Alberta Energy Regulator

Investigation Summary Report

2015-004: Murphy Oil Company Ltd.

Licence No. P44181-016

March 3, 2017

Investigation number:	2015-004
Regulated party:	Murphy Oil Company Ltd., BA code 0063
Field centre of origin:	Grande Prairie
Incident location (nearest town):	08-34-082-15W5M, about 64 km east of Peace River
Contravention/notification date:	March 1, 2015
Licence number:	P44181-016

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Executive Summary

On March 1, 2015, at 4:32 p.m., Murphy Oil Company Ltd. (Murphy) contacted the Coordination Information Centre (Reference No. 295419) to report a pipeline failure and a release of an unknown volume of hydrocarbon condensate into the environment. The call was directed to the Alberta Energy Regulator's (AER's) Grande Prairie Field Centre.

The subject pipeline, Licence No. 44181, Line No. 16, has an outside diameter of 88.9 millimetres (mm) (3 inches), and a wall thickness of 3.20 mm. This line is used to ship diluent (low-vapour-pressure condensate/solvent) to various multiwell pads for blending with raw, produced bitumen as a means of lowering the bitumen viscosity. Lowering the viscosity facilitates shipment by pipeline back to Murphy's crude bitumen production facility located at Legal Subdivision (LSD) 4, Section 33, Township 82, Range 15, West of the 5th Meridian (04-33 facility). The pipeline segment is 7780 metres (m) in length and runs from the 04-33 facility to a satellite oil facility located at LSD 03-05-083-14W5M (03-05 facility).

After an initial review of metering records and a better estimation of the release point impacts, Murphy reported the volume of condensate released to be about 2700 cubic metres (m^3) on March 8, 2015. Once Murphy was able to do a detailed review of all related flow data for the pipeline and compare the main diluent meter leaving the 04-33 facility with the diluent received at the associated well pads, the volume was revised and calculated to be 1429 m^3. Murphy estimated that the pipeline had been leaking from about mid-January until March 1, 2015, when it was shut down and the leak was reported to the AER.

Once the pipeline was isolated and response activities were underway, it was determined that there were three separate releases along the pipeline right-of-way. The three surface areas were designated as areas 1, 2, and 3. The approximate areas of impact (not including areas required for access and staging) were

- 11 700 m^2 (Area 1);
- 1400 m^2 (Area 2); and
- 300 m^2 (Area 3).

The releases required a protracted response from Murphy's employees, SWAT Consulting Inc., Matrix Solutions Inc., HSE Integrated Ltd., WorleyParsons Ltd., and various other subcontractors and provincial regulatory staff. The event received limited media coverage, and Murphy engaged the local First Nations communities to assist with response efforts and to ensure that appropriate and timely updates were directed to the affected communities early in the response phase of the event.

The AER conducted the investigation for all three releases as one investigation since it was determined that the causes and pipeline failure mechanisms were identical for all three releases.

The AER investigated whether the event contravened the *Pipeline Act*, *Pipeline Rules*, *Public Lands Act*, *Environmental Protection and Enhancement Act*, or requirements under the Canadian Standards Association *Z662-15: Oil and Gas Pipeline Systems Code*.

Summary of Facts

Company Overview

Murphy Oil Company Ltd. (Murphy), the Canadian subsidiary of Murphy Oil Corporation, has secured interests in natural gas and crude oil exploration, production, and sales in both western Canada and offshore eastern Canada, and in the production of synthetic crude oil from northern Alberta's oil sands. Net production from Canadian operations in 2015 totalled about 57 400 barrels of oil equivalent per day (about 28 per cent of the corporation's total net production).[1]

Area and System Development and Operational History

Murphy acquired the rights for the exploration and development of oil sands in northern Alberta in the Peace River (Seal Lake) area in the late 1900s. The first heavy oil and bitumen wells that were drilled in 2004 into the Bluesky–Gething Formation showed strong potential for long-term primary and enhanced oil recovery capabilities.

Murphy's assets in the area have expanded significantly and include the purchase of Koch Oil Sands Operating ULC area assets and Shell Canada Ltd. area assets. Murphy now operates more than 500 wells on 100 well pads, six facilities (two main batteries, two satellites, two saltwater disposal facilities), and over 480 kilometres (km) of associated pipeline.

Pipeline and System Overview

The subject pipeline, Line No. 16 of Licence No. P44181, is an 88.9 millimetre (3-inch), carbon steel, type Z245.1, grade 3592 pipeline and is coated with a high-density polyethylene "yellow jacket." The line is 7780 metres (m) long, runs from the facility at Legal Subdivision (LSD) 4, Section 33, Township 82, Range 15, West of the 5th Meridian (04-33 facility) to the facility at LSD 03-05-083-14W5M (03-05 facility), was installed in the winter of 2010, and was completed and commissioned in February 2011. The maximum operating pressure for this line is rated at 5102 kilopascals (kPa), and the line's normal operating pressure is about 3000 kPa.

In the Seal Lake area, Murphy uses progressive cavity pumping units[2] to lift the high-viscosity bitumen to surface. To save on the cost and address the safety concerns of trucking the bitumen as well as the cost of maintaining heavy-haul roads, Murphy has built its pipeline infrastructure to facilitate transport of the bitumen from the well pads to the central processing facilities (CPFs). Transporting the high-viscosity, low-mobility bitumen by pipeline, however, can only be done by significantly lowering the bitumen

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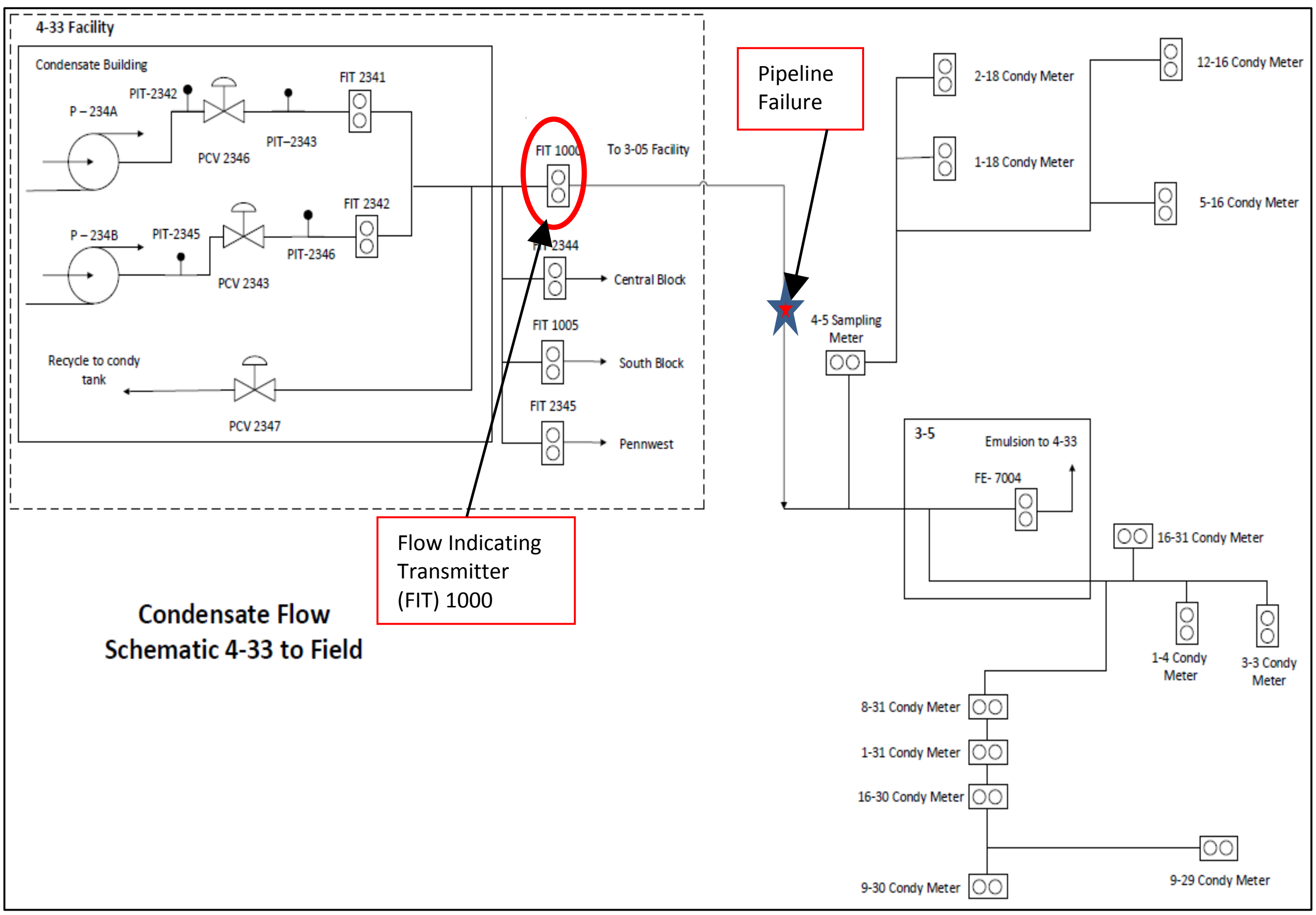
[1] Statistics from Murphy Oil's website from October, 2016 (under Global Operations, Canada). http://www.murphyoilcorp.com/Global-Operations/North-America/Canada/

[2] A progressive cavity pump is a type of positive displacement pump and is also known as an eccentric screw pump or cavity pump. It transfers fluid by progression through the pump, through a sequence of small, fixed shape, discrete cavities, as its rotor is turned. A typical progressive cavity pumping system consists of a surface driven (electric) prime mover, a wellhead drive (surface equipment), rod string, downhole rotator and stator which is housed in the production tubing of the well.

viscosity. Murphy has accomplished this by injecting a solvent, or “diluent,” into the product stream at each of the well pads (see figure 1) before shipping to the CPFs.

