



## EA Permitting Noise Management Plan

Site Address: Canalside, Dock Road, Ellesmere Port, CH65 4EF

Client Name: Cheshire West Recycling

Project Reference: NP-013701-NMP



### Authorisation and Version Control

| Revision | Reported By         | Checked By           |
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*Delivering sustainable development by promoting good health and well-being through effective management of noise.*

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## 1. Noise Management Plan ('NMP')

This noise management plan outlines the methods by which the site operator will systematically assess and minimise the potential impacts of noise generated by the site. The noise management plan is a working document with the specific aim to ensure that:

- Noise impact is considered as part of routine inspections.
- Noise is primarily controlled at source by good operational practices and 'Best Available Techniques' ('BAT'), including physical and management control measures.
- All appropriate measures are taken to prevent or, where that is not reasonably practical, to reduce noise emissions from the site.

The noise management plan addresses the impact of noise, and the control measures employed to mitigate the risk. These are supported through monitoring procedures to identify elevated levels and review complaints should they arise. The complaints management procedure is also addressed, which includes the management responsibilities.

### 1.1 Site Description & Context

The area surrounding the site predominantly contains industrial and dock logistics buildings. The M53 runs from the south to the west and is the dominant noise source in the area. To the north is the River Mersey.

The site is currently permitted to separate and store waste within 3 buildings. The functions of these buildings are as follows:

- Building A: Bin wagon/skip/HGV waste acceptance/storage building (DMR Storage Building)
- Building B: DMR Input Building
- Building C: Waste separation and bailing (MRF Building)

The site also has a main office building and vehicle maintenance building.

To facilitate the extant activities, bin wagons, skips and HGVs enter to deliver waste to the DMR storage building during the early morning and daytime hours. Material is then separated and bailed in the MRF building via conveyer fed magnetic and kinetic sorting systems, then bailed for storage externally.

The proposed permit variation will include the diversification of waste acceptance to include fibrous waste, WEEE, metals, and oils/batteries/gas canisters.

There is no proposal to increase the overall throughput, therefore there will be no increase in vehicular traffic in and out of the site.

## Hours of Operation

It is understood that the site presently operates:

- Monday to Sunday: 06:00 – 22:00 hours
  - o Waste acceptance (bin wagon/skip/HGV) is from 06:00 – 22:00
  - o The fixed separating & sorting plant operates similarly, from 06:00 – 22:00

## 1.2 Maintenance and Review of the NMP

- The company director and site manager will be responsible for the NMP and ensuring people are trained.
- The NMP will be kept in the site office.
- The NMP will be reviewed annually, or sooner in the event of substantiated complaint related to noise.
- Training needs are defined in the site EMS. Training will be given to all relevant persons to make sure they are competent in completing noise and vibration survey forms, noise and vibration complaint report forms and the site diary to ensure sufficient monitoring of noise and vibration can be carried out and any problems addressed correctly. This will include training to all new staff and re-training via toolbox talks, as applicable.
- Records of complaints and associated investigations will be maintained by the Site Manager, or suitably trained staff member, if the site manager is not available.
- All employees and sub-contractors of Cheshire West Recycling involved with potentially noise operations will receive training in noise and vibration monitoring and complaint reporting. Training will be given to all relevant persons to make sure they are competent in completing noise and vibration survey forms, noise and vibration complaint report forms and the site diary to ensure sufficient monitoring of noise and vibration can be carried out and any problems addressed correctly.

### 1.3 Noise Sensitive Receptors

Shown in the following figure are the closest noise sensitive receptors ('NSR').



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Figure 1 – NSR Locations and Site Surroundings

| Receptor | Land Use    | Direction from Site | Approximate Distance from Permit Boundary (m) |
|----------|-------------|---------------------|-----------------------------------------------|
| 1        | Residential | SW                  | 370                                           |
| 2        | Residential | SW                  | 415                                           |
| 3        | Residential | WNW                 | 468                                           |
| 4        | Residential | NE                  | 615                                           |

Table 1 – NSR Identification

### 1.4 Noise Sources & Processes

#### NIA Conclusion

A BS4142 assessment was undertaken for a permit variation application in line with the EA requirements; this is contained within report 'NP-013701 – EA Permitting NIA' by NOVA Acoustics.

