified by;

- i. Surface measurements indicate that methane is leaking from wells to ambient air (indoor or outdoor) which can directly expose community members to methane (direct exposure pathway).
- ii. Sub-surface measurements indicate that methane being released below the surface has the potential to migrate to ambient air (at surface) and therefore an indirect exposure pathway is also present.

For this assessment data collected at surface locations were considered indicative of direct receptor exposures while subsurface sampling locations were considered to have the potential to indirectly expose receptor. Subsurface transport of methane is a function of soil and slab physical and chemical parameters and should be modelled to predict potential risks to humans in the vicinity.

b) Exposure Assessment

Are data available to assess potential risks of exposure of humans to methane from leaking wells?

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Yes. As verified by;

- i. Filtering of the provided dataset indicated there are currently 9 abandoned wells leaking methane.
- ii. Various surface and sub-surface methane concentrations were available for the 9 wells. Site specific patterns and data for each well are available in Appendix 1 - Well Specific Data.

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Data availability was limited due to;

- Gas survey detection methods utilized for D079 requirements which may;
 - o overestimate methane concentrations and potential risks, or
 - o underestimate potential risks to humans as not all chemicals present in leaking well emissions were characterized or quantified.
- Incomplete dataset due to wellhead access limitations, access to radial sampling points and full grid characterization at various surface and sub-surface locations.

c) Toxicity Assessment

Are thresholds available that indicate potential adverse effects following exposure of humans to methane?

Yes. Health based methane exposure thresholds are available in Appendix 2 - Methane from Leaking Abandoned Wells: Health and Safety Issues (January 28, 2015). These thresholds were provided by Alberta Health to the AER to be used for this assessment. Table 1 provides a summary of the thresholds which can be used to assess potential risks to human health and drive key risk management considerations.

Table 1 Health based thresholds provided by Alberta Health for assessing risk from exposure to methane.

Threshold (ppm)	Duration	Endpoint
1000	Short term (months to years)	neurological effects
100	Short and long term off-site migration min range	Alberta Guideline for Landfill in off-site buildings
500	Short and long term off-site migration max range	
10000	Acute – Life threatening, Emergency evacuation threshold	Emergency evacuation (20% of the LEL = 1%)

d) Risk Analysis

The risk analysis identified the source of methane and compared the concentration of methane to the thresholds provided. The well specific information (Appendix 1) provides information on nearby

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receptors, if they exist. The well specific information is required by Alberta Health to further assess risk to humans. Every well is different with some indoors, some outdoors but in the proximity to communities, etc. The specifics of each well are needed to take the next step to contextualize impacts on human health based on exposure potential.

Deleted: This analysis does not determine if there is a pathway from source to receptor nor assess whether there are human health impacts.

The figures presented in this section illustrate methane values measured for each well at surface as well as subsurface at the wellhead. If higher methane readings were found away from the well center or wellhead, a third bar labelled “Other maximum” indicates this reading. The other maximum can be either surface or subsurface and additional data is provided in Appendix 1 Table 5. Representing surface, subsurface and "other" for each well provides a more thorough assessment of methane levels for each well.

Deleted: Potential risks to human health can be assessed by comparing concentrations of methane detected to the health based thresholds in Table 1. If the exposure concentration is greater than the health based threshold and there is potential for a human receptor, the potential for risk to humans should be assessed further to determine if adverse health impacts may be occurring. ¶

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i. Wells exceeding acute health based thresholds

Of the nine leaking wells that exceed the methane exposure threshold, six wells exceed acute threshold of 10,000 ppm. All six of the wells are leaking outside of structures and buildings in urban spaces; however, three of the wells have methane leakage inside buildings. Table 2 identifies the six wells while Figure 1 shows the methane levels that have been measured for each. Appendix 1 provides more details regarding each site.

Table 2. Abandoned wells in urban centres exceeding acute health based methane thresholds.

Licensee	Unique Well Identifier	Well License #
City of Medicine Hat	00/02-31-012-05W4/0	X0000225
City of Medicine Hat	00/13-32-012-05W4/0	X0000214
Tenwell Gas & Oil Co Ltd <i>(under care and custody of OWA)</i>	00/09-36-050-07W4	A000059
Unknown Licensee (Ming Tree Hotel or American Hotel No.1 Well) <i>(under care and custody of OWA)</i>	10-31-012-05W4 (surface location)	Not licenced
AER (ERCB relief well)	03/10-31-012-05W4	0043657
City of Medicine Hat <i>(under investigation)</i>	00/06-31-012-05W4	X0000196

Note: The City of Medicine Hat 00/06-31-012-05W4 site has detected methane anomalies that exceed 10,000 ppm outside of the building (22,500 ppm subsurface readings). The location of the well is not confirmed; therefore, the site is still under investigation to determine the location of the well and to verify methane concentrations.

