Harmony Odour Report

Odour Impact Assessment, Results, and Discussion

Dr. Ardevan Bakhtari, Scentroid

12.07.2023

DISCLAIMER

This document is intended only for its named addressee and may not be relied upon by any other person. Scentroid (IDES Canada Inc.) disclaims all liability for damages of whatsoever nature to any other party and accepts no responsibility for any damages of whatsoever nature, however caused arising from misapplication or misinterpretation by third parties of the contents of this document.

This document is issued in confidence and is relevant only to the issues pertinent to the subject matter contained herein. The work conducted by Scentroid (IDES Canada Inc.) in this commission and the information contained in this document has been prepared to the standard that would be expected of a professional environmental consulting firm according to accepted practices and techniques. Scentroid (IDES Canada Inc.) accepts no responsibility for any misuse or application of the material set out in this document for any purpose other than the purpose for which it is provided.

Although strenuous effort has been made to identify and assess all significant issues required by this document, we cannot guarantee that other issues outside of the scope of work undertaken by Scentroid (IDES Canada Inc.) do not remain. An understanding of the site conditions depends on the integration of many pieces of information, some regional, some-site specific, some structure-specific and some experience-based.

Where site inspections, testing or fieldwork have taken place, the report is based on the information made available by the client, their employees, subcontractors, agents or nominees during the visit, visual observations, and any subsequent discussions with regulatory authorities. The validity and comprehensiveness of supplied information has not been independently verified except where expressly stated and, for the purposes of this report, it is assumed that the information provided to Scentroid (IDES Canada Inc.) is both complete and accurate.

COPYRIGHT

DOCUMENT REFERENCE

Client: Harmony Developments Inc. c/o Qualico
Client Contact: Angela Yurkowski
Client Address: 100-5709 2 Street SE, Calgary, Alberta, T2H 2W4
Project: Harmony Odour Assessment
Project Number: PO10532
Reference: SO10247-D1
Report Status: Complete

Prepared By: Omid Youssefi
Reviewed By: Ardevan Bakhtari
Revision Number: D3

Signature:

Ardevan Bakhtari, PhD
President, Scentroid

Date:

12.07.2023

CONTENTS

Disclaimer 1
- Copyright 1

Document Reference 2
List of Common Abbreviations and Explanations 5
List of Figures 7
Executive Summary 8
Overview 9
- Introduction 9
- Project Contact Information 10
- Project Site 10
- Community of Harmony: Scenario 11
- Project Flowchart 11

Perceiving Odours and Estimating Odour Emissions 12
- Perceiving Odours 12
- Aggregate Exposure 12

Odour Impact Assessment Methodology 13
Initial Site Assessment 14
- Resources 14

Sampling Sites 15
- Sampling Approach 17
- Neighborhood: N01 18
- Neighborhood: N02 19
- Neighborhood: N03 20
- Neighborhood: N04 21
- Neighborhood: N05 22
- Neighborhood: N06 23
- Neighborhood: N07 24
- Neighborhood: N08 25
- Neighborhood: N09 26
- Neighborhood: N10 27
- Neighborhood: N11 28
- Neighborhood: N12 29
- WWTP: Centrifuge exhaust 30

WWTP: Ground Vent 31
WWTP: Headworks Interior 32
WWTP: Headworks Side Exhaust 33
WWTP: Membrane Building 34
WWTP: Pond, Northwest Corner 35
WWTP: Front Gate 36
WWTP: West Fence 37
Results and Discussion 38
Results: Total Detected Odour Composition 38
Results: Odour Impact Assessment, Neighborhood 39
Results: Odour Impact Assessment: Wastewater Treatment Facility 40
Calculating Odour Emissions 41
AERMOD Inputs and Infrastructure Design 41
Odour Impact Assessment 42
Air Dispersion Modeling 42
Calculating Exposure Time 46
Conclusion 47
Appendix A: AERMOD 48
Appendix B: Volatile Organic Compounds 50
Appendix C: Beaufort Scale 52
Appendix D: Averaging Period Conversion 53
References 54

LIST OF COMMON ABBREVIATIONS AND EXPLANATIONS

Annotation	Definition
VOCs	Volatile organic compounds
GC/MS	Gas chromatography/mass spectrometry
SL50 Scentinal	Scentroid's state-of-the-art monitoring station for VOCs, HAPs, particulates, and odour
(C)EN 13725:2005	Dynamic olfactometry international odour standard
ISO 17025:2005	International standard for the requirement for the competence of testing and calibration laboratories. Specifies the general requirements for the competence to conduct tests and/or calibrations, including sampling. It covers testing and calibration performed using standard methods, non-standard methods, and laboratory-developed methods.
AEP	Alberta Environment and Parks
Detection threshold (sample)	Dilution factor at which the sample has a 50% probability of being detected by a human assessor
Dilution factor	The ratio between sample flow or volume after dilution (Total Sample Volume) and the flow or volume of the odour gas ("Undiluted" Sample Volume)
Dynamic dilution	Dilution achieved by mixing two known flows of gas: odorous sample and neutral gas, respectively. The rate of dilution is calculated from the flow rates
Field blank	Odour air sample collected at the sampling site, treated as a sample in all respects, including contact with the sampling devices and exposure to sampling site conditions, storage, preservation, and all analytical procedures
Flux chamber	A device used to isolate a surface area for collecting gaseous emissions being generated as neutral gas is passed over the enclosed area
Maximum dilution factor	Maximum achievable dilution factor of the olfactometer; an instrument property
Minimum dilution factor	Minimum achievable dilution factor of the olfactometer; an instrument property

Neutral gas (diluent)	Air or nitrogen that is treated in such an away that it is as odourless as technically possible (nitrogen of 4.8 Grade or higher is recommended) and that does, according to panel members, not interfere with the odour under investigation
Odour emission rate	The quantity of odour units (OU) which crosses a given surface divided by time. It is the product of the odour concentration and the wet reference volumetric flow rate (at standard temperature and standard atmospheric pressure, 298 K and 101.3 kPa respectively). It is typically expressed as OU/s
Odour concentration	Number of odour units per volume of gas at wet standard conditions. It is typically express as OU (m^3 basis)
Odour unit (OU dimensionless)	Number of unit volumes of odourless gas required to dilute one-unit volume of odorous gas (under standard conditions) to reach the odour panels detection threshold. The accepted reference value is equivalent to 123 µg n-butanol (CAS 71-36-3). Evaporated in one cubic metre of neutral gas (at standard conditions) this produces a concentration of 0.040 µmol/mol
Sample	The amount of gas which is assumed to be representative of the gas mass or gas flow under investigation and which is examined for odour concentration
Odour panel	Composed of eight (8) assessors who are qualified to judge samples of odorous gas using dynamic olfactometry. Each assessor must be appropriately screened and meet the selection criteria outlined in the (C)EN 13725:2003 standard
Pre-dilution	Drawing a sample of stack gas while simultaneously diluting with neutral gas for the propose of preventing condensation and/or sorption of odours upon sample collection and to reduce sample gas temperature
Sweep gas	Neutral (odourless) gas which is introduced at a low velocity into a flux chamber.

LIST OF FIGURES

Figure 1: Aerial View of Harmony Site 10
Figure 2: Process Flowchart for Harmony Project 11
Figure 3: Wind Rose for Harmony Site, Extracted from Global Weather Database, and in-field data collection. Aug. 21 to Aug 26 13
Figure 4: Isolated Zones for Harmony Site. White dotted line indicates route travelled by sampling team 15
Figure 5: Aerial view of Harmony Wastewater Treatment Facility, with several points of interest indicated 16
Figure 6: Perceived Odours (if encountered) for Harmony Sampling Route 38
Figure 7: Percentage of Encountered Odours at Each Sampling Point 39
Figure 8: Percentage of Encountered Odours at Each Sampling Point within the WWTP 40
Figure 9: Harmony WWTP Odour Impact Zoomed Out 42
Figure 10: Harmony WWTP Odour Impact Zoomed In 44
Figure 11: Compiled Meteorological Data for 2020 - 2022 44
Figure 12: Harmony WWTP Odour Impact Radius from Site 45

EXECUTIVE SUMMARY

Scentroid was commissioned by Harmony Developments Inc. c/o Qualico Communities to conduct an odour impact assessment of the Harmony Residential zone. Scentroid odour experts were present on site for 5 days of sampling from August 21 – 26. An odour campaign was initiated and included an odour patrol consisting of olfactometric, chemical sampling, and analysis. Scentroid's goal was to determine the contribution of odours from a local wastewater treatment facility and a local excavation zone and determine its potential effects on the neighboring Harmony community.

Based on the sampling data obtained via observation, the TR8, and the SM100, it is evident that the primary contributors of odour were the smell of grass, mud, topsoil, wildfire, construction, decaying organics, pond water, vehicle exhaust, rain, manure, and sewage. It is important to note that the wastewater treatment facility and the excavation/wetlands operations appear to have a considerably low odour impact. Based on atmospheric dispersion model simulation, and emission rate calculations, the wastewater treatment facility has an odour concentration of 10 ou/m3 at the source, and a diminished odour concentration of 1 ou/m3 at the odour dispersion boundary approximately 50m – 400m surrounding the source.

Using olfactometric (EN 13725:2005) and chemical analysis data obtained from the initial site assessment, Scentroid calculated an odour emission rate and used AERMOD modelling to predict the odour plume extent and severity. Based on sampling data obtained on site, coupled with meteorological data collected on site and obtained from the Calgary Springbank Airport Weather Station, it was determined the odour plume is insignificant and only noticeable under highly specific conditions.

There were no noticeable odours generating from the treated wastewater pond. The water from the pond was found to be clean; in post-treatment and Chlorinated.

Based on the dispersion modeling performed on the current operational capacity of the Wastewater Treatment Facility, odour complaints have the potential to be registered up to a 400m Southeast of their source, and approximately 50 m to the North, to the West, and to the Northwest of their source.

OVERVIEW

INTRODUCTION

The goal of this project is to provide the community of Harmony with an odour survey in the community of Harmony to detect possible odours, identify odour source and review the potential impact and the effect on residents. Scentroid conducted an odour sampling and analysis campaign which consisted of an odour patrol performing olfactometric and chemical analysis.

The olfactometric analysis approach was used on collected samples from the site and was based on the (C) EN 13725:2005 international odour standard. Olfactometric analysis is the only way to determine odour concentration. To conduct proper olfactometric analysis, specialized sampling techniques and equipment are used to comply with the international standard. In this case, concentrations were obtained using Scentroid's SM100 Personal field olfactometer instrument. Scentroid is a world leader in the odour field and is proudly the world's largest manufacturer of these specialized instruments dedicated to odour sampling, monitoring, and management.

Chemical analysis is considered a standard approach in air pollution measurement. For this project, all chemical analysis was done by Scentroid's TR8 Pollutracker instrument. The key in our approach was to match the chemical analysis to the olfactometric odour concentration, and to determine the root causes of residential complaints.

Odour and chemical data were both obtained via an odour patrol that was determined to encompass and represent all major aspects and locales surrounding the facility. The odour patrol consisted of 20 sampling sites for odour, H2S, and VOCs.

Our selection of sampling sites for this project were based on a strategy that takes into consideration key factors relevant to this investigation. The rationale for each is as follows:

Resident Complaints: Complaints served as direct evidence of a potential odor nuisance in the area. Selecting sampling points in proximity to locations where complaints were filed is essential to investigate and address specific concerns of the community.

Proximity to Suspected Odour Sources: This includes areas surrounding the excavation process and operational wastewater treatment facility. These points were critical to this investigation because it enables Scentroid to assess emissions from these sources directly, allowing us to establish a causal link between sources and odour issues.

Downwind Locations: This approach considered the prevailing wind patterns, which can carry odours from their source to downwind areas. This ensures that Scentroid captures data from areas likely to be affected by odours, further deepening our understanding of their dispersion.

Variability in Odour Exposure: This variability may be due to factors such as weather conditions, time of day, or operational cycles of the wastewater treatment facility. Sampling in locations where odours were intermittent was needed to provide a comprehensive assessment.

