PROGRESSIVE ODOUR MANAGEMENT PLAN

FOR HARVEST POWER RICHMOND

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Progressive Odour Management Plan (POMP)

1. INTRODUCTION

1.1. The Harvest Power Facility in Richmond

Harvest[1] owns and operates a 24-acre Composting and Energy Garden (Anaerobic Digester and Combined Heat and Power) Facility (the "**Facility**") on leased land owned by Port Metro Vancouver. The Facility is located in an urban area with 1.7 million people living within a 15 km radius in the surrounding six municipalities (Richmond, Vancouver, Surrey, Burnaby, Delta, and New Westminster). The Facility currently accepts yard waste, leaf waste, grass clippings, garden residue, tree trimmings, chipped shrubbery, agricultural waste, commercial food waste, residential food waste, wood waste, and other similar organic materials. A Solid Waste Licence application has been submitted to Metro Vancouver to permit the operation of depackaging equipment. This will give the facility capacity to handle organic waste in containers or packages. As such, the Facility plays an important role in the zero waste goals set by Metro Vancouver.

1.2. Purpose of Progressive Odour Management Plan

Harvest's corporate goal and aspiration is to operate Harvest and all its facilities as a good citizen and neighbour within its host communities. While odours are a natural by-product of the composting and anaerobic digestion processes, a properly designed and managed Facility need not emit objectionable odours that will disrupt the outside community. The purpose of this Progressive Odour Management Plan ("**POMP**") is to provide actionable guidance.

The methods and technology in this POMP are progressive in the sense they are designed to be continuously updated and improved. As problems or opportunities arise (to reduce odours), this method and technology can be changed. In this sense it is a living document. It follows the principles of ISO 14001 of "plan-do-check-adjust". Consequently this plan provides a process for evaluation, monitoring and correction, and a format for identifying parts of the Facility that may need adjustment to prevent and/or reduce odours. It shall also provide guidance to on-site operation personnel.

[1] The Facility is owned by Harvest Fraser Richmond Organics, Ltd., which does business in British Columbia as "Harvest."

Recommendations contained herein are, in all cases, recommendations *that the ideas be considered*. They are not recommendations that the specific ideas be implemented. As stated in the Metro Vancouver Air Permit GVA1054 (May 11, 2013) (the "**Air Permit**") pertaining to the Facility, Harvest "is not required to implement the remedial actions or other improvements and procedures contained within the report."

The POMP is a tool to reduce potential emissions without impairing composting operations to Harvest Facility operators on how to manage and mitigate the potential emission of objectionable odours outside the boundary of its Facility. By operating the Harvest Facility with this goal in mind, we create a more sustainable future for this particular Facility as well as reinforce our corporate reputation as responsible, best-in-class operators.

1.3. Background: Composting and History of Odour Control

There is a common belief that odour signals a problem in the composting process. The ground for this belief was that composting, which is a natural aerobic biological process, would not generate odours when properly practiced. Odour generation is, however, an inevitable result of the decomposition of organic matter – without which we would not be able to produce compost. As one of the worldwide most recognized experts on composting has observed, "Odorous compounds inherently form as raw organic materials decompose" (Haug; 2004).

Historically organic waste facilities have been largely reactive to odour emissions following a pattern of:

- Operate according to permit conditions with no formal odour prevention or control strategy.
- React "if-and-when" odour complaints or regulatory enforcement requires a response.
- Investigate the event(s) and propose a fix to respond to the problem or complaint or citation.
- Adjust practices accordingly.

The historical approach is pragmatic, practical, and common in the industry but may be insufficient to prevent recurring problems. Especially for Harvest, which operates within a populous urban environment, the historical approach is inadequate to meet Harvest's aspiration to operate as a "good neighbor and citizen."

This **new protocol is pro-active** rather than reactive, and can be viewed as a self-regulating system. This new pattern of odour management is best described as:

- Operate so as to **minimize** the potential escape of offensive odours beyond the property line, according to permit conditions and a self-diagnostic and self-regulatory odour prevention and control strategy.
- Monitor and measure odour, odour causing compounds and conditions, and odour covariates (i.e. oxygen concentration) under a number of operating conditions, both scheduled and unscheduled, using quantitative methods.
- Evaluate measurements and respond by adjusting the Facility or the operating plan to prevent and minimize odours.

- Re-measure, re-evaluate, and adjust operations as necessary.

1.4. Relationship of POMP and other pertinent regulations

This POMP is also developed to meet certain regulatory requirements. The Air Permit directs Harvest to develop a Progressive Odour Management Plan to be submitted for review and comment by the District Director. This plan requires details about activities surrounding prevention, accountability and progressive mitigation of odours that may arise from activities at the site.

- ***Prevention*** entails proper operation of the facility. It can include the development of standard operating procedures to prevent release of odourants to the environment (*i.e*., preventative maintenance, leak detection and repair, feedstock handling, review of feedstocks *etc*.)
- ***Accountability*** outlines the expected interactions among operators, regulators, and neighbors. It provides procedures for identification, notification and resolution of malodours. It can include the development of responsibility charts, contact info, response procedures to upset conditions, response to odour complaints, communication plans etc.
- ***Progressive mitigation*** is a series of escalating operational adjustments. It can include several levels of response which can include: self-detection, correction and reporting, implementation of new or changing of existing operational procedures, restriction of feedstocks and ultimately retrofitting of technologies or controls works if so required.

This POMP also meets the requirements of B.C. Reg. 18/2002; Organic Matter Recycling Regulation including amendments up to B.C. Reg. 198/2007 ("**OMMR**"): Division 2; Construction and Operation of Composting Facilities. OMMR has a requirement for plans and specifications that include an odour management plan which stipulates how air contaminants from the composting Facility will be discharged in a manner that does not cause pollution.

1.5. Relationship of POMP and operations procedures

This POMP is not intended either to explain the standard operating procedures ("**SOPs"**) for the Facility or to replace the SOPs. Instead, it is meant to explain how those procedures in place at the time of writing have been designed to prevent and mitigate objectionable odours, and to suggest additional steps that might be considered if that does occur. SOPs evolve constantly as Harvest seeks continuous improvements. Any identified conflicts between the operating procedures and the POMP should be examined with consideration of which (or both) should be updated.

1.6. **POMP Update**

This POMP is the first annual update, following the original edition of July 31, 2013. The Air Permit requires that subsequent editions of the POMP consider "recommended updates" to the POMP, which Harvest understands to refer to recommendations made by Metro Vancouver. Following the issuance of the POMP in 2014, Metro Vancouver did not provide formal comments or feedback to Harvest. However, operations and regulatory personnel and various staff from Metro Vancouver maintained an active and constructive dialogue around odour control throughout the course of the past year. Various changes to Harvest's operations as well as its monitoring practices (such as enhanced meteorological tracking) reflect this dialogue.

2. PREVENTION

In order to minimize the development of conditions that could lead to odour problems, the material handling areas of the site and operating procedures have been designed based on the nature and quantity of materials to be received and stored, climatological factors, adjacent land use, topography, season, and drainage controls. For example, an unturned, covered aerated static pile system ("**CASP**") discharging air from the compost cells through biofilters has been implemented in order to avoid the release of odours typical of windrow-turning forms of aeration; the primary screening plant has been enclosed and a biofilter installed; and a state-of-the-art anaerobic digestion Facility (Energy Garden) has been constructed to allow the processing of large quantities of more odourous food wastes within enclosed, air-tight and gas-tight conditions.

