Recurring Human Health Complaints Technical Information Synthesis

Lochend Area

July 2015

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Alberta Energy Regulator
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Executive Summary

The Alberta Energy Regulator (AER) is developing a new process for handling recurring multiyear and multistakeholder complaints involving human health concerns. Once the process is triggered, the AER will assess and re-evaluate recurrent complaints, identify any technical gaps and risks, and determine potential AER actions. The new recurrent human health complaint process will also support coordination across different government agencies.

As part of this new process, the AER has completed a comprehensive technical assessment of the recurring complaints in the Lochend area. The assessment provides a detailed look at the complaints received by the AER, the AER's actions, area operator performance, and monitoring.

Operator compliance with AER regulations in the area has typically been at or above the provincial average. All area operators performed better than the provincial compliance average in 2014. The AER's analysis of the Lochend area complaints found that many of the issues identified were not about specific local operations. The focus was often energy development in Alberta as a whole, and hydraulic fracturing in particular.

Operators are required by the AER to measure flare and vent volumes, as well as conservation efficiency. Conservation efficiency illustrates effective and efficient use of solution gas. In January 2015, only three operators were not conserving gas and flared an estimated 69.7 thousand cubic metres (10^3 m^3), which extrapolates to a total of 821 10^3 m^3 per year. This volume, released into a 491-square-kilometre area in Lochend, is equivalent to the gas used to heat 233 households in Alberta for a year or the annual emissions of carbon dioxide from 425 passenger cars driven 19 000 kilometres each. In addition, the number of flowback operations, along with the associated flaring and venting, has declined since 2012. Minimal new development is currently planned for this area.

Analysis of specific air constituents is not typically required by the AER unless triggered by hydrogen sulphide (H_2S) concentrations. The development in this area is sweet, not sour, and hence H_2S has not been a concern. That said, ambient air quality that was monitored downwind of flaring in 2013 was analyzed by Alberta Environment and Parks[1] and was shown to meet Alberta ambient air quality objectives (data unpublished, cited with permission, Craig Knaus, Government of Alberta).

The AER has concluded that there is need for more information about air emissions from flaring in the initial stages of new development, specifically during fracturing flowback. Since area producers anticipate that no more than three new wells will be drilled in 2015, the Lochend area does not provide a sufficient sample size for a larger study of flaring emissions during fracturing flowback.

[1] Known at the time as Alberta Environment and Sustainable Resource Development.

The AER is working with Alberta Health, Alberta Health Services, and Alberta Environment and Parks regarding a larger study in an area of Alberta better suited to examining flaring emissions during fracturing flowback. Residents and industry in the Lochend area will be involved in this study.

1 Background

The Alberta Energy Regulator's (AER's) mandate is to ensure the safe, efficient, orderly, and environmentally responsible development of Alberta's hydrocarbon resources over their entire life cycle. Ensuring that resource development is done in safe and environmentally responsible ways may suggest that the AER plays a leading role in matters concerning human health. Although the AER holds strong regard for human health concerns that are related to resource development, the AER is not the human health regulator in the Province of Alberta. Alberta Health (AH) and Alberta Health Services (AHS) are Alberta's human health regulators. However, the AER supports these organizations when questions arise about the impact of energy resource development on individuals or on environmental receptors to which individuals are exposed. If the AER or Alberta's human health regulators suspect that a resource development activity or facility is contributing to environmental conditions that affect human health, the AER will collaborate with the health agencies to determine if the activity or facility is a source of the problem. The three organizations have separate but complimentary mandates and expertise: the AER is the industrial development expert and AH and AHS are the human health experts. If the resource development is confirmed as a source of or contributor to human health effects, the AER may use its regulatory authority to ensure the resource developer takes action to eliminate the risk to humans.

The AER has prepared this document to

- assess recurring complaints about oil and gas activity in the Lochend area,
- determine what steps can be taken towards satisfying the residents' concerns, and
- determine if there is a sufficient technical basis for the AER to proceed with a detailed study in the Lochend area to examine the effects of hydraulic fracturing on environmental health.

Recurrent complaints are characterized as those arising from multiple complainants over multiple years and are often complex, involving multiple government agencies. The AER has recognized that recurrent human health complaints require a new process for management towards accelerated solutions for stakeholders. To that end, the AER is working with AH and AHS to develop a recurrent complaint process and is testing the process in the Lochend area. This document supports this process and is provided for information to residents who have expressed concerns, as well as to AH and AHS.

2 Primary Concern

Residents in the Lochend area (see figure 1) have brought forward recurring complaints related to oil and gas drilling activity in the area. Since January 2010, over 30 members of the public have contacted the Midnapore Field Centre with concerns about activity in the area. There have been 56 complaints recorded. Interactions between the residents and government agencies have been extensive over the period, with residents having brought forth health concerns to AH and AHS.

The Lochend Industry Producers Group (LIPG) was formed in June 2011 to collaborate on oil and gas infrastructure for the purpose of reducing impacts in the Lochend area. The group initially had five member companies working in the Lochend area: Equal Energy Ltd., NAL Resources Ltd., PetroBakken Energy Ltd., Tamarack Valley Energy, and Orlen Upstream Canada Ltd. (formerly TriOil Resources Ltd.). Since the formation of the LIPG, energy companies have changed hands and currently four companies participate on the LIPG: Lightstream Resources Ltd., Pengrowth Energy Corporation, Orlen Upstream Canada Ltd., and Tamarack Valley Energy.

Currently, the LIPG meets every other month and the AER attends for a portion of the agenda to provide updates on any relevant information, including concerns. The LIPG provides information through its website, www.lipg.ca. It has also held an area open house and distributed four newsletters to area residents and interested parties.

A Lochend air quality technical working group also exists, as does a Cochrane/Lochend residents' health concerns committee. The AER has participated in both of these.

3 Description of Area

The Lochend area, for the purposes of this document, covers 491 square kilometres (see figure 1).

Approximately 270 wells and 54 facilities are licensed by the AER or its predecessors in the area; 170 wells and 46 facilities are producing or active and about 100 wells are inactive or abandoned.

Figure 2 shows oil and gas batteries and gas plants.

Figure 3 shows drilling activity colour coded by year, from 2010 to 2014.

Between 2010 and 2014, the AER received 135 drilling notifications.

4 Complaint and Investigation History

A total of 56 complaints were recorded from 2010 to 2014 (figure 4), several of which capture multiple concerns. Appendix 2 contains a summary of the complaints.

The complaints can be grouped as follows:

- noise
- **flaring**[1]
- human health
- hydraulic fracturing
- odours

[1] Terms in bold are defined in the glossary.

- livestock or wildlife health
- water well contamination
- other (includes concerns about property values; nuisances; notification during the application/authorization process; mineral rights; and dust or traffic)

The AER responds to all complaints in a variety of ways that range from reviewing the data submitted by industry to conducting a formal investigation.

Residents of Lochend typically express concerns about human health impacts from flaring, incinerating, and water contamination that are general in nature, i.e., not specific to a particular location, facility, or well site associated with hydraulic fracturing.

From 2010 to 2014, 84 inspections were conducted in the Lochend area. Seventy-seven of these were prompted by a public complaint or reported release and seven were based on the weighing of operator history, sensitivity of the location, and inherent risk of the project or operation or were baseline inspections chosen by the AER. Inspections covered all categories (e.g., oil and gas facilities, pipelines, drilling and servicing operations).

Additionally, the Midnapore Field Centre held an operator awareness session and a public open house in 2012 and 2013, respectively, and attended a number of LIPG meetings.

4.1 Water Well Contamination Complaints

Eight water-related complaints were received by Alberta Environment and Parks[2] and the AER between 2010 and 2014. Alberta Environment and Parks held the mandate for water well investigations related to energy resource activities until June 2014. One of the complaints was received by the AER after June 2014.

Five of the complaints received were general concerns about potential contamination of groundwater and surface water bodies; the remaining three alleged water well contamination. The following shows how a complaint with a general concern was addressed.

The complainant stated in an e-mail that

> [r]isk to water supply – the "safety" statistics touted . . . are albeit better than in some locations but are still inadequate to protect landowners with the degree of drilling that is planned in this area. A recent science magazine article shows the risk to water supplies and why testing should occur at an even higher standard than 600 metres [m]. As a result, at no cost to the landowners, any landowner wishing to have their wells tested prior to drilling should be offered the opportunity to have their well independently tested. Ongoing testing of the wells should occur throughout the drilling process. This should be regardless of the distance from the actual well.

[2] Known at the time as Alberta Environment and Sustainable Resource Development.

The AER provided the complainant with information and educational resources on hydraulic fracturing. They were also informed that the 600 m requirement referred to in the magazine article pertains to coalbed methane wells and is not required for conventional oil and gas drilling, although many licensees will test water wells if a landowner requests that they do so.

For two of the water well contamination complaints, investigations demonstrated that the problems were caused by the water well's integrity or lack of maintenance. Complainants were then advised to conduct well maintenance and contact a certified driller for assistance.

One of these complaints also had an element of a general concern. The complainant wanted all hydraulic fracturing in the province stopped and indicated that there was "frac sand" in their cistern and the water was not safe for consumption. The complaint was investigated by a former Alberta Environment and Parks water expert now working at the AER and included a third-party well test of a nearby gas well, at the licensee's expense. The review concluded that contamination in the water well was due to a lack of proper maintenance and that the "frac sand" in the well was calcium.

There was also one complaint of alleged water well contamination received before the AER assumed the mandate for water well investigations from Alberta Environment and Parks. Unsatisfied with Alberta Environment and Parks's response to their concerns about air emissions and water well contamination, the complainant then asked the AER to conduct water well testing in the area.

The complainant was advised at that time that

- the AER did not have jurisdiction over the specified legislation (*Environmental Protection* and *Enhancement Act* and the *Water Act*),
- the AER air monitoring unit was incapable of monitoring for the chemical contaminants (fracturing fluids) of concern,
- the AER was not in a position to test water wells in the area,
- Alberta Environment and Parks was the agency with the authority and jurisdiction to investigate the concerns,[3] and
- specific health questions should be directed to AHS or their doctor.

[3] Alberta Environment and Parks has no record of receiving any complaints related to water well contamination from this complainant before, or after, the AER was contacted.

4.2 Hydraulic Fracturing Complaints

Numerous inquiries have been received by the AER with respect to hydraulic fracturing, including seven complaints between 2010 and 2014, detailed below. The AER looks into every public complaint. Not all complaints warrant an in-person response or an inspection record. For concerns outside its jurisdiction, the AER will refer individuals to the appropriate authority (e.g., their health professional).

- August 14, 2012, complaint no. 20121664
  - Concern regarding tremors felt between 7:00 a.m. and 7:30 a.m.
  - The inspector determined that there were two hydraulic fracturing operations in the area; one eight days and the other two weeks before the complaint was received. One was 20 km away from the residence, the other 15 km away.
  - A bulldozer was prepping a lease that morning for an upcoming fracturing job 8.5 km away.
  - The AER, through the Alberta Geological Survey (AGS), monitors seismic activity across Alberta using the Regional Alberta Observatory for Earthquake Studies Network stations in conjunction with networks operated by other research organizations, including Natural Resources Canada, the University of Alberta, the Montana Bureau of Mines and Geology, the University of Western Ontario, and the University of Calgary. AGS determined that there were no seismic events recorded in the area.
  - Raw data are publicly available through IRIS (the Incorporated Research Institutions for Seismology; http://www.iris.edu/hq/), but a seismic consultant would need to be retained to process and interpret the data. IRIS also provides an interactive map of global seismic activity that is updated every 30 minutes.
  - The monitoring network is discussed in *Detection Threshold and Location Resolution of the Alberta Geological Survey Earthquake Catalogue* by Schultz et al., 2015 (https://www.ualberta.ca/~ygu/publications/Ryan_SRL_2015.pdf).
- July 5, 2013, complaint no. 20131333
  - Concern about the smell of diesel from a hydraulic fracturing site.
  - The most likely source of the smell was from the running of the diesel engines needed for the pumps.
- October 31, 2013, complaint no. 20132172
  - General concerns about flaring, hydraulic fracturing, and livestock health.
  - Since no specific operational concerns were noted, the file was referred to the AER's Stakeholder Engagement Group.

