Government of Saskatchewan

Ministry of Energy and Resources Investigation Report

July 2018

Tervita Corporation Waste Processing Facility Incident

WPF 2005-05, LIC#2494

January 2, 2018

Contents

1.0 Executive Summary

The Ministry of Energy Resources (ER) undertook an investigation of a suspected gaseous substance release from the Tervita Waste Processing Facility that occurred on January 2, 2018. The objectives of the investigation were to: assess the health risk of exposure to the gaseous substance based on the results of ambient air samples collected within twenty four hours of the release; determine if products delivered to the facility were the source of odours reported by residents of Unity; and, determine if the waste delivered to the Tervita facility met acceptance criteria in their license to operate.

On January 2, 2018, at approximately 8:25 pm, a shipment of liquid caustic waste was being transferred from a transport truck for disposal at the Tervita Waste Processing Facility located approximately 3 kilometers (km) southeast of Unity, Saskatchewan. Shortly after 8:40 pm, air quality monitors at the facility were triggered resulting in a temporary shut-down; the facility restarted several minutes later as the gaseous release dissipated and monitors detected air quality conditions within normal operating limits. At the time of the release, climate data indicates the wind was from the southeast at 4 km/hr. Residents of Unity reported odours to the Ministry of Environment just before 10:00 pm that same evening and a representative from the Town collected an ambient air sample in a laboratory supplied container. A second ambient air sample was also collected by the Town on January 3, 2018. Both samples were submitted to the Environment and Climate Change Canada (ECCC) analytical laboratory in Ottawa, Ontario and analyzed for a suite of compounds that could potentially have been present in the gaseous release.

ER personnel were mobilized to the facility on January 3, 2018. Highly sensitive portable air monitoring devices were used to measure hydrosulfide gas concentrations in the ambient air at various locations surrounding the facility. No detectable concentrations of the gas were encountered at the sampling locations. A Forward-Looking Infrared Radar (FLIR) camera, which can detect fugitive emissions from various types of equipment, was also used to survey the facility and other potential sources of the reported odour, but no fugitive emission sources were detected.

The laboratory analyses conducted on the two ambient air samples collected by the Town of Unity found detectable concentrations of various compounds however hydrogen sulfide gas was not detected in either sample. Based on the concentrations of the compounds and the timeframe of exposure, the release could have resulted in the short term effects reported by some residents of Unity. Serious health effects are not expected based on the comparison of measured concentrations to short-term toxicological reference values. As such, no serious or long-term health effects are expected, given the low concentrations of compounds and short-term length of exposure.

An analysis of the caustic waste fluid indicates various petroleum hydrocarbon compounds as well as hydrogen sulfide were major constituents. Portions of these compounds were detected in the ambient air samples submitted for analysis; based on the results of the samples, as well as the weather conditions at the time of the release, the 8:40 pm shipment of waste received at Tervita facility on January 2, 2018 was the likely source of odours reported by some residents of Unity.

In regards to waste acceptance criteria, the investigation has determined the shipment of liquid caustic waste delivered on January 2, 2018 was not approved for disposal. Waste manifest information indicates it was classified as a Transportation of Dangerous Goods Class 8 corrosive liquid. Although some types of hazardous wastes are allowed at the facility, the Class 8 corrosive liquid does not meet the acceptance criteria of ER's approval to operate. ER has instructed Tervita to cease accepting and processing Class 8 corrosive wastes.

1.1 Introduction

The Ministry of Energy Resources (ER) undertook an investigation of a suspected gaseous substance release from the Tervita Corporation Waste Processing Facility (WPF). On January 2, 2018 at approximately 8:40 pm a shipment of liquid caustic waste was being transferred from a transport truck for disposal at the Tervita Waste Processing Facility. Shortly after 8:40 pm, air quality monitors at the facility were triggered resulting in a temporary shut-down; the facility restarted several minutes later as the gaseous release dissipated and monitors detected air quality conditions within normal operating limits. Several residents of Unity subsequently witnessed an odor that was reported to Saskatchewan Ministry of Environment (ENV) and ER. At approximately 11:45 pm on January 2, 2018, Tervita Corporation (Tervita) reported an unintentional release from their facility to the Saskatchewan Spill Line.

The Tervita WPF is licensed by ER under *The Oil and Gas Conservation Act;* it was first permitted in 2001, to Canadian Crude Separators to handle Upstream Oil and Gas wastes. In 2005, the facility approval was amended by ER and ENV to allow for hazardous and non-hazardous wastes from additional industrial sources. In 2013, the ownership was amalgamated and became Tervita Corporation. Wastes are received and processed at the facility for the purpose of hydrocarbon recovery through the associated cavern disposal well. The WPF is equipped with fixed hydrogen sulphide (H_2S) and lower explosive limit sensors. These fixed sensors are calibrated and tested quarterly and are managed and tracked through the Tervita preventative maintenance program.

2.0 Objectives and Scope of the Investigation

2.1 Objectives

The objectives of the investigation were to: assess the health risk of exposure to the gaseous substance based on the results of ambient air samples collected within twenty four hours of the release; determine if products delivered to the facility were the source of odours reported by residents of Unity; and, determine if the waste delivered to the Tervita facility met acceptance criteria in their license to operate.

2.2 Scope of the Investigation

The scope of the investigation consisted the following:

- Detail the timeline of events and response of Tervita Corporation and Regulatory bodies;
- Provide an assessment of the suspected caustic liquid that was delivered to the WPF for disposal and its likelihood to have been the source of the odours detected in Unity;
- Determine if the waste stream processed by Tervita meets the acceptance criteria for the facility;

- Assess the health risk from the measured ambient air concentrations from the samples collected on January 2 and 3, 2018;
- Assess the odour risk from the measured ambient air concentrations from the samples collected on January 2 and 3, 2018; and,
- Describe further directed actions by ER as an outcome of the investigation.

3.0 Facility Location and Weather Conditions

3.1 Location

The WPF is located approximately 3 km southeast of Unity, Saskatchewan; the legal land location is 15-4-40-22 W3M.

Figure 1-1 shows the location of the WPF in relation to Unity, the location where the air samples were collected, and other industrial facilities near Unity (Rail Transfer Facilities and Compressor Station)

Figure 1-1 Location Plan

3.2 Weather Conditions

Weather conditions as observed at the Unity Western Yellowhead Air Management Zone Airpointer, located in Unity the evening on January 2, 2018 were as follows:

Date/Time	Wind Speed (metres/second)	Wind Direction (degrees)	Temperature (Celsius)
2018-01-02 20:00	0.16	114.01	-5.8
2018-01-02 21:00	0.55	133.39	-7.5
2018-01-02 22:00	0.6	110.53	-9.1
2018-01-02 23:00	0.7	104.38	-10.3
Average	0.5	115.60	-8.2

This correlates to an average wind speed of 0.5 metres per second with wind coming from 115.6 degrees (wind travelling from the SE to NW) and an average temperature of -8.2 degrees Celsius.

4.0 Summary of Incident Events

The following events provided by Tervita summarize the incident.