2.1 Preventative compost operations

Accountability: Operations Manager, Lorie Thatcher.

In-bound material is tipped at one of three locations, according to material type. Material types include pre- and post-consumer food waste, green waste, clean wood waste, and other materials listed under the Facility's Solid Waste License (Greater Vancouver Sewerage and Drainage District License C-004, issued 1997, last amended January 19, 2010.)

a. Green waste is normally tipped at the receiving area north of the CASP system. There is a second receiving area south of the CASP system for use during peak periods in spring and fall. Following tipping, loads are inspected for contaminants, including but not limited to plastic, glass, metal, and treated wood. Loads are accepted and rejected in accordance with the Facility's determined feedstock specification. Very large contaminants are removed by excavator. Straight food waste loads, or loads with predominantly putrescible waste will be directed from the site entrance (scale house) to the receiving hall at the anaerobic digester (Energy Garden) (preventive measures for the processing of food waste in the Energy Garden are detailed further in this document).

b. Within not more than seven days, but typically within less than 48 hours of tipping, different material types are mixed depending upon type of feedstock, bulk density and moisture content being the primary considerations. Generally composting recommendations suggest that bulk density should be less than 1000 lbs/cu. yd. (0.67 tonnes / cbm) (Oshins, 2006).Historically, size reduction (grinding) was typically not used prior to mixing. Beginning in the summer of 2013, a shredding step has been added to produce smaller, more uniform size materials to facilitate more even and faster material degradation. On a practical level, the moisture threshold for avoiding anaerobic conditions is approximately 70% (wet basis). However, this number represents a compromise and a practical target. The optimal moisture content depends on the feedstocks (e.g. particle size, degradability) and the stage of composting (Richard et al., 2002) with an optimal moisture range between 40-60%.

c. Mixed and prepared feedstock is placed as soon as possible atop the aeration piping using a loader or excavator. The Facility has been designed so as to accommodate peak flows based on seasonal variation. Pile height may vary between a minimum of approximately 3 meters to a maximum of 6 meters (or 8 meters between April 15-July 15 and October 15-December 15). In general, Facility operators keep pile heights as low as practical, taking into account volume throughput requirements. The use of equipment on top of the piles is kept to the absolute minimum and usually restricted to within 1-2 days prior to cell deconstruction. Any machinery driven on top of the pile surface loosens all compost material it has moved over upon completion of its work on the pile. These steps minimize the risk of material compaction, which can lead to the creation of anaerobic pockets and odour.

d. A vacuum is induced below the pile by stainless steel blowers, which pull air through a network of perforated pipes from the pile to maintain aerobic conditions. The system eliminates labor-intensive turning; reduces emissions sometimes associated with turning of compost; allows for proper control and homogeneous distribution of temperature and moisture maintenance through airflow adjustment, and enables excellent odour control.

e. The forced negative aeration system removes large amounts of moisture in form of vapor from the composting material. The rate of daily rainfall, even in winter, is minor in comparison with the amount of daily moisture transferred from composting material to vapor and transported through the air to the biofilters. Some liquid condenses in the aeration system and is periodically collected and reapplied to fresh inbound material, which has the capacity to absorb the liquid while remaining within the window of optimal moisture content. Should the compost operation start receiving drier material such as wood waste, a more permanent means of feedstock moisture conditioning would be explored. Currently the feedstock is primarily yard waste and source separated organics and the moisture content is optimal.

f. In a previous operational mode (prior to March 2013), hot compost air was pulled through the piles, potentially containing odourous compounds, and was diluted and cooled with fresh air by means of a fresh air vent at the far end of the common manifold. The intent of this action was to keep the biofilter at <40^{o}C. Opening the vent compromised negative pressure at each of the 24 perforated sparger pipes resulting in drastically diminished oxygen delivery to compost. Without adequate oxygen supply, anaerobic conditions developed and elevated odour resulted from non-point source locations through the CASP. Currently (March 2013- present), the fresh air intake on the end of the common manifold is kept closed. All of the air pulled through the common manifold comes through the compost pile and into the shared manifold. This exhaust air is between 40-60^{o}C and causes the biofilter media to operate at similar temperatures. We have concluded, through monitoring of inlet and outlet gases and qualitative odour evaluation, that operating in an aerobic state in the compost pile and a thermophilic state in the biofilter is sufficient to treat odours to the spirit of the Air Permit. There is research in the literature body that supports the biochemistry of thermophilic biofilters. Many positive aeration CASPs rely on a compost cover which is at a similar temperature to the compost pile, to treat odour. According to Engineered Compost Systems, a positive aeration system with a cap of compost would be as effective as biofilters in our situation. We expect that running the biofilter at higher temperatures will reduce its useful life by means of composting away the mass, creating more fine materials, and that this will be evident by increasing pressure on the biofilter inlet. Inlet pressures and outlet gasses are being monitored weekly and monthly in order to be aware of when the biofilter media needs to be replaced.

g. The expected life of the biofilters is one-two years. They were rebuilt in the winter of 2012/2013. Monitoring of pressure and performance will continue with the expectation that the media will be replaced in the winter of 2014-2015. We have been supplied with quotations for fans which can blow cool fresh air into the biofilter inlet (after the fans) which will not reduce the aeration supplied to the compost pile, but which will reduce the empty bed residence time (EBRT) of the biofilter. Despite the cooling effect of fresh air additions, the reduction in EBRT is counter- productive to odour treatment.

h. Temperatures in the CASP are measured and recorded daily. Temperatures and O2 concentrations in the sparger pipes are measured weekly. This allows for cell by cell analysis of conditions in the compost pile. Airflow is adjusted at the sparger valves to maintain aerobic conditions and optimal temperatures in the compost pile. This facilitates the identification and investigation of sub-optimal cells so the issue can be rectified before the material becomes anaerobic and causes odour problems.

i. There are two material flow streams at Harvest; one stream is through the Energy Garden (anaerobic digester) to the CASP (commercial stream) and the other is onto the CASP and then curing (organic stream). Residence time in the CASP for the organic stream is three to four weeks. Residence time in the CASP for the commercial stream is approximately nine weeks – this material has already had 14 days of decomposition in the Energy Garden tunnel. BC OMRR pathogen reduction processes temperatures are generally reached within 5 days (3 days > 55^{o}C) and vector attraction reduction processes are reached in the next 14 days (14 days > 40^{o}C with average of 45^{o}C). The remaining days (day 19 onward) are for improved stabilization and maturity. Engineered Compost Systems indicated that improving our ability to mix feedstock, by means of a large feedstock mixer, would bring the greatest improvements in compost quality and reduction in odour. We are grinding and mixing in one step with the Komptech Crambo and are getting good results and homogenous material.

j. Following the CASP, the organic stream is further cured (for an improvement in stability and maturity) in large windrow-like piles in order to improve quality and maturity. It is then screened to remove contaminants and "overs" (organic material with a particle size too large to be sold as a product). Material can be screened at any point using Screening Plant #1, which has a biofilter. Material screened with Screening Plant #2 must be 40 days old or have been tested and met conditions stipulated in the Air Permit under Source 08A to ensure it is not anaerobic at the time of screening. The commercial stream is screened when it is removed from the CASP at a trommel screen. As this screener does not have a biofilter, the material will meet the same conditions set out in the Air Permit for Screening Plant #2 (Source 08A).

k. Overs and middlings (both by-products having particle size >3/8") are recycled back through the process and ground / composted until broken down to an appropriate particle size. Contaminants are disposed.

l. Compost is sold under the OMMR classification of "Class A not solely produced from yard waste." The product is sold wholesale in bulk and periodically bagged for retail markets and is used in a variety of applications including agriculture, landscaping and horticulture, and erosion control.

