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TO: Bassetlaw District Council

BASSETLAW DISTRICT COUNCIL

ODOUR REVIEW AND SITE AUDIT

TUNNEL TECH – MUSHROOM SUBSTRATE MANUFACTURING FACILITY

1 Introduction

Sol Environment have been commissioned by Bassetlaw District Council to assess the odour associated with the Tunnel Tech North mushroom substrate manufacturing facility. The facility is located at Newington Farm, Doncaster, and has been subject to multiple complaints from the surrounding settlements. Due to the nature of the process and materials required to manufacture mushroom substrate, the site has an inherent potential to give rise to off-site odour annoyance. Nevertheless, Tunnel Tech has invested significantly in the abatement of such odours through the implementation of acid scrubbers, biofilters, the erection of enclosed structures to contain odour, and numerous extraction systems. However, despite these measures, Bassetlaw Council continue to receive odour complaints from nearby residential areas, particularly Misson.

To approach this, a desk study has been undertaken whereby the complaints associated with the Tunnel Tech site have been reviewed, as well as the previous odour monitoring and modelling. In addition to this, a site audit has been conducted to determine any obvious odour generating activities, as well as to establish the extent of odour in and around the site boundary. The location of the site is shown in Figure 1.

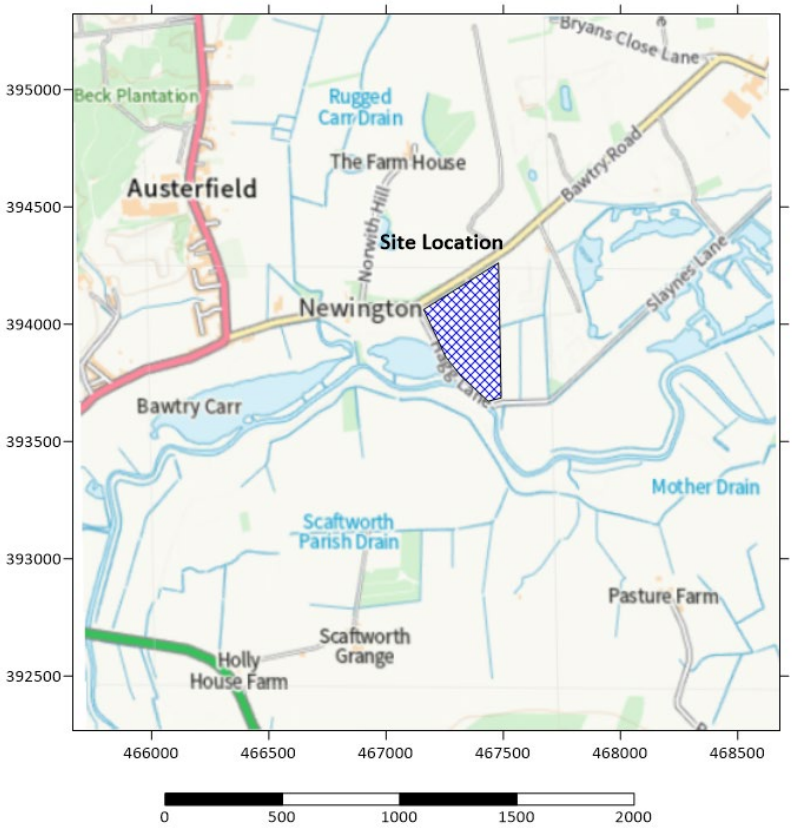

Figure 1: Site Location

The process operated at the installation is the production of compost substrate on which mushrooms will be grown. The raw materials used in the process to make mushroom substrate are rape straw, wheat straw, chicken manure, horse manure, gypsum, urea and ammonium sulphate. Straw is delivered and stored at the site in bales. The bales are stacked in the open air on the concrete yard surface. Chicken manure and horse manure is delivered to the site in sheeted tipper trucks. This is stored inside the old composting bunkers which have three concrete sides, a concrete roof and door and are contained within a building with air extraction and treatment.

