MWDA: Gillmoss Materials Recovery Facility

Noise and Vibration Assessment

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Produced for
Merseyside Waste Disposal Authority

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Abbreviations

AL	Advisory Leaflet
BS	British Standard
CEMP	Construction Environmental Management Plan
CRTN	Calculation of Road Traffic Noise
dB	Decibel
dB(A)	A-weighted decibel
DMRB	Design Manual for Roads and Bridges
DoE	Department of Environment
EHO	Environmental Health Officer
HGV	Heavy Goods Vehicle
ISO	International Organisation for Standardisation
LCC	Liverpool City Council
MRF	Materials Recycling Facility
MWDA	Merseyside Waste Disposal Authority
SPL	Sound Pressure Level
SWL	Sound Power Level
WTS	Waste Transfer Station

1 Introduction

1.1 Introduction to Report

Mouchel has been commissioned by Merseyside Waste Disposal Authority (MWDA) to undertake an assessment of the potential noise and vibration impacts associated with the proposed development of a Materials Recovery Facility (MRF) at Gillmoss, Liverpool.

This report has considered the potential impact of noise during the construction and operational phases of the proposed MRF. The scope of this assessment has been identified through consideration of the following tasks:

- Consultation with Environmental Health Officers (EHOs) at Liverpool City Council (LCC) to determine the type of noise assessment to be undertaken, taking into account the presence of existing noise levels and any existing noise nuisance;
- Desk-based study to identify the proximity of nearest sensitive receptors;
- A review of development proposals, including noise data of plant associated with the proposed MRF;
- Identification of background noise levels within the vicinity of the proposed development by undertaking an attended short-term noise monitoring survey;
- Computer-based model predictions to quantify the noise impact associated with the operational phase of the development; and
- Qualitative assessment of potential noise and vibration impacts associated with the construction phase of the development.

1.2 Legislation and Policy Context

1.2.1 British Standard 4142 Method for Rating of Industrial Noise in Mixed Residential and Industrial Areas

British Standard (BS) 4142 Method for Rating of Industrial Noise in Mixed Residential and Industrial Areas[1] provides a methodology to assess the likelihood of complaints arising from industrial sources. The specific noise level, the noise level of the industrial source, is calculated and the rating level determined based on the tonal and temporal characteristics of the noise source. The difference between the rating level and background noise levels forms the basis for assessment of the likelihood of complaints.

1.2.2 British Standard 5228 Noise and Vibration Control on Construction and Open Sites

BS 5228 Noise and Vibration Control on Construction and Open Sites[2] contains guidance on the prediction of noise levels at sensitive receptors from the operation of fixed and mobile noise sources found on construction sites. It provides sound level data for various machinery and tasks associated with the construction phase of a

site. It also contains information pertaining to mitigation of noise from a construction site.

1.2.3 The Design Manual for Roads and Bridges

The Design Manual for Roads and Bridges (DMRB Vol.11 Sect.3 Part.7 HA213/08 Noise and Vibration) provides advice on the assessment of noise and vibration impacts due to road traffic. It does not provide procedures for calculating noise from road traffic; instead it provides guidance on assessing the potential impact of changes in noise levels on sensitive receptors.

1.2.4 International Organisation for Standardisation 9613 Acoustics – Attenuation of Sound during Propagation Outdoors

International Organisation for Standardisation (ISO) 9613[3] specifies a method for calculating the attenuation of sound outdoors in order to predict the levels of environmental noise at a distance from a variety of sources. The method predicts sound pressure levels under meteorological conditions favourable to propagation from sources of known sound emission.

1.2.5 Other Legislation and Policy

In addition to the guidance documents listed above, the following legislation and guidance have been considered in the production of this assessment:

- Control of Pollution Act 1974;
- Clean Neighbourhoods and Environment Act 2005;
- Environmental Protection Act 1990; and
- Environmental Noise (England) Regulations 2006 SI 2238.

2 Assessment Methodology

2.1 Construction Phase Assessment Methodology

A qualitative assessment has been undertaken based on typical plant and processes to be used. Specific details of the construction phase were not known at the time of assessment.

In the UK, no fixed limits apply to the construction site noise. However, advice and guidelines to local planning authorities and developers can be found in BS 5228 and Department of the Environment (DoE) Advisory Leaflet (AL) 72[4]. AL 72 is out of print, but remains as a paper giving guidance on acceptable levels of noise.

2.1.1 Significance Criteria for Noise from Construction

Table 2.1 summarises the criteria given in BS 5228 and AL 72 for acceptable levels of noise generated from construction sites.

Table 2.1 - Significance Criteria for Construction Noise

Period	Building/Location	Criterion of Assessment L_{Aeq}	Purpose
Day (0700 – 1900 hours)	Dwellings/Office (façade)	75 dB	To maintain speech intelligibility
	Schools	65 dB	To maintain speech intelligibility in classrooms
Evening (1900 – 2300 hours)	Dwellings (façade)	65 dB	To avoid sleep disturbance
Night (2300 – 0700 hours)	Dwellings (façade)	45 dB*	To avoid sleep disturbance
*or equal to ambient L_{Aeq} levels if the ambient is higher then 45 dB.			