2.2 Preventative Energy Garden Operations

Accountability: General Manager Biogas Division, Suzanne Kennedy.

Most food waste loads will be directed to the Energy Garden. Key odour management considerations are:

a. The Energy Garden receiving area is kept under negative air pressure, discharging air to a biofilter, to prevent the escape of fugitive odours. Therefore, the doors to the receiving area should generally be kept closed, except for allowing delivery trucks to tip their loads, for removal of digestate, movement of equipment, or maintenance activities on the doors themselves.

b. The digestion process itself occurs under air-tight and gas-tight conditions and therefore should not result in the release of fugitive odours.

c. Feedstock is a mix of food and ground yardwaste.

d. After approximately two weeks of residence time in the percolation tunnels, the digestate (spent feedstock) is removed from the tunnels and transported immediately to the CASP airfloor. A woody bulking agent with high air space (such as mids) is then added on top of the digestate. This material allows air flow and ensures that the material remains aerobic. Regular ground feedstock from the north tip is then loaded on top of the mids and, each week, all of the material is well mixed together.

In light of this design, excessive odours would most likely be caused by (a) leaving the doors opened for an excessive period of time; (b) a malfunction of the plant ventilation system (c) degradation in the effectiveness of the biofilter; or (d) other deficiency in digester operations such as release through overpressure valves. The occurrence of such odours should be promptly investigated. The permanent presence of trained operators allow for prompt action.

2.3 Site Wide Preventative Maintenance

Engines and equipment are subject to a comprehensive maintenance program that avoids break-downs and allow for material flow without bottlenecks or interruptions

2.4 Site Wide Housekeeping

Harvest Power employees are trained and directed to maintain a clean site. Puddles are drained; waste is regularly removed from the site and organic material spilled by trucks incorporated into the cells or energy garden feedstock.

2.5 Depackaging Area

At the time of this writing, there is an application in process for a Brokering Licence in order that Harvest may install, commission and operate a depackaging machine (Turbo Separator). The machinery associated with this will be kept under cover but there may be storage of packaged goods outside. The area will be kept tidy and clean to minimize odours and vectors.

3 MEASUREMENT

3.1 Collecting data

Facility design and sound operating practices are only the first step to effective odour management. A pro-active approach requires regular monitoring and measurement of odours, followed by analysis, so that Facility operators can track the interaction of feedstock volume and composition variations, meteorological conditions, and operating practices in producing or mitigating odours. This section addresses measurement of odours, along with collection of other necessary data. The following section will address analysis.

This approach allows for correction of potentially odour-generating practices and testing of proactive measures to avoid odour generation.

3.2 Measuring odours

As of the date of this document, Harvest is measuring on-site odour using a portable dynamic olfactometer (Scentroid SM100 by IDES Canada). With this tool Odour Units (OU) are measured on site and monitored over time. One Odour Unit is defined as the minimum concentration of odour necessary for fifty percent of the population to perceive it.

a. The **Odour Unit (OU), detection threshold (DT) or dilution to threshold (D/T)**, is the theoretical minimum concentration of odourant stimuli necessary for perception in some percentage, normally 50 percent, of the population. Two types of thresholds can be evaluated, namely the detection threshold and the recognition threshold. In measuring environmental odours, which are complex mixtures and not pure compounds, the threshold cannot be expressed as a concentration level (i.e., parts per million or micrograms per cubic meter). Instead, threshold is expressed as a dilution-to-threshold ratio (D/T). A D/T ratio of 1,000, for example, means that one volume of odourous air requires 1,000 volumes of odour-free (dilution) air to reach detection threshold.

See *Appendix A: Odour Measurement* for further discussion.

3.3. Odour measurement and monitoring protocol

Accountability: Regional Regulatory Compliance Officer Scott Kerr (for both compost and Energy Garden)

For this protocol, both Field and Laboratory analysis will be used. Each time odours are measured the meteorological conditions are also recorded (wind direction, wind speed, temperature, precipitation, cloud cover, etc.).

Frequent and regular use of the Scentroid can provide more data, more quickly, to enable Harvest operators to more rapidly assess the interaction of feedstock, operating practices, and meteorological conditions and thereby pursue continuous improvement.

While there is a current requirement in The Air Permit for quarterly odour testing, this does little in establishing the relationship between feedstock, processing methods, and odour. For this reason there should be more emphasis placed on the Scentroid, as an important part of a feedback mechanism and odour management. Under this approach, third party laboratory testing would be reserved as a higher, or subsequent progressive step to be taken if, for example, other odour management techniques fail, complaints arise, and use of a third party would assist in providing independent data points.

The Facility will have 4 to 8 pre-determined and standard observation locations on site, plus additional locations will be added depending upon the conditions at that time. A plan for periodic and event-driven off-site field sampling should also be developed, taking into account complaint history and meteorological conditions.

3.4 Complaint handling

Accountability: Regional Regulatory Compliance Officer, Scott Kerr

Another important source of data and feedback for plant operations is complaint data. Complaint information is provided from Metro Vancouver and the City of Richmond. Harvest maintains an odour complaint database that records the date, time and location of complaint, along with an odour description. Complaints are analyzed with respect to weather – wind direction and speed based on four local weather stations. Based on the observed factors, most especially wind direction, the complaint is classified as either possibly caused by Harvest or not.

3.5 Record-keeping

Odour incidences are summarized and recorded in odour logs and kept in a database. Harvest has created a centralized digital repository, using cloud-based technology so that the data is readily available for purposes of evaluation and analysis.

4 PROGRESSIVE MITIGATION

4.1 Review and evaluation protocol

Accountability: Operations Manager Lorie Thatcher; General Manager Biogas Division Suzanne Kennedy

The evaluation process will yield conclusions based on performance measurements that can then be used to make corrections, improvements, and adjustments to both the Facility and the operating procedures. The intent of the evaluation process is to find odour sources and systematically minimize them through prevention, capture, and treatment.

The analysis of data collected allows facility operators to establish correlations between various operational activities and weather conditions and to evaluate the efficiency of pro-active measures. Factors to be considered during evaluation include feedstock receiving and initial processing, climatic factors that magnify or mitigate odours, scale of fugitive odours due to material handling, specific odour sources within the Facility, operational practices and schedules that generate odours. There are also mitigating factors that affect odour emission rates. They include wind and rain protection in the Facility design, material handling rates, topographic features at the Facility limit, vegetated greenbelts, and capture and control equipment (biofilters).