Under the previous bespoke permit, a low likelihood of 'adverse impact, dependant on context' was established at NSRs 2 & 3 between 06:00 – 07:00 on the weekends in accordance with BS4142. At all other times, there were no exceedances and 'low impact' was predicted.

The previous site-specific noise emissions at the NSRs were dominated by noise breakout from the MDR and MRF buildings.

Based on the subjective impressions gathered during the attended surveying, the site-specific noise emissions and lack of distinguishable acoustic features are akin to the residual noise profile. In accordance with the NPSE, the previous noise impacts were thought to align with the threshold for a 'No Observed Adverse Effect Level' ('NOAEL') as a 'worst-case' scenario.

Under the permit variation changes in isolation, a low likelihood of 'adverse impact, dependant on context' has been predicted at NSRs 1 & 2 between 06:00 – 07:00 ours on weekends in accordance with BS4142. At all other times, no exceedances are predicted and 'low impact' is likely.

In accordance with the NPSE, the noise impacts from the variation taken in isolation are thought to align with the threshold for a 'No Observed Adverse Effect Level' ('NOAEL') as a 'worst-case' scenario.

Under the cumulative bespoke permit, there are marginal exceedances of the background sound level between 19:00 – 22:00 at NSRs 1 & 2. From this discussion within the body of the report, it is thought that line with the NPSE, the noise impacts are thought to remain a NOAEL as a worst-case scenario.

It is stated that at NOAEL, *"noise can be heard, but does not cause any change in behaviour, attitude or other physiological response"*. In addition, noise at this level *"can slightly affect the acoustic character of the area but not such that there is a change in the quality of life"*.

The cumulative BS4142 assessment also show that on weekend mornings, the noise impacts could increase to 'adverse impact' at NSRs 1, 3, 4 & 5, with 'significant adverse impact' predicted at NSR2. It is thought that due to the reduced background sound climate over this period on the weekend, and the acoustic character associated with scrap metal sorting, this quantified level of risk is unlikely to be reduced by any context.

In accordance with the NPSE, the weekend noise impacts between 06:00 – 07:00 are thought to align with the threshold for a SOAEL at NSR2 and a LOAEL at all other NSRs. The first aim of the NPSE is to ensure that significant adverse effects are avoided, the second aim is for all *"reasonable steps to be taken to mitigate and minimise adverse effects on health and quality of life while also considering the guiding principles of sustainable development."*

To reduce the weekend noise impact to more acceptable levels, it was recommended that metal receipt and handling take place between the hours of 07:00 – 19:00 during the weekends exclusively. In doing so noise impact levels during these more sensitive periods would remain as they currently permitted.

## External Noise Sources

| Description                                                                     | L <sub>Aeq,T</sub><br>(dB) | L <sub>WA</sub><br>(dB) | On-Time Correction                                                                                                     | Source<br>Emitter Type      | Source<br>Height |
|---------------------------------------------------------------------------------|----------------------------|-------------------------|------------------------------------------------------------------------------------------------------------------------|-----------------------------|------------------|
| Bin/Skip Truck Pass-by <sup>[1]</sup>                                           | 77 at 10m<br>(Q2)          | 105                     | 13 & 6 events per<br>1-hour depending<br>on route <sup>[4]</sup><br>3 & 1 events per<br>15-min at night <sup>[4]</sup> | Slow-moving<br>Point Source | 2m               |
| Bin Truck/Skip Waste Drop<br>Off <sup>[1]</sup>                                 | 78 at 5m<br>(Q2)           | 100                     | 50% day 1-hour<br>100% night 15-min                                                                                    | Point Source                | 2m               |
| CAT 930M Wheel Loader<br>Moving Fibrous Waste <sup>[3]</sup>                    | 68 at 15m<br>(Q2)          | 100                     | 50% day 1-hour<br>100% night 15-min                                                                                    | Line Source<br>(per/unit)   | 2m               |
| <b>Permit Variation</b>                                                         |                            |                         |                                                                                                                        |                             |                  |
| CAT 930M Wheel Loader<br>Moving Fibrous Waste <sup>[3]</sup>                    | 68 at 15m<br>(Q2)          | 100                     | 50% day 1-hour<br>100% night 15-min                                                                                    | Area Source<br>(per/unit)   | 2m               |
| CAT 930M Wheel Loader<br>Moving Around Site <sup>[3]</sup>                      | 68 at 15m<br>(Q2)          | 100                     | 15 events per 1-<br>hour.<br>Up to 7 events per<br>15-min.                                                             | Slow-moving<br>Point Source | 2m               |
| (Fibrous Waste Drop Off) Bin<br>Truck/Skip Waste Drop Off <sup>[1]</sup>        | 78 at 5m<br>(Q2)           | 100                     | 50% day 1-hour<br>100% night 15-min                                                                                    | Point Source                | 2m               |
| Electric FL (un)Loading Scrap<br>Metal Waste from HGV<br>Trailer <sup>[2]</sup> | 64 at 9m<br>(Q2)           | 91                      | 25% day 1-hour<br>100% night 15-min                                                                                    | Point Source                | 2m               |
| Metal Breakdown/Sorting by<br>Hand <sup>[2]</sup>                               | 67 at 5m<br>(Q2)           | 89                      | 100% day 1-hour<br>100% night 15-min                                                                                   | Point Source                | 2m               |
| Tipping Dismantled Metal<br>Waste into 35 Yard<br>Container <sup>[2]</sup>      | 88 at 5m<br>(Q2)           | 110                     | 2-min day per 1-<br>hour<br>1-min night per 15-<br>min                                                                 | Point Source                | 2m               |