Figure 1. Abandoned wells in urban centres that exceed acute health based methane thresholds



ii. Wells below acute but exceeding short term health based thresholds

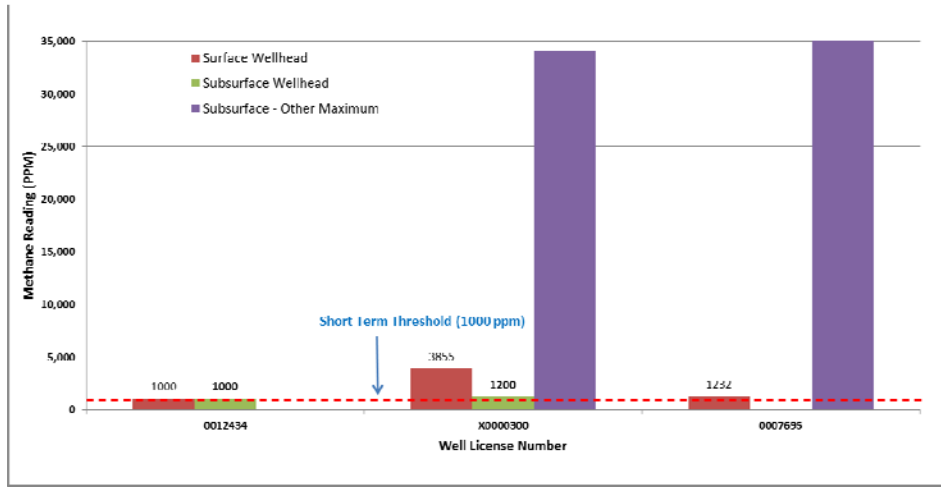
Three ~~addition~~ leaking abandoned wells in this report have methane concentrations greater than short term health based threshold of 1000ppm but are below the 10,000 ppm acute threshold. All three of these wells have been found to be leaking outside of any structures or buildings But again, in urban spaces.

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Table 3. Abandoned wells in urban centres exceeding short term health based methane thresholds.

Licensee	Unique Well Identifier	Well License #
City of Medicine Hat	00/04-06-013-05W4/0	0012434
HMQ In Right Of The Province Of Alberta	00/11-06-020-02W5/0	X0000300
Trican Petro-Chemical Corporation (under care and custody of OWA)	02/12-17-061-05W4/0	0007695

Figure 2. Abandoned wells in urban centres exceeding short term health based methane thresholds.



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3. Frequency Estimates to Predict Well Leakage

There are approximately 170,000 abandoned wells within rural Alberta and 1,500 abandoned wells in urban centres. Of the Directive 079 abandoned well testing completed to date, approximately 10% of the wells leak and approximately 2% leak at a rate sufficient to exceed either the short term or acute human health based methane thresholds identified in Table 1.

Table 4 applies these leak rates to both the urban area population where population densities are the highest, as well as to the entire abandoned well population. This table highlights the potential for exceedances of the methane thresholds.

Table 4. Predicted number of abandoned wells that leak and exceed methane thresholds in Alberta’s Urban and Rural areas.

Location of Wells	Total # Wells	~10% Leaking	~2% Exceed Thresholds
Rural Alberta	170,000	17,000	3,400*
In urban areas	1,500	150	30

*The majority of these wells are located within rural areas where exposure to human receptors may not be present.

At this time it is not known what percentage of wells in rural Alberta would be in proximity to surface development or human receptors. The completion of all phases of Directive 079 will assist with this assessment.

These estimates are very approximate and only through ground truthing and methane testing will true risks become apparent. These estimates were provided to support understanding that a more routine process to assess methane concentrations relative to human health thresholds should be put into place by the AER to track any changes in the wells that have been reported here as new data become available. In addition, this type of process will be needed to support efficient notification of Alberta Health of leaking wells of potential risk as the well assessment process continues.

4. Recommendations

1. The following six wells (five discrete locations) exceed the acute threshold and are recommended to be referred to Alberta Health (AH) by way of this report for further review. These sites may also require further risk management as determined by AH, based on their further review and AH performed risk assessment.

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Licensee	Unique Well Identifier	Well License #
City of Medicine Hat	00/02-31-012-05W4/0	X0000225
City of Medicine Hat	00/13-32-012-05W4/0	X0000214
Tenwell Gas & Oil Co Ltd <i>(under care and custody of OWA)</i>	00/09-36-050-07W4	A000059
Unknown Licensee (Ming Tree Hotel or American Hotel No.1 Well) <i>(under care and custody of OWA)</i>	10-31-012-05W4 (surface location)	Not licenced
AER (ERCB relief well)	03/10-31-012-05W4	0043657
City of Medicine Hat <i>(under investigation)</i>	00/06-31-012-05W4	X0000196

2.