An odour risk meteorological forecasting system has been established with weather consultants and academics at UBC. Odour complaints are correlated with Easterly and Southerly winds (see figure 2). Alerts are automatically emailed out each morning, to those involved in managing on-site operations. During forecast winds in the problem wind window, alerts are issued and operations are managed in order to reduce the possibility of odour complaints. Activities with a higher risk of odour generation are scheduled to coincide with favourable winds (those outside of the problem wind window).

Evaluations should be conducted and statistically interpreted if/when there is a sudden spike in off-site objectionable odours, whether or not complaints are received. Because the Air Permit has significant evaluation and reporting requirements the Air Permit conditions will drive this evaluation initially. For the initial term of the permit (to June 30, 2015), the evaluations should be conducted quarterly, upon the receipt of quarterly testing data for odours and for Volatile Organic Compounds (VOCs).

Any recommended changes should be documented in a Plan of Action.

4.2 Use of science and training

Harvest is committed to introduce new odour mitigation measures, or to revise existing mitigation measures, based on latest and rigorous science and within economic reasonably and cost-effective means.

Employees are encouraged to pursue professional development to stay acquainted with latest technology and practices.

4.3 Plan of Action: Facility and operations adjustment protocol

Accountability: Operations Manager Lorie Thatcher; General Manager Biogas Division Suzanne Kennedy

Following the above-described measurement, analysis and evaluation steps, a Plan of Action will be developed to prioritize changes to both the built Facility (capital expenses) and operations (possible operating expense). Each adjustment to the Facility will include a schedule (target date) for completion, cost estimate, and benefit statement so a cost-benefit justification can be made. A list of possible progressive Facility changes to be considered and evaluated, based on circumstances, is set forth in Section 4.4 below.

Each adjustment will include a description of roles and responsibilities as well as any required changes to the operating plan for the Facility. In some cases the regulating agency or agencies may have to be involved. For example, any new equipment brought on site that may materially affect air emissions from a regulated source must be reported.

4.4 Process mitigation measures

As described in earlier sections, this POMP is based on a data-driven, diagnostic approach. That is, when odour problems arise, the first step is to identify the source of the problem, collect data on the nature, extent, and severity of the problem, and use that data to help determine the possible cause(s). Based on such analysis, a variety of measures may be taken to either mitigate the production of odour at the source or to reduce its migration beyond the Facility boundaries.

Given the complexity of operations at the Facility and the daily and seasonal variation of feedstock inflows and operating conditions, a detailed "cookbook" that specifies each possible situation and how it should be addressed is neither practical nor advisable. Instead, this section sets forth a variety of mitigation steps that can be considered by the Facility operators as needed in response to problems.

The presence of nuisance odours identified by operators, neighbors or site inspectors initiates an escalating or progressive set of responses.

A. **Level One. Self-odour inspection and tactical correction.** For example, an operation may be suspended under certain weather conditions; odourous feedstock may be directed to the energy garden; biofilter blower speed can be increased or reduced, work shift hours may be increased to process material more promptly. The corrective actions may be temporary and situation-specific.

B. **Level Two. Operational Changes**. If Level One has not provided a durable elimination of the nuisance odour, operational changes such as reduction of pile height, increase in bulking agent, revamping of biofilters and misting system will be considered.

C. **Level Three. Capital Plant Adjustments.** If after implementing Level Two measures objectionable odour outside Facility boundaries still persists, more detailed odour identification action will be implemented and thorough retrofitting options will be considered (changes to equipment, new equipment, new biofilter material, removal of material into energy garden or alternative locations

For each potential odour source, the following table offers possible mitigation measures to be considered by Facility operators. The measures within each group are sequenced in rough approximation from easiest to implement (less expensive and/or less disruptive to operations) to more difficult to implement (more expensive and/or greater disruption). For the reasons explained in Section 1.2, the inclusion of a possible mitigation measure on the list below does not commit Harvest to implementation of that measure. Any and all mitigation measures will be assessed in terms of their anticipated technical and cost effectiveness in addressing the diagnosed cause of a specific odour problem.

Note that certain of the measures may require consultation, notification, or advance approval from the regulator.

4.4.1 Composting operation

Waste Receiving and Tipping Area (Permit Emission Source 04).

- Inspect incoming loads for odour and reject excessively odourous loads. Redirect to energy garden or incorporate immediately into cells
- Stockpile bulking agents as temporary cover for wet material or grassy material (or redirect to energy garden
- Reduce holding time (before incorporation into CASP or Energy Garden), especially for highly odourous materials and in warmer weather (above 27^{o}C).
- Restrict volume of inflows.
- Install temporary or permanent enclosed receiving area.

Feedstock

- Increase frequency of feedstock monitoring for moisture content, C:N ratio, bulk density, free air space and pH
- Amend feedstock to bring parameters to within BMPs guidelines, favouring lower odour risk at the expense of lower production (eg. keep C:N at the high end of the BMP range).

Grinding

- Don't grind odourous material if it is suitable for being loaded onto the CASP as is and restrict grinding during unfavorable conditions if material must be ground
- Mist
- Enclose

CASPs – not including biofilters (Permit Emission Sources 05 and 06)

Loading Practices

- Alter pre-mixing protocols. Possibilities include:
  - Acquire standard batch mixer (load/mix/empty)
  - Acquire batch mixer and run in semi-plug-flow mode
  - Lay out materials in windrows, then run through with straddle type windrow turner
- Expose pipe, re-chip, and red brush/over layer to replenish air floor each cell building
- Lower pile height
- Implement procedures for turning material to increase aeration
- Increase cover material, consider using finished compost as odour control cover

Unloading Practices

- Use sprinklers to water prior to unloading to reduce dust and odour
- Delay unloading if climatic conditions are unfavorable

Aeration System

- Inspect sparger pipes during pipe exposure between cell deconstruction and reconstruction
- Pump out any fluid at the pipe level or raise pipes if they have settled
- Rebuild air floor with chips, brush, overs
- Concentrate aeration on wet or poorly decomposed lines by adjusting valves from their standard position (as per Engineered Compost Systems recommendations) which equilibrates vacuum across all sparger lines, to a temporary maximum (fully open) position.
- Modify the aeration system
  - Reconfigure piping layout (double the number of sparger pipes)
  - Regrade pipes to ensure adequate drainage and no flooding
  - Reassess holes along the length of the sparger pipe
  - Replace or augment aeration pipe system
  - Add blower fan capacity
- Temperature control. Attempt to maintain temperature below 75 C by manually adjusting sparger valves to concentrate airflow rather than evenly distribute airflow. Add water if necessary and maintain maximum airflow to dissipate heat through latent heat of vaporization and discharge as exhaust.
- Augment process controls

- Automate damper controls through temperature feedback

Curing windrow management

- ❑ Build surge pile after curing to mitigate space restrictions and/or allow longer curing for piles.
- ❑ Force aeration
- ❑ Increase frequency of turning
- ❑ Build smaller windrows for increased aeration
- ❑ Plan operations based on weather forecasts
- ❑ Increase thickness of cover layer

Biofilters (Permit Emission Sources 03, 05, 06, 08)

- ❑ Alter/increase misting
- ❑ Remix media and supplement with new material
- ❑ Add media. Add 6" additional layer of compost, mids, or ground overs
- ❑ Replace media
- ❑ Add second stage polishing filter
- ❑ Eliminate biofilters by reversing aeration system to blow positive pressure and build and maintain moist covers on piles each batch
- ❑ Increase pest control to prevent rodent tunneling (emissions short circuits)

Primary Screener (Permit Emission Source 08)

- ❑ Time with weather conditions
- ❑ Check that material has been adequately cured
- ❑ Install chute off the end of the fines conveyor to prevent dispersal of dust and odours
- ❑ Cover conveyors and connect to enclosure to capture emissions and treat at biofilter

Auxiliary Screener (Permit Emission Source 08A)
See further discussion below at Section 5.