Diluent is pumped into the pipeline from a single, constant-speed pump at the 04-33 facility. Quote from page 2 of Murphy’s *System Operational History Summary*:

> The condensate pump works as a single delivery system that feeds all three areas from the 4-33 facility (South, Central, and East Blocks). The pump is controlled on a feedback control loop based on pressure set points. The pump operates at a constant speed on a recycle system, and if more or less condensate is required at the pump’s set speed, it works by actuating a recycle valve that puts the system into increased cycle if the line pressure reaches its set point, indicating adequate condensate in the system. If the pressure reduces, and remains within the operating set points, the recycle rate is reduced and more condensate is sent into the system until the pressure set point is again achieved.

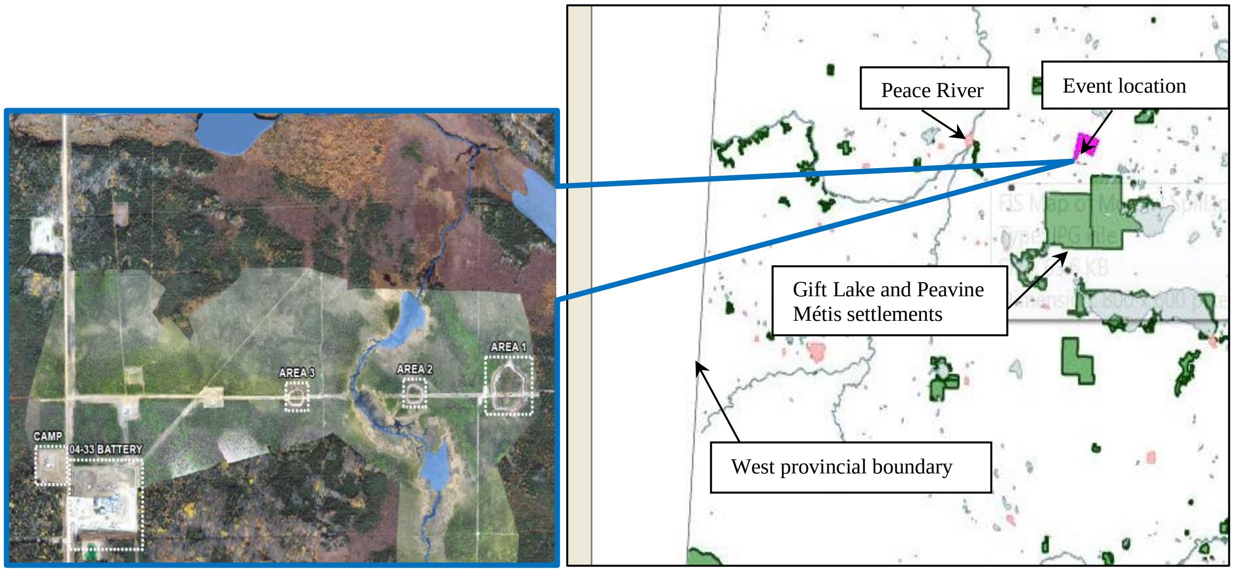


Source: From Murphy’s response to the AER’s information request.

Figure 1. Process flow diagram of condensate delivery system to the field.

Incident Overview

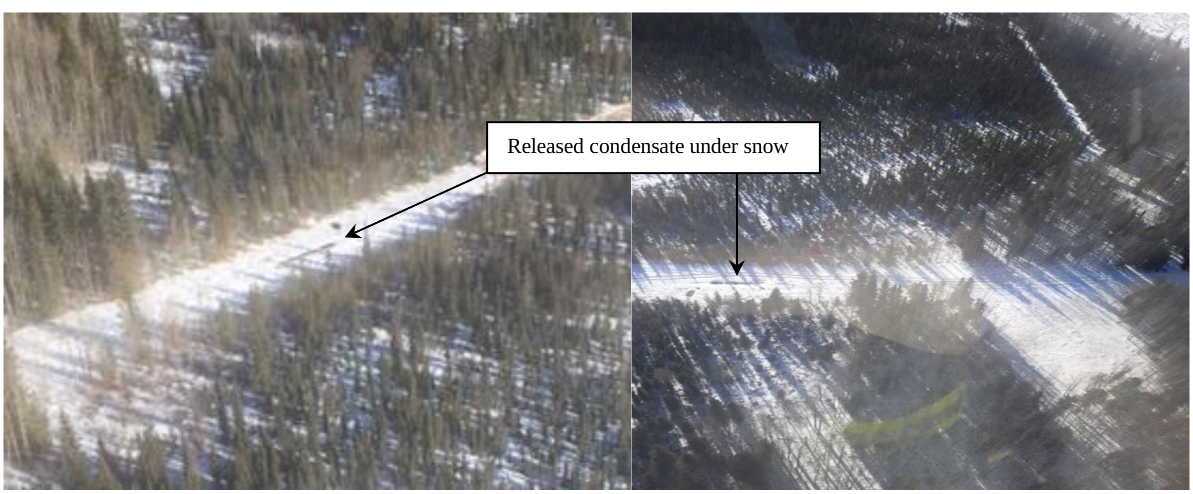
On March 1, 2015, at 4:32 p.m., Murphy contacted the Government of Alberta's Coordination Information Centre to report a pipeline failure and a release into the environment. The caller indicated that the volume of the release was unknown but was more than 2 m^3. The call was directed to the Alberta Energy Regulator's (AER's) Grande Prairie Field Centre (GPFC).



Source: Map from GIS mapping function. Inset from detailed aerial photograph included with matrix update.

Figure 2. Three pipeline failure locations along the pipeline right-of-way.

After Murphy did an initial review of the metered computational data and a more detailed site assessment, it reported the volume of condensate released to be about 2700 m^3 on March 8, 2015. Once Murphy was able to do a complete review of all related flow data for the pipeline and compare the main diluent meter leaving the 04-33 facility with the diluent received at the associated well pads, the volume was recalculated to be 1429 m^3. Murphy estimated that the pipeline had been leaking from about mid-January until March 1 (about 44 days) when it was shut down and the leak was reported to the AER.



Source: From the AER's Field Inspection System (Incident No. 20150607 attachments, March 10, 2015).

Figure 3. Aerial views of the area 1 spill site with snow cover.

Once the pipeline was isolated and response activities were underway, it was determined that there were three separate releases along the pipeline right-of-way (ROW). The three surface areas were designated as Area 1 (11 700 m^2), Area 2 (1400 m^2), and Area 3 (300 m^2), and occurred over about 1 km of the 7.8 km pipeline. Area 1, the largest impacted area, is roughly located at LSD 08-34-82-15W5M, between the 04-33 and 03-05 facilities and is the location used for reporting and communications purposes.

The released fluid is described as a light, nonaqueous-phase liquid with a relative density of 0.8 grams per cubic centimetre. It is composed of 5 per cent (mole fraction) benzene, toluene, ethylbenzene, and xylenes (BTEX); 90.5 per cent petroleum hydrocarbon (PHC) fraction (F) 1; 4 per cent PHC F2; and 0.5 per cent PHC F3 and F4.[3]

The release occurred in northwest Alberta about 64 km southeast of the city of Peace River on Crown land within a green (forestry) zone. The release occurred within the Boreal Forest Natural Region in an area called the Central Mixed Wood Natural Subregion. Landforms in the area include gently rolling plains with some hummocky upland inclusions to low-lying wetlands. Vegetation in this area is a mix of aspen-dominated deciduous stands, aspen-white spruce stands, white-spruce dominated stands, and jack pine stands on coarse, sandy upland features. Wet, poorly drained fens and bogs overlie almost half the area where black spruce, willow, bog birch, common Labrador tea, feathermosses, and peat mosses on organic soils are prevalent.[4]

Due to frozen ground conditions at the time of the release, the fluid remained mainly within the pipeline ROW, except in Area 1 where, because of the large volume released in that area, the fluid migrated in a circular pattern from the release point off the pipeline ROW.

On March 9, 2015, the day after the 2700 m^3 volume of the release was established, the manager and an investigator from the AER's investigation team determined that an investigation of this event was warranted based on the following criteria:

- Areas 1 and 2 release locations were on either side of an unnamed creek (each location was about 200 m from the creek) that is a tributary to the South Heart River. Area 1 was about 500 m from the creek. If condensate at the release points was not contained, condensate contaminated surface and groundwater would only need to flow downstream about 2.2 km to the South Heart River.
- There was a possibility of encountering sensitive wildlife (see table 1) within the release footprint and areas required for staging and access.
- The volume of the spill was significant (believed to be about 2700 m^3 at the time the event was sent to the AER investigations team).

[3] WorleyParsons, 2016, "Peat and Mineral Soil Remediation Action Plan, Seal Lake 08-34 Pipeline Spill," 13.

[4] Natural Regions Committee, 2006, "Natural Regions and Subregions of Alberta," compiled by D.J. Downing and W.W. Pettapiece, Government of Alberta, Pub. No. T/852, https://www.albertaparks.ca/media/2942026/nrsrcomplete_may_06.pdf

- When the volume of 2700 m^3 was communicated, two other failure locations were identified.
- The pipeline was only five years old, so the investigators had reason to believe that there were potential contraventions of the *Pipeline Act*, the *Environmental Protection and Enhancement Act*, the *Public Lands Act*, and Canadian Standards Association (CSA) *CSA Z662-15*.

Wildlife species in the area include amphibians, small mammals, birds, furbearers (e.g., bears, wolves), and ungulates (e.g., deer, elk). While the release locations did not fall within key wildlife and biodiversity or core grizzly bear zones, there were several provincially and federally listed species at risk that could potentially inhabit the affected areas (table 1).