The start of the process involves submersing the straw bales into a below ground-level concrete tank/sump of goody water. The tank is constructed of concrete and the straw bales remain in the goody water for up to two minutes, depending upon the quality and type of straw. Dipping of the bales takes place outside. Goody water is also added to the blended materials at this same stage. Goody water is a blend of rainwater, washing water and excess production water which is high in bacterial nutrients and nitrates that are an essential part of activating the thermophilic composting process. As a consequence, the goody water has a high odour potential. Excess goody water is stored within a tank which has air extracted to the odour control system.

The bales are removed from the goody water sump and are placed on the mechanical conveyor line where they enter the mixing building. The mixing building air is extracted to the odour abatement system and the building is held under a slight negative pressure.

The conveyor system passes the bale along a set of blades which cuts the nylon ties holding the bale together. The cut bale then passes through the bale breaker which completely breaks and chops the bale down. At this stage chicken manure, horse manure, gypsum and any inorganic supplements (such as ammonium sulphate) is added onto the conveyor belt through a controlled amount via a feed hopper. The mixed materials are transported out of the mixing building by a long-covered conveyor to the bunker building. The mixing building, bunker building and conveyors are covered and extracted to the odour abatement system.

Once the material has completed the Phase 1 composting process it is conveyed to the pasteurisation and finishing building. The conveyors are uncovered and the building is not extracted to the odour control system due to the low odour potential of the composted material.

2 Desk Study Review

2.1 Complaints Associated with the Tunnel Tech Facility.

Recorded odour complaints originate mainly from two locations. The majority of odour complaints received by Bassetlaw District Council originate from Misson Village, which is located approximately 1.5 km to the north east of the Tunnel Tech site. The other source of complaints, which are less frequent, come from Newington Road; whilst there are residential dwellings on Newington Road (200 m west of the site), these complaints are not from residents living on Newington Road but from other residents driving past the site. Figure 2 below shows the location of the main complaints received.