The data collected by Scentroid via odour patrols, olfactometric analysis, and chemical analysis was then compiled and used to fulfill the objectives of this study. Furthermore, data was used to create atmospheric dispersion model simulations and display the total odour impact extent and severity from the facility. The initial site assessment assisted the Scentroid team in determining the sources contributing to odour.

All aspects of the project were directed and personally managed by Scentroid's president, Dr. Ardevan Bakhtari, who developed all the sampling and odour measurement equipment Scentroid manufactures.

PROJECT CONTACT INFORMATION

Scentroid's primary contact for this project is Willie Miller
Phone: 1 403-999-3685
Email: willie.miller@bordeauxdevelopments.com

PROJECT SITE

The Harmony site is located approximately 24 km from downtown Calgary and 8 km from the town of Cochrane, Alberta. It has a perimeter of 2.75 km by 1.875 km and an area of 5.15625 km2. The area contains multiple parks, a golf course and clubhouse, a lake, a water treatment plant, wastewater treatment plan (including treated wastewater pond), local housing, as well as a large area where historical wetlands have been excavated for the future lake expansion (previously Glenbow Lake).

Figure 1: Aerial View of Harmony Site

COMMUNITY OF HARMONY: SCENARIO

At present, Harmony officials have received numerous complaints from residents, with several of these grievances having been filed prior to our visit. Many of these complaints specifically reference issues related to organic waste and odours perceived to be emanating from the wastewater treatment facility.

Scentroid was contacted to investigate and address concerns regarding odour emissions in Harmony. With a focus on data-driven solutions, a proven track record in assessing odour-related issues, and expertise in odour monitoring strategies, Scentroid was commissioned to identify the source of odours, quantify their impact, and ultimately assist Harmony in understanding the odour impact of their activities.

PROJECT FLOWCHART

The process begins with data collection, encompassing odour patrol and odour sampling, to gather information regarding odour sources and emissions. Following this, the collected data undergoes rigorous analysis, involving emission analysis, chemical analysis, and olfactometry, allowing for a detailed understanding of the odour characteristics. Subsequently, the project progresses to modeling, where an odour impact assessment is developed, providing insights into the extent and nature of the odours impact on the local environment. The final stage of the project involves the creation of a detailed and informative report, which summarizes the findings and provides valuable information for the development of effective odour mitigation strategies in the Harmony Community.

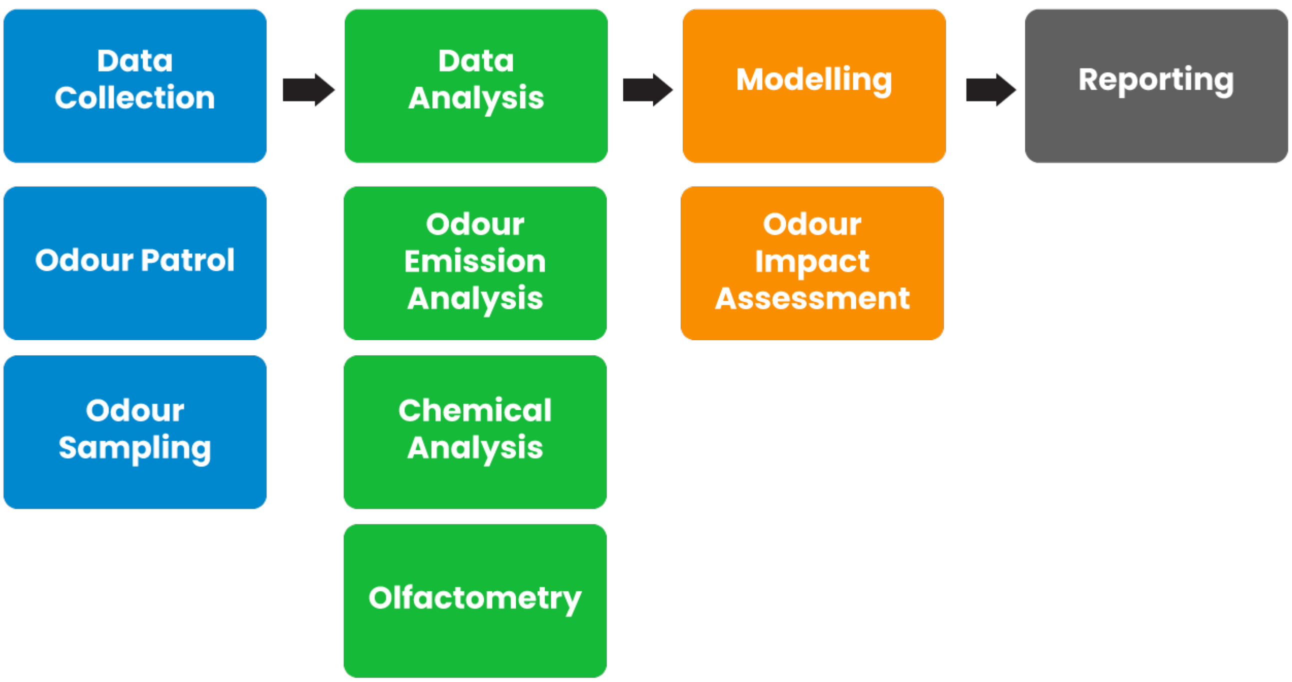


Figure 2: Process Flowchart for Harmony Project

PERCEIVING ODOURS AND ESTIMATING ODOUR EMISSIONS

Odour production from the community of Harmony wastewater treatment facility, the wetland excavation zone, and the neighboring community was obtained via measurements with the SM100i personal field olfactometer, coupled with estimations of the emission rate. The emission rate was determined by noting the gas emissions from the site in a grams per second annotation, and then divided by the area of the emission sources. Emission source areas were determined using a Google Earth aerial image of the project site incorporated as a base map into our AERMOD software.

A common approach for facility odour assessment is to incorporate dispersion modeling analysis to predict off-site odour concentrations. This method is used because it addresses meteorological conditions, provides more spatial information than ambient air monitoring alone, and has the potential to simulate various scenarios.

PERCEIVING ODOURS

There are many regulatory approaches for managing odours. This is partially the result of subjectiveness related to the single best option for controlling or managing odour issues. For this project, the ambient concentration criteria for odour were used to identify guidelines for the perception and concentration-quantification scale of odours.

1 OU/m3; 50% of the population may be able to perceive the odour (minimum threshold)

3 OU/m3; 50% of the population will be able to recognize the odour (threshold)

5 OU/m3; Odour is recognizable by most of the population (maximum threshold)

10+ OU/m3; Odour is clearly qualified and odour complaints may be registered (quantifiable odour)

For this project, our team conducted a thorough evaluation of each sampling site, employing a comprehensive approach to odour analysis. This included the utilization of olfactometric tests to ascertain the presence of any prevalent odour and what it was perceived to be, if indeed one was detected. Subsequently, in cases where a clear and continuous (active) odour source was identified, our team proceeded to calculate the dispersion rate in Odour Units per cubic meter (OU/m^3). This methodical process enabled us to quantitatively assess and address odour-related issues, laying the foundation for the development of effective mitigation strategies tailored to the specific conditions in Harmony.

Please note that odorants predicted at lower concentrations (at or below threshold levels) when aggregated may generate an observed odour.

AGGREGATE EXPOSURE

After compiling the chemical analysis data from the passive samplers, SM100i and the TR8, the total odour concentration was determined in odour units per meters cubed (OU/m3). The concentration of an odour from a source is used to calculate its emission rate in an Odour Unit per second (OU/s) annotation. The emission rate is then directly input into our AERMOD modelling suite and processed as a single odour compound (total odour).

ODOUR IMPACT ASSESSMENT METHODOLOGY

AERMOD modelling suite is the preferred and recommended modelling software developed by AERMIC; an organization comprised of the US-Environmental Protection Agency and the American Meteorological Society. It is a steady-state plume model that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concepts. This includes the treatment of both surface and elevated sources. To enhance predictive accuracy, the model incorporates meteorological data as mandatory inputs. Hourly surface observations of wind speed, wind direction, temperature, humidity, solar-flux, and cloud cover must be incorporated into the model. Additionally, the model uses a novel method to estimate the surface similarity parameters of friction, velocity, sensible heat flux, and temperature scale via routinely collected meteorological variables of cloud cover, ceiling height, wind speed, temperature and estimates of surface roughness. This approach is based on the UK ADMS-5 MET module methodology. To ensure practicality of the air dispersion model, the site was carefully examined using Google Earth and building boundaries and elevations were implemented to their nearest real-time dimensions. This ensured that an accurate building downwash effect occurred when running the AERMOD model, thereby enhancing the accuracy of the result.

The required data was extracted from our Scentroid Global Weather Database. The annual distribution of wind direction and wind speed at the site was input into the model and is presented as a wind-rose diagram below. The distribution from the wind-rose diagram indicates that the predominant wind direction is alternating between blowing towards the northeast and towards the southwest with occasional strong winds blowing to the West.

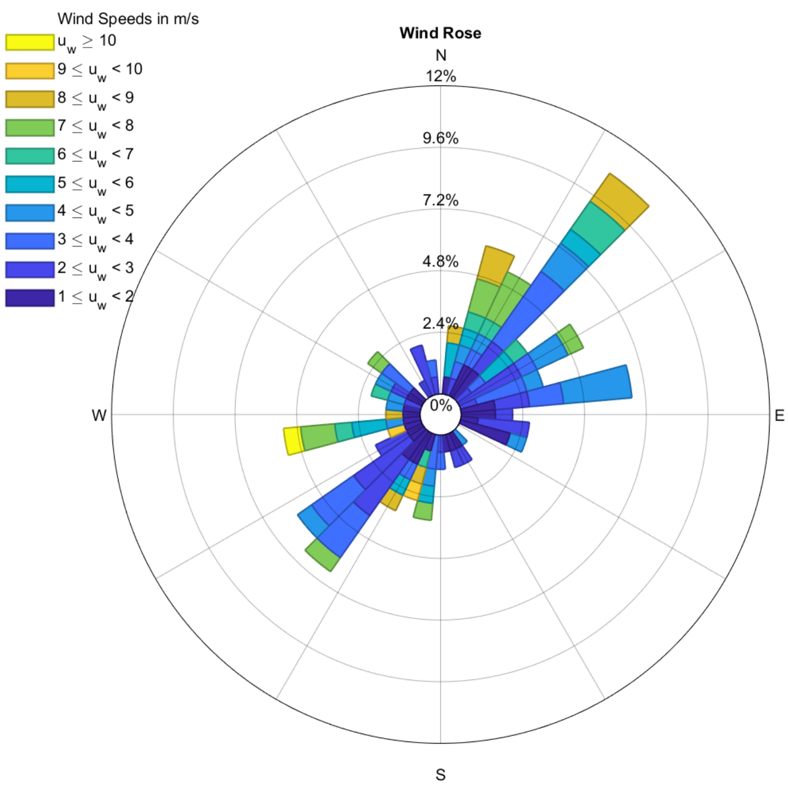


Figure 3: Wind Rose for Harmony Site, Extracted from Global Weather Database, and in-field data collection. Aug. 21 to Aug 26

INITIAL SITE ASSESSMENT

The initial site assessment is the critical first step of an odour study. The site assessment (including odour patrol) was conducted over the course of one week, from 2023-08-21 to 2023-08-26. These dates were selected as they covered the season where odours would theoretically be at their maximum strength for the entire year.

The objectives of the initial site assessment were:

Identification of sources: Determine the sources that need to be sampled and measured for odour concentrations using an olfactometric approach.

Conduct Baseline Study: Assess the facility's odour concentration at specified boundaries and interior designated locations.

Miscellaneous: Determine if other odour contributing factors are applicable – note their impact

Obtain background parameters: Obtain background parameters at sources and/or designated sampling locations. Parameters will be input into an air dispersion model to determine the severity and extent of the air-odour plume. Background parameters could include gas exit velocity, gas exit temperature, orientation angle from the north, flow rate, emission rate (g/s), volume, elevation, etc.

Quality assurance: Ensure odour sources are identified and baseline study of odour and chemical concentrations are complete. Ensure collected data is accurate and reliable.