- At approximately 8:15 pm on January 2, 2018, a truck carrying liquid caustic waste from the Shell Caroline, Alberta gas plant completes sign-in sheet to deliver its load to the WPF. Regular waste acceptance standard operating procedures include:
  - Truck driver checks in at facility operations office and reviews unloading job safety assessment with facility operations staff.
  - Trucker completes field level hazard assessment which is signed by facility operators and driver.
  - Driver is then allowed to proceed to the receiving pad to start unloading waste through a conduit referred to as the volatile line.
  - At approximately 8:20 PM standard procedures for unloading waste into the volatile line are followed which consist of mixing the material into brine or other water to reduce the overall volatility of the load being pumped through the facility infrastructure.

- The typical length time to offload a 24 m^3 shipment of waste is approximately 20-25 minutes. At 8:42 pm a fixed gas H_2S alarm in the basement of the facility is triggered. The first low-level alarm went off for H_2S at 8:42:15 pm (set at 5 parts per million (ppm) H_2S concentration) then immediately followed by high alarm at 8:42:42 pm (set at 10ppm H_2S concentration). The high alarm automatically shuts the plant down and does not allow the site to go back in operation until the alarms are cleared and H_2S concentrations are below the alarm threshold. Both of the facility's two operators were on the receiving pad at the time of the alarm. Operator 2 was near the receiving hopper checking fluid levels and his personal monitor read 5ppm concentration of H_2S, which quickly cleared. While walking by the Operators Office, Operator 1 looked into the window (within the amount of time it takes to walk 15 steps after the alarm) at the Programmable Logic Control (PLC) for H_2S concentrations. By this time the alarm had already cleared and H_2S on the PLC read 8ppm and was decreasing. Operator 1's personal alarm was not triggered during the event.

- Operators opened basement doors and then checked PLC again; readings on the fixed gas monitor quickly decreased to 0ppm H_2S. Due to the timing, it appeared that the alarms were tripped as the very last of the volatile waste load was passing through the infrastructure to be injected into the cavern. Tervita suspected that there was an unexpected component of condensate in the load and during transport the lighter/more volatile product was agitated during transport. At the very end of offloading the product, it was suspected that the lighter/more volatile components were going through the injection pumps last, which aligns with timing of the high– level alarm and subsequent plant shut down.

- Tervita operators began inspecting the facility on the evening of January 2, 2018. Activities included: visually inspecting all lines/connections for leaks/drips, or any other indication of equipment failure, ensuring vapour recovery unit and incinerator were fully functioning to eliminate any further odour releases adding to the issue, flushing the facility flowlines to clear any remaining fluid from the lines, tightening hopper valves to ensure no fluid or vapours could escape into the atmosphere through the hopper and washing the odour effected surfaces in the basement. There was no visual indication of leaks, releases or malfunction in any of the inspected infrastructure.

- Tervita uses both a Corporate Emergency Response Plan (ERP) and a Site-Specific ERP for each operating facility. The first three steps in the ERP are to Evacuate, Alarm, and Assess, which were all performed following this incident. The 'Assess' step deemed that since the alarms had cleared very quickly and no further gases were being detected on either the fixed monitors or operators personal monitors, that there was no longer a hazard present, so work could resume. As such, Tervita did not consider this incident an emergency situation; therefore the further steps of the ERP were not required.

- Regardless of which steps of the ERP are triggered, part of Tervita's incident response procedures for every incident immediately trigger an internal 4-hour incident reporting process where the details of what occurred are captured, and any further action items required are determined from there.

- After reviewing all information and the timeline of events internally with Tervita senior management, Tervita determined that the caustic waste load that tripped the fixed gas alarm, may have contributed to the odours observed in town. Tervita then reported the incident to the Saskatchewan Spill line at 11:47 pm on January 2, 2018.

- On January 6, 2018, additional inspection and maintenance activities were performed on the piping, valves and pumps in the area where the release was suspected. The following equipment did not fully pass the inspection and was replaced: gate valve to hopper, Tico pad on pump 320, one gasket above pump 320, mechanical seals on pumps 310 and 320. One of the mechanical seals that were replaced contained residual odours absorbed into the material, consistent with the waste stream in question, indicating this may have been the primary location of odour release.

- The volatile load line at Unity is designed to be a closed system; it is suspected that gaseous compounds seeped through the mechanical seals in the injection pumps located in the hopper basement. On January 6, 2018, during the thorough inspection and replacement of parts in the injection pumps, it was discovered that one of the backliner gaskets to the mechanical seal in one of the pumps was slightly extruded, resulting in an improper seal. This imperfection could not be detected from looking at the pump from the outside; rather it could only be detected by disassembling the pump. The extruded backliner gasket being pushed out was likely caused by the vapour pressure present in the process due to the unanticipated light end product (such as condensate) in the waste stream.

5.0 Town of Unity Response

Two air samples were collected by the Town of Unity in laboratory supplied containers. One sample was taken at approximately 10:40 PM of January 2, 2018, and a second sample at approximately 10:40 PM on January 3, 2018. Both samples were collected outside the Town of Unity offices for basis of comparison of the air quality during the release and when it was perceived to have dissipated the following evening (air sample locations are also shown on Figure 1-1). The air samples were provided to ENV by January 8, 2018, and were immediately sent to ECCC for analysis.

6.0 Regulatory Response

On the morning of January 3, 2018, information reported to the Saskatchewan Spill line was communicated to ER. ER immediately mobilized personnel from the Lloydminster field office to the WPF with the purpose of determining whether there was any ongoing risk of gaseous substances being released from the facility. ER personnel inspected the facility using a FLIR camera to identify any potential fugitive emissions or leaks coming from the equipment. Highly sensitive H_2S monitors which detect concentrations of H_2S in parts per billion were used to measure ambient air H_2S concentrations. No leaks or emissions were identified during this inspection. Three on-site ambient air measurements were taken with the H_2S gas monitor near the south east, east and north east areas of the facility. These locations were selected based on wind direction at the time and proximity to processing equipment that could have contributed to the release. No H_2S was detected at any of the three locations. The FLIR camera did not detect any fugitive emissions coming from the equipment and tanks on site. In addition, H_2S concentrations were measured at various locations within the town of Unity, however none were detected. The FLIR camera was also used to determine if any emissions were originating from the storage tanks at the Altex Unity Oil Terminal rail facility within the town of Unity; none were detected.

ER conducted interviews with operations staff at the Altex Unity Oil Terminal in Unity, the TransGas Compressor station southwest of Unity and the North West Terminal ethanol plant, west of Unity. On January 2, 2018, the rail transfer facility received six crude oil loads prior to 5:30 pm with an H_2S content ranging from 900 to 1,700 ppm (tested at facility with a portable monitor). The aforementioned loads remained on site in storage tanks until transferred to the rail cars. The operator stated there was no loading of rail cars that evening and at around 9:30 pm on January 2, when he checked the vent off of the scrubber there were no odours coming from the tanks and no detection of H_2S on his personal H_2S monitor. The operations staff at the Compressor Station southwest of Unity and the Ethanol plants indicated that they did not have any abnormal operations on the evening of January 2, 2018.

On January 9, 2018, ER retained a consulting firm (Intrinsik Corp.) with expertise in human health and environmental toxicology for assistance with the investigation process and to assess the results of air testing.

On January 15, 2018, ER senior engineers and field technicians, accompanied by Tervita personnel, conducted a second inspection of the facility; this inspection focused on the overall engineering of the facility as well as an analysis of the full range of potential release points. Concentrations of H_2S were also measured in similar locations of the facility taken on January 3, 2018; again, no measurable concentrations of H_2S were detected. The FLIR camera was also used at the Tervita Facility in the same locations as January 3, 2018, which showed no emissions coming from the equipment and tanks on site.