- ❑ Minimize use of the Auxiliary Screener, relative to reliance on the (enclosed) Primary Screener.
- ❑ Check to ensure that material to be processed through the Auxiliary Screener has been adequately cured and meets conditions of Air Permit.
- ❑ Schedule movement of material to the Auxiliary Screener during daytime and more unstable atmospheric conditions.

- Avoid moving material from curing to screening and avoid operating the Auxiliary Screener during times when meteorological conditions increase the probability of causing offsite odours such as warm and still night times, weekends and statutory holidays, atmospheric inversions, and constant wind speed and direction. See further discussion of meteorological conditions below.
- Collect data on odour measurements and reported off-site complaints, with timing and recorded operating hours of the Auxiliary Screener and meteorological conditions to determine more and less favorable operating protocols. Adjust operations (specifically, hours for movement of material from curing to the screener and actual operation of screener) accordingly and re-measure. -
- Install temporary or permanent enclosure.
- Install chute off the end of the fines conveyor to prevent dispersal of dust and odours

Housekeeping

- Remove uncomposted material between cells and in the aisles
- Soak up / drain puddling water
- Wet down roads and other areas to minimize dust

Contingency

- Identify alternative facilities and/or equipment for unexpected deliveries or unexpected equipment failures

General operation management

- Increasing operating shifts to accommodate all material tipped throughout the working day hours

4.4.2 Energy garden

Odourous emissions from the Energy Garden would normally originate in the Receiving Hall, which is operated under negative air pressure and controlled through the biofilter. Excessive odours would typically indicate degradation in effectiveness of the biofilter and addressed by the mitigation measures addressed under Biofilters. Odourous emissions can also originate from the opening of overpressure valves. This does typically not occur under normal operational conditions. Reduction of the percolation rate and of the digester feeding can mitigate the emissions.

Doors to the Receiving Hall

- Ensure operators cover all hours during which loads are tipped so material is moved into the hall for processing as promptly as possible.

- Vinyl strip curtains could be installed on all or part of the door opening to reduce the escape of emissions

Tunnels

- Ensure unloading only happens early in the morning during times of atmospheric instability
- Forced aeration could be installed in the tunnels to make the digestate aerobic and less odourous prior to unloading

Blowers & Biofilter

- Increase the air exchanges in the receiving hall, thereby increasing the negative pressure and reducing the fugitive odours escaping from the hall untreated

4.5 Implementation of the protocol

An Odour Management Team has been assembled for the Facility. This team includes Regional Regulatory Compliance officer (Scott Kerr), the General Manager Biogas Division (Suzanne Kennedy), Operations Manager (Lorie Thatcher) and Consultant (Geoff Hill). This team meets to review recent odour data, including complaints, on-site odour data, effectiveness of odour control methods, etc.

4.5.1 Re-evaluation

Each adjustment action plan should also include identification of specific measures that will be used to assess the effectiveness of the adjustment step, compare the odour situation before and after a measure has been implemented, along with timing and accountability for the re-measurement and re-evaluation.

4.5.2 Record keeping

Records of evaluations and Plans of Action should be kept so that they can be reviewed at least annually in connection with the update of the POMP. Again, it is recommended to use a central digital repository.

5. Source 08A (Auxiliary Screener): Special Procedures

There are two main screening plants at the Facility. One (Air Permit Source "08") is fixed and enclosed with a partial enclosure and biofilter. The other (Air Permit Source "8A") is portable and includes a portable misting/neutralizer system ("Auxiliary Screener"). The regulator has hypothesized that Auxiliary Screening operations could be a major source of odor emissions from the site. The little data available in this regard to date has neither supported nor disconfirmed the hypothesis.

5.1 Background: Review of Existing Data

According to the preliminary investigation conducted by Odor Science and Engineering in November 2012, the Auxiliary Screener alone was responsible for very little odour emission. Overall, the odour emissions associated with screening were estimated to represent approximately 7% of the Facility's total odour emissions. Of that 7% fraction, most of the odour related to screening (97%) was emitted from the hot steaming piles of freshly excavated compost material transported to the screener area and waiting to be screened. Based on this finding, it would make little difference to the overall odour impact of the Facility when during the day the screening equipment is operated. Instead, it would appear that the greater odour risk derives from movement of material from curing piles to the screener. Further documents written by Levelton, EnviroChem, and CDM Smith suggest that the screener biofilter does little to capture and treat emissions from screening and that screening itself contributes little to the total odour production onsite.

Consultants to Harvest have advised that, in their experience, odour impacts from the facilities with ground level sources (such as Fraser Richmond) tend to be ***lower*** during ***unstable*** atmospheric conditions. These conditions typically occur on sunny days, predominantly earlier in the morning when wind speeds tend to be lower. ***More stable*** atmospheric conditions tend to be correlated with greater odour impacts. In the case of Fraser Richmond, for the period July 2014 to June 2015, these theoretical associations do not appear to be borne out by the time of complaints. Figure 1 shows that most complaints were distributed throughout the day with high numbers in the morning; at time of day typically associated with unstable atmospheric conditions. However the majority of complaints occurred during easterly or south-easterly winds (see figure 2). In this region, easterly and south-easterly winds are strongly associated with stable atmospheric conditions (see figure 3). The wind direction may be a better indicator of atmospheric stability – and thus a better predictor of nuisance odour risk – than the time of day. This happens to also be the wind direction which could strip odour from HFRO organics and transport it to the densely populated Cities of Richmond and Vancouver.