RESOURCES

Various materials were used in this project. The table below displays the primary resources used during the initial site assessment.

Primary Equipment	Manpower	Duration	Location
TR8 Pollutracker **SM100** **Anemometer** **Flux Chamber**	Two (2) certified odour experts (Scentroid Odour Academy)	Five (5) day sampling campaign	Harmony, Calgary AB

TR8: Real-time measurements of H_2S and VOCs
SM100: Real-time measurements of Odour (OU/m3)

SAMPLING SITES

Scentroid analyzed odours emanating from the excavation of the local wetlands, the wastewater treatment facility, and the affected residential neighborhood zones. Scentroid established a sampling map based on any complaint data received, local weather conditions, and any potential correlated processes. By centralizing all data, our team was able to facilitate better decision making and targeted strategies.

Figure 4: Isolated Zones for Harmony Site. White dotted line indicates route travelled by sampling team.

In response to the community's concerns regarding the perceptible odours, Scentroid remained resolute in conducting a comprehensive evaluation to identify the precise sources of the problem. This commitment led to the selection of several sampling sites within the affected neighborhood zone, with a designated sampling path that encompassed the excavation zone and extended into the northern section of the residential area. Furthermore, our assessment extended eastward to encompass the pond and the wastewater treatment facility, ensuring a thorough and exhaustive analysis of odour emissions from these critical sources.

Given the differences in odor perception throughout the day, we understood the importance of developing a flexible monitoring schedule. This allowed us to compensate for variations in odor levels and patterns. Moreover, when developing our patrol maps, our experts considered other potential environmental factors, such as neighboring agricultural lands including the nearby Bison farm located just southwest of the premises, which could also contribute to the issue.

Figure 5: Aerial view of Harmony Wastewater Treatment Facility, with several points of interest indicated.

SAMPLING APPROACH

Sampling included a complete perimeter odour assessment as well as additional sampling points located within the perimeter. These interior sampling points focused on received complaint locations, public trails, neighborhood locations, and parks. Odour was sampled by certified odour experts (Scentroid Odour Academy), certified sensory panelists (EN 13725:2022), and certified operators for the SM100i personal field olfactometer instrument. In addition to odour measurements, Scentroid also conducted measurements for H_2S and VOCs at each sampling location. Finally, Scentroid placed our flux chamber on the wastewater reservoir pond for direct sampling analysis of potential odors.

There were 8 locations incorporated into the perimeter monitoring:
They included one monitoring point situated at the southernmost tip of the neighborhood zone, another at the western tip, two positioned along the outer boundaries of the excavated zone, two on the northern wall of the upper region of the neighborhood zone, and finally, two locations positioned along the fence line of the wastewater treatment facility.

There were 13 locations that were incorporated in the interior sampling:
Eight of these interior sampling points were strategically distributed, covering the entirety of the southern neighborhood zone. This approach was meticulously designed to encompass all potential directions of downwind odour dispersion, ensuring that any odours emanating from both the excavation zone and the wastewater treatment facility could be effectively captured. Additionally, the remaining five sample points were thoughtfully dispersed throughout the wastewater treatment facility (WWTP). This placement guaranteed the sampling of odours originating from various operational processes within the facility, providing a comprehensive view of the odour emissions from the WWTP's different areas and processes.

Emissions from the treated wastewater pond were assessed:
Using the Scentroid Flux Chamber, our team conducted a precise and direct assessment of emissions originating from the pond utilized by the wastewater treatment facility. This allowed us to capture and evaluate any emissions that might be escaping from the pond, offering a thorough understanding of the environmental impact and odour emissions associated with this critical component of the facility.

Locations were visited multiple times throughout the week with varying weather conditions, wind conductions, and times of day/night to ensure a full capture of all scenarios associated with odour emissions.

NEIGHBORHOOD: N01

Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odour Intensity
2023-08-21	18:53:00	120	13	17	60	Yes	Wildfire	1
2023-08-22	11:13:00	100	6	15	100	Yes	Wet soil	2
2023-08-22	13:44:00	80	7	17	55	No		0
2023-08-22	14:40:00	100	9	18	45	No		0
2023-08-22	20:08:00	80	8	15	100	No		0
2023-08-22	22:31:00	30	3	15	100	Yes	Wet dirt	2
2023-08-23	08:44:00		0	13	100	Yes	Truck Exhaust	5
2023-08-23	16:08:00	270	19	18	34	No		0
2023-08-24	10:40:00	300	11	17	40	No		0
2023-08-25	05:11:00			10	100	Yes	Cold mud	1
2023-08-25	06:18:00	70	2	10	85	Yes	Wet mud	1
2023-08-25	13:15:00	150	14	20	48	No		0
2023-08-26	11:12:00	330	10	23	40	No		0
2023-08-25	13:12:00	150	14	21	48	No		0

Table 1: Data Collected from Neighborhood Point: N01

Peak H2S Conc. (ppb)	21	Peak PID Conc. (ppm)	0.00	Peak Odour Units (OU)	27[a]

[a] Odours originating from Truck Exhaust unrelated to the WWTP or excavation

NEIGHBORHOOD: N02

Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odour Intensity
2023-08-21	18:57:00	120	12	17	64	No		1
2023-08-22	11:09:00	100	6	15	100	No		0
2023-08-22	13:41:00	80	7	17	55	No		0
2023-08-22	14:36:00	100	9	19	50	No		0
2023-08-22	20:05:00	80	8	15	100	No		0
2023-08-22	22:28:00	110	4	15	100	No	Wet wood	0
2023-08-23	08:40:00	170	2	13	100	No		0
2023-08-23	16:03:00	260	25	18	34	No		0
2023-08-24	10:37:00	310	8	17	42	No		0
2023-08-25	05:08:00			10	100	No		0
2023-08-25	06:16:00	70	2	11	85	Yes	Constructio n	2
2023-08-25	13:17:00	150	15	20	48	No		0
2023-08-26	11:09:00	330	12	22	40	Yes	Wildfire	2

Table 2: Data Collected from Neighborhood Point N02

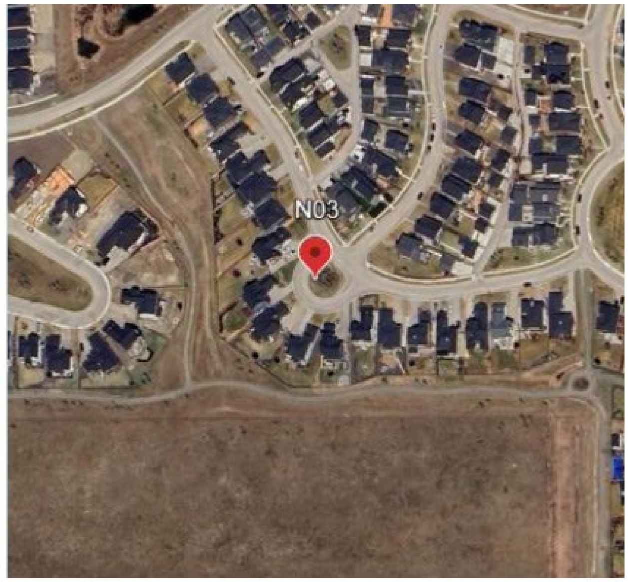
Peak H2S Conc. (ppb)	13

Peak PID Conc. (ppm)	0.00

Peak Odour Units (OU)	<5

NEIGHBORHOOD: N03








Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odour Intensity
2023-08-21	19:01:00	120	12	17	60	No		1
2023-08-22	11:05:00	100	6	15	100	Yes	Rain	1
2023-08-22	13:38:00	80	8	17	60	No		0
2023-08-22	14:33:00	90	8	18	49	No		0
2023-08-22	20:02:00	70	8	15	100	No	Rain	0
2023-08-22	22:25:00	110	4	15	100	No	Organic Decay	0
2023-08-23	08:38:00	170	2	13	100	No		0
2023-08-23	04:00:00	260	25	19	28	No		0
2023-08-24	10:35:00	310	8	17	42	No		0
2023-08-25	07:06:00			10	90	Yes	Grass	1
2023-08-25	06:13:00	70	2	11	85	No		0
2023-08-25	13:19:00	150	15	20	48	No		0
2023-08-26	11:07:00	330	12	22	40	No		0

Table 3: Data Collected from Neighborhood Point N03

Peak H2S Conc. (ppb)	7	Peak PID Conc. (ppm)	0.00	Peak Odour Units (OU)	<5

NEIGHBORHOOD: N04

Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-21	19:04:00	120	12	17	65	No		1
2023-08-22	11:03:00	100	6	15	100	No		0
2023-08-22	13:35:00	80	8	17	60	No		0
2023-08-22	14:28:00	90	8	18	50	No		0
2023-08-22	19:59:00	70	8	15	100	Yes	Rain	1
2023-08-22	22:23:00	110	9	15	100	Yes	Dead fish	3
2023-08-23	08:36:00	170	2	13	100	Yes	Grass	2
2023-08-23	15:57:00	260	23	19	29	No		0
2023-08-24	10:32:00	310	8	16.5	43	No		0
2023-08-25	05:01:00		0	7	95	Yes	Sewage	2
2023-08-25	06:11:00	70	2	11	87	No		0
2023-08-25	13:20:00	150	15	20	48	Yes	Grass	6
2023-08-26	11:04:00	340	14	22	40	No		0

Table 4: Data Collected from Neighborhood Point N04

Peak H2S Conc. (ppb)	2	Peak PID Conc. (ppm)	0.00	Peak Odour Units (OU)	12[b]

[b] Odours from excavation activity and from collection system.

NEIGHBORHOOD: N05

Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-21	19:07:00	130	10	17	65	No		1
2023-08-22	10:57:00	90	7	14	100	No		0
2023-08-22	13:32:00	80	8	17	65	No		0
2023-08-22	14:23:00	100	10	18	50	No		0
2023-08-22	19:52:00	60	7	15	100	Yes	Rain	1
2023-08-22	22:19:00	110	9	15	100	Yes	Organic Decay	5
2023-08-23	08:33:00		0			No		0
2023-08-23	15:44:00	270	21	20	26	No		0
2023-08-24	10:19:00	310	6	15	53	No	Grass	0
2023-08-25	04:58:00		0	7	95	No	Grass	0
2023-08-25	06:08:00	60	4	10	87	No		0
2023-08-25	13:22:00	160	9	21	47	No		0
2023-08-26	11:02:00	340	13	22	40	No		0

Table 5: Data Collected from Neighborhood Point N05

Peak H2S Conc. (ppb)	0	Peak PID Conc. (ppm)	0.00	Peak Odour Units (OU)	37[c]

[c] Odours related to excavation operation

NEIGHBORHOOD: N06

Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-21	18:34:00	120	14	16	65	No		1
2023-08-22	12:00:00	90	8	16	85	No		0
2023-08-22	14:07:00	90	8	18	49	Yes	Wildfire	3
2023-08-22	20:21:00	100	8	15	100	Yes	Grass	2
2023-08-23	09:08:00	180	2	13	95	Yes	Trees	2
2023-08-23	17:20:00	270	14	20	27	No		0
2023-08-24	11:08:00	320	14			Yes	Vehicle Exhaust	3
2023-08-25	05:30:00	60	3	9	95	No		0
2023-08-25	07:25:00	160	5	11	90	Yes		2
2023-08-25	13:01:00	160	16	21	45	Yes	Wildfire	1
2023-08-26	11:27:00	350	11	23	40	No		0