**Notes:**

**[1]** Taken from noise data measured by NOVA Acoustics, as per NP-013499.

**[2]** Taken from noise data measured by NOVA Acoustics, as per NP-009875. Similar site with waste metal drop off, hand sorting and tipping into storage skip.

**[3]** Taken from noise data measured by NOVA Acoustics, as per NP-013405. Similar site with fibrous waste being moved by a wheel loader. The original data includes bucket scraping and materials handling noise.

**[4]** The applicant has stipulated that the site shall have 200 vehicle movements throughout a 16hr day, and this traffic will be divided by the two routes to waste drop-off locations.

**[5]** Based on the CAT 930M wheel loader being predominantly required to load DMR waste onto the input belt, then having its time spread to accommodate materials handling in other locations on site.

Table 2 – Source Noise Levels &amp; Behaviours

### Internal Noise Breakout Emissions – Previous Permit

Presented in the following table are the internal ambient noise levels measured within the MRF and DMR Input area.

The internal ambient noise measurements were taken when all plant equipment was continuously loaded and active, which represents the 'worst-case' conditions.

| Description                                                        | 1/1 Octave Frequency Band (Hz, L <sub>eq,T</sub> dB) |     |     |     |    |    |    |    | Overall (dBA) |
|--------------------------------------------------------------------|------------------------------------------------------|-----|-----|-----|----|----|----|----|---------------|
|                                                                    | 63                                                   | 125 | 250 | 500 | 1k | 2k | 4k | 8k |               |
| MRF Main Building Internal Noise Level (screening/sorting/bailing) | 76                                                   | 75  | 80  | 79  | 80 | 79 | 73 | 67 | 86            |
| DMR Input Area (loading into hopper/conveyer/screening)            | 82                                                   | 79  | 80  | 79  | 81 | 79 | 78 | 76 | 89            |

Table 3 – Internal Ambient Noise Levels

Based on the site observations, the construction of the building envelopes and their assumed sound insulation performance is shown below.

| Description                                                      | Octave Frequency Band (Hz, SRI dB) |     |     |     |    |    |    |    | R <sub>w</sub> (dB) |
|------------------------------------------------------------------|------------------------------------|-----|-----|-----|----|----|----|----|---------------------|
|                                                                  | 63                                 | 125 | 250 | 500 | 1k | 2k | 4k | 8k |                     |
| Uninsulated Profiled Steel Sheet Walls/Roof (0.7mm steel)        | 9                                  | 11  | 15  | 20  | 25 | 30 | 35 | 35 | 25                  |
| 150mm Concrete Panels (1800kg/m <sup>3</sup> )                   | 39                                 | 39  | 39  | 47  | 55 | 61 | 66 | 66 | 51                  |
| Personnel Door (45mm FD30)                                       | 22                                 | 25  | 29  | 29  | 31 | 40 | 49 | 49 | 33                  |
| Roller Shutter Doors ('RSD') (single steel, D' measured by NOVA) | 8                                  | 10  | 14  | 19  | 18 | 18 | 18 | 17 | 19                  |
| Gaps & Openings                                                  | 0                                  | 0   | 0   | 0   | 0  | 0  | 0  | 0  | 0                   |

Table 4 – Assumed Building Envelope Sound Insulation

### Existing On-Site Screening & Topography

There are a number of waste retention walls and ancillary buildings on site, and high numbers of buildings in the intervening ground between the proposed development site and NRSs. However, the topography is largely flat with bodies of water and the raised M53 motorway being the main topographical features.