- March 8, 2014, complaint no. 20140533
  - General concerns about hydraulic fracturing and flaring, impacts on human and livestock health, and potential water contamination.
  - The complainant wanted the AER to monitor air quality downwind of hydraulic fracturing operations and near people or livestock.
  - The complainant wanted the AER to test water wells near hydraulic fracturing operations.
  - General information was provided to the complainant, along with an explanation of the AER's jurisdiction.
- April 8, 2014, complaint no. 20140809
  - Alleged water well contamination due to hydraulic fracturing.
  - The complainant wanted an immediate stop work order on all hydraulic fracturing in Alberta and a bill passed to ban the practice.
- July 8, 2014 , complaints no. 20141763 and 20141765
  - Concern that hydraulic fracturing had created surface springs on the complainant's property.
  - An AER inspector reviewed drilling and completion data/tour reports for the wells allegedly responsible for the spring activity.
  - Hydrogeologists reviewed the data on the springs and the water in the area and determined that the springs were naturally occurring due to the high water table.

    Actions taken by AER regarding complaints no. 20141763 and 20141765 are detailed below:

    - July 8, 2014: First complaint received, AER inspector commits to review.
    - July 14, 2014: Second complaint received along with statement of concern for a new project.
    - July 15, 2014: The AER requests the licensee to provide tour reports (daily records of drilling).
    - July 17, 2014: Alberta Environment and Parks refers to the AER a complaint that it received from the landowner regarding the same issue.
    - July 18, 2014: The AER receives the tour reports from the licensee.
    - July 23, 2014: AER and Alberta Environment and Parks hydrogeologists review the data and conclude that the cause is likely due to a high water table rather than oil and gas activity in the area. This information is also sent to Alberta Environment and Parks.
    - July 29, 2014: The AER receives further questions and information from the complainant.

- July 30, 2014: The AER contacts the licensee for additional information (e.g., notification information about the wells).
- July 30, 2014: The AER's Well Operations and Authorizations Groups and Alberta Environment and Parks engaged.
- July 31, 2014: AER Stakeholder and Government Relations Division and Office of Public Affairs engaged.
- September 19, 2014: Staff from both the AER and Alberta Environment and Parks visit the site. Well Operations re-engaged.
- September 19, 2014: The complainant was advised of the joint findings of the AER and Alberta Environment and Parks. Alberta Environment and Parks commits to assist the complainant in talking to Municipal Affairs. The AER refers the file to Alberta Environment and Parks and closes its field file.
- February 6, 2015: AGS compiled relevant climatic, hydrometric, surficial, geological, and hydrogeological information to gain knowledge of local and regional characteristics of the area. The following is a summary of its findings:

  Topography is rolling and the complainant's property appears to be within a flat-lying area that slopes north, towards a stream and other surface water bodies. The area is underlain by relatively thin (less than 10 m), unconsolidated materials, with the Paskapoo Formation the uppermost aquifer used locally for groundwater. Springs have been observed west of the property and are common regionally, close to streams and river courses. The water-table elevation mimics land-surface topography—locally it is obviously at or above the land surface as evidenced by springs, ponding water attributed to groundwater discharge, and flowing wells. Precipitation has increased over the last four years in neighbouring climatic stations and in river flows measured at nearby hydrometric stations. Water levels have increased by as much as 3 m in neighbouring wells that are part of an observation network maintained by the University of Calgary. Multistage hydraulic fracturing wells north of the property do not show any obvious signs of hydraulic interference with the complainant's property. Groundwater flow in the uppermost bedrock aquifer is predominantly north-northwest in the direction of the property, local surface water features, and topographically lower elevations. Hydrocarbon exploration wells have reported loss of circulation in shallower bedrock units, but to date this appears irrelevant to issues observed on the property. Increases in groundwater discharge related to geology, topography, and increased groundwater recharge over the last four years, at minimum, appear to be the likely cause for issues observed at the property currently. The cause of bubbling and/or gassy water discharge is unknown but could be characteristic of groundwater discharge.

4.3 Summary of Noncompliances

Six **noncompliances** were recorded as a result of inspections or investigations into public complaints; two were unrelated to the complainants' concern, two indirectly related, and two directly related.

Descriptions are as follows:

- June 10, 2010, complaint no. 20101064
  - Concern about a suspected spill and effects on health and wildlife from an oil and gas operation next to a water body.
  - An AER inspection determined that the fluid leaving the lease was rainwater/surface water. There was no impact to the water body, which is uphill from the lease site.
  - The inspector issued a notice of noncompliance for inadequate diking around the lease.
- November 10, 2012, complaint no. 20122270
  - Concern about a flame visible over the top of an incinerator.
  - The inspector issued a notice of noncompliance for having an exposed flame from an incinerator.
- August 1, 2013, complaint no. 20131466
  - Concern about a fire on the site (see appendix 2).
  - The inspector issued two notices of noncompliance unrelated to the fire.
  - This is an old site in Lochend (first went on production in 1986).
- April 29, 2014, complaint no. 20140991
  - Concern about flaring and impacts on human and wildlife health.
  - The flaring was the result of an operational upset. It was for a period of less than four hours. Therefore, as per *Directive 060: Upstream Petroleum Industry Flaring, Incinerating, and Venting*, AER notification was not required.
  - The inspector issued a notice of noncompliance for inadequate information in the licensee's flaring logs. This issue is administrative in nature and had no effect on the flaring.
- October 5, 2014, complaint no. 20142530
  - Concern about an unknown odour.
  - The inspector issued a notice of noncompliance because the licensee failed to immediately return a call to its 24-hour emergency number.

4.4 Complaint Summary

A summary of complaints in the Lochend area from 2010 to 2014 is provided in appendix 2. Appendix 1, figure 5, shows complaints by location.

4.5 Reportable Incidents or Releases

From 2010 to 2014, there were 36 reportable incidents that included four fires, three incidents of damage by a third party or vandalism, eight valve and equipment failures, a vehicle accident, and five **interwellbore communication** incidents related to hydraulic fracturing. Field centre inspections and investigations resulted in 20 satisfactory and five unsatisfactory or noncompliant results.

The interwellbore communication incidents were in Cardium Formation wells. All were minor in nature and presented no risk to the public and had no impact on the environment. Four of the communication incidents were a bump or increase in pressure from an offset well. The wells were monitored and managed by the licensees in accordance with AER requirements. No fluids were released to surface during these events. When interwellbore communications were anticipated, pressurized tanks were used to manage any flow that may have been required to relieve offset well pressure. The fifth incident is a suspected communication as there were issues with production of an offset well immediately after a nearby well was fractured. However, there were no lasting impacts to the wells after fracturing was completed and the pressures were reduced.

Of the five noncompliant inspections, only one was directly related to a reported release. One noncompliance was for late notification to the AER of a 25 cubic metre (m^3) spill into secondary containment around the tank farm. The second was issued to a third party (not the licensee the incident is recorded against) working close to a pipeline that did not follow proper ground disturbance procedures. The third was issued during inspection of a 9 m^3 spill around a wellhead. Multiple wells were drilled at the location, and a notice of noncompliance was issued for each wellhead that did not have an affixed identification sign. The last two inspections involved oil staining around a wellhead and vegetation on a dike surrounding the production tank. The inspector was on location investigating a fire that most likely resulted from an electric motor malfunction.

A more detailed summary is as follows:

- March 8, 2012, release no. 20120552
  - Release of 25 m^3 of crude oil into the secondary containment around the production tank.
  - Cause of the release was a crack that formed on a gate valve on the tank load/unload line. No oil escaped the secondary containment or impacted the ground. Spilled material inside the tank farm was cleaned up.
  - A satisfactory inspection was issued for the spill containment and cleanup.
  - The inspector issued a notice of noncompliance for late notification of a **reportable release** to the AER and the public was notified in accordance with AER requirements.

- November 3, 2012, release no. 201222237
  - A pipeline company conducting boring activities around another licensee's pipeline made contact with the line and caused damage.
  - No release of product occurred.
  - A notice of noncompliance was issued to the company that struck the line for failing to follow proper ground disturbance procedures, specifically failing to adequately expose a pipeline prior to mechanical excavation taking place within five metres.
- November 7, 2012, release no. 20122261
  - A 9 m^3 spill occurred immediately around a wellhead when the stuffing box wore out and a pressure control switch failed.
  - The release was contained within the lease, the well was shut in, and fluids and stained material were removed and taken to a waste management facility.
  - The inspector issued a notice of noncompliance for failing to affix a sign identifying the bottomhole location of each wellhead when there is more than one well on a single location.
- August 1, 2013, release no. 20131467
  - The shack housing the pump jack motor caught fire, most likely due to a malfunction of the motor itself, although the root cause could not be identified with certainty.
  - No damage to the well occurred and no product was released. Damaged equipment included the wooden structure housing the motor and the motor itself.
  - Two inspections and one fire investigation were documented. The fire investigation, specific to the licensee enacting its emergency response plan, was considered satisfactory. Physical inspections identified noncompliances unrelated to the fire: housekeeping around the wellhead and tank load/unload lines, and maintenance of the production tank dike.

4.6 Compliance in Lochend Relative to Provincial Averages

Over the five years from 2010 to 2014, compliance of Lochend area operators was equal to or greater than the provincial average with the exception of one operator from 2011 to 2013 (see figure 6). In 2014, Lochend area operators performed better than the provincial compliance average, which includes all categories (oil facilities, gas facilities, drilling operations, well servicing operations, pipelines, drilling waste, and well sites).

5 Industry Performance Monitoring

AER field inspections are prioritized based on the weighting of operator history, sensitivity of the location, and inherent risk of the project or operation.

- Operator history: A review of an operator's compliance history to allow AER inspectors to focus more closely on companies with higher levels of noncompliance or unsatisfactory inspections.
- Site sensitivity: An evaluation of the area where the operation is taking place for factors such as proximity to the public or bodies of water, and for areas where there has previously been significant public concern with energy resource activities.
- Inherent risk: A review of specific technical details about the facility, such as well depth, complexity of the operation, and whether the facility is sweet or sour.

The AER also carries out unannounced inspections based on reports or complaints from the public to ensure that procedures and equipment are in use to minimize environmental impacts.

Incident response, monitoring, and inspections are based on an assessment done at the time the AER is notified of an incident. Incidents generally include complaints from the public or other stakeholders, releases and failures, and emergencies such as fires, well blowouts, and injuries/fatalities. Each incident is assessed using criteria such as hazard to public safety, impact on the environment, severity of the equipment damage, or resource loss.

In Lochend and other areas, inspections or incident response are conducted based on the above criteria. Due to the sensitivity of residents in the Lochend area, new activities, such as drilling and servicing, flaring, and hydraulic fracturing, are carefully scrutinized by inspection staff. Priority may be given in situations where an inspector feels additional attention is warranted. For example, a company or contractor who has not previously worked in or has not been inspected in the Midnapore Field Centre boundary area may be inspected even if the OSI score does not meet the threshold.

The AER requires licensees to

- measure or estimate flared, incinerated, and vented gas (*Directive 060* and *Directive 017: Measurement Requirements for Oil and Gas Operations*);
- maintain a log of flaring, incineration, and venting events (*Directive 060*); and
- report monthly volumetric amounts (*Directive 007: Volumetric and Infrastructure Requirements*).

Directive 060 requires that sites conserving solution gas operate at a minimum conservation efficiency of 90 per cent. Conservation efficiencies for the Lochend area are illustrated in figures 8–12. Typical conservation efficiency in Alberta is 95 per cent.

Figures 7–12 show flaring and venting, as well as conservation efficiency, for all sites in the Lochend area between 2010 and 2014. Flare volumes peaked in 2012 and have decreased significantly in 2014.

Figure 13 shows all flaring in 2014 within the 491 km^2 Lochend area (9 038 10^3 m^3). Flaring outside of the area is also provided to justify the area's current boundaries. Based on the insignificant flare volumes, there is no basis to extend the boundaries of the Lochend area for this technical assessment.

As stated earlier, when a facility is conserving gas, all operational flaring is minimized to maximize resource conservation. If flaring occurs, it is usually due to unforeseen operational circumstances and is reported. This means that if production levels are the same, emissions would be greater when facilities are nonconserving than when they are conserving. Conserving facilities are directed to do so based on an economic assessment required by the AER. Once a facility is conserving gas, it typically remains a conserving facility. If an operator wishes to discontinue conservation, they must apply to the AER before doing so. In such cases, the operator is not allowed to consider the capital cost of the facility in its economic assessment, making it much less likely that flaring will be allowed.

Figure 14 shows that in 2015 there were six nonconserving facilities in the Lochend area, three of which reported vent volumes with no flaring. Thus, in 2015 there are only three nonconserving flaring facilities within the Lochend boundary (two batteries that reported flaring, ABBT0116043 and ABBT0118460, are in essentially the same location). All three of the nonconserving facilities were audited by the AER for gas conservation and determined to be uneconomic to conserve since the wells were reaching the end of their life (about two more years left). Flaring volumes from these facilities will decrease over time.