When AER investigation staff visited the site on July 30, 2015, it was noted that two pairs of nesting common nighthawks had moved into Area 1. Murphy's crews marked the nesting sites and appointed staff to monitor access around the two nesting areas. AER investigators noted at least one fledgling in one of the nests.

Table 1. Species at risk potentially occurring in release areas

Common name	AEP status	COSEWIC* status	*SARA* status
Western toad	Sensitive	Special concern	Schedule 1
Birds			
Horned grebe	Sensitive	Special concern	Schedule 1
Trumpeter swan	At risk		
Peregrine falcon	At risk	Special concern	Schedule 1
Yellow Rail	Undetermined	Special concern	Schedule 1
Short-eared owl	May be at risk	Special concern	Schedule 1
Barred owl	Sensitive		
Common nighthawk	Sensitive	Threatened	Schedule 1
Olive-sided flycatcher	May be at risk	Threatened	Schedule 1
Bank swallow	Secure	Threatened	No schedule
Barn swallow	Sensitive	Threatened	No schedule
Canada warbler	Sensitive	Threatened	Schedule 1
Rusty blackbird	Sensitive	Special concern	Schedule 1
Mammals			
Little brown bat	Secure	Endangered	No schedule
Northern bat	May be at risk	Endangered	No schedule
Wolverine	May be at risk	Special concern	No schedule
Grizzly bear	May be at risk	Special concern	No schedule

Source: Matrix Solutions' *Wildlife Mitigation Plan*.

* The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) was established under the *Species at Risk Act* (*SARA*) as the authority for assessing the conservation status of wildlife species that may be at risk of extinction in Canada.

Source: Picture located in AER investigator's photos.

Figure 4. A common nighthawk nest. A close-up of one of two nests found within Area 1.

Response

On March 1, 2015, at 4:32 p.m., the GPFC, in consultation with the AER's Field Incident Response and Support Team (FIRST) classified this event as a level 1 emergency based on the AER's Assessment Matrix for Classifying Incidents in *Directive 071: Emergency Preparedness and Response Requirements for the Petroleum Industry*. This emergency level was agreed upon by both the AER and Murphy.

The releases required a protracted response from Murphy employees, Matrix Solutions Inc. (Matrix), HSE Integrated Ltd., WorleyParsons Canada Services Ltd. (WorleyParsons), and various other subcontractors and provincial regulatory staff. The event received limited media coverage and Murphy engaged the local First Nations communities to assist with response efforts and to ensure that appropriate and timely updates were directed to the affected communities early into the response phase of the event.

Upon discovering the pressure and flow anomalies, which indicated the possibility of a pipeline failure, Murphy shut in the suspected pipeline, initiated their emergency response plan for the Seal Lake Area, and reported the incident to the AER. Once the release was confirmed, the pipeline was physically isolated and depressurized. Once the sites could be accessed from the ground, containment and recovery measures were initiated and, in addition, a surface and groundwater sampling program was implemented to assess whether either surface or groundwater was being adversely affected.

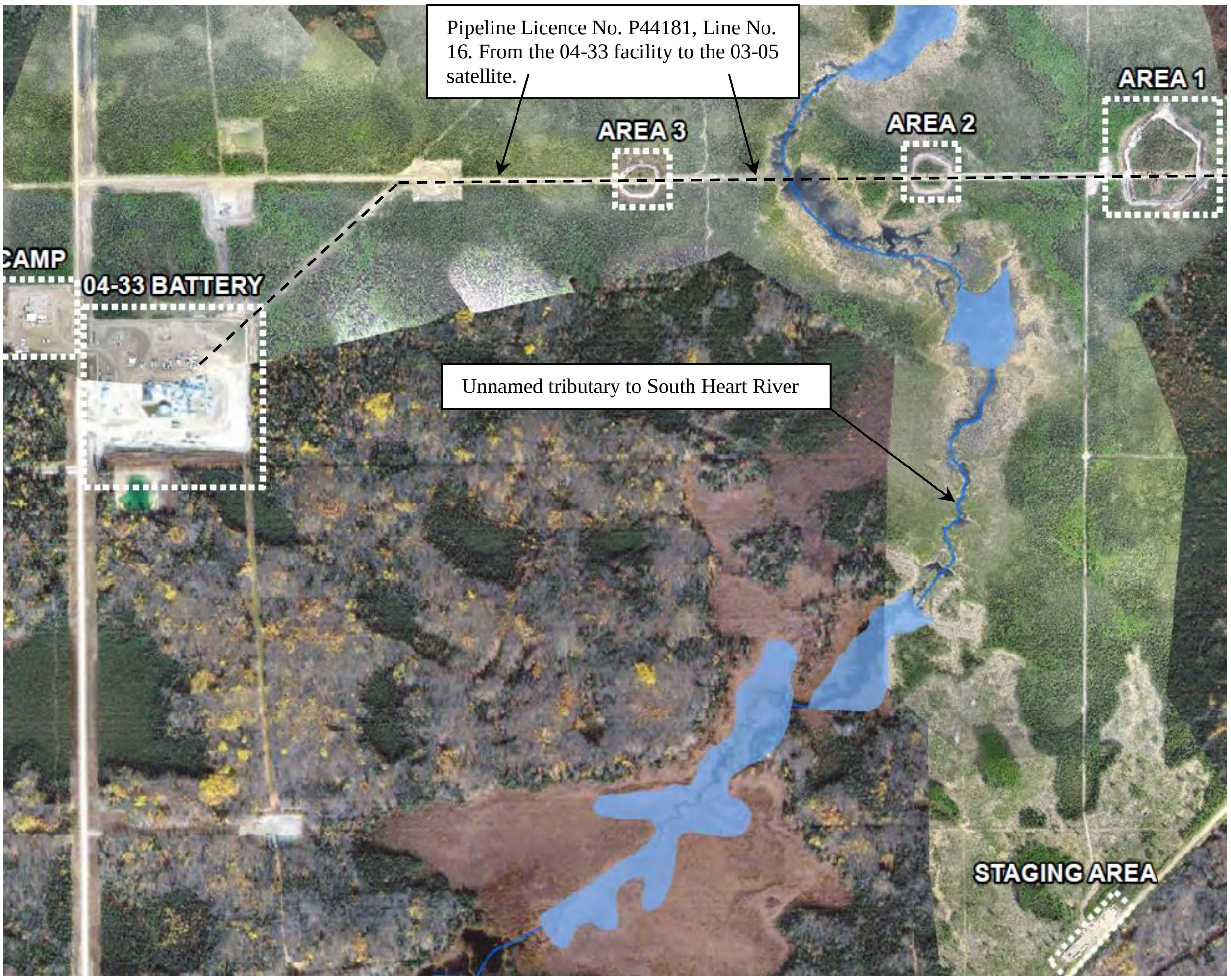
Due to the high concentrations of volatile organic compounds in the released diluent, extra precautions were taken by responding staff. These included

- fixed and roving air monitoring units;
- strict access control for responding and essential staff only;
- the use of an industrial hygienist to address worker health risks and steps needed to address these;
- along with standard personal protective equipment, staff working in high-risk areas near release points were required to wear full-face, chemical cartridge respirator masks; and
- if a lower explosive limit of >10 per cent due to fumes was picked up by any of the fixed or roving air monitoring units, staff working in the area were immediately evacuated to a safe distance until the source of the vapours could be controlled or eliminated.

Early in the response phase of the incident, Murphy drilled a series of boreholes to establish the subsurface extent of the released condensate. A water sampling program was approved by the AER to assess potentially impacted surface and groundwater in and around the affected areas. Murphy also initiated a wildlife program to monitor for and divert wildlife from the affected surface areas and water features.

The following is an excerpt from section 2.6 of Murphy's response to the AER's information request, which describes Murphy's subsequent response to the releases:

> **Subsequent Response and Control Measures**
>
> Murphy then took steps to:
>
> 1) Contain any condensate impacted surface and shallow subsurface water with the potential to migrate away from the spill site as the weather warmed (surface containment);
>
> 2) Divert unimpacted surface water away from the affected areas as the weather warmed and snow melt began (surface diversion);
>
> 3) Capture and remove water that migrated into the containment system and became impacted with condensate and send it to appropriate treatment/disposal (fluid management); and
>
> 4) Develop and test potential systems to collect free phase condensate from within the three affected areas (liquids recovery).



Source: Compass Geomatics (May 28, 2015).

Figure 5. Release areas topographic overview. Picture located in FIS Incidents 20150607

Table 2. Total volumes of peat and soils impacted and removed from sites (m^3)

	Peat			Mineral soil			Total		
Area	**10th percentile**	**50th percentile**	**90th percentile**	**10th percentile**	**50th percentile**	**90th percentile**	**10th percentile**	**50th percentile**	**90th percentile**
1	20 000	24 000	27 000	6800	8 000	9 000	27 000	32 000	36 000
2	810	1 400	2 400	100	1 300	2 900	1 400	2 700	4 800
3	1 300	2 100	3 300	660	1 900	3 800	2 400	4 100	6 600
All	24 000	28 000	31 000	9200	11 000	14 000	34 000	39 000	44 000

Source*:* WorleyParsons' *Peat and Mineral Soil Remediation Action Plan*, page 5.

Source: Compass Geomatics (May 28, 2015).

Figure 6. Area 1 aerial view (11 700 m^2 area impacted).