## Overview of Permitted Operations

The figure below is an annotated image of the currently permitted site layout and operations.

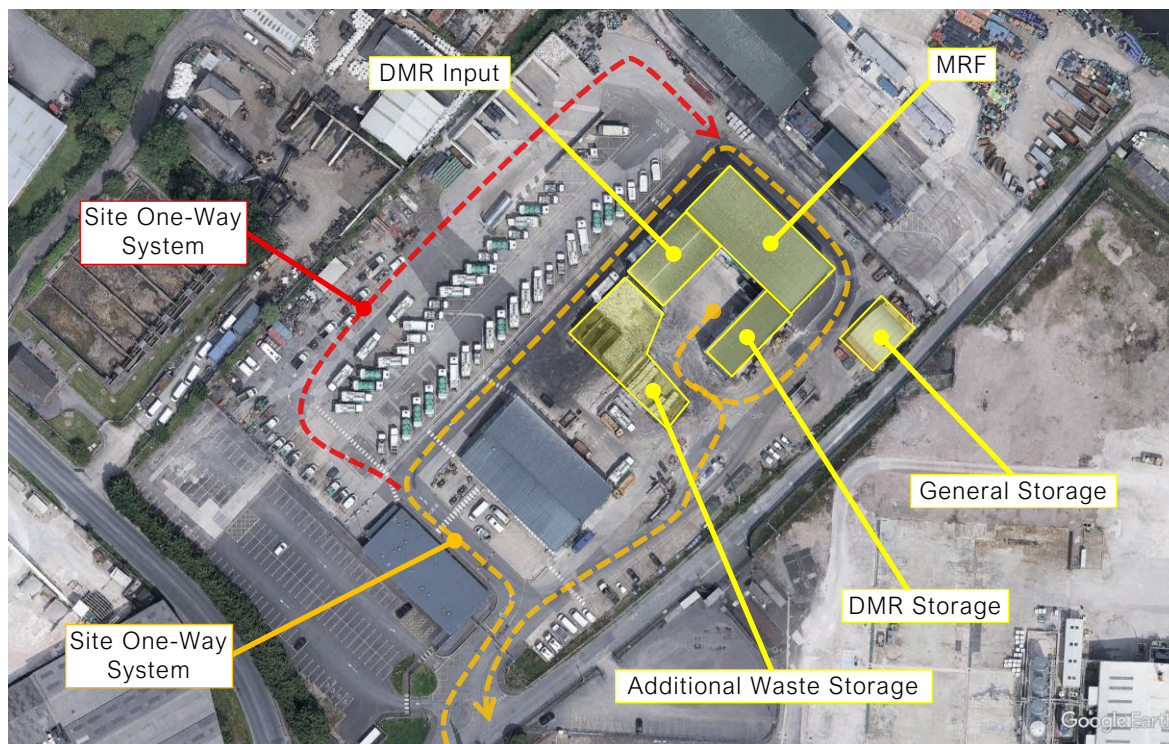


Figure 2 – Currently Permitted Layout & Operations

The following should be noted in relation to the routes indicated above:

- **Orange:** The route for bin wagons/skips/HGVs to enter, deliver / collect waste and exit the site. This is a one-way system which all vehicles shall follow.
- **Red:** This route is taken for parking and through way for waste delivery and exiting the site.

## Overview of Permit Variation

- Expanded fibrous waste storage
- Acceptance/storage of WEEE (moved by hand)
- Acceptance/sorting/storage of metal waste
- Acceptance/storage of oil/batteries/gas canisters (moved by hand)

The proposed locations for permit variation operations are shown overleaf.