Table 6: Data Collected from Neighborhood Point N06

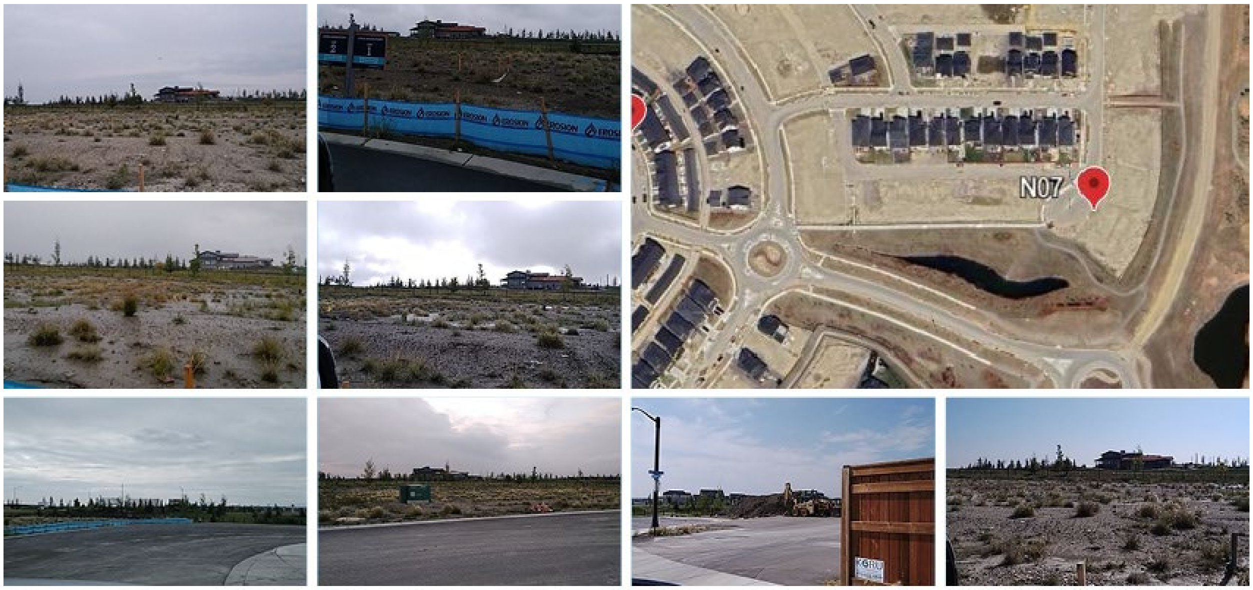
Peak H2S Conc. (ppb)	33

Peak PID Conc. (ppm)	0.00

Peak Odour Units (OU)	16[d]

[d] Odours related to wildfire

NEIGHBORHOOD: N07

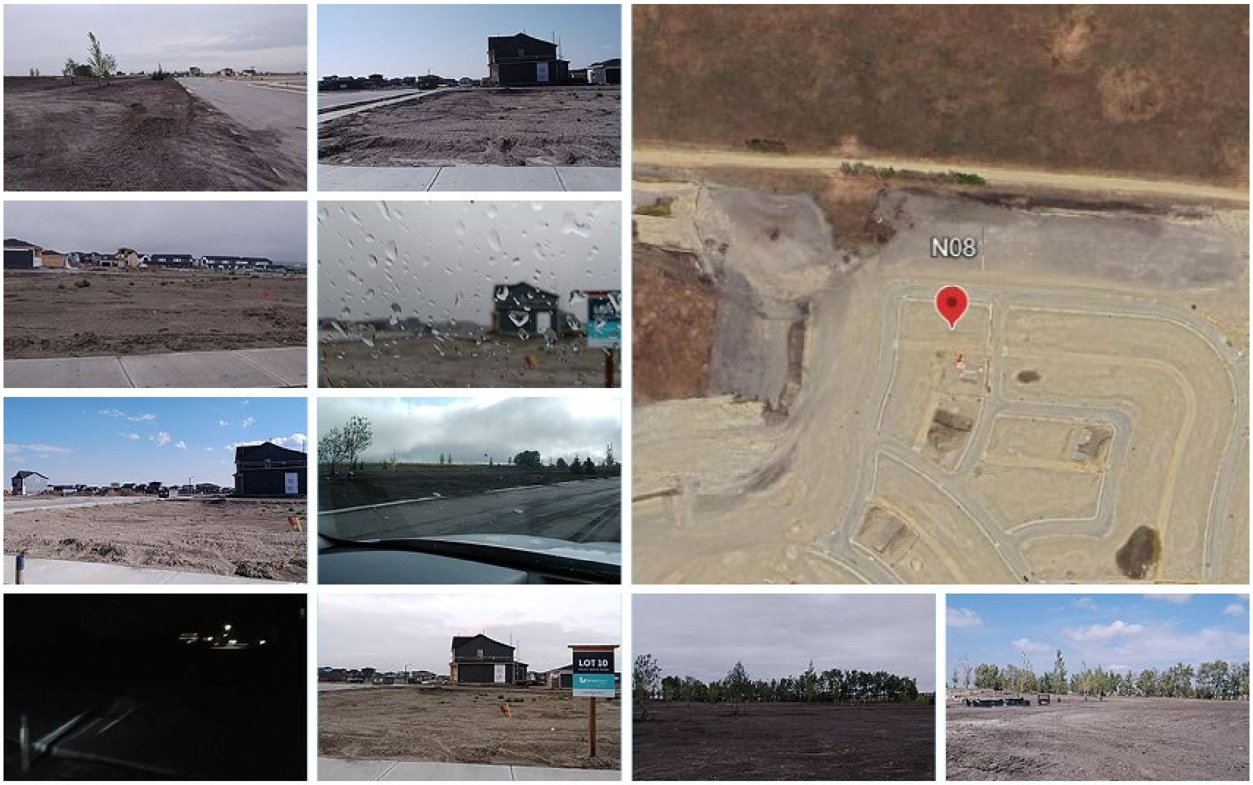


Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-21	18:25:00	120	11	17	67	No		1
2023-08-22	12:06:00	90	7	17	80	No		0
2023-08-22	14:04:00	90	8	18	52	Yes	Grass	2
2023-08-22	20:19:00	100	8	15	100	Yes	Dirt	2
2023-08-23	09:14:00	180	2	14	85	No		0
2023-08-23	17:17:00	270	14	18.5	31	No		0
2023-08-24	10:55:00	300	14	17.2	38	No		0
2023-08-25	05:26:00	60	3	9	95	No		0
2023-08-25	07:22:00	160	5	11	90	No		0
2023-08-25	12:56:00	160	15	21	47	No		0
2023-08-26	11:24:00	340	12	24	35	No		0

Table 7: Data Collected from Neighborhood Point N07

Peak H2S Conc. (ppb)	22	**Peak PID Conc. (ppm)**	0.00	**Peak Odour Units (OU)**	<5

NEIGHBORHOOD: N08

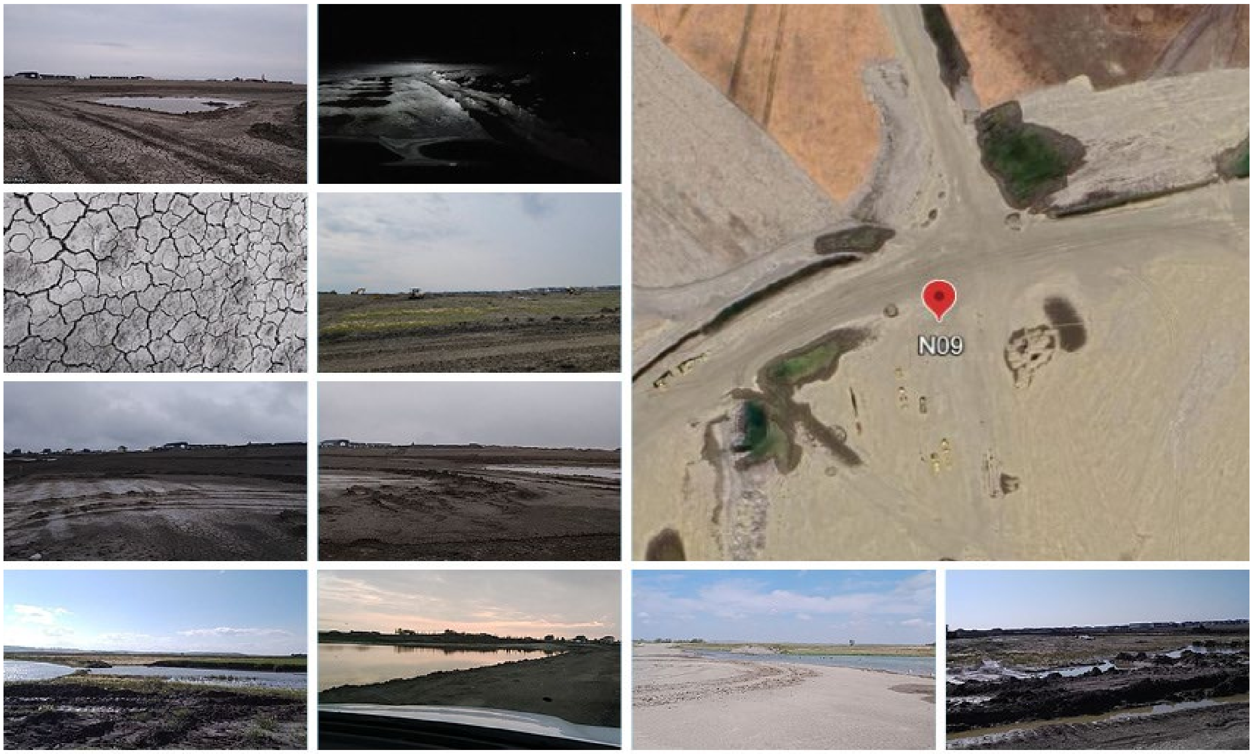


Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-21	18:30:00	120	14	16	68	No		1
2023-08-22	11:52:00	90	8	16	85	No		0
2023-08-22	14:01:00	90	7	19	50	No		0
2023-08-22	20:17:00	90	9	15	100	No	Dirt	0
2023-08-23	09:11:00	180	2	14	95	No		0
2023-08-23	17:14:00	270	14	19.2	30	No		0
2023-08-24	11:02:00	340	11	17	40	Yes	Wildfire	2
2023-08-25	05:24:00	60	3	9	95	No		0
2023-08-25	07:20:00	160	5	10	90	No	Dirt	0
2023-08-25	12:59:00	160	14	21	45	No		0
2023-08-26	11:23:00	340	10	23	40	No		0

Table 8: Data Collected from Neighborhood Point N08

Peak H2S Conc. (ppb)	24	Peak PID Conc. (ppm)	0.00	Peak Odour Units (OU)	<5

NEIGHBORHOOD: N09



Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-21	10:45:00	200	2			No		1
2023-08-21	10:49:00	200	2			No		1
2023-08-21	18:40:00	110	12	17	69	No		1
2023-08-21	18:43:00					No		1
2023-08-22	11:30:00	80	7	15	100	Yes	Mud	1
2023-08-22	13:56:00	90	7	18	50	Yes	Dirt	1
2023-08-22	20:14:00	90	9	15	100	No		0
2023-08-23	17:06:00	280	15	19	30	Yes	Muddy water	2
2023-08-25	05:19:00		0	9	100	Yes	Damp mud	2
2023-08-25	07:18:00	160	5	10	90	No		0
2023-08-25	13:08:00	150	14	20	47	No		0
2023-08-26	11:19:00	340	12	23	40	No	Dirt	0

Table 9: Data Collected from Neighborhood Point N09

Peak H2S Conc. (ppb)	19

Peak PID Conc. (ppm)	0.00

Peak Odour Units (OU)	17

NEIGHBORHOOD: N10

Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-21	10:41:00	200	2			No	No Odor[e]	9
2023-08-21	18:48:00	120	12	17	65	No		1
2023-08-22	11:26:00	80	7	15	100	No		0
2023-08-22	13:48:00	70	7	18	50	Yes	Still water	1
2023-08-22	20:10:00	80	8	15	100	Yes	Mud	2
2023-08-22	22:35:00	340	4	15	100	Yes	Mud	3
2023-08-23	08:50:00		0	13	100	Yes	Mud	3
2023-08-23	16:20:00	260	23	18	28	No		0
2023-08-24	10:46:00	300	11	16.2	43	No		0
2023-08-25	05:16:00		0	9	100	Yes	Cold mud	1
2023-08-25	07:13:00	140	3	10	90	No		0
2023-08-26	11:16:00	330	10	23	40	Yes	Manure	3

Table 10: Data Collected from Neighborhood Point N10

Peak H2S Conc. (ppb)	4	Peak PID Conc. (ppm)	0.00	Peak Odour Units (OU)	27

[e] Despite noting a high Odor Intensity of 9, detection period was incredibly brief. S100 Readings could not be performed.