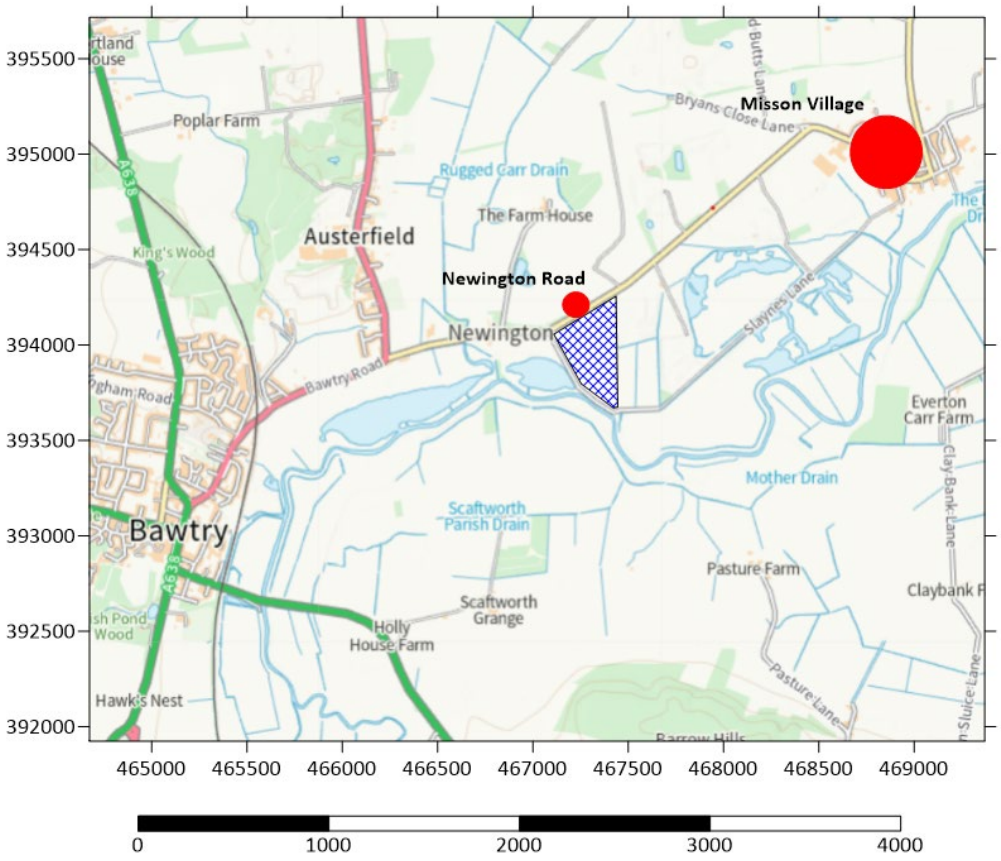

Figure 2: Locations of the Complaints Received by Bassetlaw Council.

The prevailing wind directions are from the south and west as can be seen from the windrose in Figure 3. Misson Village is located to the north east and therefore not subject to odour carried by the prevailing wind; wind blows towards the north east 9% of the time (Figure 3). Nevertheless, at a distance of 1.5 km the impact of odours should be minimal; this is supported by a dispersion modelling study undertaken by Odournet Ltd where at the closest residential dwelling in Misson Village, predicted 98th percentile of hourly mean odour concentrations were 0.2 ou_E/m^3. This is significantly below the Environment Agency's benchmark of 1.5 ou_E/m^3 for the most offensive odours and below the odour benchmark of 2.5 ou_E/m^3 set within the permit.

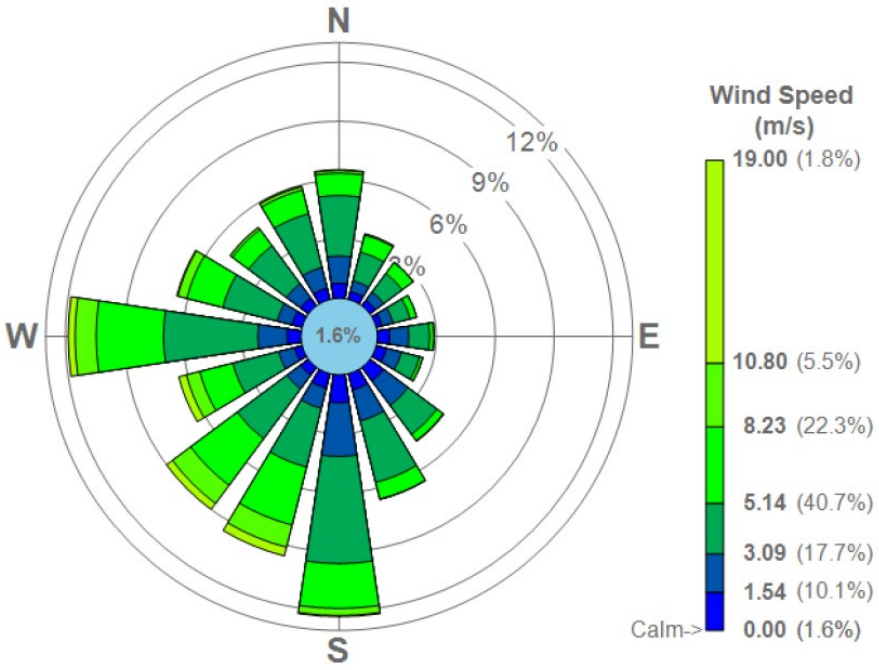

Figure 3: Windrose for Robin Hood Airport – 2011.

2.2 Review of Emissions Monitoring

Sol has been provided with three odour monitoring reports. An assessment carried out by Odournet in May 2013 measured odour using olfactometry at a number of locations including the new goody water tanks biofilter (no longer in use) and the then main composting (Phase 1) biofilter. At the time of the monitoring, all bunkers were undergoing composting, material transfer was being carried out as well as blending. Emissions from the on-site sources was investigated and dispersion modelling used to predict the impact of emissions on off-site odour by reference to the odour benchmark of 2.5 ou_E/m^3 (as the 98th percentile), as agreed with Bassetlaw District Council.