On February 9, 2018, ER officials received the results of the air samples analyzed by ECCC which were also assessed by ENV and Senior Scientists with Intrinsik Corp. Table 1-1 provides further description of the date and time when the samples were collected and Appendix A presents the results of the analyses.

Throughout the investigation ER requested, received and reviewed documentation from Tervita including but not limited to:

- standard operating procedures used to assess hazards associated with unloading and processing received wastes;
- standard operating procedures used to guide the waste acceptance and unloading procedures;
- hazard assessments detailing steps required and performed to assess waste streams as they are received;
- Tervita's site specific and corporate emergency response plans;
- wastes received and processed in 2017 and 2018 (January and February), and
- information on how H_2S and other gasses are handled through the system, and the safeguards that exist to prevent releases into the atmosphere.

Table 2-1

Detailed Description of Ambient Air Samples Collected and Analyzed

Sample Description	Unity-2	Unity-1
Sample Method	6L Silonite Cannister	6L Silonite Cannister
Sample Date	2-Jan-18	3-Jan-18
Sample Time	~10:40 PM	~10:40 PM
Sample Location	7-100 1st Ave West, Unity SK	7-100 1st Ave West, Unity SK
Sample Testing Facility	Environment and Climate Change Canada, Air Toxics Unit	Environment and Climate Change Canada, Air Toxics Unit
Analytical Method	VOC (method 1.02/2.8/M)	VOC (method 1.02/2.8/M)
Analytes	Standard list of volatile organic compounds (VOC) analyzed by National Air Pollutants Survey (NAPS)	Standard list of volatile organic compounds (VOC) analyzed by National Air Pollutants Survey (NAPS)
Physical Sample Observations by ECCC Laboratory	Sample odorous	Sample not odorous
Comments Noted by ECCC Laboratory	Five large unidentified peaks observed in chromatogram using SIM mode. Sample was re-run for qualitative analysis using SCAN mode and identified 1,1-difluoroethane, 1-chloro-1,1-difluoro-ethane, acetone, 2-propanol, benzaldehyde and acetophenone.	Sample was re-run for qualitative analysis using SCAN mode and identified 1,1-difluoroethane, 1-chloro-1,1-difluoro-ethane, acetone, 2-propanol, benzaldehyde and acetophenone.

*Note Unity-2 is presented first, as this was the sample description on the canister, but was the sample taken on Jan. 2. Unity-1 was the sample name taken on Jan.3.

7.0 Assessment of Caustic Liquid Delivered to WPF

The 24 cubic metre load of liquid caustic waste that was delivered to the WPF at approximately 8:15 pm on January 2, 2018 for cavern disposal originated from the Shell Caroline Gas Complex in Alberta. A chemical analysis of the liquid caustic waste was not available, however, chemical analyses of similar wastes from the Caroline gas plant were available in Tervita's records from 2012, 2013, and 2018. Tervita has been accepting this waste stream from Shell Caroline Gas Complex at the Unity WPF since 2013. The analytical information indicated that benzene, toluene, ethylbenzene and xylenes (BTEX), petroleum hydrocarbon fractions (PHC F1 to F4) and H_2S were major constituents of the caustic liquid. The analysis of specific sulphur-based compounds in the caustic waste from Shell Caroline (i.e., February 2018 sample) indicates that compounds such as carbonyl sulphide, methyl mercaptan and dimethyl sulphide were less than detection limits of 0.005 mg/L; however, H_2S was measured at concentrations of 90,140 ppm.

The analyses suggest that the caustic waste contains odorous compounds such as H_2S and other volatile aliphatic or aromatic compounds that would contribute to detectable odours.

Caustic and spent scavenger waste streams are usually described as having 'pungent' odours, both of which are common waste streams produced by the oil and gas industry. Both products are often used to scrub H_2S and/or mercaptans from produced oil and gas, and as such, at the end of their processes, are often left with high probability of odours.

8.0 WPF Waste Acceptance Criteria

The Tervita WPF has approval from ER to accept hazardous and non-hazardous hydrocarbon-contaminated wastes and by-products generated from or associated with the upstream, midstream and downstream petroleum and petro-chemical industry as described and listed in their 2005 proposal. The proposal also identified specific Transportation of Dangerous Goods (TDG) identification classes, which Tervita will not accept. These include:

- Class 1 - Explosives,
- Class 2 - Gases,
- Class 5 - Oxidizing Substances and Organic Peroxides,
- Class 6 - Toxic and Infectious Substances,
- Class 7 - Radioactive Materials, and
- Class 8 - Corrosives.

The federal Interprovincial Movement of Hazardous Waste Regulation requires that a Canadian Waste Manifest must accompany every interprovincial shipment of hazardous wastes. The waste received from Shell Caroline was accompanied by a Waste Manifest, describing the waste as TDG Class 8 corrosive liquid.

For out-of-province wastes, a portion of the approval states, “A representative sample shall be taken from each load and held for a minimum period of three months upon reception of the wastes”. The investigation revealed that a sample was not taken of this specific waste load.

9.0 Assessment of Human Health Risks

The ambient air samples collected on January 2nd and 3rd were analyzed for a standard list of volatile organic compounds (VOCs) monitored under the National Air Pollutants Survey (NAPS) that is conducted by ECCC across Canada. The results of air analyses were compared to short-term (i.e., ranging from hours to days) toxicity reference values for the protection of human health.

A search and comparison of Toxicity Reference Values (TRVs) established by recognized scientific and regulatory authorities was completed. A choice was made for TRVs based on relevance, scientific robustness and technical defensibility. The search for short-term TRVs extended to the following regulatory authorities:

- Agency for Toxic Substances and Disease Registry (ATSDR)
- Alberta Environment and Parks (AEP)
- California’s Office of Environmental Health Hazard Assessment (OEHHA)
- Canadian Council of Ministers of the Environment (CCME)
- Health Canada
- Netherlands National Institute of Public Health and the Environment (RIVM)
- Saskatchewan Ministry of Environment (ENV)
- Texas Commission of Environmental Quality (TCEQ)
- United States Environmental Protection Agency (US EPA)
- World Health Organization (WHO)