The noise levels presented in Table 2.1 are not aimed at setting noise limits for construction activities. Rather, they are proposed as target levels to be considered as 'non-mandatory' guideline criteria for the assessment of the significance of noise impacts associated with the construction programme.

2.1.2 Vibration Due to Construction

During the construction phase of a scheme that involves building large structures, which require substantial foundations, it is likely that piling, or other similar plant operations will be employed. Such plant has the potential to result in significant increases in the existing ground-borne vibration. In addition, small construction plant such as generators may have the potential to cause vibration.

Vibration can be perceived by people. Human response to vibration levels is influenced by the duration of vibration events (temporary or long-term) and an individual's perception.

2.1.3 Significance Criteria for Vibration from Construction

Table 2.2 summarises the thresholds at which vibration from construction activities may result in structural damage[5].

Table 2.2 - Significance Criteria of Structural Damage from Construction Vibration

Building/Location	Threshold Criterion mm/s
Industrial/Heavy Commercial Building	50 mm/s at 4Hz and above
Residential/Light Commercial Building	15 mm/s at 4Hz, 20 mm/s at 15Hz 50 mm/s at 40Hz and above

Table 2.3 summarises the thresholds at which vibration from construction activities are likely to result in adverse comment from occupiers[6].

Table 2.3 - Significance Criteria of Human Perception of Construction Vibration

Building/Location	Period	Threshold Criterion mm/s
Residential Building	Day-time	0.4 – 0.8 mm/s
Residential Building	Night-time	0.26 mm/s

2.2 Operational Phase Assessment Methodology

The assessment of potential noise impacts associated with the operational phase of the MRF has been carried out using BS 4142 guidance. BS 4142 requires the difference between the background noise level and the noise associated with the industrial source (i.e. the MRF) to be calculated. This allows the likelihood of complaints arising as a result of noise from the proposed development to be established.

The background noise level is determined through measurement at the assessment location. For this development, the assessment location is at the proposed site of the MRF. The background noise level is measured using the L_{A90} noise indicator over a time period deemed sufficient to obtain a representative value.

The noise source under assessment is referred to as the Specific Noise Source. BS 4142 advocates the use of L_{Aeq}, a level that is directly measurable and termed the 'Specific Noise Level'. The Specific Noise Level is used to produce the Rating Level which takes into account the noise characteristics for the specific noise source. The correction for characteristics such as distinguishable notes, impulses and irregular component is done by adding 5 dB to the Specific Noise Level.

The Specific Noise Level has been calculated using Cadna-A, a noise mapping software package. Cadna-A applies the propagation calculations in ISO 9613[7] for

environmental noise. The sound data of the various plant and elements associated with the MRF are based upon noise measurements taken from an existing MRF at Bidston, Wirral and manufacturer's specifications.

The sound data, in the form of Sound Power Levels (SWLs) are assumed to be located within the building envelope. Noise monitoring results obtained from an existing MRF at Bidston, Wirral, have been used to determine the combined noise level generated by the operation of the MRF inside the building.

The acoustic specification of the building has been determined from the manufacture's specification and from the monitoring results at an existing MRF. The Sound Reduction Index (SRI) for the roof of the proposed MRF building is 39.4 dB[8]. The SRI for the proposed MRF building envelope has been assumed to be 26 dB based on the Noise Level Difference obtained from the monitoring results at Bidston MRF.

The noise model has been based on a set of assumptions. These assumptions have been used to represent the worst case scenario in terms of noise levels generated by the proposed MRF. The noise model has assumed that collection vehicles will be visiting the proposed site between the hours of 0800 hrs and 1800 hrs, 7 days a week. It has also been assumed that there will be a maximum of 17 collection vehicles per hour visiting the proposed MRF during this period. During this period, it has been assumed that the 5 doors on the eastern façade will be open. When the doors on the MRF building are open there is no attenuation of sound from the building at this location. This is a worst case scenario as it is planned that the doors will operate on a fast open and close operation. Outside of the delivery period, the doors have been assumed to be closed. In the absence of available information, it has been assumed that the SRI of the doors is the same as the building.

The height of the proposed MRF building is 16.86 m and there are areas of soft ground to the north and east of the MRF. In order to represent the existing site layout the existing 3 m high barrier (from ground level) has been modelled at the boundary of the site with residential properties along Longdown Road. An existing 2 m high barrier has been modelled at the site boundary with Gillmoss Industrial Site, and an existing barrier has been modelled at a height of 2.5 m to the eastern façade of the MRF.

Day-time (07:00-23:00) and night-time (23:00-07:00) periods are defined by BS 4142.