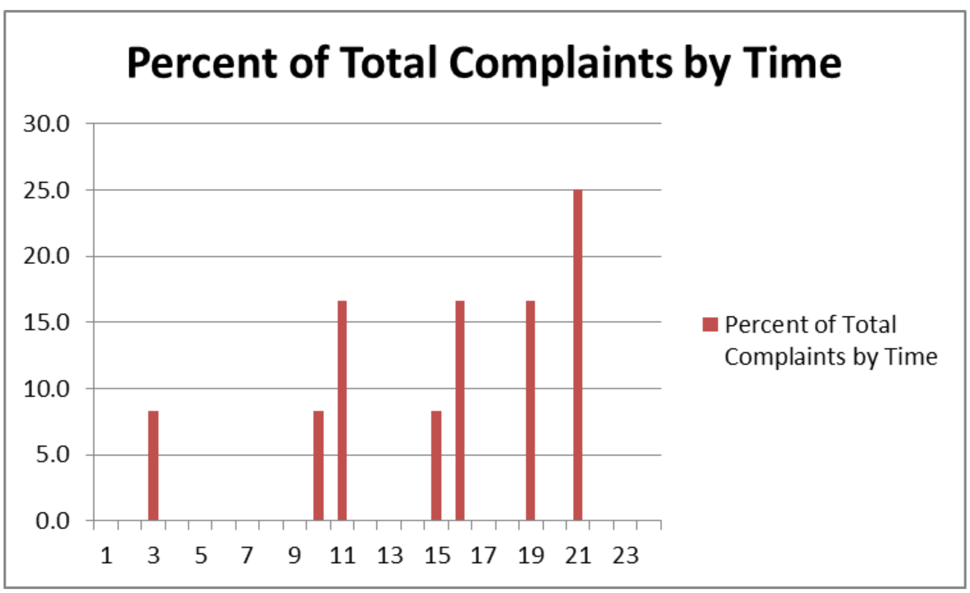
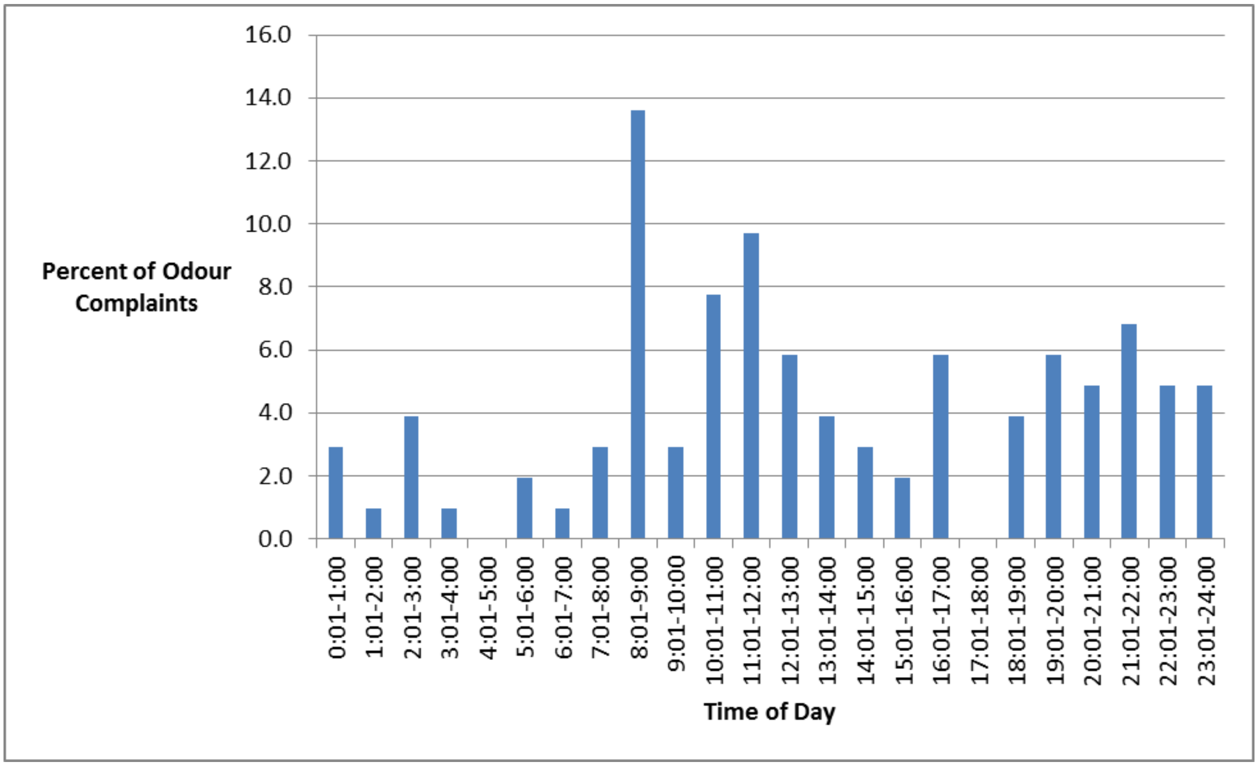


Figure 1: Distribution of 2014 odour complaints by time of day

Note: Only the complaints for which Fraser Richmond had been identified as a "possible" source in the complaints spreadsheet were used in the analysis.



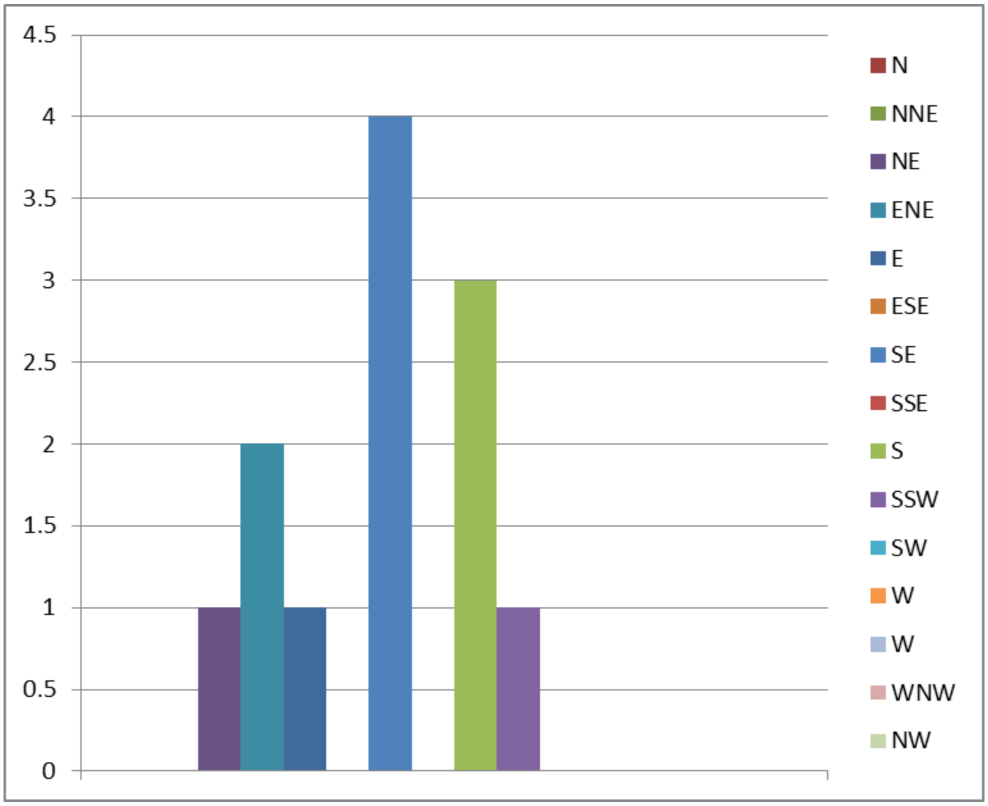


Figure 2: Number of 2014 odour complaints by wind direction – all between NE and SSW