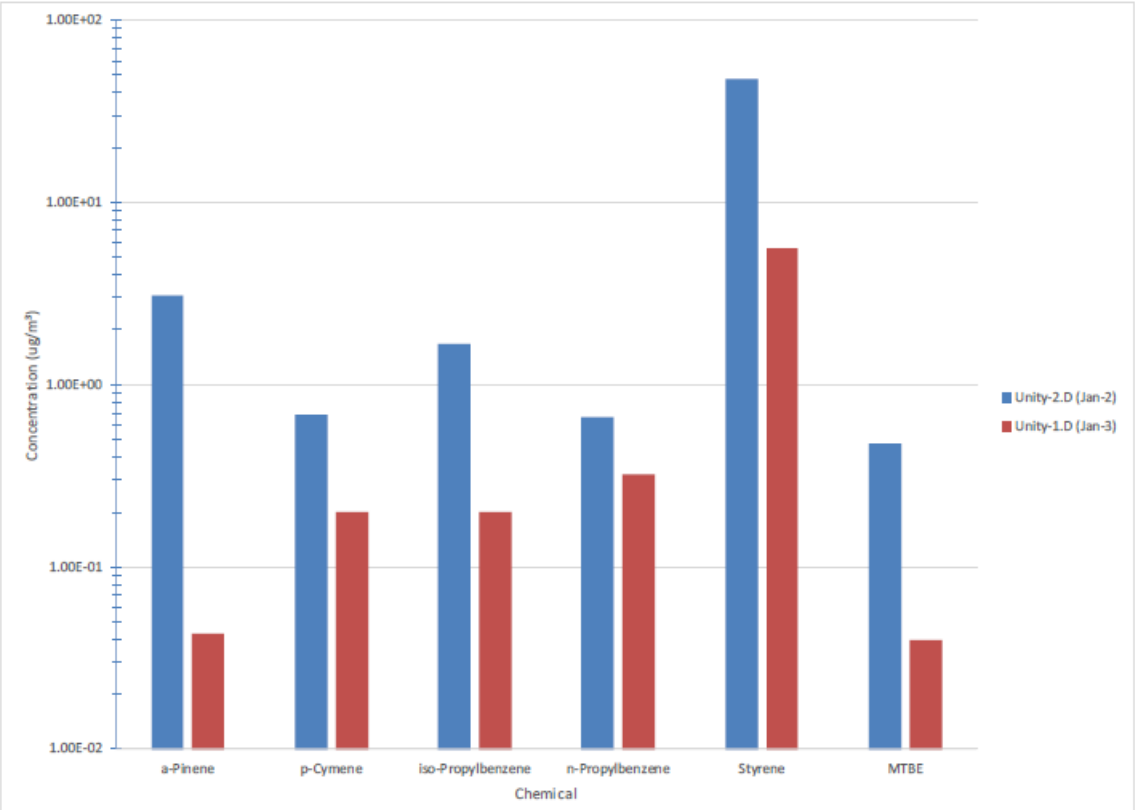
Appendix A presents a comparison of the measured instantaneous air concentrations to short-term human health based TRVs. In all instances, the measured ambient air concentrations were less than short-term health based TRVs, signifying that adverse health effects are not expected. In addition to comparing the measured air concentrations to TRVs, Appendix A also presents minimum, average and maximum ambient air concentrations for similar chemicals measured at the Environment Canada ambient air monitoring station in Regina (ECCC 2016). The statistical summary presented in Appendix A was calculated based on 24-hour samples collected in 2016 every 6th day from the National Air Pollution Surveillance (NAPS) Program. The monitoring station is located at 1621 Alberta Street in Regina, Saskatchewan. The comparison provides an indication of concentration levels for similar compounds in other areas of Saskatchewan. Comparison of the measured ambient air concentrations from Unity to ambient levels in Regina indicates that most of the chemicals were similar to or within an order of magnitude of the concentrations measured in Regina. Only a small portion (<5%) of the chemicals measured in Unity (i.e., iso-propylbenzene, MTBE, styrene, a-pinene, p-cymene, and n-propylbenzene) were more than an order of magnitude (i.e., 10 to 165 times greater) than what was measured in Regina. The comparison indicated that most chemical concentrations measured in the air during the emission event were similar to what has been measured in Regina and that a limited number of chemicals appear to be elevated when compared to the Regina measurements.

Finally, the nature of the testing wherein a sample was collected during the emission event and then a second sample was collected one day later may provide an indication of how concentrations changed. Figure 3-1 presents the measured air concentrations on Day 1 and Day 2 for those chemicals measured in Unity that appeared to be most elevated when compared to the Regina measurements (i.e., iso-propylbenzene, MTBE, styrene, a-pinene, pcymene, and n-propylbenzene). This information shows how concentrations for these chemicals dramatically decreased, suggesting that the source had been removed shortly after the emission event.

These findings also show that the concentration of the compounds analyzed were below short-term health based TRVs, signifying that adverse health effects are not expected.

Figure 3-1

Observed Reduction in Measured Concentrations for Selected Chemicals Between Days



10.0 Assessment of Odour Risks

Comparisons between the measured instantaneous air concentrations of the chemicals detected in Unity and their corresponding odour thresholds are presented in Appendix A.

The concentrations of most of the chemicals measured in Unity were lower than the minimum odour thresholds reported in the aforementioned scientific and regulatory authorities; however, there were several chemicals for which measured concentrations exceeded their respective minimum odour thresholds. These chemicals are as follows:

Chemical	Unity Measurement		Odour Threshold		
	Day 1 (Jan 2)	Day 2 (Jan 3)	Range (µg/m³)	Geomean (µg/m³)	Character
a-Pinene	3.07E+00	4.30E-02	3.60E-01 – 1.05E+05	5.0E+02	turpentine, rosiny, pine tree, camphorous, fir needles
H_2S	<1.4E-01	<1.4E-01	5.60E-02 – 5.00E+03	1.1E+01	rotten eggs
Methyl Mercaptan	<3.0E-02	<3.0E-02	<0.01 – 1.10E+03	3.1E+00	rotten cabbage, garlic
Styrene	4.75E+01	5.60E+00	1.20E+01 – 2.58E+05	1.4E+03	sharp, sweet

Note: H_2S and methyl mercaptan were non-detect in both air samples; however, the detection limit for each chemical falls within the range of reported odour thresholds.

In some cases, the measured concentrations or detection limits were above their minimum reported odour thresholds, but much lower than the maximum odour thresholds and all the measured concentrations were below the central estimate (i.e., geomean) of the reported odour thresholds. These findings suggest that the odour of these chemicals might be noticed by people with a keen sense of smell but might go unnoticed by much of the population.

11.0 Discussion

The following lines of evidence suggest that the WPF was the source of reported odour:

- A shipment of 24 cubic metres of liquid caustic waste was delivered to Tervita Unity WPF at 15-4-40-22 W3 for cavern disposal at 8:15 pm on January 2, 2018.
- At approximately 8:20PM, the waste was transferred from the truck to the WPF for cavern disposal which takes 20-25 minutes to unload and at 8:42 pm ambient H_2S monitors at the WPF were triggered resulting in a temporary shut-down of systems at the WPF.
- Personnel at the WPF traced the H_2S release to a malfunctioning pump, which was subsequently replaced January 9, 2018.
- Climate data from the Western Yellowhead Air Management Zone air pointer located in Unity showed wind was from the south and southeast the evening of January 2, 2018. Figure 1-1 shows that the WPF is located approximately 3 km directly southeast of Unity.

The measured wind speed was low (i.e., average speed was ~0.5 m/s) the evening of January 2, 2018. Based on the distance (i.e., 3 km) and wind speed (i.e., ~0.5 m/s), the estimated time that emissions from the WPF would have reached Unity was approximately 100 minutes. Residents in Unity started to report odours and adverse effects just before 10:00 pm on January 2, 2018.

12.0 Conclusion

Evidence collected during the investigation indicates the source of odours reported by some residents of Unity on January 2, 2018 likely originated from an unexpected component in the waste stream that was received at the Tervita WPF. ER believes there may have been some lighter, more volatile components in the waste shipment, which the facility is not designed to handle. The damaged backliner gasket in the pump was likely the cause of the accidental release.