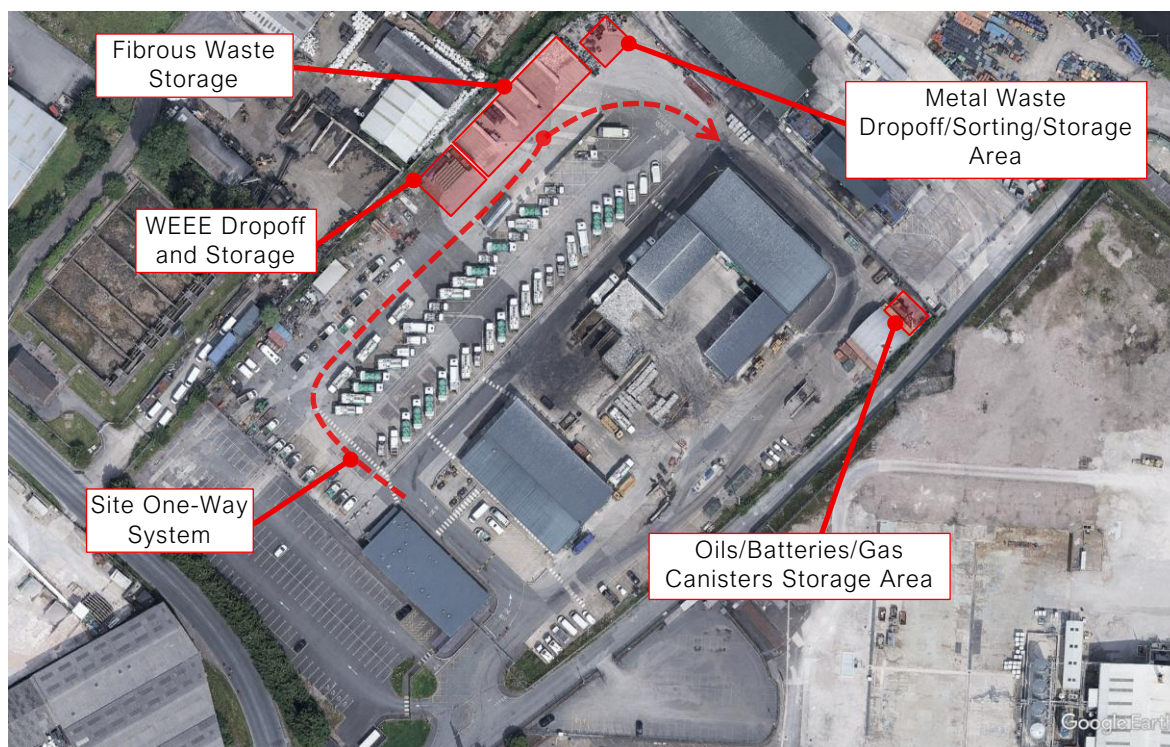


Figure 3 – Permit Variation Layout

## 1.5 Control Measures & Process Monitoring

### Appropriate Measures & Best Available Techniques (BAT)

| Description                                | Operating Hours             | Control Measures / BAT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                 | Impact Contribution             | Action Taken if Outside Optimum Process Parameters                 |
|--------------------------------------------|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------------------|--------------------------------------------------------------------|
| DMR Input Building Opening                 | Mon – Sun:<br>06:00 – 22:00 | Daily visual inspection of conveyer system, yearly full mechanical inspections, trained staff using equipment. Regular toolbox sessions on standard procedures. Regular site walks by site manager checking on procedures.                                                                                                                                                                                                                                                                                             | High                            | Cease operation and investigate reasons for elevated sound levels. |
| MRF Building Opening                       |                             | Daily visual inspection of conveyer, waste sorting and separating systems, yearly full mechanical inspections, trained staff using equipment. Regular toolbox sessions on standard procedures. Regular site walks by site manager checking on procedures.                                                                                                                                                                                                                                                              |                                 |                                                                    |
| Bin/Skip Truck Pass-by                     |                             | Reversing alarms will be self-adjusting white noise models. Vehicle horns to be used as a Health and Safety measure only. Drops heights will be reduced where practicable. The appropriate exhaust silencers will be installed. All skip wagon chains shall be wrapped with an impact dampening layer to minimise the contact emissions with the side of the skip. The access routes throughout the site shall be well maintained ensuring any potholes are filled. A maximum site speed of 10mph shall be maintained. | Low                             |                                                                    |
| Bin Truck/Skip Waste Drop Off              |                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                 |                                                                    |
| CAT 930M Wheel Loader Moving Fibrous Waste |                             |                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                        |                                 |                                                                    |
| Dropping Dismantled Metal Waste into Skip  | Mon – Sun:<br>07:00 – 19:00 | Drops heights will be reduced and trained staff using equipment. Regular toolbox sessions on standard operating procedures. Regular site walks by site manager checking on procedures.                                                                                                                                                                                                                                                                                                                                 | Medium (Impulsive Noise Source) |                                                                    |