2. The following three additional wells exceed short term exposure thresholds and should also be referred to Alberta Health. These sites may also require further risk management as determined by AH, based on their further review and assessment.

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Licensee	Unique Well Identifier	Well License #
City of Medicine Hat	00/04-06-013-05W4/0	0012434

HMQ In Right Of The Province Of Alberta	00/11-06-020-02W5/0	X0000300
Trican Petro-Chemical Corporation <i>(under care and custody of OWA)</i>	02/12-17-061-05W4/0	0007695

3.

3. A process be developed by AER using a decision support tool and data management system to allow for data entry, integration of data, data QA/QC, automated comparison of data to AH thresholds and to identify the high risk wells with methane leaks requiring notification of AH. Tracking of these notifications and any follow-up activities will also be important to ensure AER due diligence in assessment, reporting and notification.

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Regulation References

Alberta Energy Regulator. 2003. ID 2003-01: 1) Isolation Packer Testing, Reporting, and Repair Requirements; 2) Surface Casing Venting Flow/Gas Migration Testing, Reporting, and Repair Requirements; 3) Casing Failure Reporting and Repair Requirements. January 30, 2003. <https://www.aer.ca/rules-and-regulations/interim-directives/id-2003-01>

Alberta Energy Regulator. 2016. Directive 020: Well Abandonment. March 15, 2016. <http://www.aer.ca/rules-and-regulations/directives/directive-020>.

Alberta Energy Regulator. 2014. Directive 079: Surface Development in Proximity to Abandoned Wells. November 28, 2014. <http://www.aer.ca/rules-and-regulations/directives/directive-079>.

Government of Alberta. 2012. Advisory Land Use Planning Notes on New Regulatory Requirements for Surface Development in Proximity to Abandoned Wells. Information Bulletin No. 05/12. Municipal Services Branch.

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Appendix 1 - Additional Well Data

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Wells Exceeding Acute Health Based Thresholds for Methane

The following six wells exceed acute thresholds and additional information is provided for each site

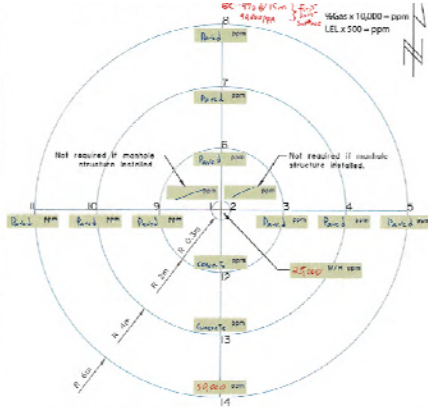
Licensee	Unique Well Identifier	Well License #
City of Medicine Hat	00/02-31-012-05W4/0	X0000225
City of Medicine Hat	00/13-32-012-05W4/0	X0000214
Tenwell Gas & Oil Co Ltd <i>(under care and custody of OWA)</i>	00/09-36-050-07W4	A000059
Unknown Licensee (Ming Tree Hotel or American Hotel No.1 Well) <i>(under care and custody of OWA)</i>	10-31-012-05W4 (surface location)	Not licenced
AER (ERCB relief well)	03/10-31-012-05W4	0043657
City of Medicine Hat <i>(under investigation)</i>	00/06-31-012-05W4	X0000196

i. City of Medicine Hat (X0000225)

Municipality	Licence	Surf Location	Licensee	BA Code
Medicine Hat	X0000225	02-31-012-05W4	City of Medicine Hat	0150
<p>Well is located in the middle of the T-intersection just prior to entering the main street. There is high background methane level in the area at a ~25 meter radius of 45 ppm. From testing conducted on September 29, 2014 (report date January 23, 2015), 30,000 ppm was initially detected in the manhole system which is over the well. There are businesses located nearby as seen in the photos provided.</p> <p>On June 11, 2015 when probe entered into manhole cover (well location), 22,000 ppm was detected. In addition, there was a 90,000 ppm reading 15 meters from the well at the first non-paved surface. Methane levels dissipate extremely fast above ground surface boundary layer. Additional information has been requested from the licensee.</p>				

ii.