The laboratory analysis results of the air samples collected on January 2 and January 3, 2018, indicate a mixture of gaseous compounds of petroleum hydrocarbons and sulfur-based compounds; the concentrations of these were compared to established and recognized standards and guideline values published by Health Canada, the World Health Organization, and the United States Agency for Toxic Substance and Disease Registry, among others. The concentrations of the compounds measured in Unity, and the timeframe of exposure, could have resulted in the short-term effects experienced by some residents; however, serious effects are not expected based on the comparison of measured concentrations to short-term TRVs. The compounds analyzed were below short-term health based TRVs, signifying that adverse health effects are not expected. Due to the low levels and short-term length exposure no serious or long term health effects are expected.

The waste accepted at the WPF was not accompanied by the sample required as a licence condition nor was the caustic liquid approved for disposal.

13.0 Regulatory Actions and Follow-up

Upon discovery that Tervita was receiving Class 8 corrosive wastes they were advised to cease accepting and processing of this classification of waste. As a result of the investigation, Tervita is also required to complete the following within 90 days of this report:

- Conduct and submit a third-party engineering assessment of its waste processing and disposal system. This assessment must consider the current equipment (piping, tanks, processing equipment, vapour recovery systems, thermal destruction system, pumps, seals, valves and flanges) and the ability to process the different waste streams Tervita is approved to accept at the facility. The engineering report should detail the wastes Tervita has received or proposed to receive and assess how they would interfere with, inhibit or constrain the recoverability or salability of crude oil products stored in the cavern and assess the integrity of the cavern as the storage receptacle for the wastes. The third-party consultant contracted to perform the work must be employed independent of the licensee and licensed to engage in the practice of professional engineering in Saskatchewan pursuant to *The Engineering and Geoscience Professions Act.*
- Develop a sampling procedure satisfactory to ER to ensure wastes received at the facility, are within acceptability criteria.

In addition to these actions, ER will also be taking steps to amend Tervita's facility licence to:

- Clearly state the substances that can be received for processing at the facility. During the investigation, ER determined that licensing documents related to the substances that could be disposed at the facility were overly complex and difficult to interpret.
- Establish site-specific incident reporting requirements in addition to those found in ER's current reporting directive. The new requirement will ensure Tervita immediately notify ER of any release of gas that activates the facility's emergency shut down procedures.

Appendix A

Appendix A - Screening Table for Ambient Air Concentrations Measured in Unity, SK Against Regina NAPS Data, Acute Exposure Limits and Odour Thresholds