Figure 14 indicates flared volumes in January 2015 for the three flaring batteries of 15.9 10^3 m^3, 34.9 10^3 m^3, and 18.9 10^3 m^3. Extrapolating for the year 2015 provides a total volume of 821 10^3 m^3.

In *Directive 060*, facilities with gas volumes less than 900 m^3 per day are considered small and would not normally be expected to conserve. Facilities with gas volumes greater than 900 m^3 per day are required to conduct an annual economic evaluation. In the economic evaluation, the three batteries were evaluated together and still showed conservation to be uneconomic. In this context, the three facilities mentioned above flared on average an estimated 513 m^3 per day, 1126 m^3 per day, and 610 m^3 per day.

Total solution gas, flared plus vented, in Alberta is about 900 000 10^3 m^3 per year. The release of 821 10^3 m^3 per year into the Lochend area is equivalent to the gas used to heat 233 average households in Alberta for a year or the annual carbon dioxide emissions from 425 passenger cars driven 19 000 km each.

5.1 Flowback Flaring and Well Cleanup

Figure 15 shows total cumulative flaring associated with **flowback** and clean up for multistage, hydraulically fractured wells in the Lochend area from 2010–2014 inclusive. The total comes to 26 117 10^3 m^3 over five years, which is a calculated annual rate of 5 223 10^3 m^3 per year. In 2014, flaring from flowback decreased to 1702 10^3 m^3.

If H_2S concentration is greater than one per cent, **dispersion modelling** is required to confirm that the operation complies with Alberta ambient air quality objectives for sulphur dioxide (SO_2.) For well test flaring, if the H_2S concentration is greater than five per cent, operators must also apply to the AER for a flaring permit. As part of its review of the application, AER staff will assess compliance with Alberta ambient air quality objectives, the volume requested to be flared, and the feasibility of options to reduce flaring, such as in-line testing. For flaring, incinerating, and venting, performance requirements in *Directive 060* must be met. In this situation, the majority of complaints from residents were after flaring and venting occurred; therefore, inspections of the operation and equipment could not be completed. The wells in this area are sweet (0 per cent H_2S).

Well tests generally last between three and 30 days with intermittent flaring. *Directive 060* requires well test flaring be limited to 72 hours without AER extension approval. Due to the number of stages fractured, the majority of the wells in this area required an extension past the 72-hour limit. The Midnapore Field Centre, along with specialists from the AER's head office, had numerous discussions with area operators looking for ways to reduce flaring during these operations. Options included clustering and in-line testing where infrastructure was available. The Midnapore Field Centre also reviewed flaring notifications and conducted mini-audits of information regarding various flaring events. When investigated, the licensees had met the conditions to test beyond the 72-hour limit.

During a typical well test, production is directed to a vessel where liquids are separated and sent to tanks. Gas is then directed to a flare or incinerator. Liquids produced during the test are primarily hydraulic fracturing fluids and additives, as well as hydrocarbons and water from the formation. The liquids are then recycled, reused, or shipped for appropriate disposal, as required by *Directive 058: Oilfield Waste Management Facility Approvals—Notification and Amendment Procedures*. Gases sent to flare or that are incinerated are primarily made up of formation hydrocarbon gas and liquids or gases that may have been used for hydraulic fracturing. (Water and nitrogen are common, but propane-based fracturing fluid was used on area wells).

6 Ambient Air Quality Monitoring

Air quality monitoring has not been a focus for the AER because the wells in the Lochend area are sweet (0 per cent H_2S) and the AER's mobile air monitoring units are designed to monitor for H_2S and SO_2.

Alberta Environment and Parks performed a special survey to monitor air quality in the Lochend area on August 27 and 28, 2013 (unpublished data, cited with permission, Craig Knaus, Government of Alberta). To assess air quality during flaring events, a mobile air monitoring laboratory (MAML) was deployed downwind of two flares. Equipped with instruments that measure air quality and meteorological parameters, the MAML sampled for

- carbon monoxide,
- SO_2,
- H_2S,
- total reduced sulphur,
- ozone,
- nitrogen oxide,
- nitrogen dioxide,
- nitrogen oxides,
- ammonia,
- methane,
- nonmethane hydrocarbon,
- total hydrocarbon,
- particulate matter (PM) with diameters less than 10 micrograms (µg; PM10), 2.5 µg (PM2.5), 1 µg (PM1), and
- polycyclic aromatic hydrocarbons.

At two of seven locations, the MAML detected hydrocarbons levels above typical ambient levels for Alberta.

Canister air samples were also taken at three MAML monitoring locations and analyzed for volatile organic compounds (VOCs) and reduced sulphur compounds. Two canisters had enhanced levels of nonmethane VOCs, which were primarily composed of isobutene, butane, isopentane, and pentane. This is consistent with the combustion of natural gas.

The concentrations of the compounds measured by the MAML and the canisters were compared with the Alberta ambient air quality objectives and the Texas Commission on Environmental Quality's Effects Screening Levels. None of the measured concentrations exceeded ambient air quality objectives.

7 Provincial Context

The four townships within the Lochend area were examined from a provincial perspective using a number of parameters for the period of 2009 to 2013, the last full year for which data are available. The findings are as follows:

Complaints (2009–2013): The number of complaints in the Lochend area was above average compared to other areas of the province.

Satisfactory inspections (2010–2013): The number of satisfactory inspections in this area is above the provincial average.

Statements of concern (formerly objection letters) (2009–2013): The number of objection letters received in response to applications in the area is above average.

8 Conclusion

The AER's examination of the complaints received from Lochend area residents revealed that many of the complaints were general in nature, containing concerns over fracturing in the province.

Compliance

Compliance in this area by members of the LIPG has typically been at or above the provincial average. In 2014, all operators in the area were above the provincial average for compliance with AER requirements. Over the five years assessed (2010–2014), 6 of 84 inspections found noncompliances. This means that 7 per cent of the total inspections (approximately 1.4 per cent per year) found noncompliances. Further, the few noncompliances have not typically been related to the subject of the complaints or emissions-related concerns. Over all the years assessed, the number of inspections exceeded the number of complaints and the number of compliances far outweighed the number of noncompliances.

Air quality and flaring

Operators are required to measure flare and vent volumes to determine conservation efficiency as it relates to effective and efficient use of the resource. Compositional air analysis is not typically required unless triggered by H_2S concentrations. The development in this area is sweet, not sour, and hence H_2S has not been a concern. That said, ambient air quality monitored downwind of flaring in 2013 met Alberta ambient air quality objectives.

Fracturing activity and flaring in this area reached a peak in 2012. In 2015, only three operators are not conserving, and flare volumes from these facilities are estimated to be 821 10^3 m^3 per year. In addition, the number of flowback operations, along with the associated flaring and venting, has declined since 2012. Minimal new development is planned for this area due to recent oil prices.

Next steps

The AER concludes that there is a need for more information about air emissions from flaring in the initial stages of new development, specifically during fracturing flowback.

In order to conduct a study of the effects of hydraulic fracturing on environmental health, there must be enough industrial activity in an area to provide a sufficient sample size to establish relationships among source, pathway, environmental receptor, and human health receptor. In addition, the receptors must be of adequate distribution and sample size to establish relationships with potential sources of exposure. Examining environmental health indicators falls under the AER's purview, while AH and AHS are responsible for examining human health indicators.

LIPG members have stated that in the Lochend area there will be a maximum of three wells drilled in 2015. The area, therefore, does not provide a sufficient sample size for a larger study of flaring emissions during fracturing flowback.

The AER has started discussions with AH and AHS about the need for, and scope of, a larger study with adequate statistical power in an area of Alberta more technically suited to examining this issue. As a result, the AER will be pursuing this study through strategic discussions with provincial agencies, including AH, AHS, and Alberta Environment and Parks. Residents and industry in the Lochend area will be invited to participate in the study.

Appendix 1 Figures

R.5 R.4 R.3 R.2 R.1W5M. R.29 R.28W4M.

T. 28

T. 27

T. 26

T. 25

N

Airdrie

Cochrane

Calgary

Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Alberta Energy Regulator

Lochend Study Area

Roads and Highways

Publication Date: June 23, 2015
Data Date: June 23, 2015

Projection: 10TM AEP Forest
Datum: GCS NAD83

Figure 1. Map of the Lochend area

0 5 10 km

1:150 000

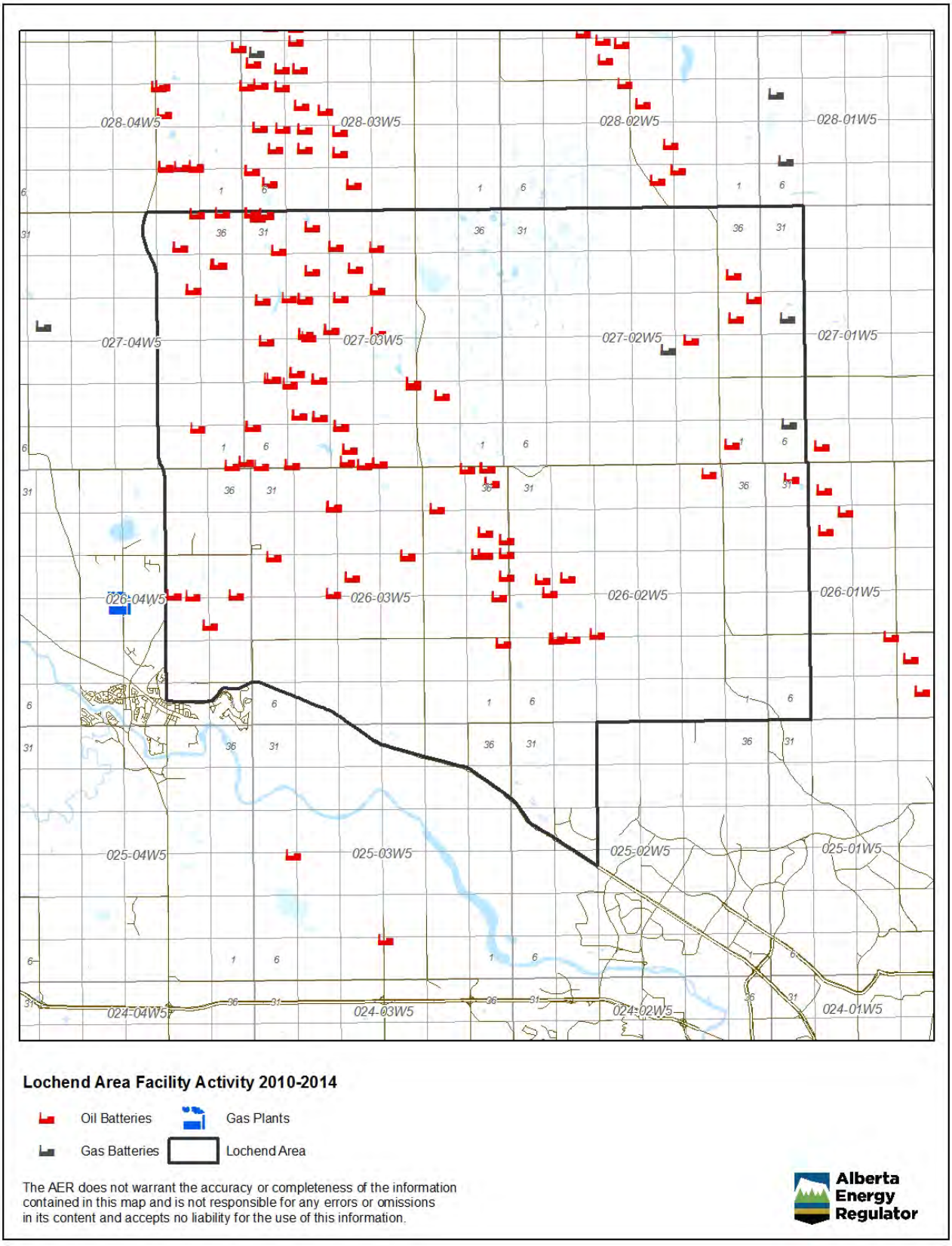

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Figure 2. Lochend area facility activity, 2010–2014