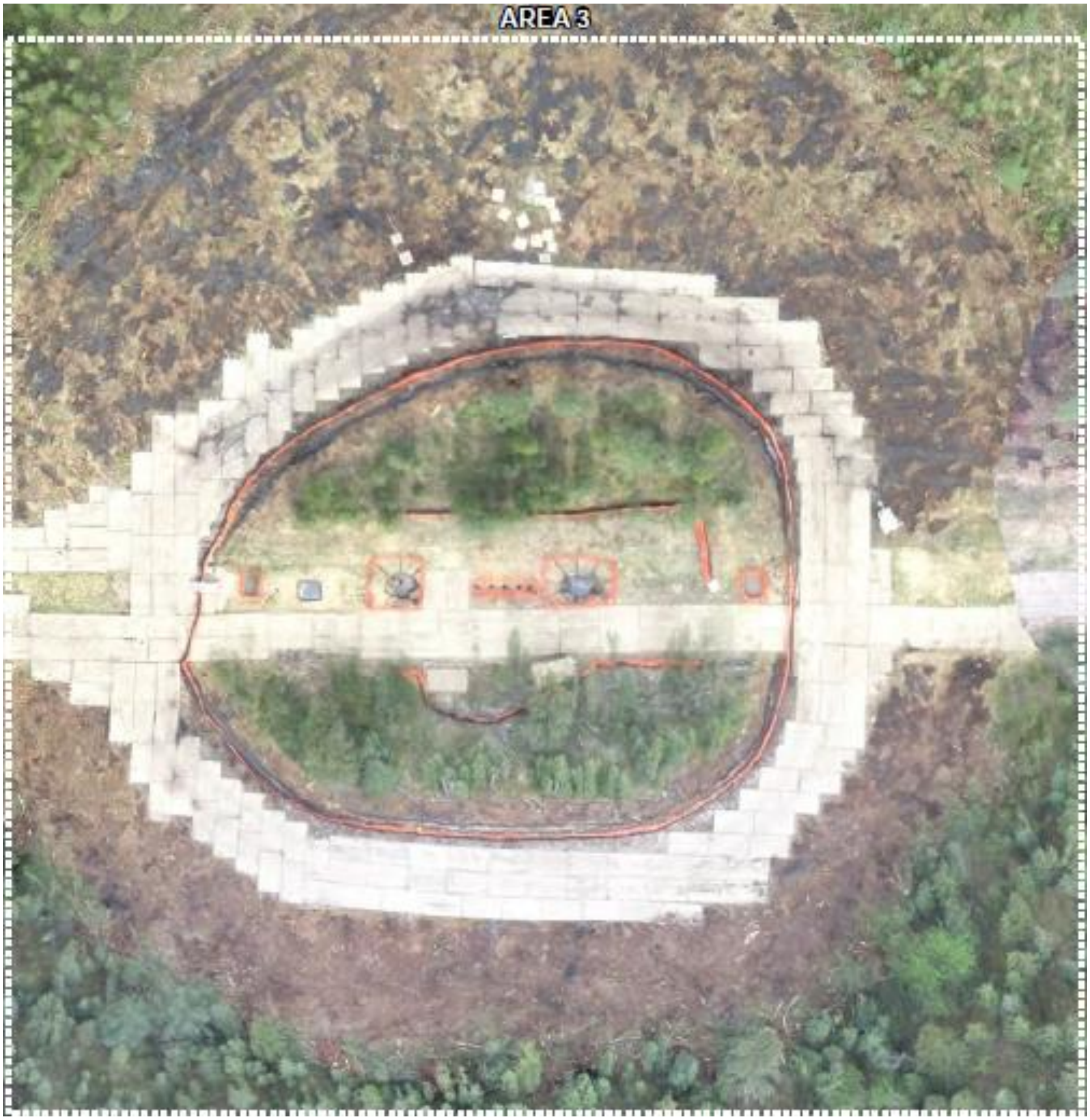
Source: Picture from AER investigator's photos.

Figure 7. Significant impact in Area 1—condensate saturated organic layer and impacted vegetation (Note: swamp matting throughout site).

Source: Compass Geomatics (May 28, 2015).

Figure 8. Area 2 aerial view (1400 m^2 area impacted).

The incident was downgraded from a level 1 to a level 0 (alert) on June 12, 2015. Although the AER's FIRST transferred lead responder status to the GPFC on March 25, 2015, the emergency level was maintained at level 1 until the company could achieve both full surface containment and subsurface monitoring of the release and confirm source control.



Source: Compass Geomatics (May 28, 2015).

Figure 9. An aerial view of Area 3 (300 m^2 area impacted).

Investigation

Investigation Process

The AER assigned two investigators to this file. The preliminary work the investigators carried out included gathering photographic documentation of the release areas and related impacts, photographs of associated process equipment, discussions with Murphy's operations staff regarding operational data sourced from the company's supervisory control and data acquisition (SCADA) system, and documentary information needed to do an initial assessment of the file. The AER investigators requested the following preliminary information from Murphy on March 12, 2015:

- The most recent analysis of the condensate that is typically shipped through the subject pipeline (after Pumps No. 234-A and 234-B)
- All meter calibration records associated with the condensate system from 2014 and January, February, and March of 2015. This includes condensate meters at the various wells and satellites serviced by this pipeline
- Material balance and/or reconciliation of condensate entering the facility versus condensate delivery metering points (wells and satellites)
- Cathodic protection survey reports from 2013 and 2014
- A copy of Murphy's operation procedures and alarm protocols
- A copy of Murphy's *Pipeline Integrity Manual*, including corrosion monitoring and mitigation for this line
- Copies of operator logbook pages from January 1, 2014, to present date
- Any overline surveys conducted on this line (ROW surveys as well as coating surveys)
- Copies of process flow and instrumentation diagrams for the condensate system
- Copies of any in-line inspection records (e.g., tether-tool) as well as results from integrity digs, ultrasonic thickness testing on the system, pipeline analysis from any previous failures
- Copies of the chemical supplier (Champion) recommendations for the chemical injected into this system along with a material safety data sheet of the chemical
- All construction records pertaining to the installation of this pipeline and appurtenances

The AER visited the 04-33 facility and release sites on seven separate occasions for more photographic documentation, to gain a better understanding of the environmental impacts and the condensate delivery system and to witness milestone events such as pipeline failure cut-outs. The investigators made six separate information requests and conducted a total of 11 witness interviews, all of which were considered while compiling the information necessary to assess the causes of the pipeline failure and the licensee's duty of care relating to the incident.

Murphy's Failure Analysis

Murphy contracted WorleyParsons Asset Integrity Group – Speciality Engineering to assess the causes of the pipeline failure and subsequent spill (the WorleyParsons report). Due to the dangers associated with working around the released condensate, an investigation plan was developed taking into account worker, wildlife, and environmental safety while examining all potential risk factors that could have affected the integrity of the pipeline. The investigation plan developed by WorleyParsons included the following:

- A review of Murphy's documentation relating to engineering design, materials, and construction
- An inspection of the external coating and cathodic system in place to mitigate external corrosion
- An in-line inspection (ILI) of the pipeline with a "smart" tool (pig) to determine existing internal and external metal loss
- A review of Murphy's existing internal and external corrosion programs
- A review of all related construction data (engineered drawings, as-built diagrams, process flow and instrumentation diagrams, and welding procedures)
- A review of Murphy's existing operating practices
- Several integrity digs that will accomplish or confirm the following:
  - Results of the coating and ILI surveys
  - An inspection of construction quality at the dig sites
  - Failure specimen cut-outs to be sent to a third-party, metallurgical lab for analysis

WorleyParsons' comprehensive and exhaustive analysis of the three pipeline failures took into account all of the listed risk factors associated with these events. WorleyParsons' analysis included the services of the companies listed in table 3 to assess the different aspects of the failures (the services were directly paid for by Murphy):

Table 3. Subcontractors commissioned by WorleyParsons to assess different aspects of the cause of the pipeline failure

Company	Service provided
Cormetrics Ltd.	Fluid corrosivity testing Chemical inhibitor residual analysis Water chemistry Sludge analysis Waxy deposit analysis Dig area inspection services Non-destructive/destructive metallurgical analysis of the failed pipe segments Soils (near failure locations) analysis
Onstream Inspection Ltd.	ILI services
PureHM Inc.	External line inspection,coating services Depth of cover verification
Team Industrial Services Inc.	ILI metal loss feature verification Non-destructive metallurgical testing at verification dig sites.

Company	Service provided
Acuren Group Inc (for Cormetrics).	Non-destructive (magnetic particle) examination of pipe sections at failure locations to look for cracking and/or metal fatigue indications Mechanical testing at Acuren's Edmonton testing facility
Maxxam (for Cormetrics)	Liquid hydrocarbon chromatographic analysis
Sologics	Root cause analysis (RCA) with RCA chart and final report

Failure Cause

Worley Parsons' analysis of the failures in Areas 1, 2, and 3 determined that internal corrosion was the cause of failure in all three locations. The corrosion mechanism in all three failures has been identified as localized pitting beneath deposits formed on the lower (about six o'clock position) quadrant of the pipe. The following is an excerpt of the conclusion of the Worley Parsons report:

> The cause of the NPS 3 condensate pipeline failure at the three locations (Area 1, Area 2 and Area 3), which resulted in the condensate spill along the pipeline ROW at these locations, was internal corrosion that developed under deposits on the inside surface along the bottom of the pipe.
>
> The corrosion mechanisms were generally driven by localized pitting corrosion reactions that occurred beneath the deposits formed on the inside of the pipe. Internal corrosion inhibition was provided by continuous injection of Cortron RN-500. It was noted that no documentation was provided to MOCL to establish that the Cortron RN-500 corrosion inhibitor was suitable to protect the NPS 3 condensate pipeline. The manufacturer's technical data for Cortron RN-500 indicated that it is intended for low to high brines; moderate to high concentrations of CO_2, H_2S, and/or organic acids; minimizing emulsification characteristics in heavier oil systems; improving dispersibility in high total dissolved solids brine; neutralizing low pH (acidic) environments; minimizing treating issues in low levels of paraffinic crude; and providing improved filming in high shear environments. Based on the information available for this review, this was not the fluid service environment of the NPS 3 condensate pipeline.
>
> The mechanisms that led to the failure of the NPS 3 condensate pipe and the consequent spill of the condensate along the pipeline ROW were compounded by the absence of pigging and a sound pipeline integrity management program, which are standard practices in the pipeline industry. Pigging the line is necessary to keep it clean internally, and an integrity management program would have helped to detect and monitor the progress of the potential failure threats to the pipeline. These practices help to ensure safe pipeline operations and compliance with CSA Z662. In addition, the flow of condensate in the pipeline was expected to have been at a very low rate, which may have allowed water and entrained solids to drop out, build up along the bottom of the pipe and provide a supportive environment for under-deposit corrosion.[5]

Release Impacts

The following has been quoted from an email provided to the investigators by the AER's risk assessment specialist and toxicologist requesting an assessment of the initial and potential (if left unmitigated) impacts of the release.[6]

[5] WorleyParsons Canada Services Ltd., "Cause and Failure Analysis."