D79 Abandoned Well Methane Toxicity Assessment
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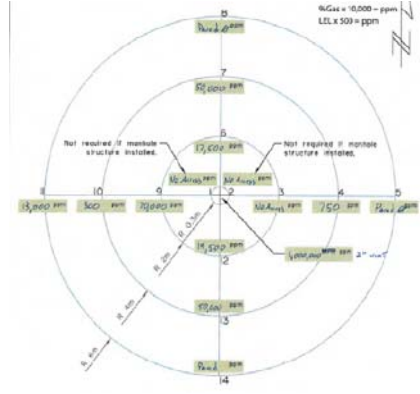


ii. City of Medicine Hat (X0000214)

Municipality	Licence	Surf Location	Licensee	BA Code
Medicine Hat	X0000214	13-32-012-05W4	City of Medicine Hat	0150
<p>From testing conducted on May 25, 2015 (report date June 24, 2015), 1,000,000 ppm methane is measured from the well's venting system, a 2" diameter stack 10 feet high that is tied into the wellhead with a rate of 2.4 mcf/d. The highest subsurface reading is 70,000 ppm located 0.3 meters from the well. The well is located in a parking lot. There are nearby residential homes to the well as shown in the photo.</p> <p>Previous intervention resulted in increasing the radius of gas migration This was mitigated by perforating the well to allow gas into the wellbore and left venting to reduce the gas migration radius.</p> <p>Repair options are currently being investigated.</p>				

iii.

D79 Abandoned Well Methane Toxicity Assessment
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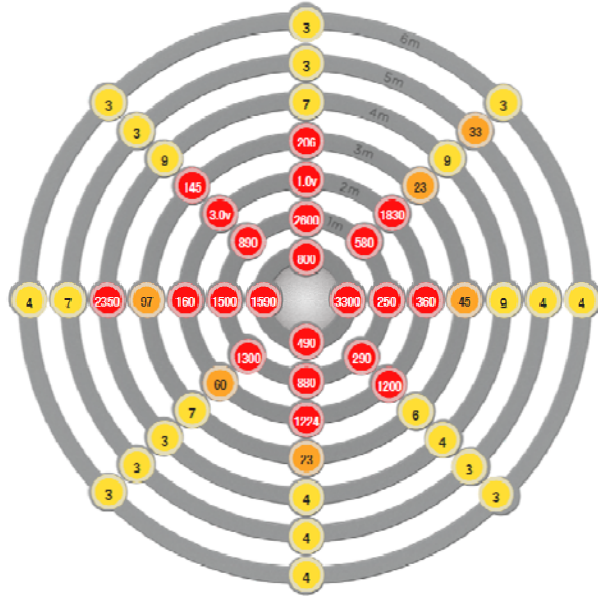
iii. Tenwell Gas & Oil Ltd - OWA (A0000059)

Municipality	Licence	Surf Location	Licensee	BA Code
Vermillion	A0000059	9-36-050-07W4	Tenwell Gas & Oil <i>(under care and custody of OWA)</i>	0B50
<p>The well was initially tested June 20, 2013 and August 1, 2013; subsurface methane levels (3 ft deep hole) was detected at 901,000 ppm at probable well centre and 13 ppm at ground level. The next highest methane reading away from the well was at 7 meters (at a hole beside the power pole) was measured at 420,000 ppm subsurface and 20 ppm at ground level. There are residential homes near the well as shown in the photo.</p> <p>OWA re-entered well to perform a repair in September 2014. The radial extend of gas migration decreased and is occurring adjacent to the fenced wellbore while the levels by the power pole appear to be reduced to zero. Methane levels above ground surface boundary layer dissipate extremely fast. A wellhead is still installed with a vented stack that is 2 inches in diameter and is 10 feet tall.</p> <p>The most current testing data (September 14, 2016) has methane at 700, 000 ppm subsurface at 1 meter from the well (3300 ppm at ground level). The methane reading at surface (wellhead venting system) is 880,000 ppm with a flow rate of 1.44 m³/day.</p>				

iv.



Surface Soil Gas Data



iv. Unknown Licensee and AER

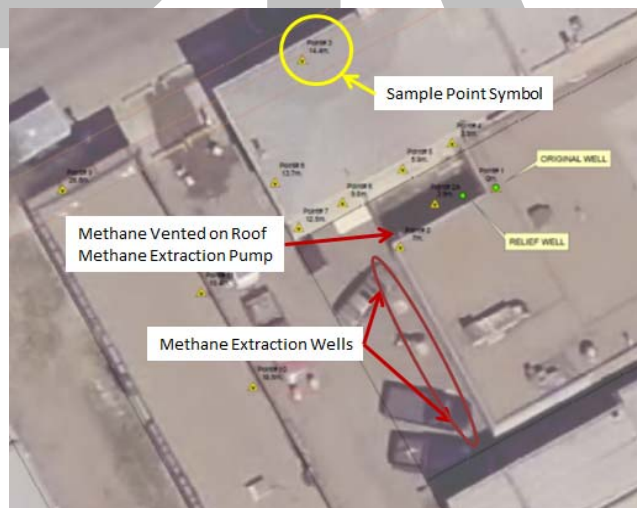
Municipality	Licence	Surf Location	Licensee	BA Code
Medicine Hat	Not Licensed	10-31-012-05W4	Ming Tree Hotel <i>(under care and custody of OWA)</i>	
	0043657	103 10-31-012-05W4	AER – relief well	0338