NEIGHBORHOOD: N11

Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-22	11:38:00	80	7	15	90	Yes	Swamp	3

Table 11: Data Collected from Neighborhood Point N11

NEIGHBORHOOD: N12

Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-22	11:43:00	80	7	15	90	No		0

Table 12: Data Collected from Neighborhood Point N12

WWTP: CENTRIFUGE EXHAUST

Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-21	17:27:00				70	No		1
2023-08-25	12:43:00					No		0
2023-08-25	12:46:00				90	No		0

Table 13: Data Collected from WWTP Point Centrifuge Exhaust

Peak H2S Conc. (ppb)	0	**Peak PID Conc. (ppm)**	0.00	**Peak Odour Units (OU)**	<5

WWTP: GROUND VENT



Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-25	12:36:00				93	Yes	Sewage	6
2023-08-25	12:39:00				95	No		0

Table 14: Data Collected from WWTP Point Ground Vent

Peak H2S Conc. (ppb)	23

Peak PID Conc. (ppm)	0.29

Peak Odour Units (OU)	65

WWTP: HEADWORKS INTERIOR

Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-21	18:07:00	120	12	17.5	66	Yes	Sewage	8
2023-08-25	12:45:00				95	No		0

Table 15: Data Collected from WWTP Point Headworks Interior

Peak H2S Conc. (ppb)	0

Peak PID Conc. (ppm)	0.00

Peak Odour Units (OU)	286

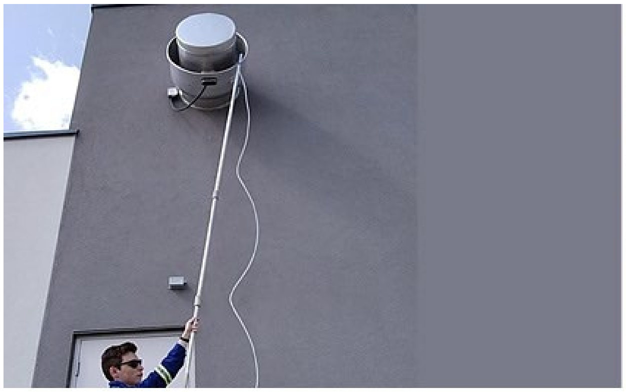
WWTP: HEADWORKS SIDE EXHAUST

Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-25	12:30:00				93	Yes	Sewage	3

Table 16: Data Collected from WWTP Point Headworks Side Exhaust

Peak H2S Conc. (ppb)	85	Peak PID Conc. (ppm)	0.29	Peak Odour Units (OU)	156

WWTP: MEMBRANE BUILDING



Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-25	12:41:00				93	No		0

Table 17: Data Collected from WWTP Point Membrane Building

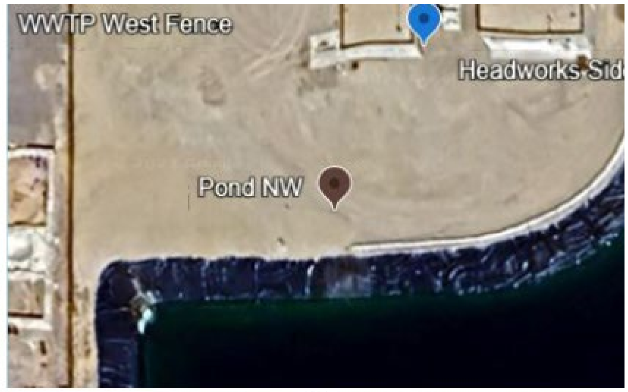
Peak H2S Conc. (ppb)	7

Peak PID Conc. (ppm)	0.20

Peak Odour Units (OU)	0

WWTP: POND, NORTHWEST CORNER










Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-21	16:53:00	120	9	18	67	Yes	Wastewater	2
2023-08-21	17:13:00	130	9	17.9	67.5	Yes	Wastewater	3
2023-08-22	12:13:00	90	8	17	85	Yes	Pond	4
2023-08-21	17:20:00	130	9	17.8	67	No		1
2023-08-25	12:25:00	140	17	21	45	No		0
2023-08-21	10:59:00	40	2			Yes	Sewage	7
2023-08-24	11:14:00	340	11	16	45	Yes	Truck Exhaust	4
2023-08-23	09:19:00		0	14	80	Yes	Algae	2

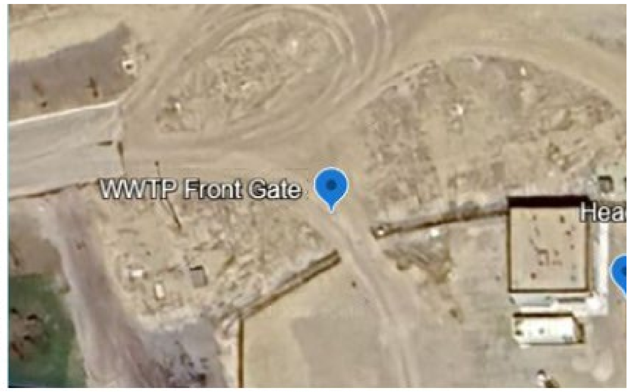
Table 18: Data Collected from WWTP Point Pond, Northwest Corner

Peak H2S Conc. (ppb)	0

Peak PID Conc. (ppm)	0.00

Peak Odour Units (OU)	158

WWTP: FRONT GATE



Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-22	20:25:00	100	8	15	100	No		0

Table 19: Data Collected from WWTP Point Front Gate

Peak H2S Conc. (ppb)	0

Peak PID Conc. (ppm)	0.00

Peak Odour Units (OU)	0

WWTP: WEST FENCE

Collection Date	Collection Time	Wind Direction	Wind Speed	Temp (C)	RH (%)	Measured Odour?	Describe Smell	Odor Intensity
2023-08-25	05:35:00	80	3	10	95	No		0
2023-08-22	22:31:00	90	9	15	100	Yes	Sewage	6
2023-08-22	12:30:00	100	7	18	80	Yes	Waste water	8

Table 20: Data Collected from WWTP Point West Fence

Peak H2S Conc. (ppb)	0

Peak PID Conc. (ppm)	0.00

Peak Odour Units (OU)	160

RESULTS AND DISCUSSION

The following devices were used to determine odour and VOC concentrations at the Harmony Residential Zone site: The SM100i Intelligent Olfactometer and the TR8+ Pollutracker. Using the Pollutracker, real-time measurements of H_2S and VOCs were obtained in units of ppb (parts per billion). The SM100i was used to obtain measurements of odour in units of OU/m3, when applicable.

RESULTS: TOTAL DETECTED ODOUR COMPOSITION

During our odor testing, we encountered a range of distinct odours at varying concentrations, offering a comprehensive snapshot of the odor landscape within the neighborhood zone. The chart below presents a breakdown of the percentages of these odours encountered during the study, shedding light on the diversity of odor sources and the extent to which they were present in the area:

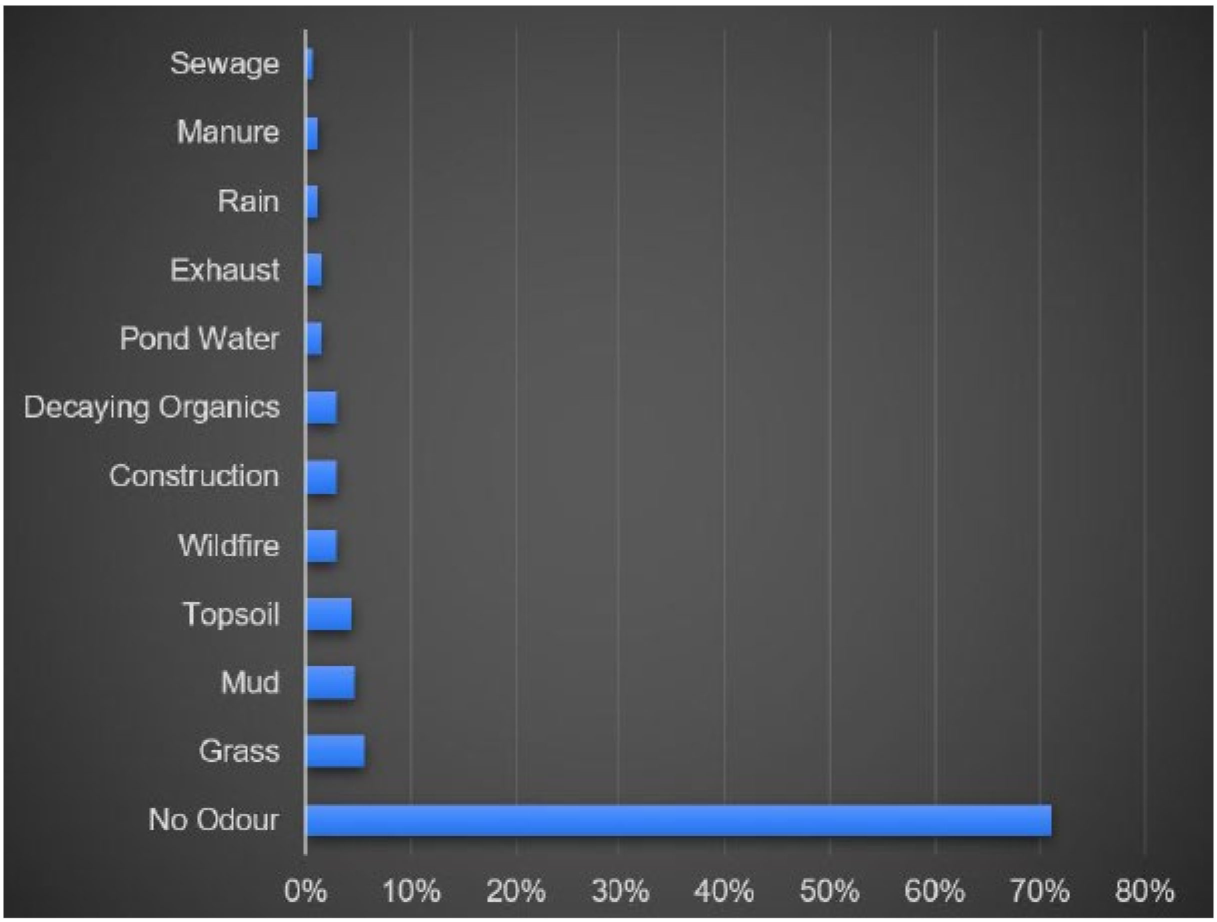


Figure 6: Perceived Odours (if encountered) for Harmony Sampling Route

Of all residential zone sample tests, only 29% yielded an odor.

This data not only helps to quantify the prevalence of different odour sources but also serves as a valuable reference for understanding the odor-related challenges in the neighborhood zone.

RESULTS: ODOUR IMPACT ASSESSMENT, NEIGHBORHOOD

Results from the sampling conducted within the local community zone provided valuable insights into the odour landscape of this region. Notably, our findings indicated that, on average, approximately 71% of the sampling points did not register any odour presence. However, in instances where odours were detected, the analysis revealed a diverse spectrum of odour sources. These included faint traces of odours associated with pondwater, which could be linked to any standing water within the community and vicinity.

Additionally, odours reminiscent of wildfire smoke, construction activities, grassy areas, exhaust emissions, mud, topsoil, and manure were identified, suggesting the influence of multiple environmental factors. Furthermore, our findings hinted at the presence of rain-related odours, along with sewage and a faint trace of decaying organics, particularly noticeable towards the southernmost sampling point. This comprehensive range of identified odour sources underscores the complex and multifaceted nature of the odour issues within the community.