As the geometric mean, measured emission concentrations from the goody water storage tank biofilter was 228 ou_E/m^3. For the main composting biofilter, concentrations varied between 239 and 826 ou_E/m^3 depending on the activity taking place. These concentrations are typical of a well-managed biofilter.

Odournet provided an impact assessment for two scenarios. Scenario 1 considered the main biofilter in isolation (i.e. excluding other sources such as fugitive emissions). Scenario 2 considered a future scenario with the Phase 1 bunkers and conveyors enclosed and other planned improvements (subsequently completed).

Further monitoring was undertaken by Olfasense (formerly Odournet) in December 2020 and December 2021. This monitoring considered emissions from the two biofilters including the biofilter that is used to treat air from the new building created to enclose the Phase 1 bunkers. A summary of inlet and outlet concentrations is provided in Table 1. The inlet measurements were understood to have been obtained at the inlet to the acid scrubber.

Table 1: Measured Odour Concentrations – 2020 and 2021				
OCU	Source	Unit	2020	2021
Bunkers OCU	Scrubber inlet	ou_E/m^3	4,795	19,719
	Biofilter outlet	ou_E/m^3	298	2,809
	Abatement efficiency		94%	86%
Operational area OCU				
	Scrubber inlet	ou_E/m^3	5,451	14,719
	Biofilter outlet	ou_E/m^3	538	2,439
	Abatement efficiency		90%	83%

In 2020, measured concentrations from the biofilters were again consistent with a well-managed odour control system. Removal efficiencies were 90% or higher. In 2021, the inlet concentrations were substantially higher (3 to 4 times that measured in 2020). In addition, the outlet concentrations in 2021 were 5 to 9 times higher than in 2020. This resulted in a lower removal efficiency of between 83% and 86%, less than would be expected for a well-managed odour control system. It is not clear why there would be a significant difference in the inlet concentrations, but it may be related to activities carried out on the days monitoring was undertaken. It should also be noted that OCU outlet concentrations in 2021 were between 6 and 7 times higher than measured in 2013 (396 ou_E/m^3 as the geometric mean) for which the odour impact assessment was undertaken.

2.3 Review of Ambient Monitoring

Bassetlaw District Council deployed a number of passive diffusion tubes on and around the site during the Summer of 2020. It is not clear whether this monitoring was carried out before or after the recent improvements. The tubes were used to measure long-term concentrations of ammonia (NH_3) and hydrogen sulphide (H_2S). The samples were exposed for 25 to 28 days. Diffusion tubes are not ideal for measuring odours as long-term concentrations are not characteristic of short-term odour impacts. For example, intermittent elevated short-term concentrations can cause an annoyance, but these elevated concentrations could have little influence on measured concentrations over the longer term. The location of the monitoring sites is provided in Figure 4. It is understood that a control site was held for comparison purposes. A summary of measured concentrations is provided in Table 2.

Table 2: Measured Concentrations of H_2S and NH_3			
Location	H_2S June ($\mu g/m^3$)	H_2S July ($\mu g/m^3$)	NH_3 July ($\mu g/m^3$)
Misson Mill	0.2	<0.1	5.3
West Street	<0.1	<0.1	5.7
Tunnel Tech	6.8	21.4	262.3
Newington Road	<0.1	-	5.3
Manor Close	<0.1	<0.1	6.1