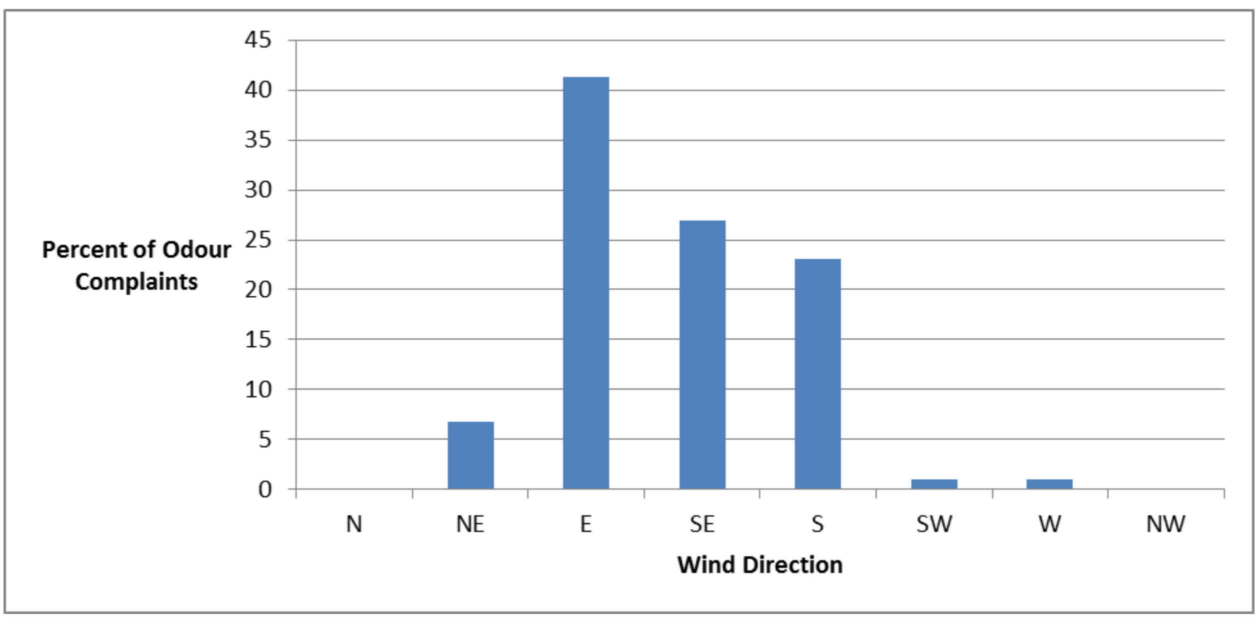


Figure 2: Number of odour complaints by wind direction – From July 2014 to June 2015

Higher atmospheric stability and easterly winds are quite well correlated as shown on the windroses for the Facility, which show a predominance of easterly and southeasterly winds for Stability Classes 4-6 (neutral to Moderately/Extremely Stable). These are the wind directions correlated with odour complaints. *See Figure 3.*

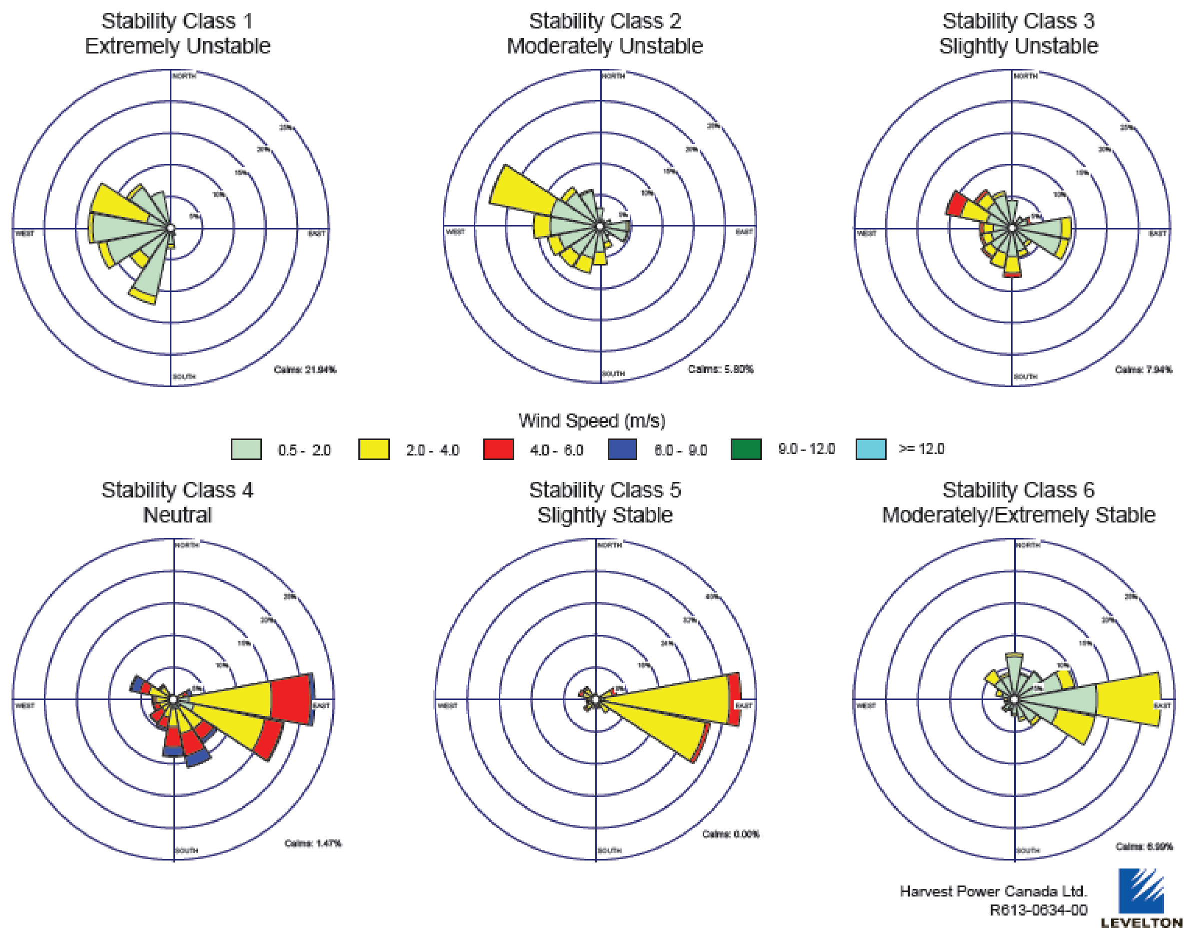


Figure 3: Wind Direction by Stability Class

In theory, this would suggest that if operating hours for the Auxiliary Screener must be extended to deal with volume demands, especially during summer, the hours should be extended in the direction of starting closer to sunrise (when atmospheric conditions are more unstable), rather than waiting until 7:00 or 8:00 am, to take further advantage of unstable conditions associated with warming post-sunrise.

The historical complaint data must be interpreted cautiously, since most of the complaints were registered in late 2012 and early 2013 when certain operational deficiencies combined with publicity about Facility odours produced a rash of complaints. (The days with the highest number of complaints tended to be within 24 hours of news reports.) Significant operational improvements have occurred since that time. Also, the available complaint data cannot be correlated with operations of the Auxiliary

Screener. The historical complaint data is not, therefore, a useful guide to future operations of the Auxiliary Screener.