[6] Email from Catherine Evans regarding the initial and potential impact of the Murphy Oil release.

Soils and Vegetation

A great deal of the damage to the local ecosystems was physical from the condensate or from the collateral damage arising from the containment and remediation activities. Losses of soil materials in the directly impacted areas will occur and even soil that is found to be recoverable after treatment will take time to replace and restore to full function. Some of the area involved has been previously disturbed by pipeline activities, so it was not pristine at the start of the incident but was still functional habitat. Trenching and the extensive berming that was established to control condensate and water movements on the site also contributed to the physical footprint. Other remediation and monitoring activities (rig mats, boardwalks, vehicle traffic, etc.) also contribute to the overall physical impact but these areas don't have as much soil loss (except where pads had to be established) and the peaty soils are likely to recover well over time if not compressed too greatly. The chemical footprint outside the removal area was limited but there were mobile components moving in the landscape and in groundwater via the pipeline fill material and in sand seams that intersected the deeper impacts. There would be an eventual recovery to the area following reclamation but the timetable is unknown as the remediation is ongoing.

Wildlife: low as a direct effect of the spill, moderate due to the disturbance in the area.

Any smaller wildlife caught in the bulk condensate or areas with intense vapours would not have survived but since the release was late winter/early spring, wildlife movements were limited and the vapours may have acted as a deterrent to larger wildlife moving into the release areas. It is not possible to tell if smaller animals in the release area were killed via direct contact with the condensate as smaller bodies are difficult to find and may have been underground or hidden in debris (frogs in this area overwinter on land)

Water: moderate impact to localized areas

Condensate is dominated by lighter hydrocarbons with high water solubility and high mobility in moving surface and groundwater. However, this incident site was frozen at the time of the release and there was a relatively low snowpack in the immediate area that winter. The movement of surface water that year during the thaw and freshet was limited. While traces dissolved hydrocarbons were found some distance away there was no sign that the major water bodies in the area were impacted. Groundwater in the immediate impact areas and areas slightly outside this zone were impacted but large scale movements were not seen.

If the release materials had been left in place and had not been contained/remediated:

Key Message: Condensate components are highly mobile and in this type of landscape, will spread out and impact a much larger area if not rapidly contained before any major thaw. In addition, there was an acute fire hazard (potential for additional damage to vegetation and wildlife over large area).

Soils and Vegetation: severe and long-term adverse impact in localized area of release, severe impact in downgradient areas due to the extreme mobility of the product released

Complete impairment of normal soil function in the main release area would have occurred for the foreseeable future until evaporation, dispersion in water and bacterial degradation acted to remove the hydrocarbon impacts. This would have taken years (especially for the less mobile and degradable heavier components of the condensate mixture and for pockets of hydrocarbons trapped in layers of wetter soils) and a great deal of the local natural attenuation would have come at the expense of downgradient areas and air quality. Damage to vegetation would have been reversible in the extremely long term.

Wildlife: severe acute impact in localized area due to vapours and direct contact with spill, potential to severely impact wildlife travelling through dispersal areas downgradient and severely impact wildlife using local water bodies. Hazard to wildlife would also translate as immediate acute hazard to any humans using the area for traditional or other activities. There would be high potential to taint meat of game animals. There would also be high potential to impact local and migratory birds as well as significant impact to frogs and toads once they emerged from hibernation.

Water: severe and acute impacts locally, becoming more chronic further downgradient but potentially impacting a large volume of moving water. The extent and magnitude of the impact is highly weather and terrain dependent.

If left uncontrolled, the more mobile components that form a large portion of the condensate mixture would have spread out and seeped over a wider portion of the landscape. It is highly likely that they would have impacted local creeks and, given the volume of the release and the landscape, it is likely that the local rivers would have seen some impacts. Precipitation events, especially heavy rains that come in before the ice is fully out of the peat, can move dissolved mobile hydrocarbons large distances over frozen or partially frozen ground and it is possible that free product would also have moved long distances under the right circumstances. During warmer and drier periods, the high organic content of the soil would have acted to keep the heavier hydrocarbons closer to the site if seepage was slow, but movement in spring can be very unpredictable and movement along preferential surface and subsurface flow pathways (channels in the surface or sand seams in the subsurface) can act to spread contaminants rapidly in certain directions. It is very likely that levels in local streams would have exceeded human drinking water guidelines as well as aquatic life guidelines. If substantial free product movement took place (common in freshet conditions and during heavy storms), shoreline fouling in local creeks and river banks would have been possible. Fouling of small “pocket” pools of water in this type of landscape with dissolved phase and free product (free-phase hydrocarbons) would almost certainly occur.

Investigation Findings and Potential Contraventions

The AER investigators considered several factors when assessing the causes of this pipeline failure. These factors took into account risks or combinations of risks that are considered in *CSA Z662*, the National Association of Corrosion Engineers’[7] recommended practices, industry recommended practices and the investigation team’s applied knowledge and experience. Because the primary cause of the failure and failure mechanisms had been established by Murphy and WorleyParsons, the risks that the AER focused on were

- operating procedures,
- construction related (pipe handling or backfill procedures),
- maintenance and repair (cleaning/pigging),
- internal/external corrosion monitoring and mitigation,
- leak detection systems and processes, and
- training.

[7] National Association of Corrosion Engineers (NACE) International was established in 1943 and is a professional organization for the corrosion control industry with headquarters in Houston, TX. NACE's main focus of activities includes cathodic protection, coatings for industry, inspection, corrosion testing, and material selection for specific chemical resistance.

After careful consideration of all the evidence collected through the investigative process and the information gathered from initial and supplementary information requests, the investigators had grounds to believe that

- the release adversely affected the environment—specifically, vegetation, about 44 000 m^3 of peat and mineral soils (see table 2), and groundwater;
- the release, if left unmitigated, would cause a significant adverse effect on the environment;
- if the release occurred after spring thaw (during freshet) the condensate would have saturated a much larger area and may have impacted the nearby unnamed tributary;
- the pipeline's leak detection system was not operating to the standard that was outlined in Murphy's leak detection procedure located in the *Pipeline Operations, Maintenance and Integrity Manual* (*POMIM*) or *CSA Z662*. Operating and instrumentation devices were not capable of early leak detection;
- staff were not adequately trained on the leak detection procedures as required by Murphy's *POMIM*; and
- Murphy did not conduct and document an evaluation of the subject pipeline to determine the necessity for, and the suitability of, internal corrosion mitigation procedures annually when information available to them indicated the potential for corrosion and the risk to the environment should a failure occur.
- based on the higher volumes that were measured on and (which continued to increase) after January 12, 2015, by the main diluent meter leaving the 04-33 facility, Murphy ought to have investigated the potential of a failure by at least January 15, 2015. The average difference in daily volumes for the last 44 days the pipeline was in operation was about 55 per cent higher than for the three previous months.

The investigation has uncovered contraventions of legislation under the jurisdiction of the AER, some of which are also offences that can be prosecuted by the Crown. The following establishes the contraventions that are also offences:

Contravention 1

Legislation/Guideline name	Section	Citation
Public Lands Act	54(1)	No person shall cause, permit or suffer (a.1) loss or damage to public land,
And where the following also states		
Public Lands Act (Prohibitions)	56(1)	A person who […] (g) contravenes section 53, 54, 54.01(2), (3), (4) or (5), 57, 58 or 69.6 is guilty of an offence.

Findings

The release caused damage to public land

The release occurred in the Peace River (Seal) area on Crown land. The total area impacted by the three releases encompassed about 13 400 m^2 (1.34 hectares) of previously disturbed (pipeline corridor) and undisturbed (off the pipeline ROW) public lands (this does not include the surface areas required for access to the release sites and work/staging areas). Because the vegetation, organic layer, mineral layers and clay layers became saturated, it was necessary to "seal" the outer boundaries of each release area with a clay berm that extended downwards to the clay sub-layer. Once completed, free-phase condensate had to be recovered and impacted surface and groundwater, impacted vegetation, organic materials, and subsoils had to be removed to remediate the site.

Supporting Evidence

- Remediation Action Plan presentation to the AER, April 22, 2016.
- WorleyParsons *Peat and Mineral Soil Remediation Action Plan*, March 11, 2016.
- Detailed aerial view of releases 1, 2, and 3 show significant impacts for each release site.

Contravention 2

Legislation/Guideline name	Section	Citation
Pipeline Rules	7(3)	Operations, maintenance and integrity management manuals A licensee shall […] (b) be able to demonstrate that the procedures contained in the manuals are being implemented
And where the following then states		
Pipeline Act	52(2)(a)	A person who;(a) whether as a principal or otherwise, contravenes any provision of this Act or of the rules or of any order, direction or licence under this Act, is guilty of an offence

Findings

Murphy failed to demonstrate that it had implemented its procedures

The AER investigation found three instances where Murphy failed to demonstrate that its *POMIM* was being implemented.