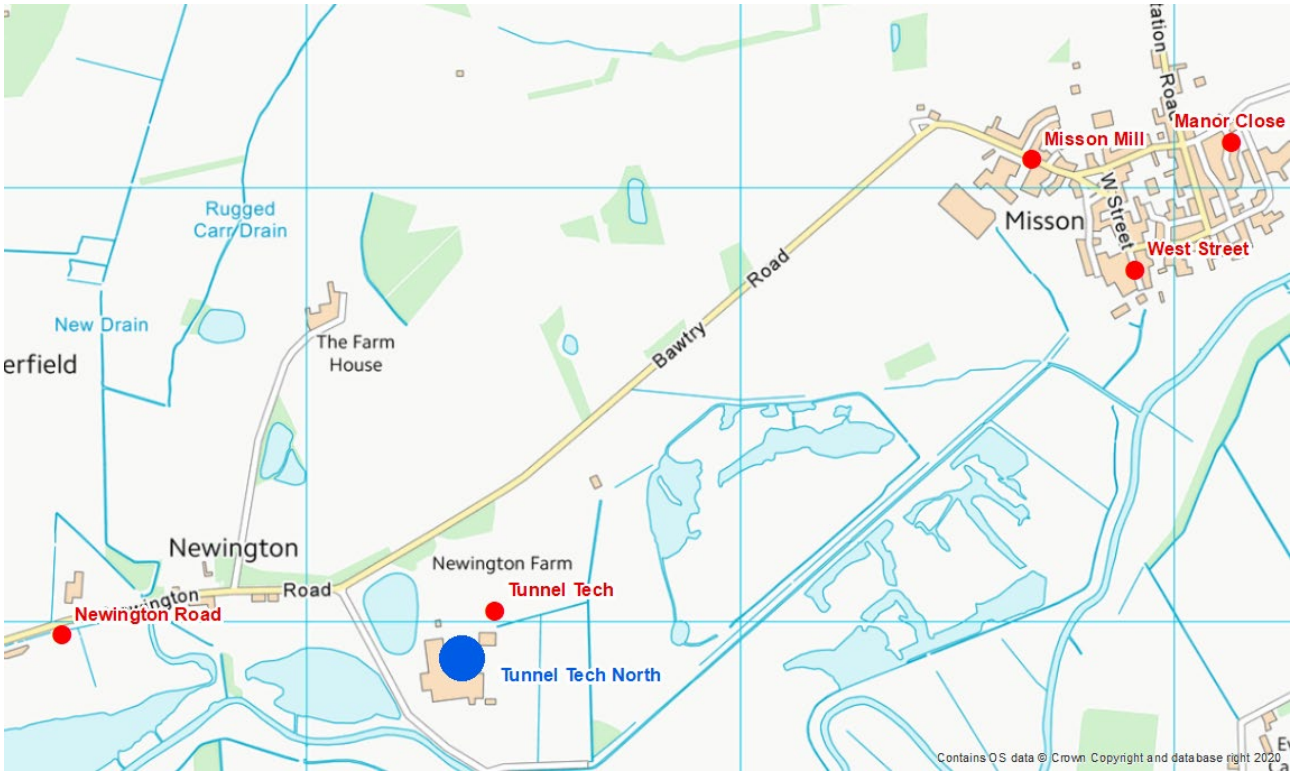

Figure 4: Location of Diffusion Tube Monitoring Sites

For H_2S, measured concentrations off-site were very low and mostly below the detection limit of the analysis. The World Health Organization (WHO) provide an odour annoyance criterion of 7 µg/m^3 as a half hourly mean. The monthly mean concentrations at the Tunnel Tech site were close to or in excess of this. This would indicate that the half hourly mean criterion would be regularly exceeded within the site and that the site is (was) a significant source of H_2S.

For NH_3, off-site concentrations were similar and comparable to the control sample. Therefore, the site does not appear to have a significant impact on long-term off-site NH_3 concentrations. However, the limitations of using long-term measurements for assessing short-term impacts needs to be taken into consideration. Measured concentrations on-site were a factor of around 50 higher than measured off-site. Therefore, it is evident that the on-site activities are a significant source of NH_3.

2.4 Site Audit: 14th of March 2022

A site audit was carried out by Dr Amanda Gair on 14th March 2022. The purpose of the audit was to assess the potential for off-site odours, the effectiveness of odour management and control at the site and to make recommendations for improving the control and management of odours at the site. During the visit the weather conditions were bright and sunny but with a strong breeze. The site audit was accompanied by Andrea Stewart of Bassetlaw District Council and Simon Middlebrook of Tunnel Tech.