This site has an extensive history. The unlicensed well is located under an abandoned hotel. A relief well was drilled by the ERCB (predecessor to AER) in 1972 to mitigate the methane leaking from the unlicensed well. A methane extraction system was installed beside the abandoned hotel and operates 24/7. The extraction system vents the methane from the roof of the hotel. The extraction system keeps methane levels as low as possible both inside the hotel and nearby adjacent buildings. The nearby buildings are commercial businesses.

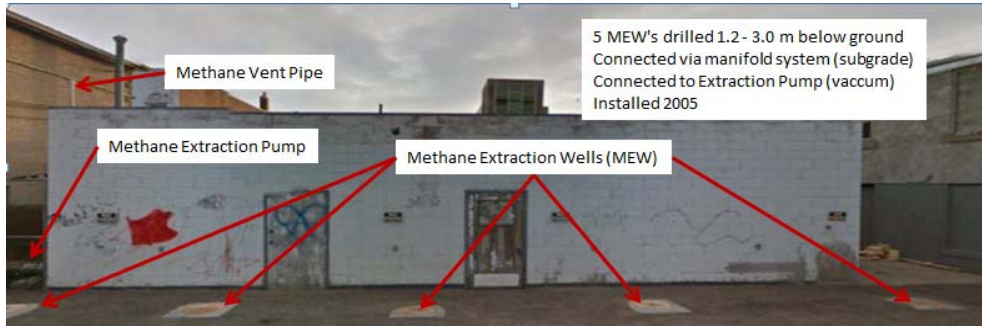
The most recent ambient air quality measurements have been conducted in the nearby buildings and have measured methane levels up to 90 ppm. There are also readings taken in the nearby buildings using the vacuum system along any cracks in the foundation or walls. The higher methane readings are from the extraction system (on the roof top).

The City of Medicine Hat is in the process of purchasing the hotel and then working with the OWA to develop a plan for further mitigation of the methane levels.

v.



D79 Abandoned Well Methane Toxicity Assessment
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A	C	D	E	G	H	I	J	K	L	M	N	O	P	Q	R	S
Test Date	Test Equipment	Weather	Tester Comments	Is Expeller Running ?	1 Hitch'n Post / Rockpit: Vent on Roof	2 Hitch'n Post / Rockpit: Expeller	2A Hitch'n Post / Rockpit: Hot Spot	3 Above 540: Ambient Inside Front Door	4 Above 540: Going Downstairs	5 Above 540: Under Basement Stairs	6 Above 540: Storage Room Wall	7 Above 540: Rear Wall Past Bathroom & Electrical Fan	8 Above 540: Rear Wall (Between Walls)	9 Shut Up & Wear It: Ambient Inside Front Door	10 Shut Up & Wear It: Mechanical Room Cracks	11 Shut Up & Wear It: Storage Room (Hole in Board)
2016-Jun-29	GMI #88	Sunny & Clear 26 C	1:30 - 2:00 pm. Ambient in Above 540 Basement = see data log. Test Point #3 taken through mail slot.	Yes	160,000	5,000	620,000	90	see data log	see data log	see data log	see data log	see data log	5	5	5
2016-Jul-07	GMI #88	Sunny & Clear 22 C	Ambient in Above 540 Basement = see data log. Test Point #3 taken through mail slot.	Yes	190,000	6,000	600,000	40	see data log	see data log	see data log	see data log	see data log	15	35	30
2016-Jul-13	GMI #88	Sunny & Clear 23 C	Ambient in Above 540 Basement = see data log. Test Point #3 taken through mail slot.	Yes	160,000	6,000	580,000	60	see data log	see data log	see data log	see data log	see data log	15	30	5
2016-Jul-20	GMI #88	Sunny & Clear 20 C	Ambient in Above 540 Basement = see data log. Test Point #3 taken through mail slot.	Yes	150,000	8,000	680,000	30	see data log	see data log	see data log	see data log	see data log	5	5	5

v. Under investigation - City of Medicine Hat (X0000196)

Municipality	Licence	Surf Location	Licensee	BA Code
Medicine Hat	X0000196	6-31-012-05W4	City of Medicine Hat	0150

Initial methane readings were detected inside the church kitchen with readings of 2,550 ppm in September 2014. Measurements were conducted on a monthly basis to verify highest methane source readings. The readings fluctuated with a maximum of 2,650 ppm detected.