Murphy's *POMIM* indicates in the section titled "Pipeline Work Order/KPI Procedure" that a planned work order would be issued annually for the evaluation of internal corrosion on steel pipelines and an internal corrosion mitigation review would occur quarterly. The investigation determined that Murphy failed to implement this requirement for three consecutive years as only one internal corrosion evaluation was completed, contrary to the requirements in the *POMIM*, which requires yearly evaluations. The only internal corrosion evaluation of the pipeline occurred on April 14, 2011. It was done by Champion Technologies Ltd. The evaluation was submitted after the completion and commissioning of the East Block pipeline project, which occurred in February 2011. The evaluation states that

> Condensate is transported to each "end of the line" through a series of LVP pipelines. These pipelines are made of bare steel and currently have no inhibition program. It is Champion's understanding that the condensate transported in these pipelines contains some water which can vary in content from trace to 20% by volume. This water poses a moderate internal corrosion threat and therefore should be mitigated.

Murphy's low vapour pressure (LVP) pipeline leak detection procedure located in the *POMIM* indicates that regular inspections and maintenance of all instruments and systems affecting the LVP leak detection system will be performed. The AER found that maintenance was not being performed, as most of the receiving diluent meters at the well pads had not been calibrated since October 2012.

The same section in the *POMIM* indicated that annual LVP leak detection system tests (training exercises) would be performed; however, when interviewed, most of the interviewees were not aware that a leak detection system was in place and were not trained in leak detection. Therefore, Murphy also failed to demonstrate that the annual training exercises required by the *POMIM* were being implemented.

From the foregoing, the AER investigation has found that Murphy has failed to implement the procedures in its *POMIM*, as required by section 7(3) of the *Pipeline Rules*.

Supporting Evidence

- Murphy's *Pipeline Integrity Manual*
- Champion Chemical's 2011 evaluation of the condensate pipeline and associated system, page 6, paragraph 4
- Murphy's *POMIM* (Leak Detection section), page 2, paragraph 2

Contravention 3

Legislation/Guideline Name	Section	Citation
Pipeline Rules	54(1)	Annual evaluation for internal corrosion mitigation Unless otherwise authorized by the Regulator, a licensee shall conduct and document an evaluation of any operating or discontinued metallic pipelines in a pipeline system to determine the necessity for, and the suitability of, internal corrosion mitigation procedures (a) annually
And where the following then states		
Pipeline Act	52(2)(a)	A person who;(a) whether as a principal or otherwise, contravenes any provision of this Act or of the rules or of any order, direction or licence under this Act, is guilty of an offence

Findings

Murphy failed to evaluate the internal corrosion mitigation system

The investigation determined that internal evaluations for corrosion mitigation were not being performed annually as required by section 54 of the *Pipeline Rules*.

The only internal corrosion evaluation of the subject pipeline occurred on April 14, 2011. Champion Technologies Ltd submitted its evaluation after the completion and commissioning of the East Block pipeline project, which occurred in February 2011. The evaluation states that

> Condensate is transported to each "end of the line" through a series of LVP pipelines. These pipelines are made of bare steel and currently have no inhibition program. It is Champion's understanding that the condensate transported in these pipelines contains some water which can vary in content from trace to 20% by volume. This water poses a moderate internal corrosion threat and therefore should be mitigated.

Therefore, Murphy was aware that there was potential for water to enter the product stream in the line, causing a potentially corrosive environment. Once the potential for corrosion was identified, suitable internal corrosion mitigation procedures were necessary.

According to the engineering piping and instrumentation diagram gathered from the site by the AER during an initial visit, the condensate pipeline leaving the 04-33 facility was configured with an in-line removable spool piece that is used for corrosion monitoring. During witness interviews, it was evident that there was no knowledge of this piece of equipment, so it was never removed from the pipeline to evaluate for internal corrosion. An in-line spool piece is an effective and easily evaluated means of monitoring for corrosion. Murphy could have used the in-line spool piece to monitor for corrosion, but it did not do so.

According to WorleyParsons' *Pipeline Failure Analysis Report*, an appropriate pipeline integrity management program would have helped to ensure that risks of internal corrosion would have been monitored and mitigated prior to failure of the pipeline. Further, a pigging program to keep the pipeline free of deposition would have helped to mitigate threats of under deposit corrosion, which was the main failure mechanism identified in the cause analysis. The WorleyParsons report states that

> The mechanisms that led to the failure of the NPS 3 condensate pipe and the consequent spill of the condensate along the pipeline ROW were compounded by the absence of pigging and a sound pipeline integrity management program, which are standard practices in the pipeline industry. Pigging the line is necessary to keep it clean internally, and an integrity management program would have helped to detect and monitor the progress of the potential failure threats to the pipeline. These practices help to ensure safe pipeline operations and compliance with CSA Z662. In addition, the flow of condensate in the pipeline was expected to have been at a very low rate, which may have allowed water and entrained solids to drop out, build up along the bottom of the pipe and provide a supportive environment for under-deposit corrosion.

Therefore, the WorleyParsons report also concluded that it was necessary for Murphy to have and evaluate an internal corrosion mitigation system.

There was extensive corrosion throughout this pipeline. Murphy did a partial (3.532 km of 7.780 km) ILI of the pipeline on August 13, 2015. An integrity management and pigging program, which are industry standard practices for metallic pipelines, would have helped detect and monitor the progress of internal corrosion within this pipeline. The final ILI indicated the following:

Table 4. Total corrosion features for 3.53 km of the pipeline

Pit depth (%)	Number of features
<50	1130
50–59	25
60–69	19
70–79	3
80+	7
Total	**1184**

This requirement is also clearly stated in *CSA Z662,* clause 9.10.3.1: "Operating companies shall monitor the effectiveness of their internal corrosion control programs."

Supporting Evidence

- Champion Chemical's 2011 evaluation of the condensate pipeline and associated system, page 6, paragraph 4
- Process piping and instrumentation diagram showing removable spool piece Drawing No. 04-33-082-15W5-F-003
- WorleyParsons' *Pipeline Failure Analysis Report;* section 12, page 49, paragraph 3
- Onstream Pipeline Inspection Ltd., tether-tool (smart pig) report June 25, 2015

Contravention 4

Legislation/Guideline Name	Section	Citation
Pipeline Act	52(2)(a)	A person who;(a) whether as a principal or otherwise, contravenes any provision of this Act or of the rules or of any order, direction or licence under this Act, Is guilty of an offence
And where the following then states		
Pipeline Rules	9(3)	Except as otherwise specified by these Rules, the minimum requirements for the design, construction, testing, operation, maintenance, repair and leak detection of pipelines are set out in CSA Z662.
And where the following then states		
CSA Z662	10.3.3.3	Installed devices or operating practices, or both, shall be capable of early detection of leaks.

Findings

Murphy's pipeline was not operated with the capability of early leak detection

The investigation determined that (1) there were no operating practices in place with respect to early leak detection, and (2) the receiving diluent meters were not properly calibrated and therefore were not capable of early leak detection.

With respect to the lack of operating practices, although Murphy's *POMIM* established procedures with respect to early leak detection using material balance calculations, these procedures were not being carried out.[8] During witness interviews, the AER learned that material balance calculations were not being communicated to operations personnel. When asked about leak detection training, Murphy's operations manager (at the time of the release) stated that there was no leak-detection training.

The AER requested material balancing records for the months of January and February 2015; however, no records were available.

Additionally, with respect to the lack of operating practices for early leak detection, Murphy's LVP pipeline leak detection procedure in the *POMIM* indicates that regular inspections and maintenance of all instruments and systems affecting the LVP leak detection system should take place. The AER discovered that most of the receiving diluent meters at the well pads had not been calibrated since October 2012, demonstrating that regular maintenance was not occurring. If the end-point meters would have been calibrated on a minimum yearly interval and alarm set-points adjusted to appropriate tolerances, the system would have been able to provide early leak detection capabilities. Since the meters were not calibrated, the installed devices were not capable of early leak detection, as required by *CSA Z662* and in contravention of section 9(3) of the *Pipeline Rules*.

Murphy has a pipeline integrity management program in place. However, some of the critical procedures outlined in the program were not adhered to, such as the LVP pipeline leak detection procedure (procedure No. 108) from the *POMIM*. This procedure recommends regular inspections and maintenance of all instruments and systems affecting the LVP leak detection system. The AER discovered that most of the receiving diluent meters at the well pads had not been calibrated since October 2012.

The pipeline ROW inspection procedure (procedure No. 101) indicates a checksheet will be filled out for every ROW inspection. Although Murphy was conducting aerial surveys of their ROWs, no checklists were available when the AER investigators requested them. Furthermore, according to Murphy's current pipeline integrity coordinator, due to inclement weather in January 2015, the aerial survey for the month was cancelled but no ground survey was completed in lieu.

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[8] Murphy's *POMIM* states that material balancing records will be maintained as per MOCL *POMIM 002 – Pipeline Records Management Procedure*.

The same section in the *POMIM* indicated annual LVP leak detection system tests (training exercises). However, when interviewed, most of the interviewees were not aware that there was a leak detection system in place and were not trained in leak detection.

This requirement is clearly stated in *CSA Z662*, Annex E.1.2, which states that the operating company shall develop, implement, and periodically evaluate the leak detection strategy for new or existing pipelines. The purpose of the leak detection strategy is to ensure that methods are in place that will contribute to the certain and timely detection of a service fluid release in order to support and inform appropriate pipeline control and emergency response actions. The leak detection strategy shall consider an integrated leak detection approach that includes surveillance, controller monitoring, and computational and/or leak sensing methodologies. The leak detection strategy should include a pipeline leak detection system with a continuous monitoring capability. The leak detection strategy and systems should be integrated into pipeline control and emergency response procedures.