Frequency of odour complaints has reduced dramatically and continues to trend downwards. Over the first six months of 2014 there was a 70% reduction in the number of complaints attributable to FRSF when compared to the first half of 2013, as shown in figure 4. This reduction is primarily due to major process and operational changes made in 2013. The number of odour complaints attributable to Harvest has tracked one par with 2013 in recent months. Historically odour complaints were analyzed based on the meteorological data from the single on-site weather station. From the start of 2014 weather data from four local weather stations has been analyzed in establishing whether or not FRSF is a possible source of the odour. This increased reliance on regional data has led to increased confidence in the assignment of odour complaints.

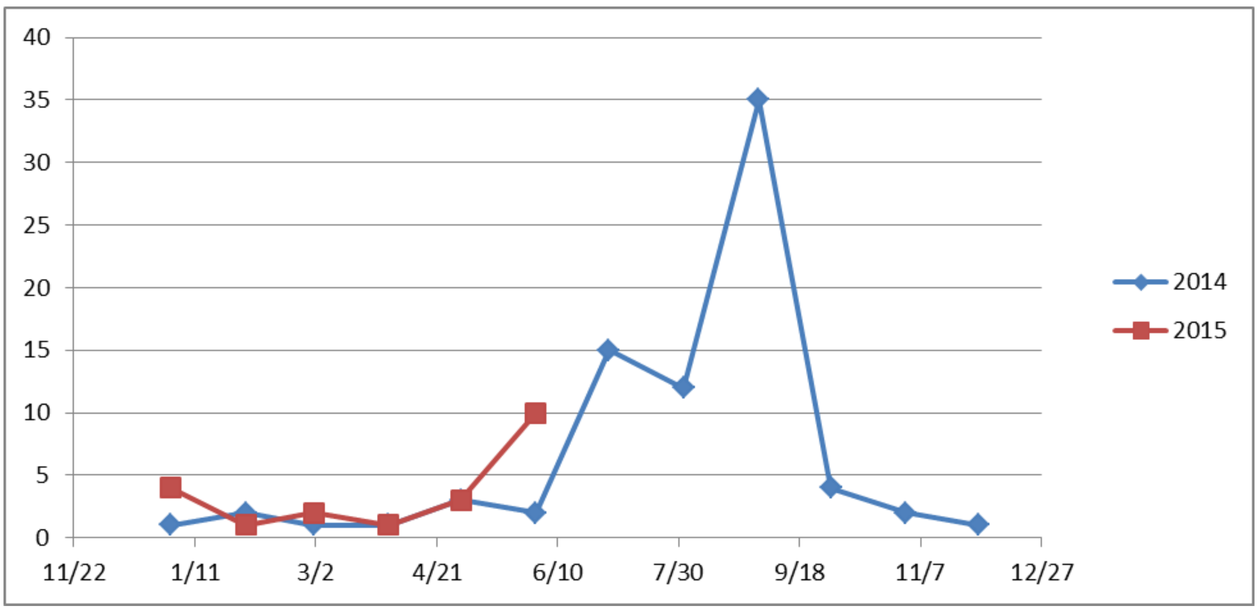


Figure 4: Frequency of odour complaints by month – Calendar year 2014 compared with the first half of 2015

Nonetheless, Harvest should pursue a conservative operating plan with respect to the Auxiliary Screener, which combines careful operating practices, especially around movement of material from curing to screening, with close attention to odour measurements.

5.2 Progressive Mitigation

Based on our investigation of the data and consultations with experts around odour science and operations, Harvest should consider the following options and measures for reducing any objectionable odours, should they occur, from the operation of the auxiliary screener:

1. Minimize use of the Auxiliary Screener, relative to reliance on the (enclosed) Primary Screener.

2. Check to ensure that material to be processed through the Auxiliary Screener has been adequately cured. The Air Permit specifies timing and oxygen requirements. These should be met, at a minimum.

3. Schedule movement of material to the Auxiliary Screener during daytime and more unstable atmospheric conditions.

4. Avoid moving material from curing to screening and avoid operating the Auxiliary Screener during times when meteorological conditions increase the probability of causing offsite odours such as warm and still night times, weekends and statutory holidays, atmospheric inversions, and constant wind speed and direction, especially from the east and south. During summer months, consider starting screening operations at dawn – though be careful to monitor odour impact and discontinue if complaints arise.

5. Correlate on-site odour measurements and reported off-site complaints, with timing, maturity of material to be screened, operating hours of the Auxiliary Screener and meteorological conditions to determine more and less favorable operating protocols. Adjust operations accordingly and re-measure.
    - The Odour Management Team should review this data at least monthly from July through September, or more frequently if necessary.
    - Thereafter, the Odour Management Team should determine an appropriate review schedule, based on experience.
    - Schedule review of available data and operational history as part of 2014 revision of this POMP.

6. Literature & Relevant Literature

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Appendix A: Odour Measurement

A wide variety of odourants including volatile organic chemicals, alcohols, aldehydes, volatile fatty acids, ammonia and other nitrogen compounds, and various sulfur compounds exist in the urban environment from a wide variety of sources. Some or all of these may potentially come from this Facility as well. This section addresses how volatile odourous chemicals and their relative concentrations relate to the total odour quality. The factors of individual compound odour character or quality and their associated odour threshold are important in understanding the total picture when making odour observations

Odour field assessments require recording observations about the meteorology at a given point in time, what operations are in progress at the plant, and what odour levels. Odour Assessment Technicians at the Facility perform this valuable task.

Most local odour regulations define a nuisance odour as one that has such characteristics and during which unreasonably interferes with a person's enjoyment of life and property. Harvest Power's Air Permit (GVA1054) stipulates that there should be no odour at the property boundary.

Appendix B: Biofilter Technology

This is an overview. Refer to operations guidance for more detailed information. Biofiltration is the use of microorganisms growing in a media bed to remove and oxidize odour compounds in a foul airstream. A typical biofilter consists of a media bed containing compost microorganisms, a media support structure, an air distribution system, and some method of controlling the biofilter moisture content.

This checklist serves as a guide to assist in developing a method of monitoring and operating biofilters.

- ❑ Check inlet gas temperature and media temperature
- ❑ Check to insure condensate has not accumulated in the filter sub-region
- ❑ Check the surface for crusty or dry spots
- ❑ Check the surface for settlement or low spots
- ❑ Check the surface steam pattern to see if there are dead spots
- ❑ Check the perimeter for significant steam patterns that may indicate leaks

- ❑ Analyze the media for physical and biological characteristics

Media maintenance and replacement are the most important elements for effective biofiltration. Media replacement can be initiated based on a media effective depth, observations of surface irregularities and exhaust odour, or based on back pressure measurements. All of these are reasonable approaches, and they can be used together if necessary.

A decision model for media exchange based on age, surface appearance, effective depth, exhaust quality, and backpressure is under development. This requires a procedure to record system characteristics and filtration performance. For example, if any of the model parameters exceed a selected specification (i.e. settlement is more than 1 meter, surface has dry spots, or the exhaust has odours present) the biofilter media should be replaced.

It should be noted that backpressure will be unique to each biofilter but trends over time can indicate problems, such as a gradually rising backpressure that consumes horsepower and reduces airflow. Depth and age are also closely correlated. If the biofilter loses too much effective depth, it generally also has reached an advanced age since the depth decreases over time.