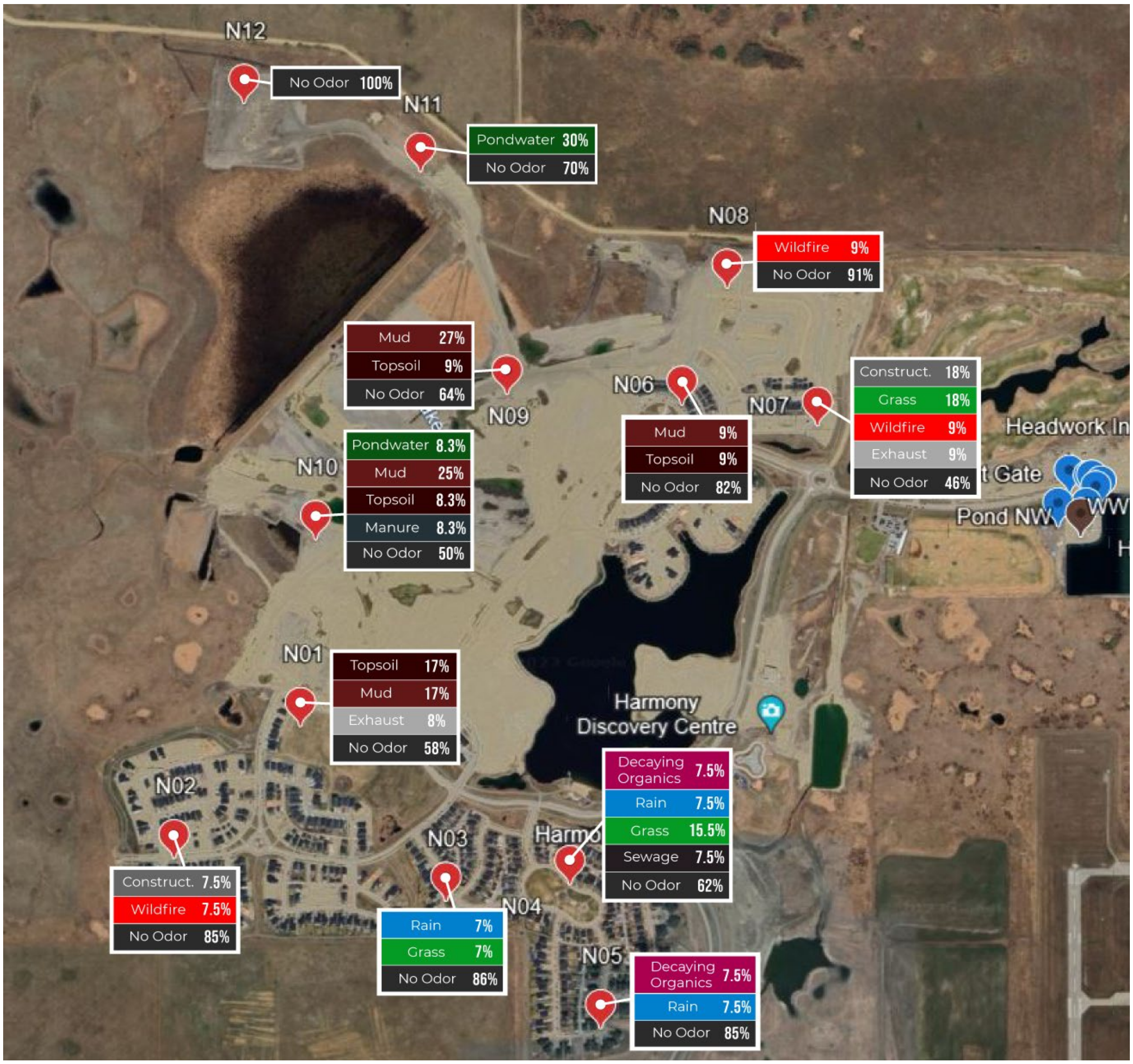


Figure 7: Percentage of Encountered Odours at Each Sampling Point

RESULTS: ODOUR IMPACT ASSESSMENT: WASTEWATER TREATMENT FACILITY

Notably, our findings indicated that approximately 60% of the sampling points showed no discernible odour presence, underscoring the success of certain containment measures and management strategies employed by the facility. However, in instances where odours were detected, sewage emerged as the most prominent and identifiable source. Additionally, we observed faint traces of odours associated with pondwater and vehicle exhaust, which suggested potential contributions from both the facility's processes and surrounding factors.

Despite the presence of sewage odours, it's crucial to emphasize that the emission levels remained relatively small and, more importantly, negligible from a broader environmental perspective. Our data revealed that at the perimeter wall of the facility, only 570 parts per billion (ppb) of hydrogen sulfide (H_2S) and 106 ppb of volatile organic compounds (VOCs) were detected. These relatively low emission levels indicate that even though odours were present within the facility, their emission rates were minimal. This suggests that any potential impact on the local community would essentially be undetectable and falls well within acceptable regulatory limits.

Figure 8: Percentage of Encountered Odours at Each Sampling Point within the WWTP

CALCULATING ODOUR EMISSIONS

To gather an accurate odor emission rate, we collected on-site data from known odour sources – primarily the operational Wastewater Treatment Plant.

A summary of odor emission rate data collected was compiled in the table below. The typical emission rates were calculated and identified for each source. This value was then incorporated into the atmospheric dispersion model. For regulatory reporting, it is necessary to identify the maximum odor impact potential; this maximum overview ensures that under extreme or unusual meteorological and operational conditions, the maximum potential odor impacts can be identified.

For this project a 99.5th percentiles maximum is considered as per regulatory framework for Alberta, Canada. (see Reference: Alberta, Air Quality Monitor Guideline)

AERMOD INPUTS AND INFRASTRUCTURE DESIGN

The infrastructure design of each of the Wastewater Treatment Facility components was digitized into AERMOD using Lakes's AERMOD View. In cases where residences were located within five (5) kilometers of the WWTP, at least one (1) sensitive receptor was included in the modeling simulation. The STP infrastructure elevations were digitized to their nearest real-time dimensions. Sensitive receptor elevations were assumed to be at least 1 meter higher than local ground-level. The sensitive receptor utilized a receptor height of 1.6 meters – this is the standard AERMOD flagpole height, intended to represent an individual's nose-level. The plant boundary of the facility was identified using Google satellite imagery and in-person identification.

The primary odor sources at the Harmony WWTP were identified to be the Contact Pond, Headworks Vent, Northern Ground Vent, Southern Ground Vent, and ventilation from the membrane building. For the AERMOD simulation, Scentroid identified a total of five (5) emission sources.

Type	Desc	Emission Rate	Base Elevation (m)	Height (m)	Diameter (m)	Exit Velocity (m/s)	Exit Temp. (K)	Release Type	Length:x (m)	Length:y (m)
AREA_CIRC	Contact Pond	0	1187.77	0	123	NA	NA	NA		
POINT	Headworks Vent	1204.3	1187.09	2.4384	0.102	0.01651846	Ambient	HORIZONTAL		
AREA	WWTP Ground Vent North	4.5	1187.65	0		NA	NA	NA	9.2	1.3
AREA	WWTP Ground Vent South	4.5	1187.63	0		NA	BA	NA	9.2	1.3
POINT	Membrane Building	0	1187.86	5.1816	0.5	1.9228869	Ambient	VERTICAL		

Table 21: AERMOD Inputs

ODOUR IMPACT ASSESSMENT

AIR DISPERSION MODELING

Predicted odor impact from the WWTP was modeled using design parameters obtained from on-site visits, and emission rate data gathered from the SM100i, TR8+, and SF450 Flux Chamber calculations. The results are presented as the maximum potential concentrations at multiple designated sensitive receptors.

The 99.5th percentile odor concentration was determined based on denoting scenarios of odor concentrations using meteorological data ranging from January 1, 2020 – December 31, 2022. The top 0.5% of potential implications were removed to account for discrepancies and irregularities. Furthermore, the odor concentration was converted from 1 hour average (AERMOD standard averaging to 30 min average following the conversion factor outlined in Appendix D).

The results described in this analysis are based on meteorological data indicating up to 98.1% of wind conditions range between calm to a moderate breeze. If elevated meteorological conditions (strong winds, storms, natural hazards, etc.) were to occur in the immediate area, the surrounding neighborhood is more likely to readily exceed triggering conditions.

As these occurrences are highly situational, they are typically not modelled and considered outliers.

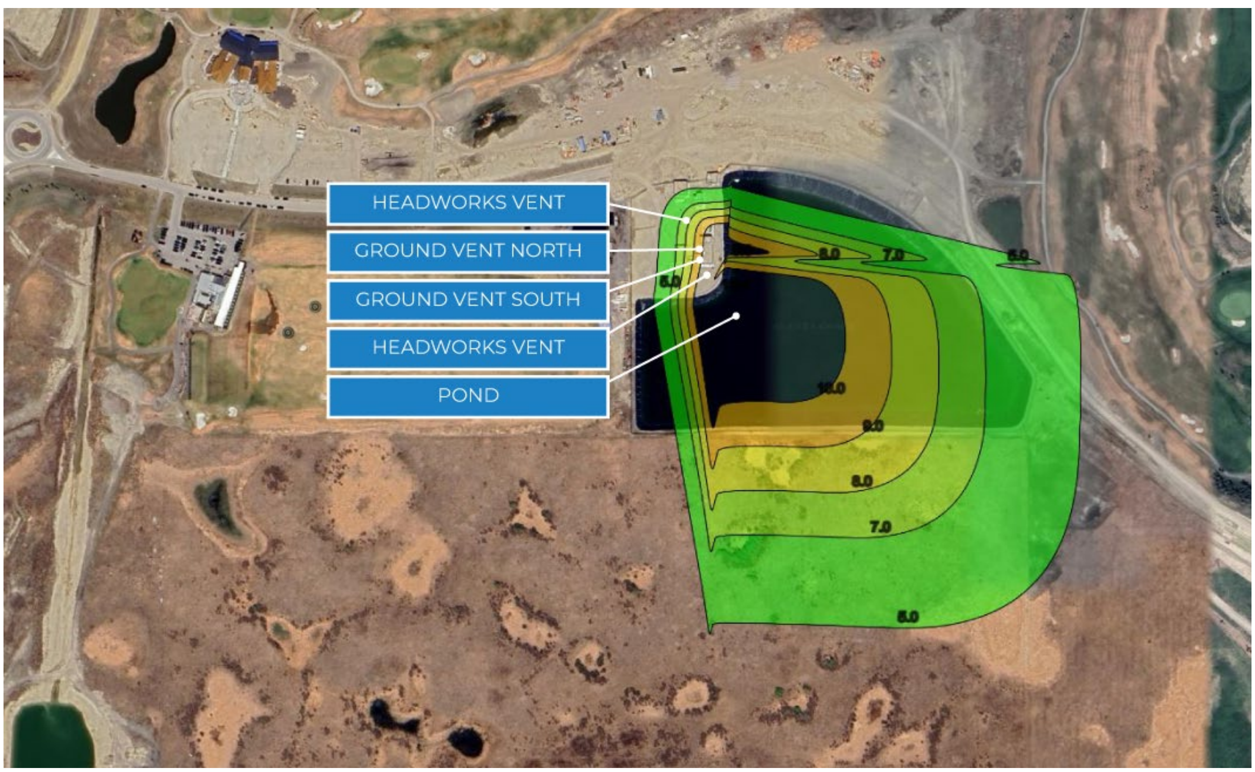


Figure 9: Harmony WWTP Odour Impact Zoomed Out

Figure 9 and 10: Odour Concentration in the Southeast

As indicated in Figures 9 and 10, the wastewater treatment plant in Harmony is the primary source of odours in the community. These figures illustrate that the odour concentration is most prominent in the southeastern quadrant, with the heaviest concentration observed near the pond. The concentration gradually decreases as distance from the source increases. The prevailing direction of odour dispersion in this area is towards the southeast.

Figure 11: Wind Direction Analysis

Figure 11 provides valuable insights into the wind patterns at the location. It indicates that the average wind direction in this region has predominantly been towards the Southeast. This consistent wind pattern has a significant influence on the dispersion of odours, directing them towards the southeast.

Figure 12: Odour Impact in Neighboring Regions

Figure 12 visually represents the extent of odour impact in the neighboring regions surrounding the wastewater treatment plant and pond. It is noted that a concentration of 5 odour units (the typical range in which identifiable detection occurs) can travel up to 400 meters away from the wastewater treatment plant, primarily favoring the southeastern direction.