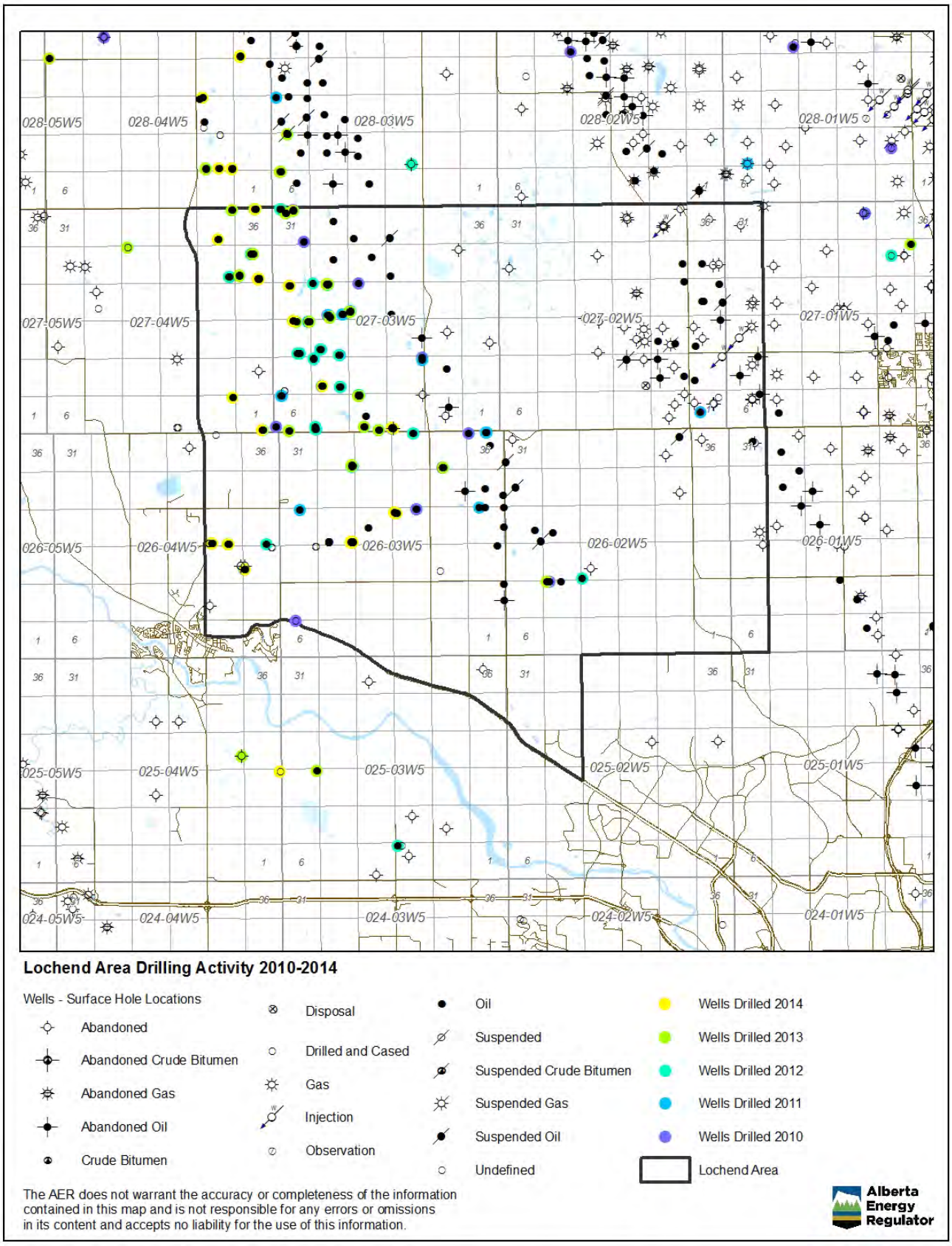

Figure 3. Lochend area drilling activity, 2010–2014

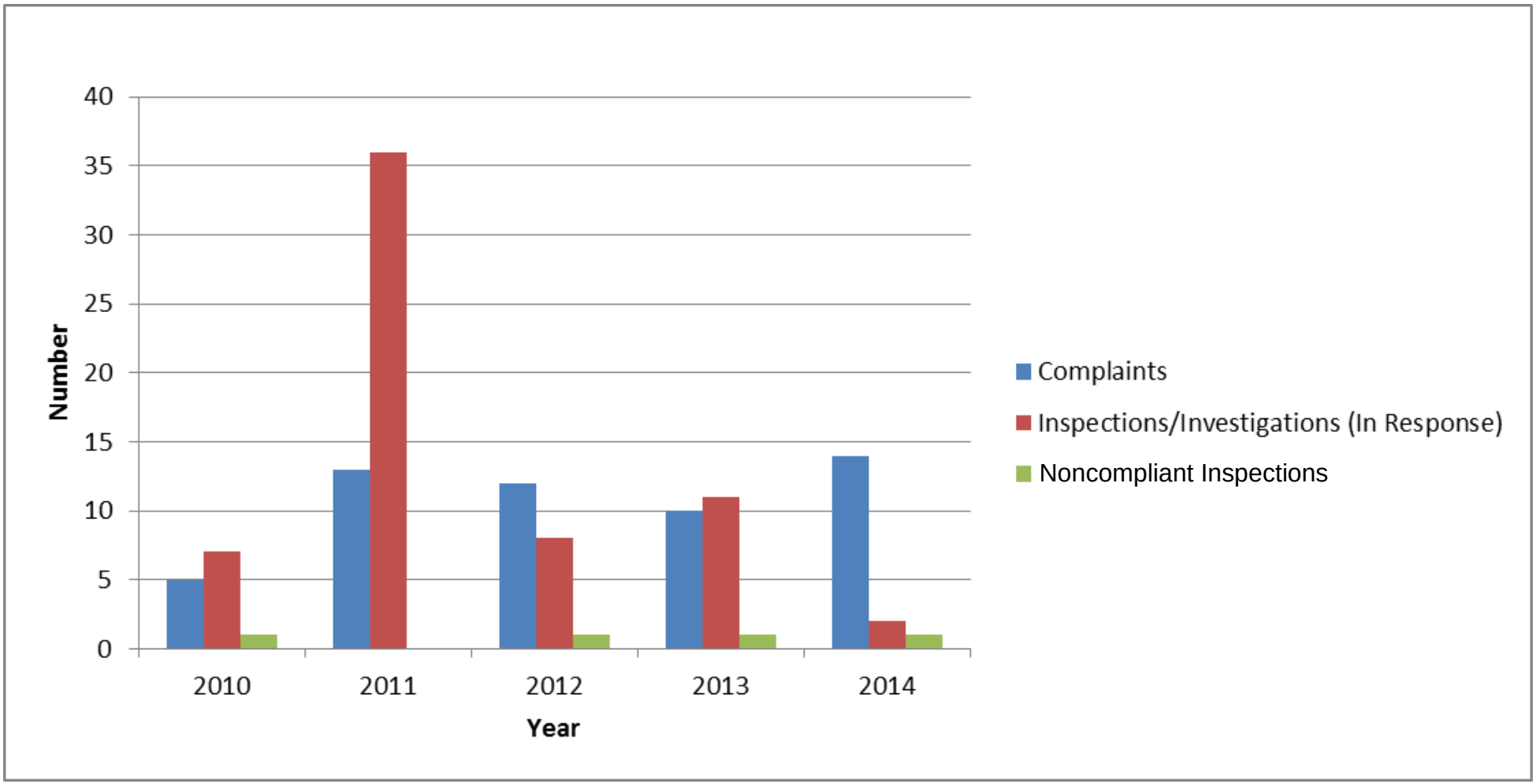

Figure 4. Summary of complaints, resulting inspections, and noncompliances

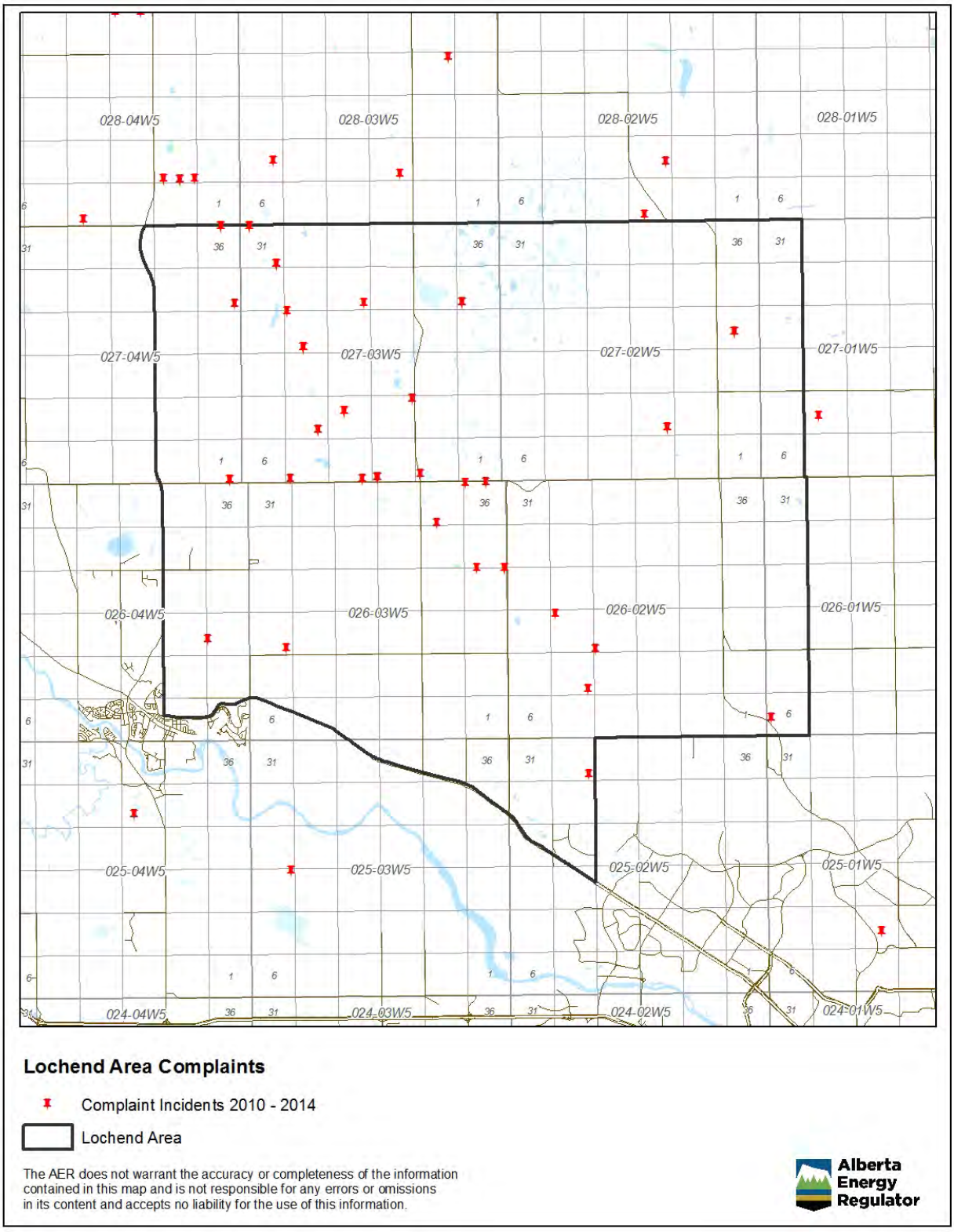

Figure 5. Complaint incidents in the Lochend area, 2010–2014

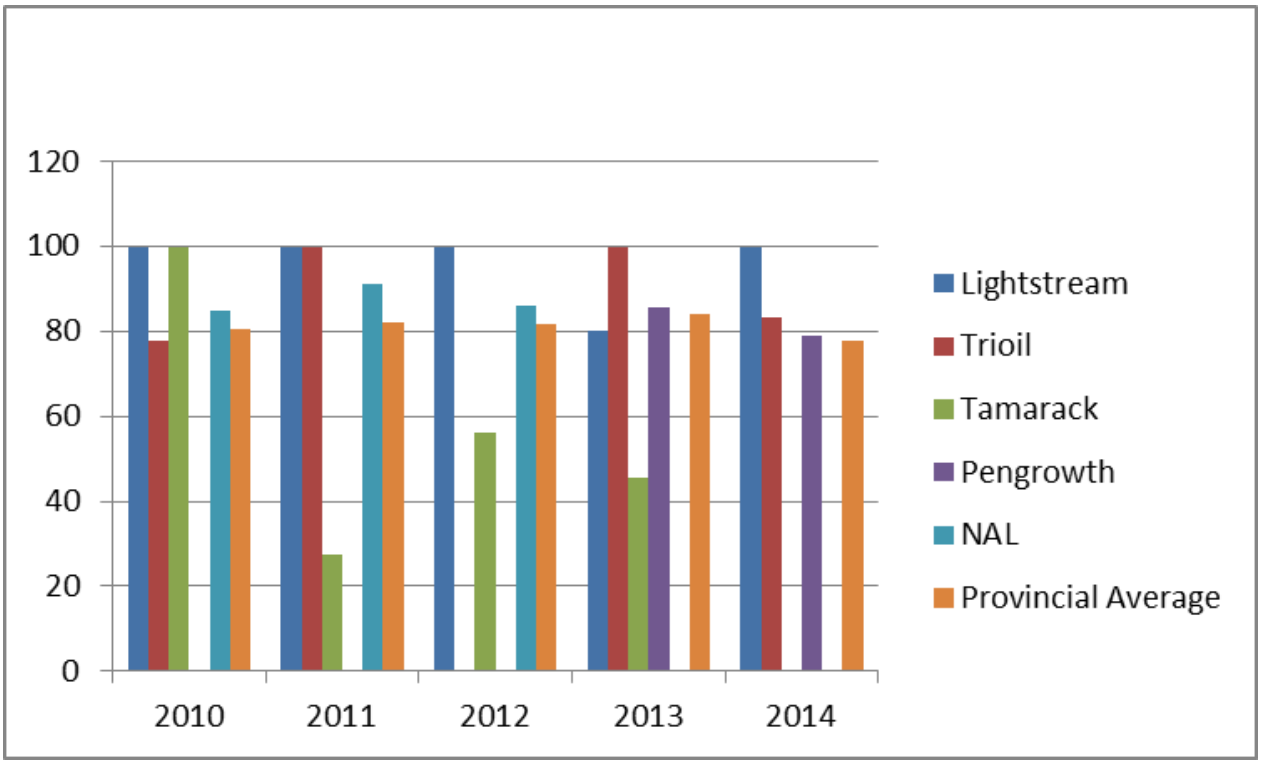

Figure 6. Overall provincial compliance of Lochend area producers compared to provincial averages