| Description                     | Operating Hours             | Control Measures / BAT                                                                                                                                                                                                       | Impact Contribution | Action Taken if Outside Optimum Process Parameters                 |
|---------------------------------|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|--------------------------------------------------------------------|
| Metal Breakdown/Sorting by Hand | Mon – Sun:<br>07:00 – 19:00 | Drops heights will be reduced and trained staff using equipment. No throwing of waste metal materials. Regular toolbox sessions on standard operating procedures. Regular site walks by site manager checking on procedures. | Low                 | Cease operation and investigate reasons for elevated sound levels. |

*Table 5 – Noise Control Measures & BAT*

## **Equipment Maintenance**

All failed/broken plant and equipment will be replaced with equivalents that produce equal or lower levels of noise. This will be verified with manufacturers technical datasheets or on-site noise measurements.

All plant and machinery will be regularly and properly maintained in accordance with the preventative maintenance schedule of which the appropriate staff will be trained in.

## **1.6 Operator Monitoring Plan**

Monitoring of noise emissions from the site will be undertaken both subjectively and objectively.

### **Continuous Subjective Noise Monitoring**

- All operational staff will, as part of their induction, be made aware of their roles and responsibility. It is the responsibility of all staff to be aware of noise on site and to report any potential noise issues to the sites Operations Manager at the earliest opportunity.
- All staff will have refresher training on noise issues, prevention and management at six-monthly intervals.
- If members of staff report any instances of elevated noise, this should be investigated immediately. In the event that increased noise levels are verified; the source of the noise should be taken out of commission and must be fixed/corrected prior to the equipment being put back into commission.
- A visual inspection of all equipment should be made before use to ensure that there are no obvious faults or malfunctions that could lead to elevated noise levels. It will be ensured that all noise mitigation measures (silencers, etc.) are installed as per manufacturer's guidance.

### **Objective Noise Monitoring**

- A class 2 sound level meter should be purchased to measure sound levels on site. This will take place during typical operations when the site is in use and associated plant vehicles are operating as normal.

### **Monthly Measurements**

Noise levels will be measured at monthly intervals, indicative locations are shown overleaf.