The most recent measurements on June 22, 2106, have detected methane that exceed thresholds outside of the building (22,500 ppm surface readings) while the maximum indoor reading is 275 ppm. The location of the well and source of the methane are not confirmed; thus this site is still under investigation. The city has determined a potential well site location in the church parking lot and will be trying to verify if the well is at this location.

vi.

Under Surface Structure Gas Detection Survey

Abandoned Well UWI: 100/06-31-012-05W4 Survey Date: JUNE 22 2016

Well Name: MH #1C / North / Fifth Avenue United Church

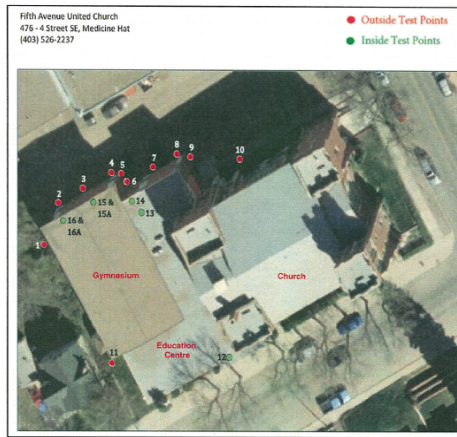
Technician: J. M. HARGRE Testing Equipment: GMT # 88

Weather: + 21.0 °C Clear / Sunny

Comments: * POINTS # 6 & 7 HAD READING NEAR THRESHOLD IN 1/2 GAS THEN QUICKLY DROPPED IN TO LOW READINGS

Supervisor Signature: John Hamilton

Test Point #	Test Point Description See Attached Test Points Diagram	Time Tested Between 1:30 ^{PM} - 2:00 ^{PM}	Test Result (ppm) % Gas x 10,000 = ppm LEL x 500 = ppm
1	Outside West Facing Wall of Auditorium		140 ppm
2	Outside North Facing Wall of Auditorium		115 ppm
3	Outside North Facing Wall of Auditorium		175 ppm
4	Outside North Facing Wall of Auditorium		275 ppm
5	Outside East Facing Wall of Auditorium		175 ppm
6	Outside East Facing Wall of Auditorium	120,000 125,000 → 45% 125,000 → 20% (LEL)	22,500 125,000
7	Outside North Facing Wall of Auditorium	70,000 75,000 → 20% 100,000 (LEL)	10,000 100,000
8	Outside NE Corner of Auditorium		110 ppm
9	Outside East Facing Wall of Auditorium		65 ppm
10	Outside North Facing Wall of Church		50 ppm
11	Outside SW Corner of Auditorium		125 ppm
12	Ambient Inside Front Door		20
13	Downstairs Kitchen: Under the Sink		45 ppm
14	Downstairs Kitchen: NW corner, Under the Heater		55 ppm
15	Auditorium: 1 st Room Office (Closest to Main Entrance of Auditorium), Under Heater, In Crack in Wall		15 ppm
15 A	Auditorium: 1 st Room Office (Closest to Main Entrance of Auditorium), Under Heater, 4 inches Away, Ambient		5 ppm
16	Auditorium: 2 nd Room Office (Past 1 st Office), Under Heater, In Crack in Wall		10 ppm
16 A	Auditorium: 2 nd Room Office (Past 1 st Office), Under Heater, 4 inches Away, Ambient		10 ppm



Wells Exceeding Short Term Thresholds for Methane

The following three wells exceed short term thresholds.

Licensee	Unique Well Identifier	Well License #
City of Medicine Hat	00/04-06-013-05W4/0	0012434

D79 Abandoned Well Methane Toxicity Assessment
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HMQ In Right Of The Province Of Alberta	00/11-06-020-02W5/0	X0000300
Trican Petro-Chemical Corporation (under care and custody of OWA)	02/12-17-061-05W4/0	0007695

i. City of Medicine Hat (0012434)

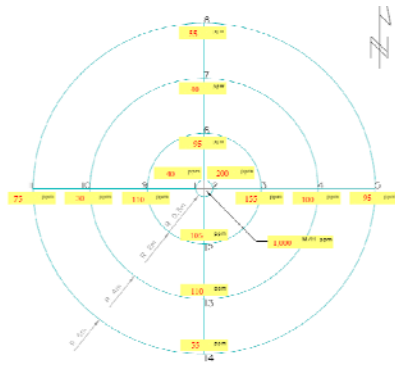
Municipality	Licence	Surf Location	Licensee	BA Code
Medicine Hat	0012434	4-6-013-05W4	CMH - Well #37, C.E. Roth #1, Hockey Hounds	0150

The initial testing (September 29, 2014) measured methane at 1,000 ppm at well centre in a manhole system over the well. However, data collected on November 18, 2015 measured 299 ppm at well centre and no gas migration out to 6 meters. There are nearby residential homes as shown in the photo. There is an AER Annual Monitoring approval in place till Nov 30, 2019.