When interpreting figure 6, it should be noted that if a licensee had no inspections in a particular year, the chart would indicate 0% compliant. Likewise, if a licensee had only one inspection and the result was satisfactory, the chart would indicate 100% compliant (the opposite would be true if that single inspection was noncompliant). The risk level associated with any noncompliances is not illustrated in the figure.

Figures 7–12, show flaring, venting and conservation efficiency for all sites in the Lochend area between 2010 and 2014. These charts, by year, do not distinguish data from initial well testing; well test flaring and venting are included in these volumes. Only facilities that reported flaring or venting from the stated year are captured. Charts illustrate a number of facilities that are no longer producing. Venting and flare volumes, as indicated by the green and red bars, are very small. Conservation efficiency is calculated as gas production minus flare minus vent all divided by gas production. Note: 1000 m^3 = 10^3 m^3.

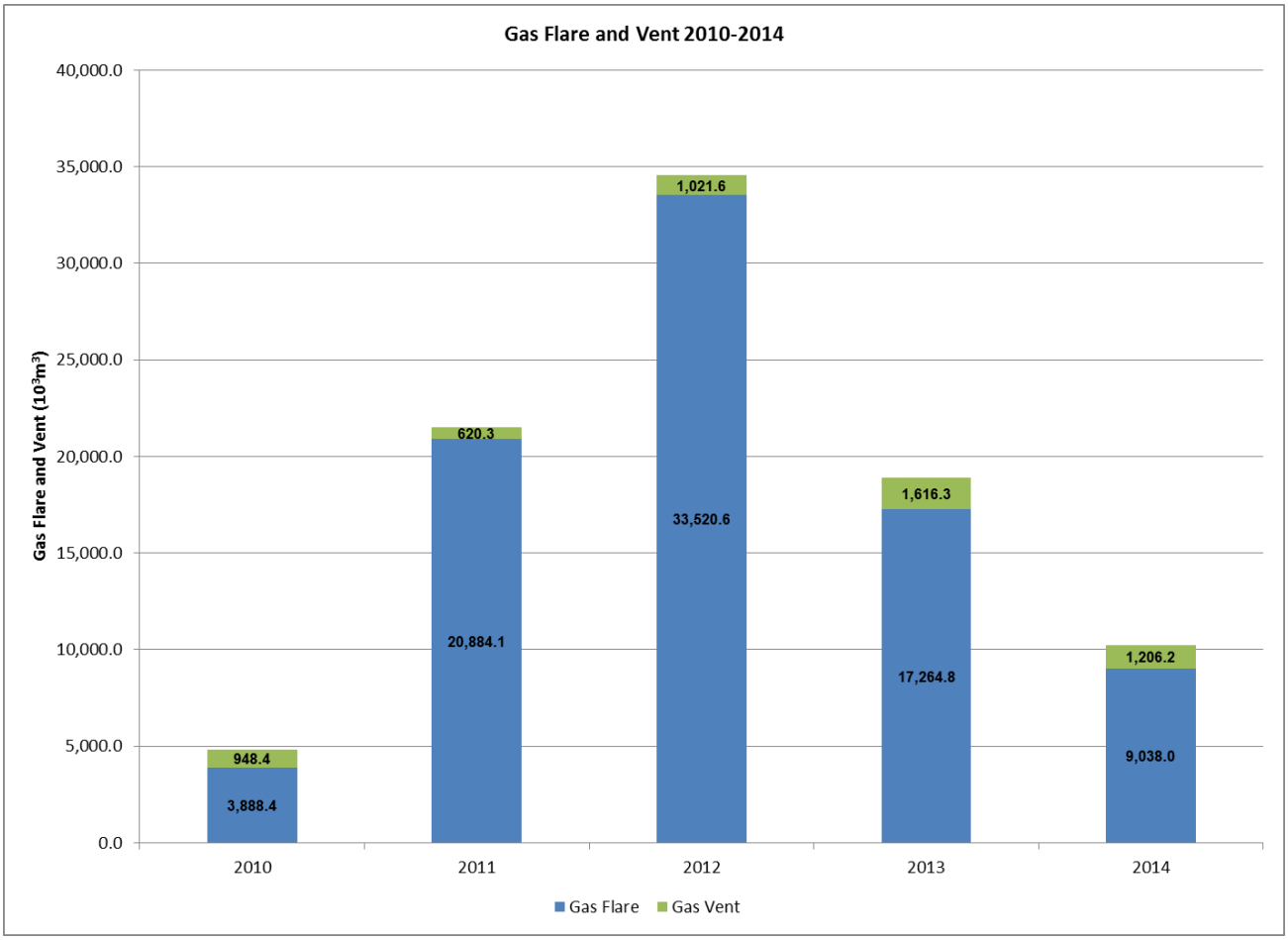

Figure 7. Gas flare and vent volumes in Lochend area, 2010–2014

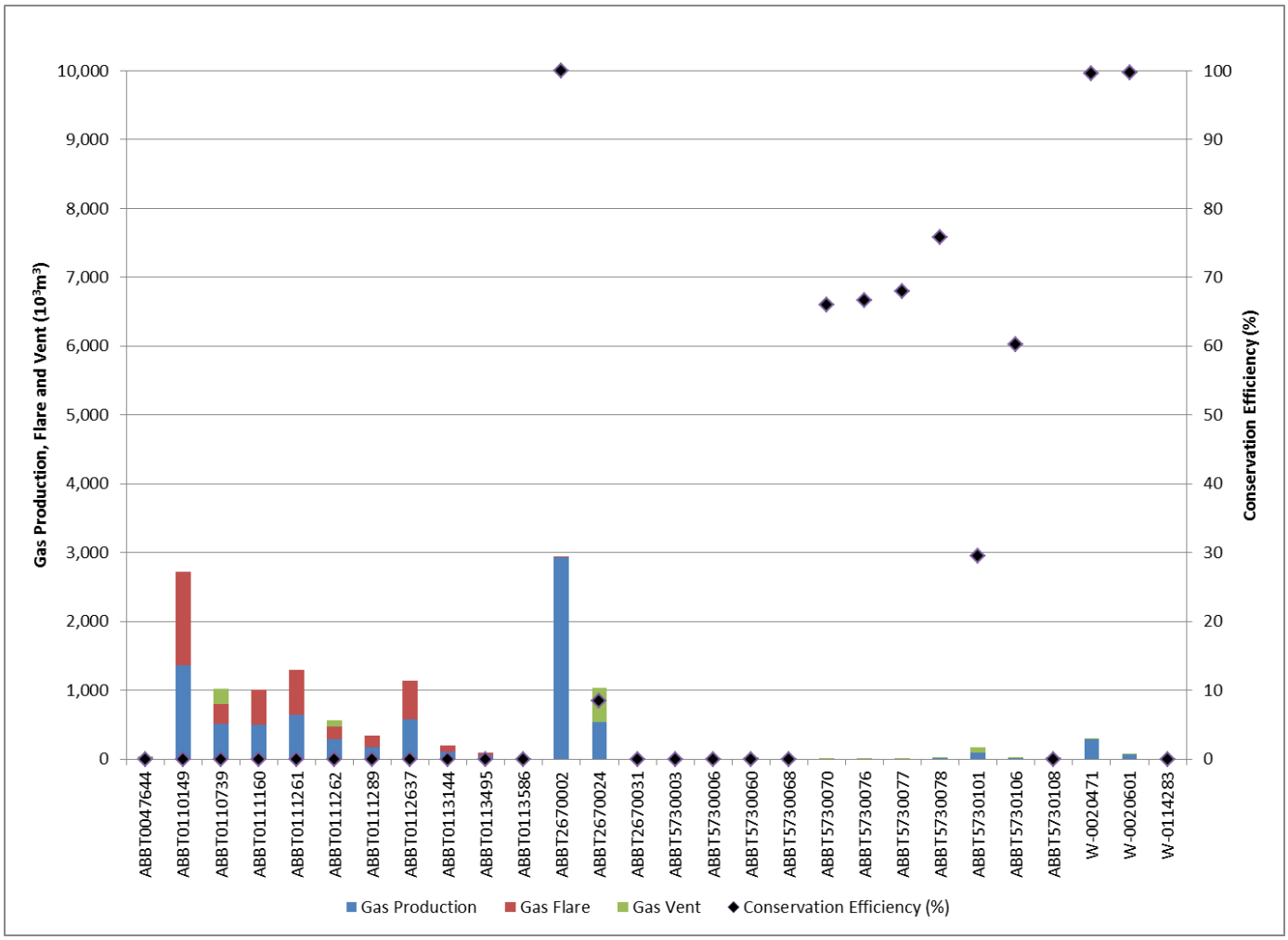

Figure 8. Gas production, flare, vent, and conservation efficiency in the Lochend area, 2010

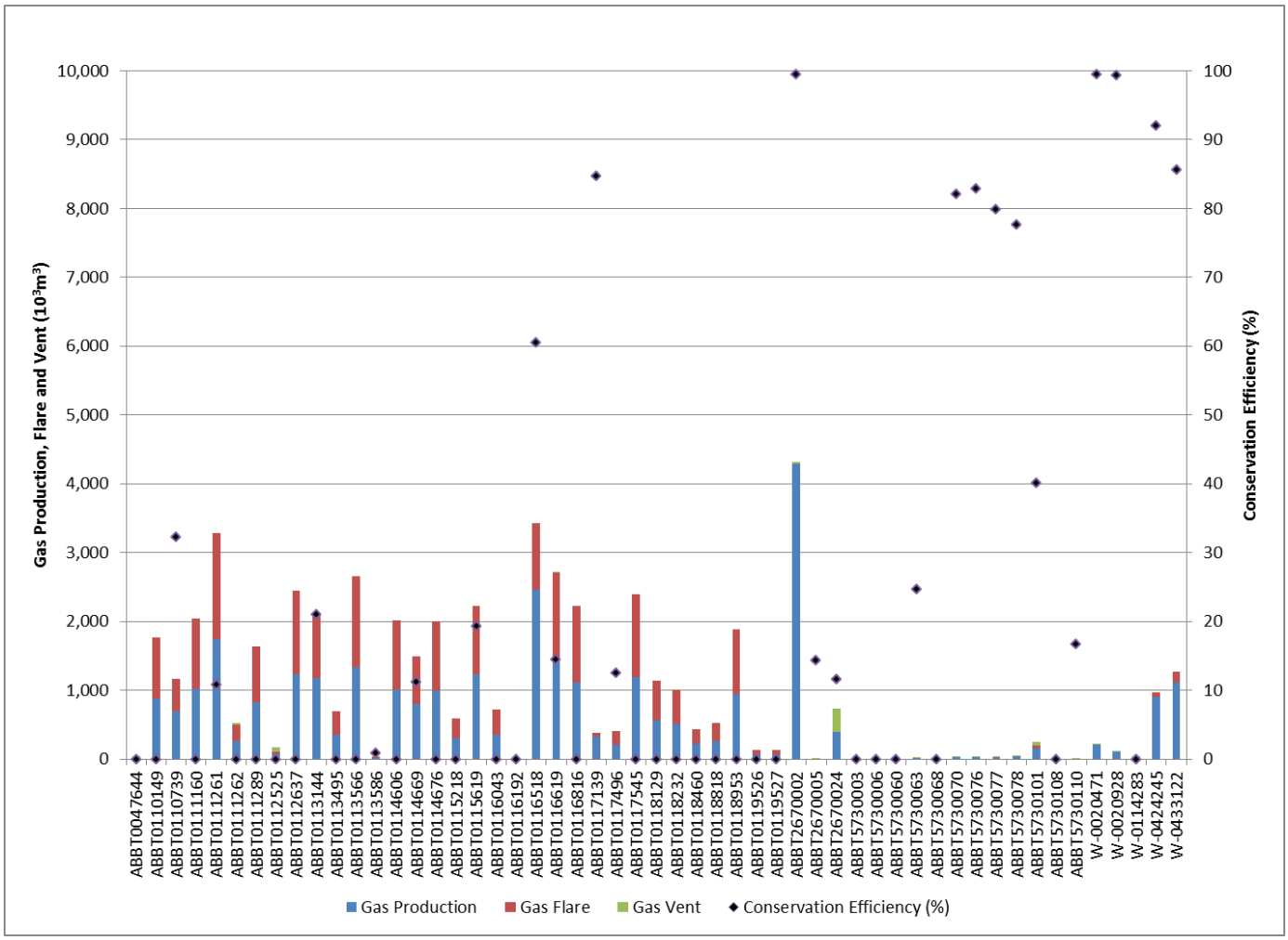

Figure 9. Gas production, flare, vent, and conservation efficiency in the Lochend area, 2011