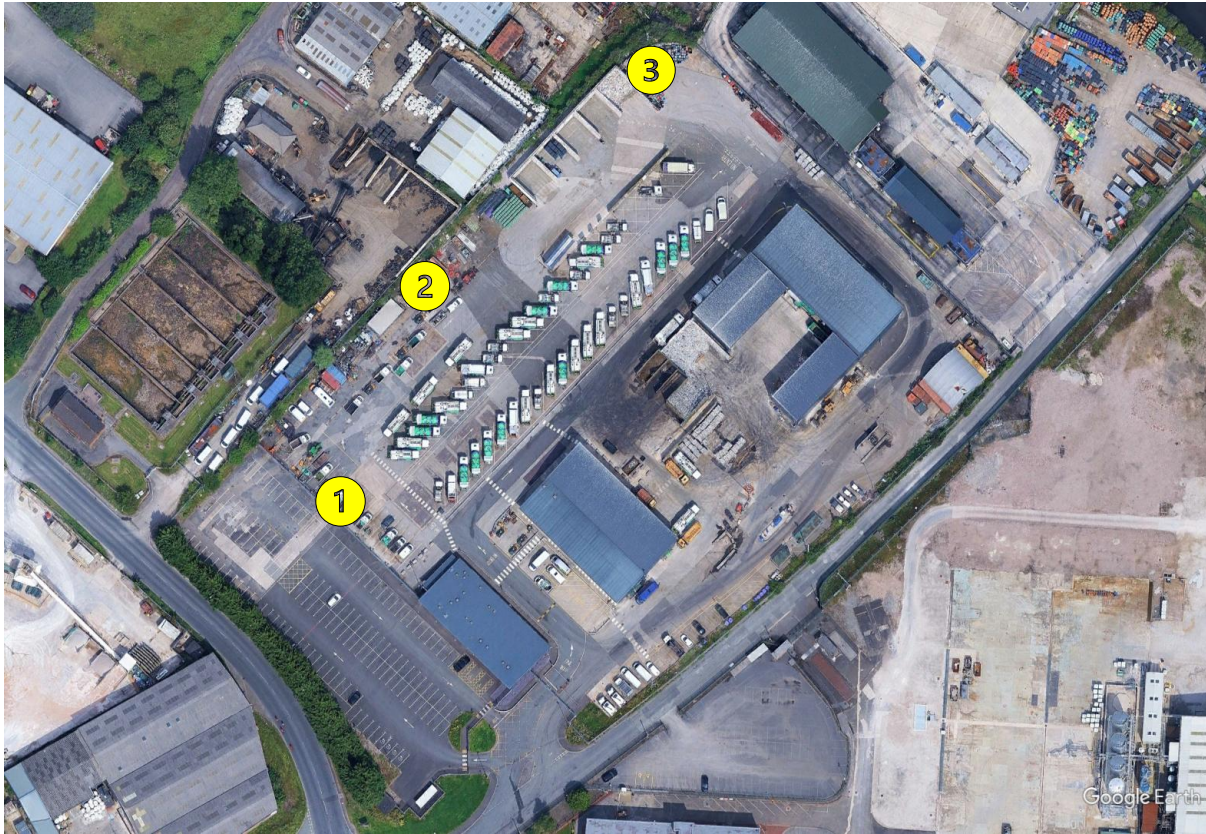


Figure 4 – Proposed Monitoring Locations

- $L_{Aeq,1hour}$  (A-weighted noise levels averaged over a 1-hour assessment period) and  $L_{AFmax}$  noise levels will be recorded. Measurements taken on site will be compared with previous measurements. If  $L_{Aeq,1hour}$  noise levels increase by more than 3dB from the previous month then the cause of the increase shall be investigated.
- When the source of the elevated noise levels is discovered, remedial work shall be undertaken to reduce noise emissions to 'normal' levels. If complex remedial work is required, the offending equipment will be taken out of commission until repair work is completed. This will be logged in an IMS (Issue Management System).

## 1.7 Management Control Measures

- Users of on-site plant and equipment complete a daily defect log at the beginning of the working day if they observe that their vehicle is not working to its optimum. An on-site mechanic actions the defect log on the same working day and machines are not used until this action has been completed.
- Tool-box talks are provided by site management on a regular basis to site operatives. These talks include all aspects of the management plans for this site.
- Plant maintenance schedules using the manufacturer's recommendations where vehicles are serviced after 500 hours of operation.
- Pre-use checks are completed prior to using plant and equipment daily.
- Defects are reported and actions are taken to rectify the problem or remove the offending item from service until such time as the issue is resolved.
- All plant and equipment are visually inspected by the operator at the end of the working day.

- Throughout the day operators are vigilant in checking vulnerable areas like exhausts and engine bays.
- Specialist contractors are used to perform maintenance outside the scope and expertise of the site management and operatives.
- All documentation relating to plant and equipment maintenance is retained in the site office for inspection.

## 1.8 Noise Complaint Investigation

It is understood that an Issue Management System ('IMS') is not currently implemented.

Therefore, this should be completed by a site manager and should include a site diary, plus forms and records of complaints. Further to this, a complaints procedure should be implemented; this procedure would need to allow for all complaints, feedback and requests made by third parties regarding the site's operational activities, as well as the health and safety performance or quality of service/product.

A phone number for the head office should be available online (it is understood that this available) in order to allow for any member of the public to lodge a complaint without entering the operational site. The operations manager will be specifically assigned to deal with complaints.

All complaints received from third parties including statutory authorities, statutory consultees, members of the general public and representatives of the company will be forwarded to the operations manager to action as below within 2 hours (where feasible). The complaint will be logged in the incident database within 72 hours.