Group	CAS No.	Chemical	2016 NAPS Ambient Air Measurements - Regina (µg/m³)			Acute Exposure Limits (µg/m³)			Odour Thresholds (µg/m³) (1)			Unity Air Concentrations (µg/m³)	
			Minimum	Average	Maximum	Value	Critical Effect	Source	Min	Max	Character	Unity-2.D (02-Jan-18)	Unity-1.D (03-Jan-18)
BTEX	71-43-2	Benzene	1.55E-01	3.32E-01	8.35E-01	5.80E+02	Immunological effects	TCEQ	1.50E+03	1.00E+06	aromatic, sweet, solvent, empyreumatic	1.57E+00	1.15E+00
BTEX	108-88-3	Toluene	1.65E-01	8.09E-01	4.87E+00	7.50E+03	Neurological effects	ATSDR	8.00E+01	1.00E+06	sour, burnt	9.84E+00	2.12E+00
BTEX	100-41-4	Ethylbenzene	2.56E-02	1.10E-01	4.13E-01	2.17E+04	Neurological effects	ATSDR	<1.00E+01	7.83E+04	oily, solvent	9.67E-01	7.42E-01
BTEX	179601-23-1	m and p-Xylene	6.64E-02	2.97E-01	1.41E+00	7.40E+03	Respiratory irritation and neurological effects	TCEQ	5.20E+01	8.60E+04	sweet, empyreumatic	1.88E+00	1.87E+00
BTEX	95-47-6	o-Xylene	2.74E-02	1.08E-01	4.33E-01	7.40E+03	Respiratory irritation and neurological effects	TCEQ	7.70E+02	2.36E+04	sweet, empyreumatic	7.65E-01	8.13E-01
BTEX	1330-20-7	Total Xylenes (calculated)	NA	NA	NA	7.40E+03	Respiratory irritation and neurological effects	TCEQ	5.20E+01	8.60E+04	sweet, empyreumatic	2.65E+00	2.69E+00
Halogenated	71-55-6	1,1,1-Trichloroethane	1.17E-02	1.60E-02	2.50E-02	6.00E+03	Neurological effects	US EPA	5.30E+03	3.90E+06	sweet, etherish	<2.64E-02	<2.64E-02
Halogenated	79-34-5	1,1,2,2-Tetrachloroethane	8.40E-04	2.06E-03	3.81E-03	NA			1.60E+03	5.00E+04	solvent	<3.18E-02	<3.18E-02
Halogenated	79-00-5	1,1,2-Trichloroethane	1.93E-03	3.62E-03	1.16E-02	NA			NA	NA	NA	<2.64E-02	<2.64E-02
Halogenated	75-34-3	1,1-Dichloroethane	1.74E-03	5.19E-03	1.23E-02	NA			NA	NA	chloroform, aromatic	<2.37E-02	<2.37E-02
Halogenated	75-35-4	1,1-Dichloroethylene	1.69E-04	8.41E-04	1.22E-03	7.10E+02	Liver effects	TCEQ	2.00E+05	5.50E+06	chloroform	<2.37E-02	<2.37E-02
Halogenated	75-37-6	1,1-Difluoroethane	NA	NA	NA	NA			NA	NA	NA	qualitative analysis	qualitative analysis
Halogenated	120-82-1	1,2,4-Trichlorobenzene	7.85E-04	6.52E-03	5.95E-02	NA			2.20E+04	2.20E+04	aromatic	9.60E-02	<8.90E-02
Halogenated	95-50-1	1,2-Dichlorobenzene	5.82E-04	3.19E-03	2.28E-02	NA			1.20E+02	4.20E+03	camphor	<2.64E-02	<2.64E-02
Halogenated	107-06-2	1,2-Dichloroethane	2.92E-02	5.85E-02	8.17E-02	2.20E+03	Nasal irritation	TCEQ	1.75E+04	4.00E+06	sweet	2.14E-01	9.30E-02
Halogenated	78-87-5	1,2-Dichloropropane	7.12E-03	2.50E-02	3.59E-02	2.30E+02	--	ATSDR	1.20E+03	4.00E+04	sweet	7.40E-02	2.80E-02
Halogenated	541-73-1	1,3-Dichlorobenzene	5.08E-04	2.50E-03	1.83E-02	NA			NA	NA		<2.64E-02	<2.64E-02
Halogenated	106-46-7	1,4-Dichlorobenzene	7.52E-03	3.25E-02	1.52E-01	1.20E+04	Respiratory irritation	ATSDR	7.30E+02	<90000	camphor, mothballs	9.70E-02	<2.37E-02
Halogenated	100-44-7	Benzylchloride	1.24E-03	3.77E-03	8.14E-03	2.40E+02	Respiratory and eye irritation	OEHHA	2.10E+02	2.40E+02	pungent	<1.96E-02	<1.96E-02
Halogenated	75-25-2	Bromoform	6.00E-03	1.24E-02	2.60E-02	NA			2.00E+03	1.50E+05	chloroform, sweet, suffocating	<4.94E-02	<4.94E-02
Halogenated	74-83-9	Bromomethane	2.18E-02	3.18E-02	5.47E-02	2.00E+02	Neurological effects	ATSDR				3.90E-02	<3.26E-02
Halogenated	56-23-5	Carbontetrachloride	3.33E-01	4.78E-01	5.93E-01	1.90E+03	Reproductive, developmental, hepatic and neurological effects	OEHHA	1.06E+04	4.53E+06	sweet, ethereal, dry cleaner, aromatic	5.73E-01	5.77E-01
Halogenated	108-90-7	Chlorobenzene	1.16E-03	8.55E-03	4.66E-02	4.60E+04	AEGL 1	US EPA AEGL	4.00E+02	5.93E+04	almond-like, shoe polish	4.30E-02	<3.32E-02
Halogenated	75-00-3	Chloroethane	6.33E-03	1.52E-02	4.50E-02	4.00E+04	Developmental effects	ATSDR	1.00E+04	>1.0E+06	pungent	3.00E-02	<2.7E-02
Halogenated	67-66-3	Chloroform	7.84E-02	9.66E-02	1.51E-01	4.90E+02	Hepatic effects	ATSDR	5.00E+02	6.90E+06	sweet, etherous, suffocating	7.21E-01	1.51E-01
Halogenated	74-87-3	Chloromethane	7.57E-01	1.01E+00	1.22E+00	1.00E+03	Neurological effects	ATSDR	>2.10E+04	>2.10E+04	sweet, etherish	1.35E+00	1.11E+00
Halogenated	75-09-2	Dichloromethane	1.98E-01	3.09E-01	6.43E-01	2.00E+03	Neurological effects	ATSDR	4.10E+03	1.53E+06	sweet	3.52E+00	5.48E-01
Halogenated	75-68-3	Ethane, 1-chloro-1,1-difluoro-	NA	NA	NA	NA			NA	NA	NA	qualitative analysis	qualitative analysis
Halogenated	75-69-4	Freon 11	1.29E+00	1.67E+00	4.27E+00	NA			2.80E+04	1.12E+09	NA	1.91E+00	1.66E+00
Halogenated	76-14-2	Freon 114	8.84E-02	1.10E-01	1.25E-01	NA			NA	NA	NA	1.30E-01	1.26E-01
Halogenated	75-71-8	Freon 12	1.93E+00	2.43E+00	2.71E+00	NA			9.88E+08	9.88E+08	ethereal	3.88E+00	2.84E+00
Halogenated	75-45-6	Freon 22	7.22E-01	9.92E-01	4.28E+00	NA			7.08E+08	7.08E+08	ethereal	2.19E+00	1.05E+00
Halogenated	87-68-3	Hexachlorobutadiene	7.91E-04	1.98E-03	1.04E-02	NA			NA	NA	NA	<5.39E-02	<5.39E-02
Halogenated	127-18-4	Tetrachloroethylene	2.28E-02	3.72E-01	4.66E+00	6.80E+03	Neurological effects	TCEQ	8.10E+03	4.80E+05	etherish	2.52E-01	1.31E-01
Halogenated	79-01-6	Trichloroethylene	2.22E-03	1.35E-02	4.24E-02	4.10E+05	AEGL 1	US EPA AEGL	2.50E+03	9.00E+05	ether, solvent	9.60E-02	<2.37E-02
Halogenated	75-01-4	Vinylchloride	4.00E-04	1.64E-03	5.48E-03	6.80E+04	Eye and nasal irritation, and neurological effects	TCEQ	5.20E+05	9.10E+05	sweet	<2.08E-02	<2.08E-02
PHC	106-99-0	1,3-Butadiene	8.52E-03	2.89E-02	1.11E-01	1.50E+01	Developmental effects	US EPA	2.20E+02	1.69E+05	aromatic, rubber	<3.58E-02	8.80E-02
PHC	106-98-9/115-11-7	1-Butene/Isobutene	5.93E-02	1.49E-01	4.82E-01	6.20E+04	--	TCEQ	8.30E+02	4.88E+06	petroleum	5.36E-01	4.87E-01
PHC	109-67-1	1-Pentene	1.37E-02	6.16E-02	2.57E-01	3.40E+04	Decreased body weight	TCEQ	2.90E+02	2.90E+02	NA	4.10E-02	8.40E-02
PHC	563-46-2	2-Methyl-1-Butene	9.06E-03	4.26E-02	1.87E-01	NA			NA	NA	NA	5.10E-02	1.32E-01
PHC	513-35-9	2-Methyl-2-Butene	1.07E-02	4.98E-02	2.83E-01	NA			NA	NA	NA	6.30E-02	1.70E-01
PHC	563-45-1	3-Methyl-1-Butene	3.07E-03	1.19E-02	4.57E-02	NA			NA	NA	NA	2.80E-02	3.50E-02
PHC	106-97-8	Butane	3.53E-01	3.05E+00	1.42E+01	2.20E+05	--	TCEQ	1.00E+03	1.20E+07	natural gas	7.41E+00	1.44E+01

Appendix A - Screening Table for Ambient Air Concentrations Measured in Unity, SK Against Regina NAPS Data, Acute Exposure Limits and Odour Thresholds