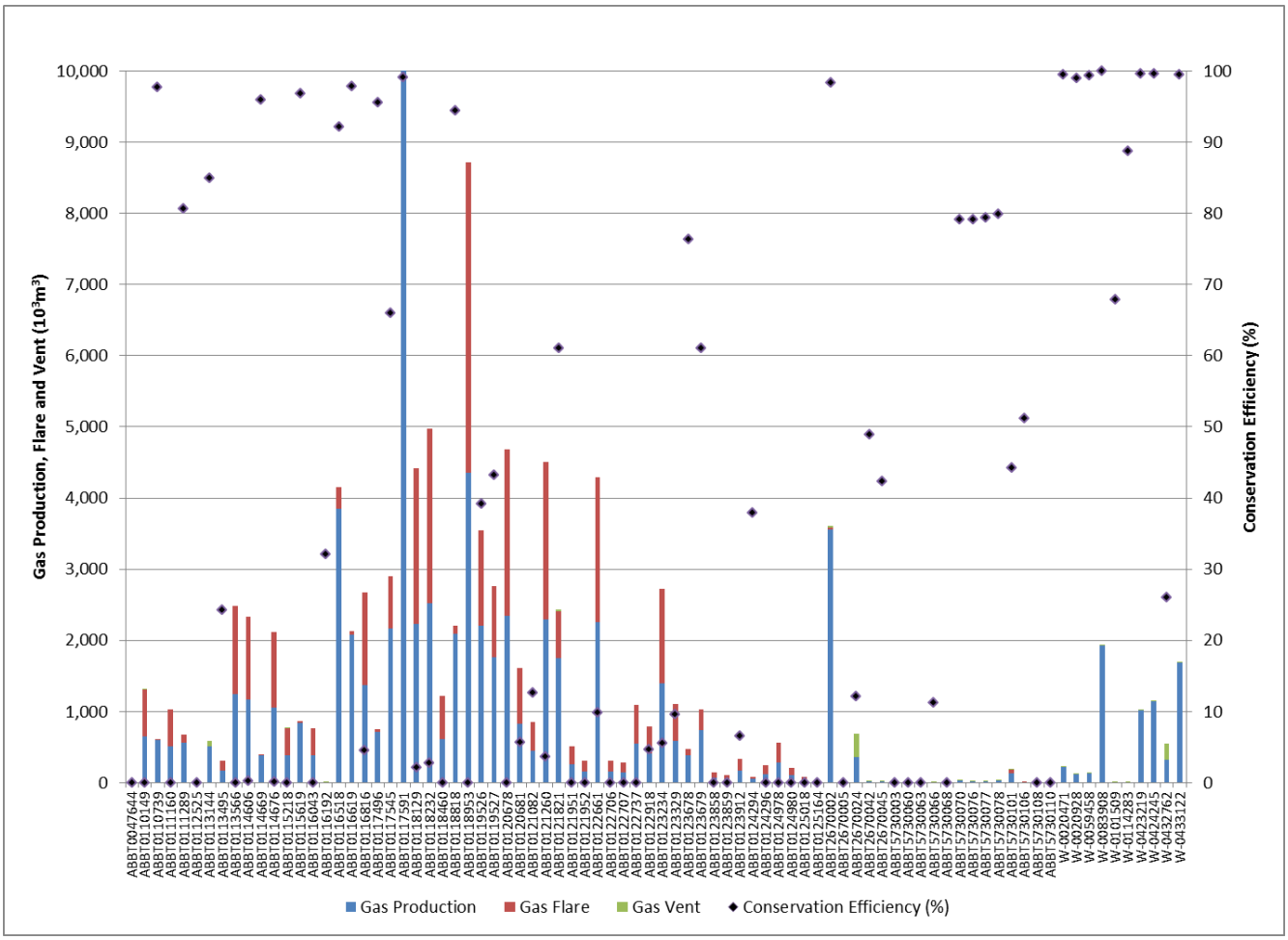

Figure 10. Gas production, flare, vent and conservation efficiency in the Lochend area, 2012

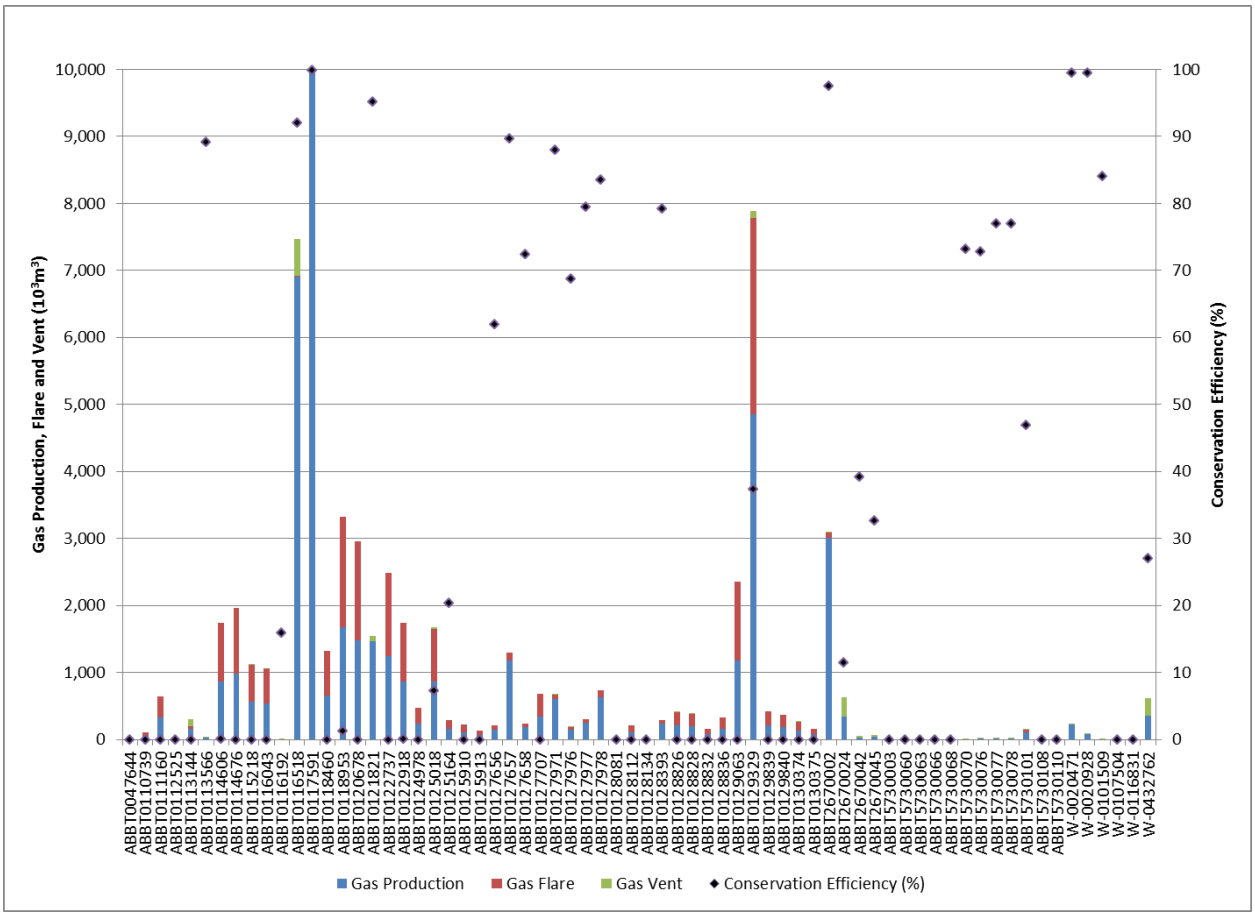

Figure 11. Gas production, flare, vent, and conservation efficiency in the Lochend area, 2013

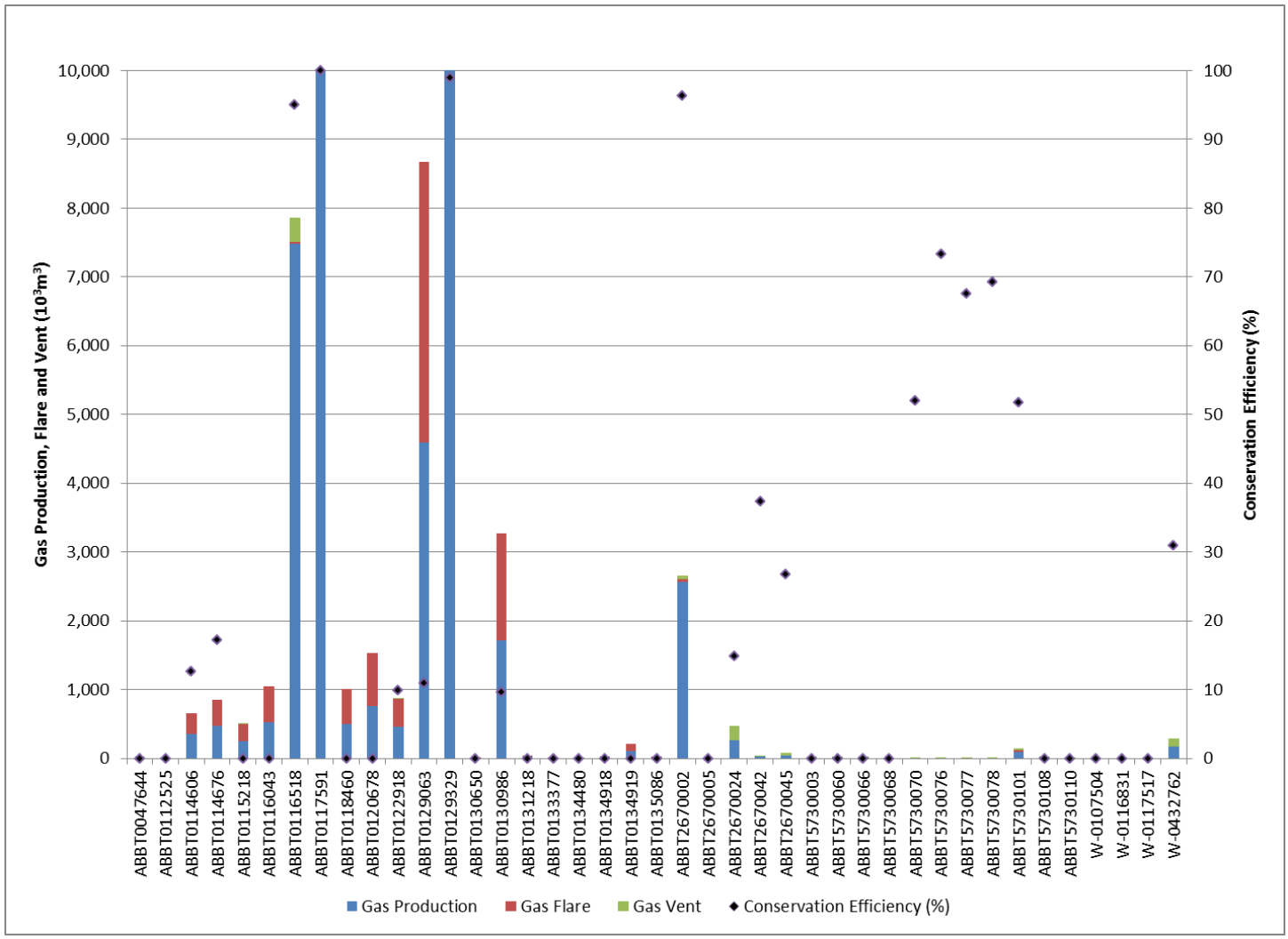

Figure 12. Gas production, flare, vent, and conservation efficiency in the Lochend area, 2014