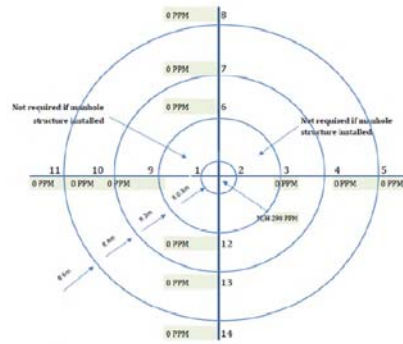
ii.



D79 Abandoned Well Methane Toxicity Assessment
Preliminary Analysis
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Abandoned Well UWI: 100/04 06 013 03/01
Wellbore Evidence: 627mg/m³ wellhead 41ppm
Survey Date: September 24, 2014

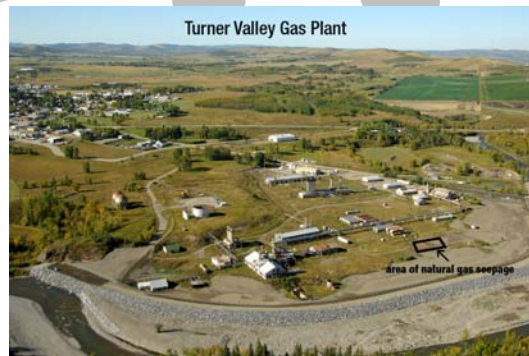


Abandoned Well UWI: 100/04 06 013 03/01
Where Evidence (circle): 627mg/m³ wellhead 41ppm nil
Survey Date: November 18, 2015 Technician: Garry Foster

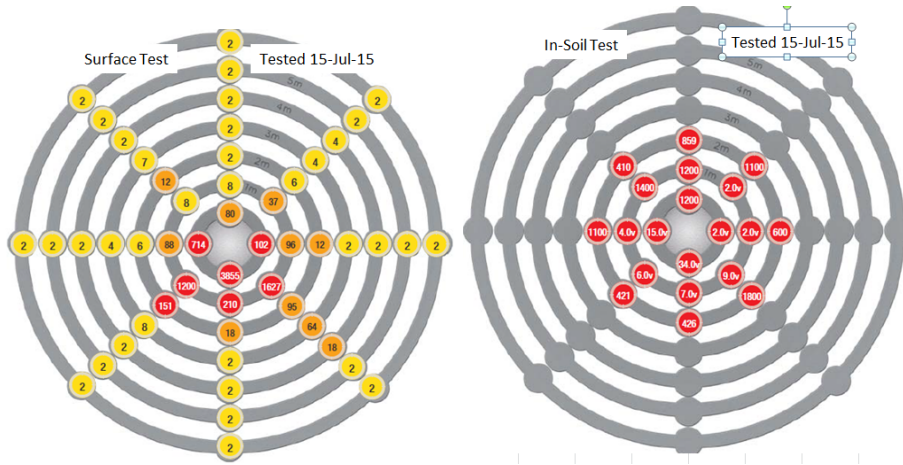
ii. HMQ In Right Of The Province Of Alberta (X0000300)

Municipality	Licence	Surf Location	Licensee	BA Code
Turner Valley	X0000300	11-6-020-02W5	HMQ – Dingman #2	0898
<p>Alberta Culture owns well located on the Turner Valley Gas Plant Site. The initial testing December 5, 2013) detected subsurface methane at levels greater than 50,000 ppm. Ambient air readings ranged from 55 to 155 ppm. The nearby buildings are part of the gas plant and the nearest residential homes are located across river (see photos below). The most recent test data has measured subsurface methane at 340,000 ppm and surface (ground level) methane at 3385 ppm. Alberta Culture has an identified a Vendor to perform some additional work on this well.</p>				

iii.