Group	CAS No.	Chemical	2016 NAPS Ambient Air Measurements - Regina (µg/m³)			Acute Exposure Limits (µg/m³)			Odour Thresholds (µg/m³) (1)			Unity Air Concentrations (µg/m³)	
			Minimum	Average	Maximum	Value	Critical Effect	Source	Min	Max	Character	Unity-2.D (02-Jan-18)	Unity-1.D (03-Jan-18)
PHC	590-18-1	cis-2-Butene	7.50E-03	4.76E-02	3.90E-01	3.40E+04	Decreased body weight	TCEQ	2.85E+04	2.85E+04	petroleum	<2.60E-02	1.42E-01
PHC	627-20-3	cis-2-Pentene	3.75E-03	2.37E-02	1.38E-01	3.40E+04	Decreased body weight	TCEQ	NA	NA	NA	<2.40E-02	6.70E-02
PHC	287-92-3	Cyclopentane	1.23E-02	8.44E-02	4.42E-01	NA			NA	NA	NA	4.49E-01	5.15E-01
PHC	75-28-5	Isobutane	2.88E-01	1.65E+00	1.00E+01	7.80E+04	--	TCEQ	1.37E+06	1.37E+06	natural gas	1.17E+01	1.08E+01
PHC	78-78-4	Isopentane	3.85E-01	1.80E+00	1.20E+01	2.00E+05	--	TCEQ	3.80E+03	3.80E+03	sweet	6.95E+00	8.39E+00
PHC	78-79-5	Isoprene	9.43E-03	8.96E-02	6.70E-01				1.30E+02	1.00E+04	aromatic	3.01E-01	1.13E-01
PHC	109-66-0	Pentane	2.43E-01	2.63E+00	1.29E+01	2.00E+05	--	TCEQ	4.10E+03	3.09E+06	sweet	1.16E+01	6.56E+00
PHC	74-98-6	Propane	8.16E-01	5.90E+00	2.78E+01	1.00E+07	AEGL 1	US EPA AEGL	2.70E+06	3.60E+07	natural gas	1.15E+01	2.24E+01
PHC	115-07-1	Propylene	9.07E-02	1.98E-01	8.03E-01	NA			2.20E+04	1.70E+05	gassy, aromatic	2.43E-01	6.24E-01
PHC	100-42-5	Styrene	2.22E-03	3.46E-02	2.88E-01	2.10E+04	Eye and respiratory effects	OEHHA	1.20E+01	2.58E+05	sharp, sweet	4.75E+01	5.60E+00
PHC	624-64-6	trans-2-Butene	7.47E-03	5.71E-02	5.51E-01	3.40E+04	Decreased body weight	TCEQ	2.70E+06	2.70E+06	petroleum	<7.02E-02	1.75E-01
PHC	646-04-8	trans-2-Pentene	6.49E-03	4.48E-02	2.69E-01	3.40E+04	Decreased body weight	TCEQ	NA	NA	NA	<2.79E-02	1.21E-01
PHC-F1	526-73-8	1,2,3-Trimethylbenzene	7.46E-03	2.25E-02	7.77E-02	1.50E+04	Neurological effects	TCEQ	NA	NA	aromatic	2.25E-01	2.37E-01
PHC-F1	95-63-6	1,2,4-Trimethylbenzene	2.66E-02	8.91E-02	3.05E-01	1.50E+04	Neurological effects	TCEQ	1.40E+02	1.10E+03	aromatic	1.43E+00	9.05E-01
PHC-F1	108-67-8	1,3,5-Trimethylbenzene	5.45E-03	2.70E-02	9.68E-02	1.50E+04	Neurological effects	TCEQ	1.80E+02	1.20E+04	aromatic	2.45E-01	2.72E-01
PHC-F1	141-93-5	1,3-Diethylbenzene	1.51E-03	6.11E-03	1.95E-02	NA			3.90E+02	3.90E+02	NA	4.90E-02	7.70E-02
PHC-F1	105-05-5	1,4-Diethylbenzene	4.90E-03	1.76E-02	6.14E-02	NA			2.10E+00	2.10E+00	NA	1.74E-01	2.01E-01
PHC-F1	592-76-7	1-Heptene	9.19E-03	2.70E-02	4.38E-02	NA			1.50E+03	3.70E+04	NA	<4.64E-02	<4.64E-02
PHC-F1	592-41-6/763-29-1	1-Hexene/2-Methyl-1-Pentene	1.06E-02	2.80E-02	6.01E-02	NA			4.80E+02	4.80E+02	petroleum	4.20E-02	8.80E-02
PHC-F1	540-84-1	2,2,4-Trimethylpentane	4.55E-02	2.21E-01	7.74E-01	1.90E+04	Neurological effects	TCEQ	3.10E+03	3.10E+03	gasoline, oil	5.40E-01	1.38E+00
PHC-F1	75-83-2	2,2-Dimethylbutane	1.16E-02	7.61E-02	5.57E-01	1.90E+04	Neuroendocrine effects	TCEQ	7.00E+04	7.00E+04	gasoline	1.99E-01	3.22E-01
PHC-F1	565-75-3	2,3,4-Trimethylpentane	3.88E-03	2.04E-02	5.03E-02	NA			NA	NA	NA	1.40E-01	3.26E-01
PHC-F1	79-29-8	2,3-Dimethylbutane	1.43E-02	7.27E-02	3.43E-01	1.90E+04	Neuroendocrine effects	TCEQ	1.50E+03	1.50E+03	gasoline	2.86E-01	5.27E-01
PHC-F1	565-59-3	2,3-Dimethylpentane	1.53E-02	9.50E-02	2.60E-01	3.40E+04	Neurological effects	TCEQ	1.80E+04	1.80E+04	gasoline	4.26E-01	1.24E+00
PHC-F1	589-43-5	2,4-Dimethylhexane	3.58E-03	1.85E-02	6.14E-02	NA			NA	NA	NA	1.43E-01	2.42E-01
PHC-F1	108-08-7	2,4-Dimethylpentane	8.83E-03	3.98E-02	1.13E-01	3.40E+04	Neurological effects	TCEQ	3.90E+03	3.00E+06	gasoline	1.71E-01	4.57E-01
PHC-F1	592-13-2	2,5-Dimethylhexane	2.36E-03	1.36E-02	4.53E-02	NA			NA	NA	NA	2.11E-01	1.81E-01
PHC-F1	611-14-3	2-Ethyltoluene	7.12E-03	2.37E-02	7.91E-02	NA			3.60E+02	3.60E+02	NA	4.04E-01	3.25E-01
PHC-F1	592-27-8	2-Methylheptane	1.14E-02	4.92E-02	1.30E-01	NA			5.20E+02	5.20E+02	NA	4.21E-01	4.82E-01
PHC-F1	591-76-4	2-Methylhexane	2.63E-02	1.40E-01	5.95E-01	3.40E+04	Neurological effects	TCEQ	1.70E+03	1.70E+03	gasoline	7.95E-01	1.23E+00
PHC-F1	107-83-5	2-Methylpentane	5.29E-02	3.32E-01	1.86E+00	1.90E+04	Neuroendocrine effects	TCEQ	2.50E+04	2.50E+04	gasoline	1.22E+00	2.44E+00
PHC-F1	620-14-4	3-Ethyltoluene	1.73E-02	5.87E-02	2.17E-01	NA			8.80E+01	8.80E+01	NA	1.25E+00	7.31E-01
PHC-F1	589-81-1	3-Methylheptane	9.60E-03	3.53E-02	1.17E-01	NA			7.10E+03	7.10E+03	NA	2.15E-01	3.67E-01
PHC-F1	589-34-4	3-Methylhexane	3.21E-02	1.76E-01	1.19E+00	3.40E+04	Neurological effects	TCEQ	3.40E+03	3.40E+03	gasoline	8.16E-01	1.49E+00
PHC-F1	96-14-0	3-Methylpentane	4.18E-02	2.45E-01	1.04E+00	1.90E+04	Neuroendocrine effects	TCEQ	3.10E+04	3.10E+04	gasoline	9.17E-01	1.49E+00
PHC-F1	622-96-8	4-Ethyltoluene	8.32E-03	2.73E-02	1.02E-01	NA			4.10E+01	4.10E+01	NA	8.12E-01	3.54E-01
PHC-F1	589-53-7	4-Methylheptane	4.00E-03	1.58E-02	5.14E-02	NA			8.00E+03	8.00E+03	NA	1.02E-01	1.70E-01
PHC-F1	80-56-8	a-Pinene	7.99E-04	3.36E-02	1.72E-01	NA			3.60E-01	1.05E+05	turpentine, rosiny, pine tree, camphorous, fir needles	3.07E+00	4.30E-02
PHC-F1	127-91-3	b-Pinene	1.28E-03	1.91E-02	1.07E-01	NA			1.80E+02	6.50E+04	turpentine, rosiny, pine tree, camphorous, fir needles	1.28E-01	<1.9E-02
PHC-F1	79-92-5	Camphene	2.23E-03	1.29E-02	1.03E-01	NA			2.60E+04	3.00E+04	NA	5.33E-01	2.28E-01
PHC-F1	2207-01-4	cis-1,2-Dimethylcyclohexane	5.70E-03	9.53E-03	1.85E-02	NA			NA	NA	NA	5.50E-02	1.24E-01
PHC-F1	7688-21-3	cis-2-Hexene	1.45E-03	5.95E-03	2.82E-02	NA			NA	NA	NA	1.40E-02	2.00E-02
PHC-F1	922-62-3	cis-3-Methyl-2-Pentene	2.52E-03	8.49E-03	2.76E-02	NA			NA	NA	NA	5.80E-02	7.50E-02
PHC-F1	691-38-3	cis-4-Methyl-2-Pentene	1.10E-03	6.23E-03	2.58E-02	NA			NA	NA	NA	<1.84E-02	<1.84E-02
PHC-F1	110-82-7	Cyclohexane	1.40E-02	1.03E-01	4.92E-01	NA			1.80E+03	2.70E+06	pungent	1.68E+00	1.03E+00
PHC-F1	124-18-5	Decane	1.42E-02	5.59E-02	2.46E-01	5.80E+03	Eye irritation	TCEQ	3.60E+03	1.60E+05	NA	5.82E-01	4.84E-01
PHC-F1	5989-27-5	d-Limonene	6.09E-04	6.09E-02	7.26E-01	NA			5.90E+00	5.50E+04	NA	3.63E+00	4.52E-01
PHC-F1	142-82-5	Heptane	2.45E-02	1.73E-01	1.66E+00	3.40E+04	Neurological effects	TCEQ	2.70E+03	2.24E+06	gasoline	1.88E+00	1.65E+00