Supporting Evidence

- Murphy's *POMIM* (Leak Detection section); page 2, paragraph 2
- Murphy's *Pipeline Integrity Manual*
- Murphy's *Release Volume Calculation Report* identifies meter calibration frequency on page 4, table 1

Contravention 5

Legislation/Guideline name	Section	Citation
Environmental Protection and Enhancement Act	109(2)	No person shall release or permit the release into the environment of a substance in an amount, concentration or level or at a rate of release that causes or may cause a significant adverse effect.
And where the following also states		
Environmental Protection and Enhancement Act	227 (Offences)	A person who […] (j) contravenes section 60, 61, 67, 75, 76, 79, 87, 88, 108, 109, 110(1) or (2), 111, 112, 137, 148, 149, 155, 157, 163, 169, 170, 173, 176, 178, 179, 180, 181, 182, 188, 191, 192, 209 or 251 is guilty of an offence.

Findings

The released hydrocarbon condensate may have caused a significant adverse effect if not remediated

The investigation has found that the release of hydrocarbon condensate from the pipeline has caused the following adverse effects on the environment:

Soils and Vegetation

- Access routes, staging areas, and excavations around the perimeters of the three releases were required to mitigate the releases, which caused a loss of the limited vegetation regrowth that had occurred.
- Soil affected by the release in areas undisturbed by the pipeline construction but still inside the pipeline corridor was likely composed of the original peat-like soils, which take a very long time to re-establish.
- In those areas outside the pipeline corridor/release site (Area 1), the release directly impacted a delicate bog ecosystem where hydrocarbon condensate is expected to cause persistent adverse effects on the vegetation.

The investigation has found that the release of hydrocarbon condensate from the pipeline may have caused the following adverse effects to the environment if not mitigated:

Wildlife

- If left in place, the condensate would be expected to adhere to wildlife during all or part of the summer months.
- The condensate would have likely impacted birds and smaller terrestrial wildlife.

Soils and Vegetation

- If left in place, soil function in the release site would have been completely impaired for the foreseeable future by the condensate.
- Because of its mobile nature, the heavier fractions entrained in the condensate would have travelled with surface water and groundwater following natural pathways leading to the unnamed tributary (creek) in proximity to the releases and ultimately would have entered the South Heart River.

Supporting Evidence

- Remediation Action Plan Presentation to the AER, April 22, 2016.
- WorleyParsons Peat and Mineral Soil Remediation Action Plan, March 11, 2016.
- Detailed aerial view of releases 1, 2 and 3. Shows significant impacts for each release site.

- Email from Catherine Evans regarding the initial and potential impact of the Murphy Oil Release.

Contravention 6

Legislation/Guideline name	Section	Citation
Environmental Protection and Enhancement Act	110(1)	Duty to report release A person who releases or causes or permits the release of a substance into the environment that may cause, is causing or has caused an adverse effect shall, as soon as that person knows or ought to know of the release, report it to (a) the Director,
And where the following also states		
Environmental Protection and Enhancement Act	227 (Offences)	A person who […] (j) contravenes section 60, 61, 67, 75, 76, 79, 87, 88, 108, 109, 110(1) or (2), 111, 112, 137, 148, 149, 155, 157, 163, 169, 170, 173, 176, 178, 179, 180, 181, 182, 188, 191, 192, 209 or 251 is guilty of an offence.

Findings

Murphy failed to report the release on January 15, 2015 , when they ought to have known the release had occurred

Between mid-January and March 1, 2015, a break in Murphy's 04-33 to 03-05 condensate pipeline allowed the release of 1429 m^3 of light hydrocarbon condensate (diluent) into the environment, which caused an adverse effect; specifically, the contamination of sensitive wetland soils and vegetation. The release occurred over about 44 days. Murphy's description of the event states that

> Murphy previously estimated that the pipeline may have been leaking for some time with an early estimate of potentially up to 2,700 m^3 (~17,000 bbl) of condensate released. After internal investigation and site sampling, the maximum release volume is now considered to be 1,429 m^3 (~9,000 bbl) with an initial start date of mid-January 2015.

Murphy failed to report the release on January 15, 2015, when they ought to have known the release had occurred. Murphy's SCADA system had the instrumentation and software in place to facilitate early detection of a pipeline failure; however, because aspects of the system, such as end-point diluent meter calibrations, established and current material balance parameters, and alarm set-point tolerances, were not managed or applied, there was no alarm when the material balance deviation was evident. Elevated flow rates at the 04-33 pump discharge meter versus lower than normal combined flow rates at the various end-point meters were experienced and should have initiated an alarm or shutdown procedure. Murphy was also not able to produce any material balance deviation records when requested by the AER to do so.

Table 5 references the main diluent flow quantity instrumentation transmitter (FQIT) leaving the 04-33 facility upstream of the failure location from December 1, 2014 to March 1, 2015. The AER would expect the company to verify a potential failure was occurring – this could take up to three or four days to correlate metering differences and verify a leak by aerial survey or by walking the pipeline ROW;

however, based on the higher volumes that were measured on January 12, 2015 – which continued to increase until the line was shut down (see table 5), the AER concludes that Murphy ought to have investigated and reported the potential of a failure by at least January 15, 2015.

Table 5. Flow quantity instrumentation transmitter (main meter) diluent discharge from 04-33 facility.

Source: Murphy Oil Submission SCADA Historian data.

Date	FQIT 1000	Date	FQIT 1000	Date	FQIT 1000
1-Dec-14	41.2	1-Jan-15	32.2	1-Feb-15	50.7
2-Dec-14	44.4	2-Jan-15	31.5	2-Feb-15	48.6
3-Dec-14	49.0	3-Jan-15	32.7	3-Feb-15	50.2
4-Dec-14	39.7	4-Jan-15	35.6	4-Feb-15	52.0
5-Dec-14	36.6	5-Jan-15	28.1	5-Feb-15	51.7
6-Dec-14	39.3	6-Jan-15	25.9	6-Feb-15	48.6
7-Dec-14	26.5	7-Jan-15	29.2	7-Feb-15	53.1
8-Dec-14	36.3	8-Jan-15	25.6	8-Feb-15	51.6
9-Dec-14	24.6	9-Jan-15	26.0	9-Feb-15	46.4
10-Dec-14	28.7	10-Jan-15	30.5	10-Feb-15	52.2
11-Dec-14	42.1	11-Jan-15	38.1	11-Feb-15	52.6
12-Dec-14	34.2	12-Jan-15	46.9	12-Feb-15	52.0
13-Dec-14	40.5	13-Jan-15	47.2	13-Feb-15	60.3
14-Dec-14	49.9	14-Jan-15	45.6	14-Feb-15	54.2
15-Dec-14	39.3	15-Jan-15	44.5	15-Feb-15	53.7
16-Dec-14	35.1	16-Jan-15	48.7	16-Feb-15	56.5
17-Dec-14	39.3	17-Jan-15	48.7	17-Feb-15	54.2
18-Dec-14	36.4	18-Jan-15	48.0	18-Feb-15	52.7
19-Dec-14	36.3	19-Jan-15	48.6	19-Feb-15	56.8
20-Dec-14	30.4	20-Jan-15	48.7	20-Feb-15	57.8
21-Dec-14	25.1	21-Jan-15	46.1	21-Feb-15	58.9
22-Dec-14	26.3	22-Jan-15	46.0	22-Feb-15	57.9
23-Dec-14	30.6	23-Jan-15	46.9	23-Feb-15	58.3
24-Dec-14	41.1	24-Jan-15	48.2	24-Feb-15	56.8
25-Dec-14	31.6	25-Jan-15	49.2	25-Feb-15	57.2
26-Dec-14	34.7	26-Jan-15	47.6	26-Feb-15	53.9
27-Dec-14	35.6	27-Jan-15	49.6	27-Feb-15	72.0
28-Dec-14	28.0	28-Jan-15	47.6	28-Feb-15	90.1
29-Dec-14	30.9	29-Jan-15	53.3	1-Mar-15	Shut in
30-Dec-14	29.6	30-Jan-15	50.7		
31-Dec-14	29.4	31-Jan-15	48.4		

Pages 1 and 2 of Murphy's *POMIM* indicate the following for the LVP Pipeline Leak Detection Procedure (latest revision April 2014):

Material Balance

i. Operations will complete material balancing on the LVP pipelines.
ii. Based on CSAZ662-11, Annex E Table E.1, the interval for data retrieval will be 24 hours.
iii. The calculation window will be daily, weekly and monthly.
iv. Based on material balance records, alarm set points at acceptable tolerances will be developed.
v. Material balancing records will be maintained as per MOCL POMIM 002- Pipeline Records Management Procedure.

Shut Down Procedures

Material balance deviations in excess of acceptable tolerances will initiate a shutdown procedure, unless deviations can be readily and clearly explained and verified by independent means.

LVP Leak Detection System Maintenance, Auditing and Testing

i. Scheduled work orders as per MOCL POMIM 003 – Work Order Procedure will be created to schedule:
   - Inspections and maintenance of all instruments and systems affecting the LVP leak detection system.
   - Regular audits of the LVP leak detection system.
   - Annual LVP leak detection system tests (training exercises).

Even without the deviation set-point tolerances properly programmed into the SCADA system Murphy's operations and production accounting personnel should have seen and investigated why there was such a large discrepancy in meter volumes by January 15, 2015. The average daily volume being measured by FQIT 1000 was about 34 m^3/day up to January 11, 2015. The daily average from January 12 until March 1, 2015 was about 53 m^3/day—an additional 19 m^3, or 55 per cent higher that the daily average for three months prior to the failure.