The operations manager will ensure that:

- The complaint is investigated to identify the cause, if necessary, this may involve direct communication with the complainant.
- The noise source will be measured using a class 2 sound level meter and compared with monthly objective monitoring records.
- In the event of elevated noise being detected, the presence of 'abnormal' onsite activity is assessed and if necessary, action is taken immediately to prevent a reoccurrence of the same problem. These actions must be documented.
- The complainant will be contacted and given information on the investigations conducted and actions taken as appropriate.
- All complaints are reported to regional directors and discussed at site meetings.
- Details of other complaints are sent to the other company personnel as appropriate.

If the investigation indicates that the complaint has not been justified this will be clearly recorded on the incident report. All complaints will be logged.

## 1.9 Reporting Measures

In the event of elevated levels of noise being identified, the event will be reported into the IMS by a member of operational staff. Upon notification of an environmental incident, the site manager will complete an incident reporting form. The completed form is then distributed throughout the company for review at operational, management and health and safety meetings.

All performance failures will be categorised for input into the IMS as follows:

- Minor event: quick fix possible, locally resolved.
- Medium event: brief disruption to service, management intervention required.
- Major event: significant disruption to service.

Each non-conformance category must have a given deadline for rectification. The deadline for each category is:

- Minor Event: within 24 hours
- Medium Event: within 6 hours
- Major Event: within 1 hour

The IMS/EHS will record any actions taken to rectify the issue, ensure that any necessary actions or review are recorded onto the IMS/EHS and ensure that the person reporting the incident is notified. The site manager will investigate the performance failure within a reasonable time frame (ideally 2 hours). Once the issue has been resolved, the corrective action will be entered onto the system, and the issue will be closed.

## Appendix A – Acoustic Terminology

|                                                                    |                                                                                                                                                                                                                                                   |
|--------------------------------------------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| A-weighted sound pressure level, $L_{pA}$                          | Quantity of A-weighted sound pressure given by the following formula in decibels (dBA). $L_{pA} = 10 \log_{10} (pA/p_0)^2$ . Where: $pA$ is the A-weighted sound pressure in pascals (Pa) and $p_0$ is the reference sound pressure (20 $\mu$ Pa) |
| Background Sound                                                   | Underlying level of sound over a period, $T$ , which might in part be an indication of relative quietness at a given location                                                                                                                     |
| Equivalent continuous A-weighted sound pressure level, $L_{Aeq,T}$ | Value of the A-weighted sound pressure level in decibels (dB) of a continuous, steady sound that, within a specified time interval, $T$ , has the same mean-squared sound pressure as the sound under consideration that varies with time         |
| Facade level                                                       | Sound pressure level 1 m in front of the facade                                                                                                                                                                                                   |
| Free-field level                                                   | Sound pressure level away from reflecting surfaces                                                                                                                                                                                                |
| Indoor ambient noise                                               | Noise in a given situation at a given time, usually composed of noise from many sources, inside and outside the building, but excluding noise from activities of the occupants                                                                    |
| Noise Criteria                                                     | Numerical indices used to define design goals in a given space                                                                                                                                                                                    |
| Noise Rating (NR)                                                  | Graphical method for rating a noise by comparing the noise spectrum with a family of noise rating curves                                                                                                                                          |
| Octave Band                                                        | Band of frequencies in which the upper limit of the band is twice the frequency of the lower limit                                                                                                                                                |
| Percentile Level, $L_{AN,T}$                                       | A-weighted sound pressure level obtained using time-weighting “F”, which is exceeded for $N\%$ of a specified time interval                                                                                                                       |
| Rating Level, $L_{Ar,Tr}$                                          | Equivalent continuous A-weighted sound pressure level of the noise, plus any adjustment for the characteristic features of the noise                                                                                                              |
| Reverberation time, $T$                                            | Time that would be required for the sound pressure level to decrease by 60 dB after the sound source has stopped                                                                                                                                  |
| Sound Pressure, $p$                                                | root-mean-square value of the variation in air pressure, measured in pascals (Pa) above and below atmospheric pressure, caused by the sound                                                                                                       |
| Sound Pressure Level, $L_p$                                        | Quantity of sound pressure, in decibels (dB), given by the formula: $L_p = 10 \log_{10} (p/p_0)^2$ . Where: $p$ is the root-mean-square sound pressure in pascals (Pa) and $p_0$ is the reference sound pressure (20 $\mu$ Pa)                    |
| Weighted sound reduction index, $R_w$                              | Single-number quantity which characterizes the airborne sound insulating properties of a material or building element over a range of frequencies                                                                                                 |



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