Key Findings and Implications:

Primary Odour Source: The wastewater treatment plant is identified as the primary source of odour emissions in the area, with the heaviest concentration near the pond.

Dominant Wind Direction: The prevailing wind direction, which ranges predominantly to the east/southeast, plays a crucial role in spreading odours from the source in the same direction.

Odour Impact Range: The odour impact extends into the neighboring regions, with a significant impact zone identified. A concentration of 5 odour units can travel up to 400 meters, indicating a notable impact in the southeastern direction, in accordance with figure 12.

Odour Thresholds: It is important to consider relevant odour thresholds and community tolerances in assessing the potential impact on the surrounding areas.

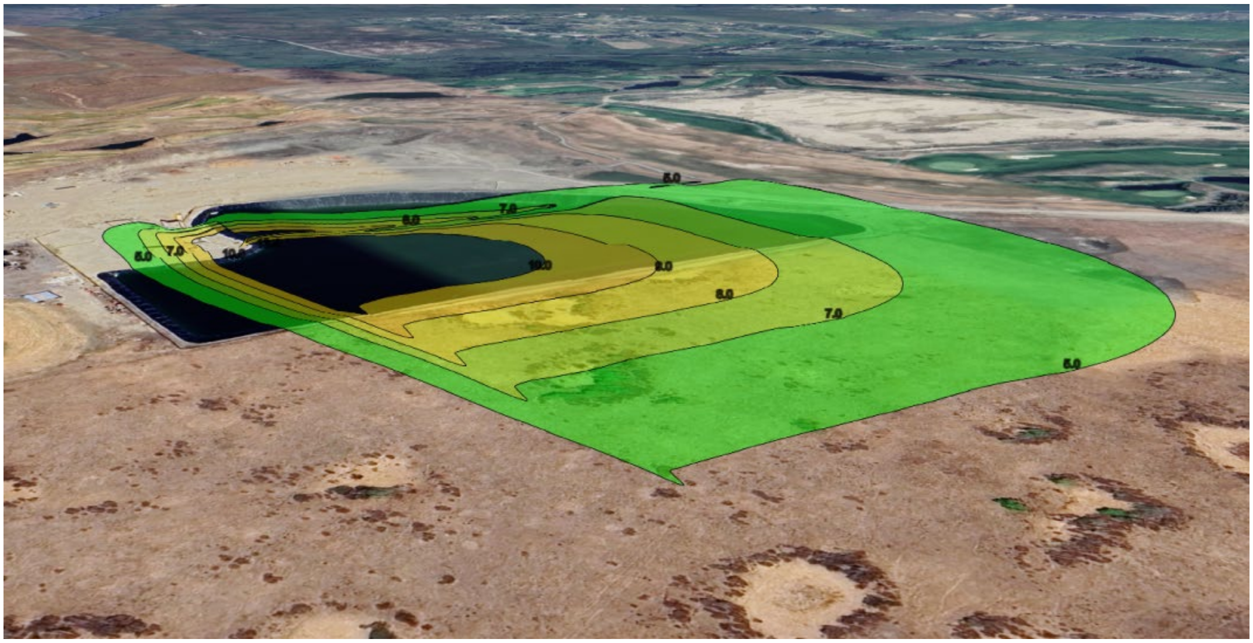


Figure 10: Harmony WWTP Odour Impact Zoomed In

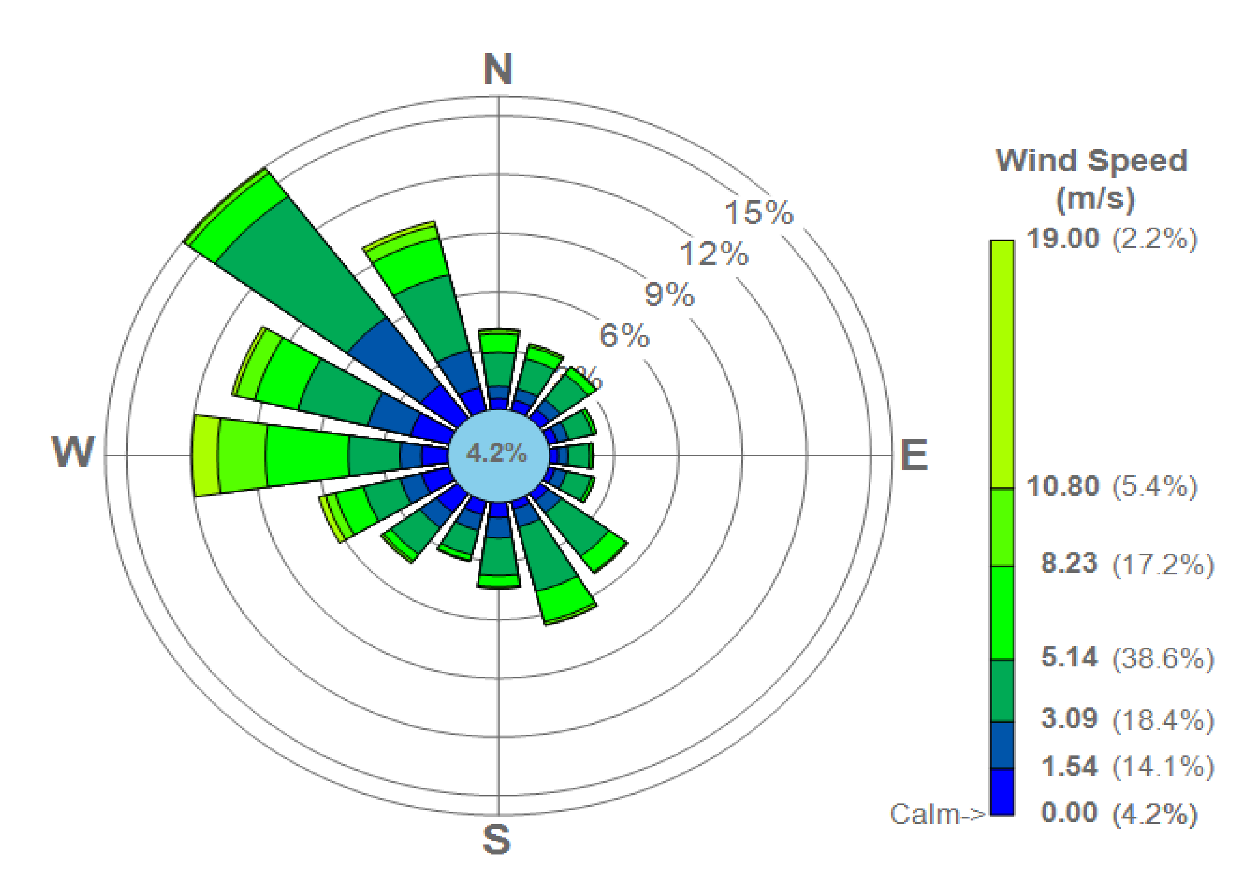


Figure 11: Compiled Meteorological Data for 2020 - 2022.

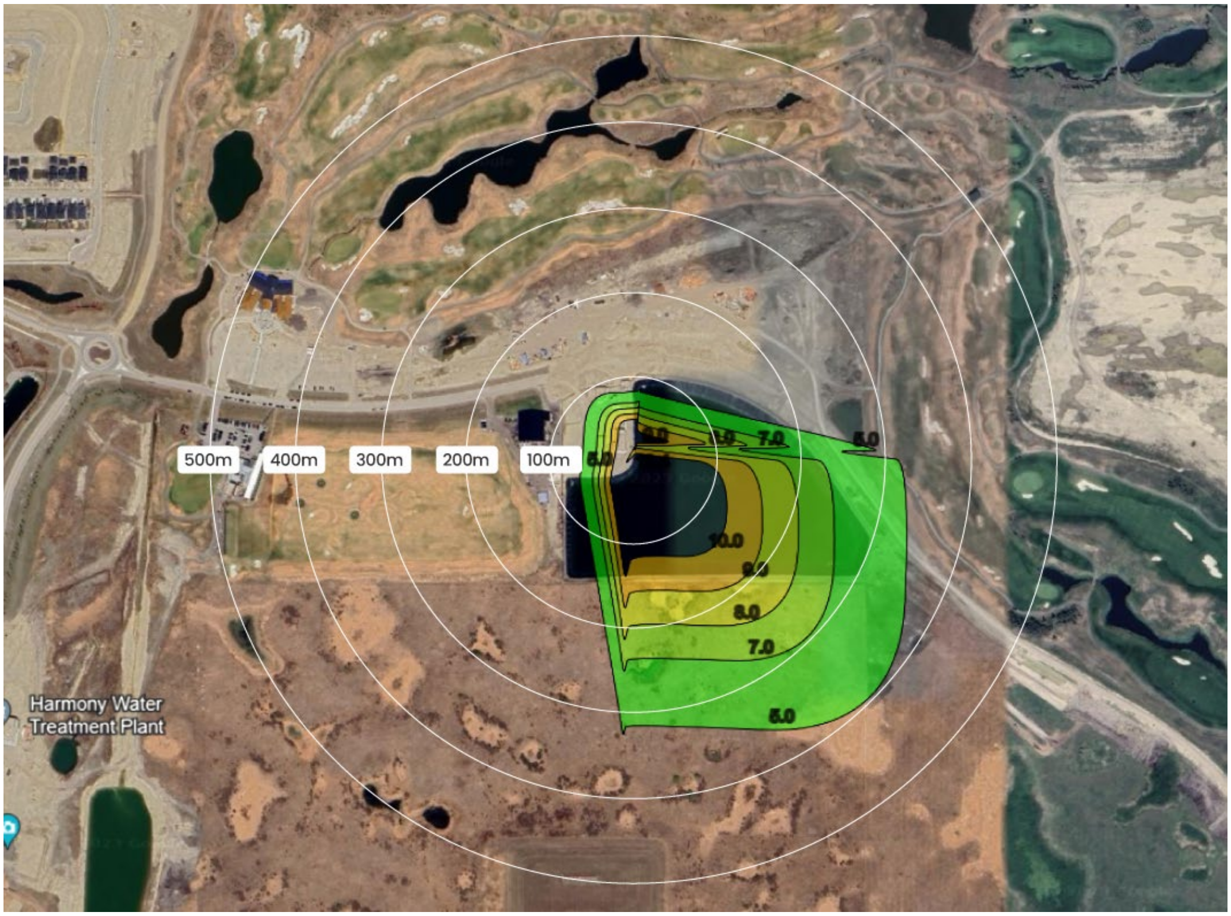


Figure 12: Harmony WWTP Odour Impact Radius from Site

CALCULATING EXPOSURE TIME

To calculate potential exposure time, Scentroid assessed a variety of factors, and utilized dispersion modeling. This modeling method integrates data on odorous compound emissions, meteorological factors like wind speed and direction, and the physical characteristics of the excavation zone to create a dynamic and predictive representation of how odours disperse in the surrounding atmosphere.

Using dispersion modeling, we were able to map out the interplay between these factors and predict the spread of odours under varying conditions, providing valuable insights into the duration and intensity of odor exposure in the excavated wetland zone, and the wastewater treatment facility.

To find the exposure time, Scentroid conducted an examination of various factors influencing odour dispersion. At each identified odour source, we observed that the odour exposure displayed an elevated reading, despite being minimally detectable. To understand the rate at which odorous compounds were released, we assessed the emissions from the excavation zone and the wastewater treatment plant. This entailed the measurement or estimation of the quantity and volatility of compounds released per unit of time, providing a quantitative perspective on the emissions.

Additionally, our assessment extended to identifying the active source times. This involved considering the operational processes at the wastewater treatment facility and the specific periods of active excavation in the wetlands. Since odours were not continuously present, their occurrence was often triggered by specific events, such as particular processes at the neighboring wastewater treatment facility or excavation equipment disturbing an odorous pocket of organic material.

Furthermore, to impact residents, the correct wind speed and direction played a pivotal role. We identified the ideal wind conditions that would carry odours away from the source site towards specific areas in the neighboring community, all of which was determined through the utilization of our dispersion model. This model provided a visual representation of how plumes of odorous compounds moved under varying wind conditions.