Due to the scheduling of activities over the working week not all activities were in progress during the site visit. Therefore, the potential for assessing the odorous nature of all on-site activities was somewhat limited since, the more odorous activities were not being undertaken which included:

- Straw bale dipping in goody water;
- Storage or handling of chicken and horse manure;
- Filling of bunkers within Phase 1 or moving material between bunkers.

The process uses chicken manure and horse manure. Therefore, odours generated are likely to be mostly nitrogen based (e.g. ammonia and ammoniacal compounds). However, gypsum and ammonium sulphate are added to the raw mix and the addition of sulphur increases the potential for sulphides (e.g. H_2S and mercaptans) to be generated. The following observations were noted.

- As discussed above, bale dipping, raw material mixing and Phase 1 bunker filling/emptying were not being carried out during the site audit.
- The majority of the most odorous sources are contained with air extracted and diverted to the acid scrubber/biofilter. These include the goody water storage tanks, raw material mixing building, Phase 1 bunkers, Phase 1 building and conveyors between the mixing building and the bunkers.
- The conveyance of material from Phase 1 bunkers to the pasteurisation building was carried out by conveyors in the open. The material was hot and there was visible steam generated by the material. However, the odour from these was quite earthy and not unpleasant and unlikely to cause an off-site odour under normal conditions.
- Extracted odorous air passes through the acid scrubber before being split and then passing through the two biofilters.
- The acid scrubber will treat and remove alkali-based odours such as NH_3 and ammoniacal compounds. For the volume of air that appeared to be treated the scrubber looked relatively small. Therefore, it would be useful to determine the residence time of the air within the scrubber.
- The two biofilters are constructed of whole logs and in this respect are unusual. It was stated that this was to improve the flow of air through the filters. However, biofilters work by having micro-organisms living on the filter media. Therefore, whole logs will have a low surface area compared to the more traditional wood chips and will reduce the residence time of the odorous air through the filter. This could be compensated by increasing the size of the filter bed. As for the scrubber, the residence time of the air within the filter bed should be determined.
- The biofilters are designed to remove hydrocarbon-based odours and H_2S. However, the micro-organisms generally feed by consuming carbon-based material and may not be particularly effective in treating H_2S depending on the micro-organisms present within the filter media.
- Site records and process checks are thorough. The off-site smell checks appear to be carried out as required and records retained. Some checks are carried prior to staff arriving on-site but others where staff leave the site to carry out sniff tests. These can tests can suffer from olfactory fatigue with the staff member becoming accustomed to odours from being on-site.
- There is an anemometer for recording wind speed and direction which can be used to validate any odour complaints.
- The odour management plan (OMP) for the site is out of date since the recent improvements have been completed.

3 Recommendations

It is considered that the site is well managed and with the recent improvements in containing and treating odorous emissions should provide a process that minimises off-site odour (subject to the limitations of the audit). However, it was not possible to audit all activities, particularly the more odorous activities within the site. In addition, it was also difficult to assess the effectiveness of the containment and of the odour control systems. Therefore, the following are recommended.

- The difference in odour concentrations between the 2020 and 2021 monitoring surveys should be investigated to determine the reason for the difference.
- The residence times of the extract air within the acid scrubber and the two biofilters should be determined for a range of operating conditions.
- The number of building volume changes per hour from the extraction system should be determined for a range of operating conditions.
- The odour management plan should be updated and staff trained to ensure they understand the requirements of the plan to minimise odours.
- The odour impact assessment using dispersion modelling should be re-evaluated based on the 2021 emissions monitoring.
- An understanding of the effectiveness of the individual odour control systems should be provided. The current monitoring only considers the effectiveness of the system as a whole. This could be achieved by measuring the inlet to the scrubber the outlet from the scrubber (biofilter inlet) and the outlet from the biofilters. This should be provided for the next emissions monitoring survey.
- An understanding of the effectiveness of the control of H_2S should be provided. It is recommended that at the next emissions monitoring assessment that H_2S concentrations of the inlets and outlets are obtained (including the inlet and outlet from the scrubber).