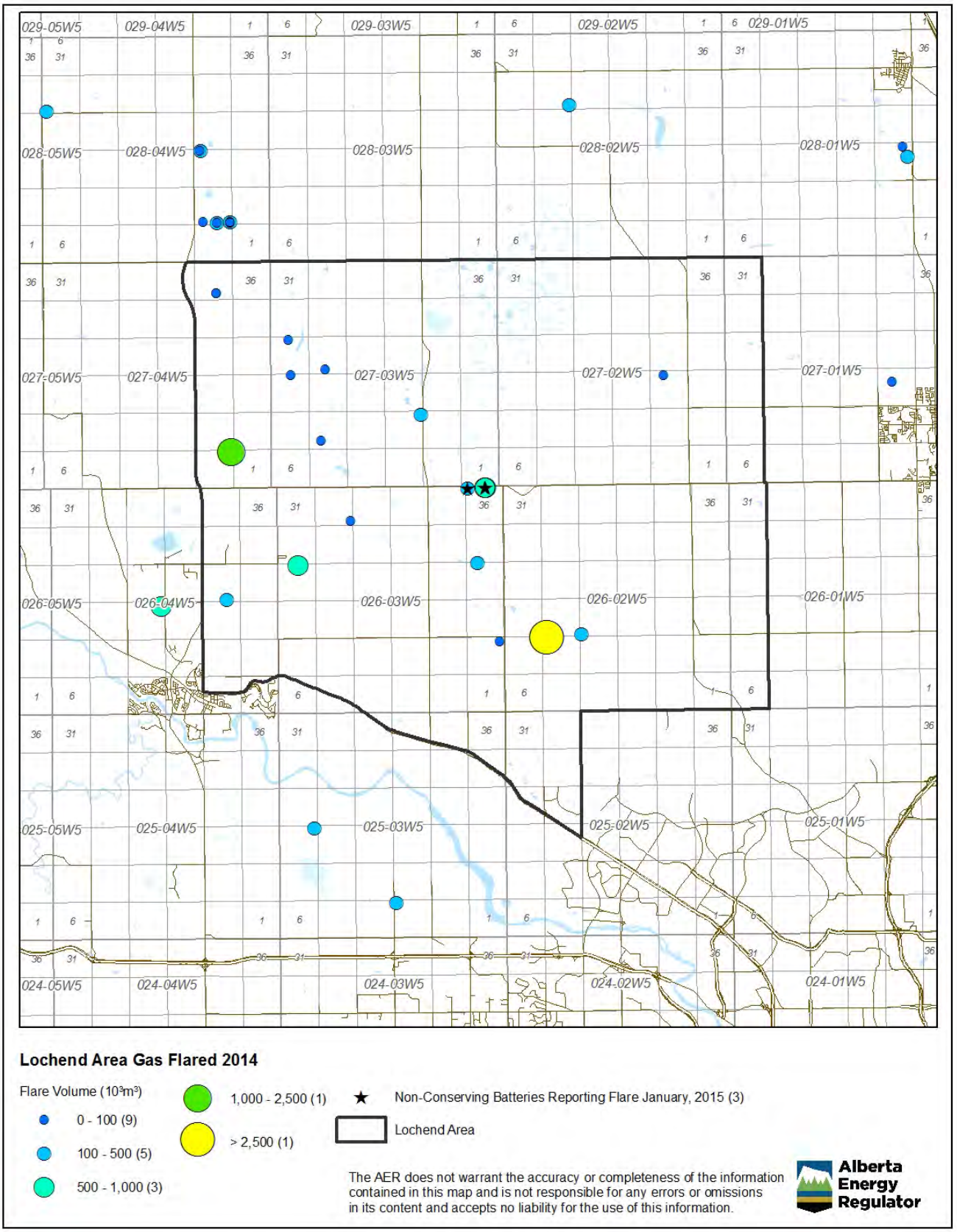

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Figure 13. All flaring in the Lochend area, 2014, with the nonconserving batteries in 2015 indicated

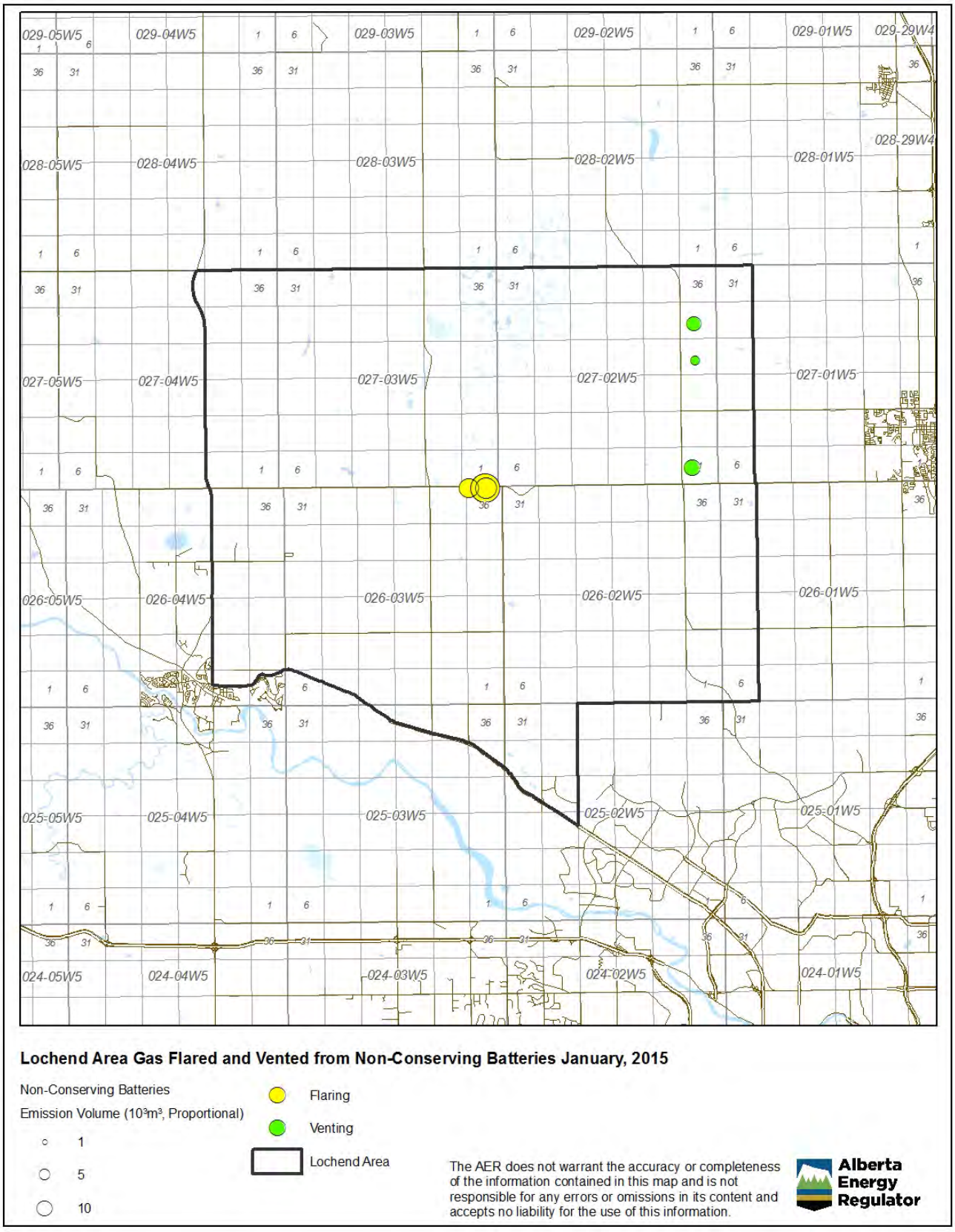

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Figure 14. Nonconserving facilities in the Lochend area, January 2015

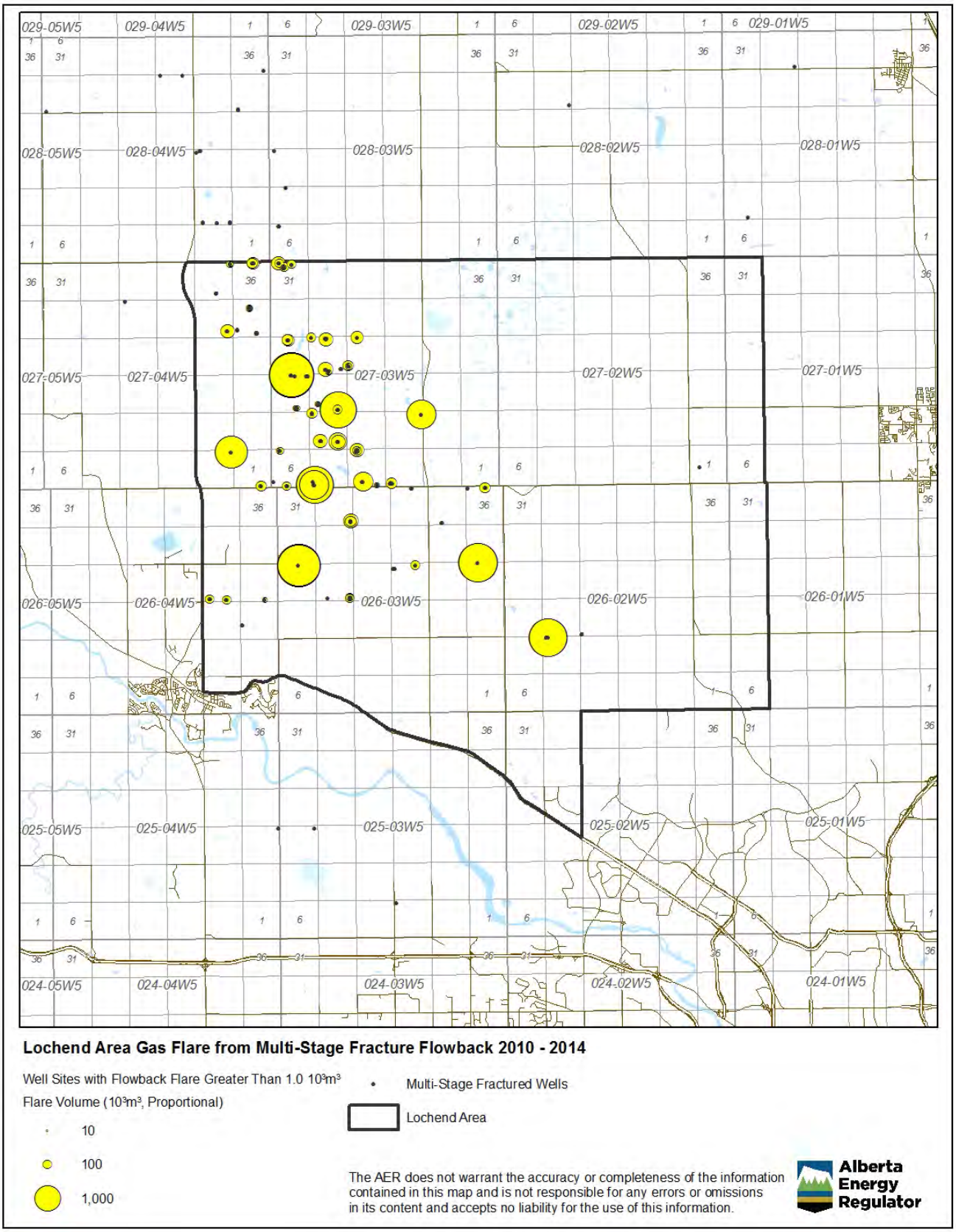

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Figure 15. Gas flare from multistage fracture flowback, total cumulative volumes from 2010–2014