The investigation has found that Murphy failed to take reasonable steps—such as operator training, implementing operating procedures, or preventive maintenance—to ensure that the leak detection system was capable of the early detection of leaks. That failure prevented Murphy from knowing the pipeline failure had occurred. The release was not reported to the AER until March 1, 2015, about 48 days after the diluent meter leaving the facility started to register (on January 12) higher than normal volumes—when the AER believes the release began—and 44 days after January 15, 2015, when Murphy ought to have known the leak occurred.

Supporting Evidence

- Murphy's *POMIM* (Leak Detection section), page 2, paragraph 2.
- Murphy's Release Volume Calculation Report, page 4 (meter calibrations).
- Murphy's instrumentation and SCADA monitoring for the various flow-indicating transmitters and pressure-indicating transmitters in XLS. Note FIT 1000 and FIT raw data worksheets.

Contravention 7

Legislation/guideline name	Section	Citation
Environmental Protection and Enhancement Act	112(1)	**Duty to take remedial measures** Where a substance that may cause, is causing or has caused an adverse effect is released into the environment, the person responsible for the substance shall, as soon as that person becomes aware of or ought to have become aware of the release, (a) take all reasonable measures to (i) repair, remedy and confine the effects of the substance, and (ii) remediate, manage, remove or otherwise dispose of the substance in such a manner as to prevent an adverse effect or further adverse effect, and (b) restore the environment to a condition satisfactory to the Director.
And where the following also states		
Environmental Protection and Enhancement Act	227 (Offences)	A person who […] **(j)** contravenes section 60, 61, 67, 75, 76, 79, 87, 88, 108, 109, 110(1) or (2), 111, 112, 137, 148, 149, 155, 157, 163, 169, 170, 173, 176, 178, 179, 180, 181, 182, 188, 191, 192, 209 or 251 is guilty of an offence.

Findings

Murphy failed to confine the effects of the release on January 15, 2015, when they ought to have known the release had occurred

Between mid-January and March 1, 2015, a break in Murphy's 04-33 to 03-05 condensate pipeline allowed the release of about 1429 m^3 of light hydrocarbon condensate (diluent) into the environment, which caused an adverse effect; specifically, the contamination of sensitive wetland soils and vegetation. The release occurred over about 44 days. Murphy's description of the event states that

> Murphy previously estimated that the pipeline may have been leaking for some time with an early estimate of potentially up to 2,700 m^3 (~17,000 bbl) of condensate released. After internal investigation and site sampling, the maximum release volume is now considered to be 1,429 m^3 (~9,000 bbl) with an initial start date of mid-January 2015.

Murphy ought to have known that a pipeline failure was occurring by January 15, 2015. Murphy's SCADA system had the instrumentation and software in place to facilitate early detection of a pipeline failure. However, because aspects of the system, such as end-point diluent meter calibrations, established and current material balance parameters, and alarm set-point tolerances, were not managed or applied, there was no alarm when the material balance deviation was evident. Elevated flow rates at the 04-33 pump discharge should have initiated an alarm or shutdown procedure. Murphy was also not able to produce any material balance deviation records when requested by the AER to do so.

Pages 1 and 2 of Murphy's *POMIM* indicates the following for the LVP Pipeline Leak Detection Procedure (latest revision April 2014):

Material Balance

vi. Operations will complete material balancing on the LVP pipelines.
vii. Based on CSAZ662-11, Annex E Table E.1, the interval for data retrieval will be 24 hours.
viii. The calculation window will be daily, weekly and monthly.
ix. Based on material balance records, alarm set points at acceptable tolerances will be developed.
x. Material balancing records will be maintained as per MOCL POMIM 002- Pipeline Records Management Procedure.

Shut Down Procedures

Material balance deviations in excess of acceptable tolerances will initiate a shutdown procedure, unless deviations can be readily and clearly explained and verified by independent means.

LVP Leak Detection System Maintenance, Auditing and Testing

i. Scheduled work orders as per MOCL POMIM 003 – Work Order Procedure will be created to schedule:

- Inspections and maintenance of all instruments and systems affecting the LVP leak detection system.
- Regular audits of the LVP leak detection system.
- Annual LVP leak detection system tests (training exercises).

Even without the deviation set-point tolerances properly programmed into the SCADA system Murphy's operations and production accounting personnel should have seen and investigated why there was such a large discrepancy in meter volumes by January 15, 2015. The average daily volume being measured by FQIT 1000 was about 34 m^3/day up to January 11, 2015. The daily average from January 12 until March 1, 2015 was about 53 m^3/day—an additional 19 m^3, or 55 per cent higher than the daily average for three months prior to the failure.

The AER would expect the company to verify a potential failure occurred—it could take up to three or four days to correlate metering differences and verify a leak by aerial survey or by walking the pipeline ROW; however, based on the higher volumes that were measured on January 12, 2015—which continued to increase until the line was shut down (see table 5)—the AER concludes that Murphy ought to have investigated and actively responded to the potential of a failure by at least January 15, 2015.

The investigation has found that Murphy failed to take reasonable steps—such as operator training, implementing operating procedures, or preventive maintenance—to ensure that the leak detection system was capable of the early detection of leaks. That failure prevented Murphy from knowing the pipeline failure occurred. Remediation of the release did not begin until March 1, 2015, about 48 days after the diluent meter leaving the facility started to register (on January 12) higher than normal volumes—when the AER believes the release began—and 44 days after January 15, 2015, when Murphy ought to have known the leak occurred.

Supporting Evidence

- Murphy's *POMIM* (Leak Detection section); page 2, paragraph 2
- Murphy's *Release Volume Calculation Report*, page 4 (meter calibrations)
- Murphy's instrumentation and SCADA monitoring for the various flow-indicating transmitters and pressure-indicating transmitters in XLS. Note FIT 1000 and FIT raw data worksheets

Due Diligence

After a review of all information available, there is little evidence to support due diligence by Murphy for the reasons that follow.

Although most of the systems and written operating procedures were in place to allow Murphy to monitor and manage the internal corrosion and corrosion mechanisms that resulted in the failure and subsequent hydrocarbon condensate spill, these systems and operating procedures were not being implemented on the subject pipeline. WorleyParsons' *Pipeline Failure Analysis Report* states that

> The mechanisms that led to the failure of the NPS 3 condensate pipe and the consequent spill of the condensate along the pipeline ROW were compounded by the absence of pigging and a sound pipeline integrity management program, which are standard practices in the pipeline industry.

Furthermore, Murphy was required to evaluate whether the measures for internal corrosion and leak detection were adequate, yet there is no evidence that Murphy did so.

The investigation has also found that Murphy failed to take reasonable steps, such as operator training, implementing operating procedures, or preventive maintenance, to ensure that the leak detection system was capable of the early detection of leaks. That failure prevented Murphy from knowing the pipeline failure occurred in mid-January. Subsequently, the duration and magnitude of the release and the adverse effect on the environment was significant.

Compliance History

Table 6. AER compliance history (Ind = Industry, Lic = Licensee)

Inspection type	Number of inspections Ind/Lic	Number of low risk Ind/Lic	% Low Risk Ind/Lic	Number of high risk Ind/Lic	% high risk Ind/Lic	Number of Sat Ind/Lic	% Sat Ind/Lic
Drilling	1713/6	224/1	13.08/16.67 -3.59	155/0	9.05/0 +9.05	1334/5	77.88/83.33 -5.45
Drilling waste	718/2	72/0	10.03/0.00 +10.03	81/2	11.28/100 -88.72	565/0	78.69/0.00 +78.69
Gas facility	10700/11	2524/1	23.59/9.09 +14.5	344/0	3.22/0.00 +3.22	7832/10	73.2/90.91 -17.71
Oil facility	21235/1323	3513/45	16.54/3.4 13.14	513/28	2.42/2.12 +0.30	17209/1250	81.04/94.48 -13.44
Pipeline	9620/17	849/1	8.83/5.88 +2.95	1407/1	14.63/5.88 +8.75	7364/15	76.55/88.24 -11.69
Well service	1206/3	89/0	7.38/0.00 +7.38	37/0	3.07/0.00 +3.07	1080/3	89.55/100 -10.45
Well site	25705/22	3997/8	15.55/36.36 -20.81	565/0	2.2/0.00 +2.2	56895/1297	79.69/93.71 -14.02
Provincial totals	**71352/1384**	**11343/56**	**15.900/4.05 +11.85**	**3150/31**	**4.41/2.24 +2.17**	**56859/1297**	**79.69/93.71 -14.02**

Source: From Field Inspection System. January 2011 to October 2016.

Table 7. The Government of Alberta's enforcement history for Murphy, from 2000*

Accountable party	Action	Decision date/penalty	Municipality legal description	Acts and sections	Comments/disposition
Murphy Oil Company	Warning letter	15-Nov-2002	County of St. Paul; 11-58-5-W4	AEPEA(R) 227(e)	The company operates the Lindberg enhanced recovery in-situ heavy oil processing plant pursuant to an approval. It contravened its approval by submitting its soil monitoring proposal for 2001 late.
Murphy Oil Company	Warning letter	17-Jun-2004	MD of Clear Hills; 23-94-13-W6	AEPEA(R) 227(e)	The company operates the Hamburg sour gas processing plant pursuant to an approval. It contravened its approval by submitting the 2003 annual industrial wastewater and runoff report late. In addition, this approval contravention was not immediately reported by telephone to Alberta Environment, as is also required by the approval.

*The enforcement history shown here in this table is from the Government of Alberta's Environmental Law Centre through its Environmental Enforcement Historical Search Service.

Conclusion

The AER has determined that there are a significant number of contraventions under the *Pipeline Act*, the *Pipeline Rules*, *CSA Z662-15*, the *Environmental Protection and Enhancement Act*, and the *Public Lands Act.* Based on all the evidence gathered, the AER determined that Murphy could not demonstrate due diligence in relation to the contraventions that have been identified.