Appendix A - Screening Table for Ambient Air Concentrations Measured in Unity, SK Against Regina NAPS Data, Acute Exposure Limits and Odour Thresholds

Group	CAS No.	Chemical	2016 NAPS Ambient Air Measurements - Regina (µg/m³)			Acute Exposure Limits (µg/m³)			Odour Thresholds (µg/m³) (1)			Unity Air Concentrations (µg/m³)	
			Minimum	Average	Maximum	Value	Critical Effect	Source	Min	Max	Character	Unity-2.D (02-Jan-18)	Unity-1.D (03-Jan-18)
PHC-F1	110-54-3	Hexane	4.75E-02	3.44E-01	1.42E+00	1.90E+04	Neuroendocrine effects	TCEQ	5.30E+03	8.75E+05	gasoline	2.64E+00	2.51E+00
PHC-F1	496-11-7	Indane	4.16E-03	1.44E-02	6.15E-02	NA			NA	NA	NA	1.31E-01	1.73E-01
PHC-F1	98-82-8	iso-Propylbenzene	2.46E-03	6.82E-03	2.30E-02	2.50E+05	AEGL 1	US EPA AEGL	1.70E+01	6.40E+03	sharp	1.67E+00	1.99E-01
PHC-F1	108-87-2	Methylcyclohexane	1.79E-02	1.07E-01	4.41E-01	NA			6.00E+02	6.00E+02	petroleum	1.74E+00	1.73E+00
PHC-F1	96-37-7	Methylcyclopentane	3.27E-02	2.04E-01	9.92E-01	NA			5.80E+03	5.80E+03	NA	1.03E+00	1.42E+00
PHC-F1	91-20-3	Naphthalene	1.66E-03	7.82E-02	3.47E-01	NA			7.00E+00	5.34E+03	tar, creosote, mothballs, empyreumatic	2.26E-01	<3.35E-02
PHC-F1	111-84-2	Nonane	1.78E-02	4.61E-02	1.37E-01	1.60E+04	Neurological effects	TCEQ	1.20E+04	1.08E+05	gasoline	3.79E-01	8.08E-01
PHC-F1	103-65-1	n-Propylbenzene	7.44E-03	2.14E-02	6.41E-02	NA			1.90E+01	1.44E+04	NA	6.65E-01	3.19E-01
PHC-F1	111-65-9	Octane	1.66E-02	5.23E-02	1.44E-01	1.90E+04	Neurological effects	TCEQ	8.00E+03	1.10E+06	gasoline, oil	7.13E-01	6.81E-01
PHC-F1	99-87-6	p-Cymene	3.96E-03	1.19E-02	5.81E-02	NA			1.20E+01	7.20E+03	NA	6.83E-01	2.01E-01
PHC-F1	4050-45-7	trans-2-Hexene	1.70E-03	8.54E-03	3.78E-02	NA			NA	NA	NA	<2.37E-02	3.30E-02
PHC-F1	13389-42-9	trans-2-Octene	1.51E-03	1.51E-03	1.51E-03	NA			NA	NA	NA	<2.00E-02	<2.00E-02
PHC-F1	616-12-6	trans-3-Methyl-2-Pentene	1.44E-03	6.21E-03	2.10E-02				NA	NA	NA	<2.00E-02	2.80E-02
PHC-F2	112-40-3	Dodecane	6.39E-03	3.82E-02	1.55E-01	NA			7.70E+02	5.00E+04	NA	2.29E-01	<3.9E-02
PHC-F2	1120-21-4	Undecane	7.44E-03	4.88E-02	2.36E-01	NA			5.60E+03	3.74E+05	NA	4.62E-01	1.11E-01
Sulphur Compound	75-15-0	Carbon Disulfide	NA	NA	NA	6.20E+03	Developmental effects	OEHHA	5.00E+01	9.89E+04	vegetable, sulfide, medicinal	1.61E-01	<1.30E-01
Sulphur Compound	463-58-1	Carbonyl Sulfide	NA	NA	NA	1.00E+01	Neurological effects	OEHHA	1.40E+02	2.50E+02	unpleasant	1.19E+00	1.08E+00
Sulphur Compound	75-18-3	Dimethyl Sulfide	NA	NA	NA	NA			3.00E-01	2.06E+04	disagreeable, asparagus, putrid	<8.00E-02	<8.00E-02
Sulphur Compound	7783-06-4	Hydrogen Sulfide	NA	NA	NA	9.80E+01	Respiratory irritation	ATSDR	5.60E-02	5.00E+03	rotten eggs	<1.40E-01	<1.40E-01
Sulphur Compound	74-93-1	Methyl Mercaptan	NA	NA	NA	1.40E+04	AEGL 2	US EPA AEGL	1.00E-09	1.10E+03	rotten cabbage, garlic	<3.00E-02	<3.00E-02
Other	67-63-0	2-Propanol	NA	NA	NA	3.20E+03	Eye and respiratory irritation	OEHHA	2.50E+03	5.40E+06	sharp, rubbing alcohol	qualitative analysis	qualitative analysis
Other	67-64-1	Acetone	NA	NA	NA	2.60E+04	Neurological effects	TCEQ	9.40E+02	2.79E+07	sweet, fruity, etherous	qualitative analysis	qualitative analysis
Other	98-86-2	Acetophenone	NA	NA	NA	NA			1.20E+00	2.90E+03	sweet, almond, pungent, oranges, river water	qualitative analysis	qualitative analysis
Other	100-52-7	Benzaldehyde	NA	NA	NA	NA			<1.00E-02	3.40E+06	bitter almond, fruit, vanilla	qualitative analysis	qualitative analysis
Other	1634-04-4	MTBE	1.73E-03	4.96E-03	1.00E-02	7.20E+03	Neurological effects	ATSDR	1.10E+02	6.30E+02	anesthetic	4.75E-01	<3.97E-02

NA: Not available