Appendix 2 Complaint Summary

FIS Number	Incident Date	Company	Location	Concern Reported	Results of Inspection or Investigation
2010 Complaint Summary					
20100288	12-Feb-10	Bonavista Petroleum Ltd.	05-33-028-04 W5	Operational Impact - Flare, Operational Impact - Smoke	Satisfactory
20100944	15-May-10	Equal Energy Corp.	01-31-027-03 W5	Operational Impact - Nuisance	Notification to the AER after the fact (operation or concern no longer ongoing/inspection not possible)
20101064	10-Jun-10	Equal Energy Corp.	01-31-027-03 W5	Operational Impact - Spill, Health - Wildlife	Low Risk
20101987	28-Oct-10	NAL Resources Limited	04-03-027-03 W5	Odours - Other	4 Satisfactory
20102096	15-Nov-10		00-25-027-04 W5	Odours - SO2	Satisfactory
2011 Complaint Summary					
20110954	05-May-11	NAL Resources Limited	13-36-026-03 W5	Odours - THC	2 Satisfactory
20111333	20-May-11	NAL Resources Limited	04-03-027-03 W5	Operational Impact - Noise & Physical Impact - Water Well	Notification to the AER after the fact (operation or concern no longer ongoing/inspection not possible)

FIS Number	Incident Date	Company	Location	Concern Reported	Results of Inspection or Investigation
20111207	06-Jun-11	Equal Energy Corp.	01-31-027-03 W5	Operational Impact - Noise, Health - Wildlife	2 Satisfactory
20111509	15-Jul-11	TriOil Resources Ltd.	08-07-028-03 W5	Physical Impact - Property	Notification to the AER after the fact (operation or concern no longer ongoing/inspection not possible)
20111600	07-Aug-11	TriOil Resources Ltd.	15-36-026-03 W5	Procedural or Design - Inadequate Procedure	2 Satisfactory
20112010	02-Oct-11	Lightstream Resources Ltd.	00-09-027-03 W5	Operational Impact - Noise	6 Satisfactory
20112012	03-Oct-11	Lightstream Resources Ltd.	00-09-027-03 W5	Operational Impact - Noise	6 Satisfactory
20112039	04-Oct-11	Lightstream Resources Ltd.	00-09-027-03 W5	Operational Impact - Noise	6 Satisfactory
20112042	04-Oct-11	Lightstream Resources Ltd.	00-09-027-03 W5	Operational Impact - Noise	6 Satisfactory
20112127	18-Oct-11		00-09-027-03 W5	Operational Impact - Noise	4 Satisfactory
20112219	02-Nov-11		01-28-027-03 W5	Health - Human	Notification to the AER after the fact (operation or concern no longer ongoing/inspection not possible)
20112504	16-Dec-11	The Locke Stock & Barrel Company Ltd.	16-24-026-03 W5	Equipment Failure - Defect	Satisfactory
20112531	18-Dec-11	Lightstream Resources Ltd.	16-10-027-03 W5	Health - Human	Satisfactory

FIS Number	Incident Date	Company	Location	Concern Reported	Results of Inspection or Investigation
2012 Complaint Summary					
20120262	30-Jan-12		16-23-028-03 W5	Operational Impact - Spill	NAL investigated to confirm if release occurred. Release occurred by trucking company. ERCB's contacted Rockyview County to advise of release.
20120326	30-Jan-12		16-23-028-03 W5	Operational Impact - Spill	Linked to FIS # 20120262 ERCB aware of spill. Complainant obtaining copy of investigation through Information Services. No licence associated with this complaint.
20120259	31-Jan-12	TriOil Resources Ltd.	05-13-026-04 W5	Procedural or Design - Inadequate Procedure	Satisfactory
20120598	14-Mar-12	Velvet Energy Ltd.	02-10-028-03 W5	Operational Impact - Noise	Satisfactory
20120712	29-Mar-12	Lightstream Resources Ltd.	01-08-027-03 W5	Operational Impact - Noise, Operational Impact - Flare, Odours - Other	Satisfactory

FIS Number	Incident Date	Company	Location	Concern Reported	Results of Inspection or Investigation
20121104	26-May-12	TriOil Resources Ltd.	04-05-027-03 W5	Operational Impact - Flare	Complainant left message on ERCB inspector's cell phone prior to contacting ERCB 24 hour number. Prior to the complainant's initial call, TriOil regarding flaring. Notification to the AER after the fact (operation or concern no longer ongoing/inspection not possible)
20121436	09-Jul-12	No Licence	01-18-026-03 W5	Operational Impact - Nuisance	Concerned about no notification of a new lease. Area was being surveyed, application for well was withdrawn. Notification to the AER after the fact (operation or concern no longer ongoing/inspection not possible)
20121664	14-Aug-12		04-25-027-03 W5	Operational Impact - Hydraulic, Health - Human, Operational Impact - Flare	Tremors felt earlier in the morning. Notification to the AER after the fact (operation or concern no longer ongoing/inspection not possible)
20122270	10-Nov-12	Lightstream Resources Ltd.	13-20-027-03 W5	Operational Impact - Flare	High Risk

FIS Number	Incident Date	Company	Location	Concern Reported	Results of Inspection or Investigation
20122454	24-Nov-12	Bonavista Energy Corporation	12-30-027-03 W5	Physical Impact - Drilling Waste	Notification to the AER after the fact (operation or concern no longer ongoing/inspection not possible)
20122471	25-Nov-12	NAL Resources Limited	03-20-027-03 W5	Operational Impact - Flare	Satisfactory
20122424	01-Dec-12	NAL Resources Limited	03-20-027-03 W5	Operational Impact - Flare, Heath - Human	Satisfactory
2013 Complaint Summary					
20130124	17-Jan-13	The Locke Stock & Barrel Company Ltd.	16-24-026-03 W5	Noise - Pump Jacks	Satisfactory
20130709	05-Apr-13	Inter Pipeline Extraction Ltd	16-16-026-04 W5	Operational Impact - Noise	Satisfactory
20130827	13-Apr-13	Lightstream Resources Ltd.	13-31-027-03 W5	Operational Impact - Flare, Operational Impact - Smoke, Operational Impact - Noise	Satisfactory
20131298	30-Jun-13	NOVA Gas Transmission Ltd.	03-04-028-04 W5	Physical Impact - Public Hazard	Late notification to the AER. Issues with getting contact information for NEB. ERCB Team Leader aware. Notification to the AER after the fact (operation or concern no longer ongoing/inspection not possible)
20131333	05-Jul-13	Pengrowth Energy Corporation	01-04-027-03 W5	Odours - Other & Operational Impact - Hydraulic	Satisfactory

FIS Number	Incident Date	Company	Location	Concern Reported	Results of Inspection or Investigation
20131466	01-Aug-13	The Locke Stock & Barrel Company Ltd.	16-24-026-03 W5	Operational Impact - Fire	2 Satisfactory, 1 Low Risk
20131594	20-Aug-13	Lightstream Resources Ltd.	14-24-026-03 W5	Noise - Well Test/Fare/Vent	Satisfactory
20131664	28-Aug-13	Pengrowth Energy Corporation	03-35-026-03 W5	Noise - Drilling/Servicing	Satisfactory
20131695	30-Aug-13	Lightstream Resources Ltd.	16-10-027-03 W5	Health - Human	Prior complaint reported. Licensee sent to investigate. ERCB Team Leader aware.
20132172	31-Oct-13	Bonavista Energy Corporation	04-11-028-04 W5	Health - Human, Operational Impact - Flare, Operational Impact - Hydraulic	General concerns. Referred to ERCB's Community Relations.
2014 Complaint Summary					
20140001	01-Jan-14	Inter Pipeline Extraction Ltd	16-16-026-04 W5	Odours - Other	Satisfactory
20140373	15-Feb-14	Inter Pipeline Extraction Ltd	16-16-026-04 W5	Health - Human	Flaring no longer occuring at the time of the call. Notification to the AER after the fact (operation or concern no longer ongoing/inspection not possible)

FIS Number	Incident Date	Company	Location	Concern Reported	Results of Inspection or Investigation
20140372	15-Feb-14	Inter Pipeline Extraction Ltd	16-16-026-04 W5	Health - Human	Flaring no longer occuring at the time of the call. Notification to the AER after the fact (operation or concern no longer ongoing/inspection not possible)
20140533	08-Mar-14	Bonavista Energy Corporation	02-11-028-04 W5	Health - Human, Health - Livestock, Operational Impact - Hydraulic, Physical Impact - Water Well	Health emergency/issues not the jurisdiction of the AER. Wanting AER to conduct water well testing/sampling. (outlined in Water Well Complaint section above)
20140809	08-Apr-14	TriOil Resources Ltd.	02-01-027-04 W5	Opeational Impact - Hydraulic, Health - Livestock, Physical Impact - Water Well	Wanting a stop work order for Hydraulic Fracturing in Alberta. (outlined in Water Well Complaint section above)
20140991	29-Apr-14	Pengrowth Energy Corporation	03-20-027-03 W5	Operational Impact - Flare, Health - Human, Health - Wildlife	Low Risk
20141180	22-May-14	Inter Pipeline Extraction Ltd	16-16-026-04 W5	Noise - Other	Satisfactory
20141765	08-Jul-14	TriOil Resources Ltd.	13-27-028-04 W5	Operational Impact - Hydraulic	Notification to the AER after the fact (operation or concern no longer ongoing/inspection not possible)

FIS Number	Incident Date	Company	Location	Concern Reported	Results of Inspection or Investigation
20141763	08-Jul-14	TriOil Resources Ltd.	15-27-028-04 W5	Opeational impact - Hydraulic	Notification to the AER after the fact (operation or concern no longer ongoing/inspection not possible)
20141723	16-Jul-14	Sulpetro Limited	06-27-025-04 W5	Physical Impact - Reclamation	Notification to the AER after the fact. Complaint forwarded to Closure and Liability.
20142297	12-Sep-14	Hard Rock Resources Ltd.	10-04-028-03 W5	Human - Health	Satisfactory
20142530	05-Oct-14	Lightstream Resoures Ltd.	09-34-027-04 W5	Unknown	High Risk
20142936	31-Oct-14	Bonavista Energy Corporation	01-11-028-04 W5	Unknown	Satisfactory
20142980	12-Nov-14	Pengrowth Energy Corporation	03-20-027-03 W5	Unknown	Satisfactory

Appendix 3 Glossary

Dispersion modelling

Modelling how a plume of emissions moves through the air and the concentrations of compounds that might be in the air after dispersion.

Flaring

The igniting of natural gas at the end of a flare stack—a long metal tube within which the gas ascends and is burned in the atmosphere at the top.

Hydraulic fracturing flowback

In the hydraulic fracturing process, proppant, along with a carrier fluid (water, nitrogen, carbon dioxide, or other fluids and chemical additives), is pumped down a well to fracture and prop open the formation creating a path for hydrocarbons to flow to surface.

Immediately after the fracturing process, the carrier fluid is flowed back to surface by the pressure in the wellbore. The carrier fluid is collected and gas is separated at the surface.

The multistage hydraulic fracturing flowback operation is a brief part of a larger process and is required to complete the well in preparation for oil or gas production.

Typically because of gas pipeline specifications (e.g., limits on water content, carbon dioxide, etc.), the gas mixture during flowback cannot be conserved immediately. As a result, the gas mixture in the flowback is vented or flared to the atmosphere rather than conserved.

Once flowback is complete and the pipeline specification is met, hydrocarbon is produced for processing.

Incineration

The mixing and combusting of waste gas streams, air, and fuel in an enclosed chamber.

Interwellbore communication

Occurs when hydraulic fracturing on a wellbore affects another wellbore in the same formation.

The AER fully expects licensees to maintain well control at all times so as not to impact the environment, public safety, and efficient recovery of the resource and to prevent adverse effects to offset energy wellbores.

Noncompliance (also known as noncompliant event)

When a company or licensee does not follow AER requirements. Education, prevention, and enforcement activities are used to ensure compliance with AER requirements.

Directive 019: Compliance Assurance focuses on the prevention and enforcement aspects of compliance assurance and applies to all AER requirements and processes.

The AER uses a risk assessment process to predetermine the level of inherent risk associated with a noncompliance with each AER requirement. Each noncompliant event has an associated low or high risk rating based on the results of the risk assessment process for each AER requirement.

Reportable release

- Any unrefined product release of more than 2 m^3 on lease.
- Any substance release that may cause, is causing, or has caused an adverse effect.
- Any substance release off lease.
- Any substance release into a water body.
- Any pipeline release or pipeline break (including during pressure testing).
- Pipeline hits.
- Any uncontrolled gas release of more than 30 000 m^3.
- Any well flowing uncontrolled.
- Any fire caused by a flare or incinerator.
- Any fire causing a loss of more than 2 m^3 of oil or 30 000 m^3 of gas, or causing damage to a wellhead.
- Any fire that occurs on an oil sands site that results in the deployment of major fire-fighting equipment.