D79 Abandoned Well Methane Toxicity Assessment
 Preliminary Analysis
 DRAFT – NOT FOR DISTRIBUTION

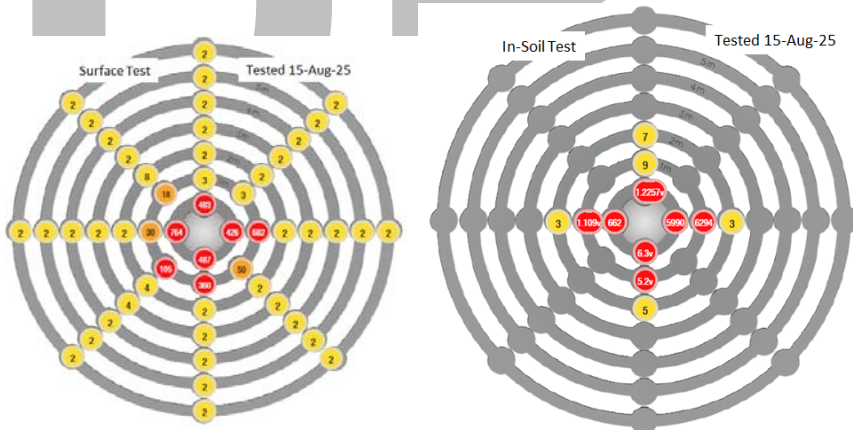


iii. Trican Petro-Chemical Corporation (OWA) (0007695)

Municipality	Licence	Surf Location	Licensee	BA Code
Bonnyville	0007695	12-17-061-05W4	Trican <i>(under care and custody of OWA)</i>	0B82

Well is in middle of cultivated field. The initial testing found surface (ground level) methane readings of 28 ppm and subsurface methane readings of 345,000 ppm. OWA has performed gas migration testing over the last couple of years to monitor the well. There is another well located nearby (00/12-17 AltaGas) which was also leaking and was repaired in 2015. Previous testing (May 11, 2015) have measured methane levels at surface at 1232 ppm. However, data collected on August 25, 2015 indicated methane levels at surface (ground level) above well centre to be below 1000 ppm but subsurface methane readings to be 63,000 ppm.

iv.



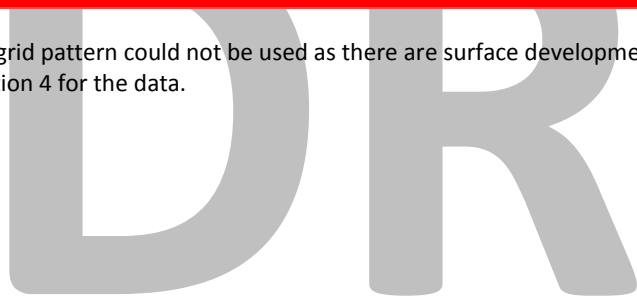
DR

D79 Abandoned Well Methane Toxicity Assessment
Preliminary Analysis
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Table 5. Summary Table of Leaking Well Methane Concentrations compared to Acute and Short Term Health Based Thresholds and Thresholds for Potential Migration.

General Information					Surface (PPM)					Subsurface (PPM)					Other Readings			
Company Name	Well License Number	UWI	Date Abandoned	Region	Surface Wellhead	0.3m	1m	2m	4m	6m	Sub Wellhead	0.3m	1m	2m	4m	6m	Other Max Reading (ppm)	Max Reading Distance (m)
City Of Medicine Hat	3000005	00105-31-012-05W4-0	11-11-49	Medicine Hat	75,000					90,000							90,000 (Subsurface)	15
City Of Medicine Hat	3000021	00105-30-01-05W4-0	11-11-49	Medicine Hat	1,000,000								70,000	90,000	13,000			
Terrill Gas & Oil Co Ltd (TGA)	A0000050	00103-36-050-07W4	08 Oct 42	Wainwright	350,000		10,000	500,000	112	0							18,000 (Surface)	2
Medicine Hat Energy Services	3000007		11-11-49	Medicine Hat	100,000												700,000 (Subsurface)	2
City Of Medicine Hat	3000018	00105-31-012-05W4															90,000 (Surface)	-
City Of Medicine Hat	3000013	00104-06-01-05W4-0	05-26-72	Medicine Hat	1,000						1,000	200		155	110			
FMU in Right Of The Province of Alberta	30000300	00111-06-020-02W5-0	17 Jul 40	Malapans	3,868		1,627	151	18	2		2,000	0,000	1,300			34,000 (Subsurface)	0.5
Black Hills Energy (BHE)	3000005	00102-10-01-05W4-0	24-10-94	Stettinville	1,232	74	40	4	2	2		61,000	52,000	7			90,000 (Subsurface)	3
Exceeds maximum migration level 100 ppm																		
Exceeds maximum migration level 500 ppm																		
Exceeds short term 100 ppm																		
Exceeds Acute Threshold 10,000 ppm																		

* 6 meter grid pattern could not be used as there are surface developments within the grid. Please refer to the Section 4 for the data.



**Appendix 2 - Alberta Health “Methane from Leaking Abandoned Wells:
Health and Safety Issues” January 28, 2015**

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