Ultimately, this multifaceted approach enabled us to determine the total exposure time within the residential zone. We achieved this by calculating the duration during which odour concentrations exceeded a specified threshold level in the designated areas within the neighboring community. The threshold level was established in alignment with regulatory odour detection limits or the tolerance levels of the local community. This comprehensive analysis allowed us to paint a precise picture of odour exposure in the region.

The dispersion model along with the field monitoring campaign shows minimal impact on neighboring residents from the wastewater treatment operation. Sewage collection has some negligible impact on some neighborhoods but is believed to be below the allowable 0.5% exposure time. Full modeling analysis of these sources is beyond the scope of this work.

CONCLUSION

Through on-site sampling and analysis over a period of 5 days, Scentroid aimed to identify the primary contributors of odour, particularly assessing the impacts of a local treatment facility near the Harmony community. Based on atmospheric dispersion model simulation, and emission rate calculations, the wastewater treatment facility has an odour concentration of 10 ou/m3 at the source, and a diminished odour concentration of 1 ou/m3 at the odour dispersion boundary.

Findings indicate that a concentration of 5 odour units (the typical range in which identifiable detection occurs) can travel up to 400 meters away from the wastewater treatment plant, primarily favoring the Southeastern direction. Based on the dispersion modeling performed on the current operational capacity of the Wastewater Treatment Facility, odour complaints have the potential to be registered up to a 400m Southeast of their source, and approximately 50 m to the North, to the West, and to the Northwest of their source.

The wastewater treatment facility has a notably low odour impact. The identified contributors to odour encompass a range of natural and anthropogenic sources, with the wastewater treatment facility showing a diminished odour concentration at the dispersion boundary. Importantly, the odour plume from the facility is determined to be insignificant and only perceptible under highly specific conditions.

There were no noticeable odours generating from the treated wastewater pond. The water from the pond was found to be clean; in post-treatment and Chlorinated.

APPENDIX A: AERMOD

AERMOD is the U.S. EPA preferred air dispersion model. The development of AERMOD started in 1991, based on the indications of AERMIC (American Meteorological Society / Environmental Protection Agency Regulatory Model Improvement Committee) that outlined a new basis for steady state air quality models to be used for regulatory purposes. Starting from December 2007 AERMOD has replaced ISC3 among the models recommended by U.S. EPA for modelling the impact of ground level and elevated industrial sources on flat or moderately complex terrain.

AERMOD can simultaneously simulate many sources with different shapes, at ground or elevated, buoyant, or non-buoyant, emitting one or more pollutants. AERMOD is capable to account for the non-homogeneous vertical structure of the boundary layer (also using a vertical profile of meteorological variables). Vertical mixing is limited in case of stable conditions. The dispersion for unstable conditions is non-Gaussian, so to correctly describe the high concentrations of pollutants that can be observed close to stacks under convective conditions.

AERMOD is made of different modules:

The atmospheric dispersion module (itself called **AERMOD**).

The terrain processor **AERMAP**, which is used in presence of complex terrain to evaluate the scale height of each receptor.

The meteorological processor **AERMET**, which is used to prepare the input for the simulations with the dispersion module.

The **AERSURFACE** module can be used to determine the geophysical parameters (roughness length, albedo, Bowen ratio) to be inputted in AERMET.

AERMOD requires two sets of meteorological data, one at surface and the other referring to a vertical profile, both with hourly time resolution. The required variables at surface are sensible heat flux, friction velocity, convective velocity, vertical temperature gradient in the first 500 m above the planetary boundary layer, the extent of the convective boundary layer, the extent of the mechanical boundary layer, the Monin-Obukhov length, the surface roughness, the Bowen ratio, the albedo, the wind speed, the wind direction, the anemometer height, the temperature, the thermometer height. Variables included in the vertical profile are, for each elevation above ground, the elevation itself, the wind speed, the wind direction, the temperature, the standard deviation of wind direction and the standard deviation of vertical wind speed. It is particularly important to have a complete picture about wind direction and wind speed when doing an atmospheric dispersion simulation.

A screening version of AERMOD, called **AERSCREEN**, has been developed by the US-EPA to estimate the worst possible ground level concentrations (GLCs) from a sole source.

AERMOD includes several improvements compared to standard Gaussian models:

Turbulence

Standard Gaussian models are based on six discrete stability classes (Pasquill Gifford classes) to which correspond dispersion parameters that are based on observations from ground level releases. On the contrary, AERMOD uses vertical continuous profiles of horizontal and vertical turbulence that are either based on measurements or computed based on similarity theory.

Dispersion under convective conditions

AERMOD describes the non-Gaussian vertical dispersion under convective conditions, which are characterized by the presence of updraft and downdraft motions with different probability of occurrence and different intensity. Under convective conditions the plume is made of three components: a direct plume that is brought to the ground by a downdraft, an indirect plume that is captured by an updraft up to the superior lid and is then possibly brought downwards by a downdraft, and a third plume penetrating the mixing lid and dispersing more slowly in the stable layer above and possibly re-enter in the mixing layer and reach the ground.

Dispersion under stable conditions

Under stable conditions AERMOD describes the horizontal and vertical dispersion in the same way standard Gaussian models as ISC3 do. However, while models as ISC3 assume an infinite boundary layer, AERMOD accounts for the possible reflections by a superior lid.

Plume buoyancy

Standard Gaussian models use the Briggs equations for calculating the effective height of the release due to the buoyancy of the plume with the wind speed and temperature gradient values at the stack height. Instead, under stable atmospheric conditions AERMOD uses the values at stack height at half distance from the final height due to buoyancy, while under convective conditions it superimposes the random displacements due to the random fluctuations of the convective velocities.

Urban environment

Sources can be treated as rural or urban independently.

Complex terrain

AERMOD has a terrain processor (AERMAP) that prepares the data for their use within the model by advanced algorithms that discriminate the streamline division based on a critical height.

Sources: EPA-454/R-03-004 (2004) AERMOD: Description of model formulation.

APPENDIX B: VOLATILE ORGANIC COMPOUNDS

What Are VOCs?

VOCs are organic compounds containing one or more carbon atoms that have high vapour pressures and therefore evaporate readily to the atmosphere. There are thousands of compounds that meet this definition, but most programs focus on the 50 to 150 most abundant compounds containing two to twelve carbon atoms. Environment Canada defines VOCs under Schedule 1 (item 65) of the Canadian Environmental Protection Act, 1999 (CEPA 1999). This definition excludes photochemically low-reactive compounds such as methane, ethane, and the chlorofluorocarbons (CFCs).

How can I be exposed to Volatile Organic Compounds (VOCs)?

Volatile Organic Compounds (VOCs) commonly enter(s) the body through:

Inhalation (breathing)

- Breathing vehicle exhaust, fuel emissions, releases from products and processes that contain VOCs, and cigarette and second-hand smoke.

Skin contact

- Touching products that contain and release VOCs.

Why are We Concerned about VOCs?

VOCs are primary precursors to the formation of ground level ozone and particulate matter which are the main ingredients of smog. Smog is known to have adverse effects on human health and the environment.
The Environment Canada Clean Air site provides more information on smog formation.

A recent smog science assessment conducted by the Government of Canada concluded that both particulate matter and ozone need to be treated as having no safe level.

Short-term:
Short-term exposure to various VOCs may cause:

- Irritation of the eyes and respiratory tract
- Headaches
- Dizziness
- Visual disorders
- Memory problems

Long-term:
Long-term exposure to various VOCs may cause:

- Irritation of the eyes, nose, and throat
- Nausea
- Fatigue
- Loss of coordination
- Dizziness
- Damage to the liver, kidneys, and central nervous system
- Cancer

What Are the Potential Impacts on Human Health and the Environment?

Air pollution has been shown to have a significant adverse impact on human health, including premature deaths, hospital admissions and emergency room visits. Studies indicate that air pollution is associated with an increased risk of lung cancer and heart disease.

Scientific evidence also indicates that ground level ozone can have a detrimental impact on the environment. This impact can lead to reductions in agricultural crop and commercial forest yields, reduced growth and survivability of tree seedlings, and increased plant susceptibility to disease, pests, and other environmental stresses (e.g., harsh weather).

APPENDIX C: BEAUFORT SCALE

BEAUFORT SCALE

Force	Anemometer reading mph	kmh	m/s	knts	Description	
0	0-1	<1	<0.3	0-1	Calm; smoke rises vertically.	Calm
1	1-3	1-5	0.3-1.5	1-3	Direction of wind shown by smoke drift, but not by wind vane.	Light air
2	4-7	6-11	1.5-3.3	4-6	Wind felt on face; leaves rustle; ordinary vanes moved.	Light Breeze
3	8-12	12-19	3.3-5.5	7-10	Leaves and small twigs in constant motion; wind extends light flag.	Gentle Breeze
4	13-18	20-28	5.5-8.0	11-16	Raises dust and loose paper; small branches are moved.	Moderate Breeze
5	19-24	29-38	8.0-10.8	17-21	Small trees in leaf begin to sway; crested wavelets form on inland waters.	Fresh Breeze
6	25-31	39-49	10.8-13.9	22-27	Large branches in motion; whistling heard in telegraph.	Strong Breeze
7	32-38	50-61	13.9-17.2	28-33	Whole trees in motion; inconvenience felt when walking.	Near Gale
8	39-46	62-74	17.2-20.7	34-40	Breaks twigs off trees; generally impedes progress.	Gale
9	47-54	75-88	20.7-24.5	41-47	Slight structural damage occurs (chimney-pots and slates removed).	Severe Gale
10	55-63	89-102	24.5-28.4	48-55	Seldom experienced inland; trees uprooted; considerable structural damage occurs.	Storm
11	64-72	103-117	28.4-32.6	56-63	Very rarely experienced; accompanied by wide-spread damage.	Violent Storm
12	73-83	≥118	≥32.6	64-71		Hurricane

APPENDIX D: AVERAGING PERIOD CONVERSION

Since the lowest averaging time of the AERMOD model is 1-hour, and noting odor complaints may be registered due to shorter duration exceedances, the 1-hour averaged odor concentration value was converted into a shorter averaging period. This is a standardized procedure commonly used in regulatory reporting involving atmospheric dispersion modeling.

To convert to a shorter averaging period,

$C_0 = C_1 \times F$

where,

C_0 = the concentration at the averaging period t_0

C_1 = the concentration at the averaging period t_1

F = factor to convert from the averaging period t_1 to the averaging period t_0

$= (t_1/t_0)^n$

and where n=0.28

This approach is used to calculate shorter averaging period concentrations such as a 5-minute point of impingement (the point at which a contaminant contacts the ground or building) limit starting from a modeled 1-hour averaged concentration (Air Dispersion Modeling Guideline, Ontario Ministry of the Environment and Climate Change, pp 47, 2017). The converted concentrations are displayed in Error! Reference source not found. An example using Eq. (1) is shown below.

$$F = \left(\frac{t_1}{t_0}\right)^n$$

$$F = \left(\frac{60\ minutes}{5\ minutes}\right)^{0.28}$$

$$F = 2.00$$

$$C_0 = C_1 \times F$$

$$C_{10\ minutes} = C_{60\ minutes} \times F$$

$$C_{10\ minutes} = C_{60\ minutes} \times 2.00$$

$$C_{10\ minutes} = 5 \times 2$$

$$C_{10\ minutes} = 10\ OU/m^3$$

REFERENCES

Air Policy, Alberta Environment and Parks. "Air Quality Monitoring Guideline." **Alberta Government,** 15 Nov. 2021, https://open.alberta.ca/dataset/cefcad38-6d49-4cce-98f7-23b1741f85b7/resource/b4ed8dc9-3850-4e5f-a618-42b29c4ba2d4/download/aep-aqmg-air-quality-model-guideline-2021-09.pdf

Feddes, J., and G. Clark. "Odour and Air Quality." **Alberta Government**, Department of Agricultural, Food and Nutritional Science, University of Alberta, https://www.alberta.ca/system/files/custom_downloaded_images/af-odour-and-air-quality-science-to-social-issues.pdf