It is the difference (**effect**) between the background noise level and the Rating Level which determines the likelihood of complaints (**impact**). Table 2.4 gives the criteria used for assessing the likelihood of noise complaints during the operational phase of the proposed MRF.

Table 2.4 - Significance Criteria for Operational Noise

Change in noise level (dB)	Likelihood of Complaints	Significance (Adverse or Beneficial)
-10	Complaints Unlikely	None
+/- 1	Not perceptible	Negligible
+ 3	Not usually perceptible	Slight
+ 5	Marginal Significance	Moderate
+ 10	Complaints Likely	Substantial

It is generally considered that a change in noise level of 1 dB or less is not perceptible by the general public. A change in noise level of 3 dB or less is not usually perceptible.

2.3 Sensitive Receptors

Sensitive receptors with respect to noise and vibration include:

- Residential dwellings;
- Places of work;
- Sensitive buildings, including schools, hospitals, home for the blind and aged persons homes;
- Amenity areas (open spaces, parks, recreational areas and footpaths); and
- Designated areas (National Parks, Areas of Outstanding Natural Beauty, and Special Areas of Conservation).

Following an initial desk study, the nearest sensitive receptors for noise and vibration to the site have been identified and are listed in Table 2.5.

Table 2.5 - Noise and Vibration Sensitive Receptors

Type of Sensitive Receptor	Name of Receptor	Approximate Distance from Site Boundary*
Residential Dwellings	Longdown Road	0.01 km (N)
	Wadebridge Road	0.05 km (N)
	Elizabeth Road	0.10 km (N)
	Pamela Close	0.17 km (N)
	Valerie Close	0.24 km (N)
School	Croxteth Community Comprehensive	0.53 km (SE)
	Fazakerley Primary and High School	0.83 km (NW)
Hospital	University Hospital Aintree	1.10 km (NW)

Type of Sensitive Receptor	Name of Receptor	Approximate Distance from Site Boundary*
	Walton Neurology & Neuro	1.10 km (NW)
Doctors	Copplehouse Medical Centre	0.60 km (N)
Nursery	Gingerbread Cottage Day Nursery	0.50 km (N)
	Buckels Nursery	0.50 km (N)
Nursing Home	Alt Park Nursing & Residential Home	0.90 km (SW)
Recreational Amenity	Fazakerley Hall Recreational Ground	0.62 km (NW)
Places of Work	Gillmoss Industrial Estate	0.01 km (E)

** The proposed MRF is to be located in the south west corner of the site, therefore the distance from the MRF building to these sensitive receptors is different to that shown in this table.*

3 Noise and Vibration Baseline

3.1 Proposed MRF Site Description

The Gillmoss site is currently owned by MWDA, and operated on behalf of MWDA by its appointed contractor (currently Mersey Waste Holdings Limited). A Waste Transfer Station (WTS) is in operation on the existing site with large collection vehicles (and larger waste transport vehicles) frequently entering and leaving the site during operating hours.

The northern boundary of the site is flanked by residential housing and Gillmoss Industrial Estate is located on the eastern boundary. Stonebridge Lane runs along the western perimeter of the site boundary which provides access off the A580, approximately 250 m south of the site. At the time the baseline noise level survey was carried out (August 2007 to September 2008), land to the south of the site was open and awaiting development.

Gillmoss Industrial Estate is occupied by medium sized industrial units undertaking a variety of industrial and warehouse activities. A bus depot operated by the bus company, Stagecoach, is located to the east of the industrial estate, approximately 280 m from the Gillmoss site boundary. The A580 is a main artillery route into Liverpool and consists of a dual carriage with a speed limit of 40 mph.

3.2 Baseline Monitoring

Mouchel was appointed to undertake a noise monitoring exercise to establish the existing environmental noise climate in the vicinity of the proposed MRF site at Gillmoss. The purpose of this monitoring exercise was to establish ambient (i.e. background) noise levels to represent the noise climate for a typical week day, night-time and weekend with the existing traffic network, and to ascertain the influence of noise from adjacent roads and other sources (non-traffic) in the area.

Between 8th August 2007 and 4th September 2008, attended noise measurements and frequency data were taken at 3 locations for a period of up to 3 hours. Figure 3.1 shows the location of measurement positions used in the monitoring survey. The monitoring locations were determined due to their proximity to the site boundary and as potential sensitive receptors. The monitoring locations have been agreed with LCC as being representative. The meteorological conditions during the measurement periods were dry, with wind speeds of less than 5 m/s and a temperature of between 9ºC and 18ºC.

The baseline survey was undertaken in accordance with the principles of BS 7445[9] and following the guidance given in the CRTN[10]. It was undertaken by Mouchel's Acousticians certified as competent in environmental noise monitoring.

A Norsonic 118 Type 1 Sound Level Meter (serial number 31786) was used to undertake the measurements and calibrated in the field with a Norsonic 1251

calibrator (serial number 31460). The relevant calibration certificates are contained in Appendix A of this report.

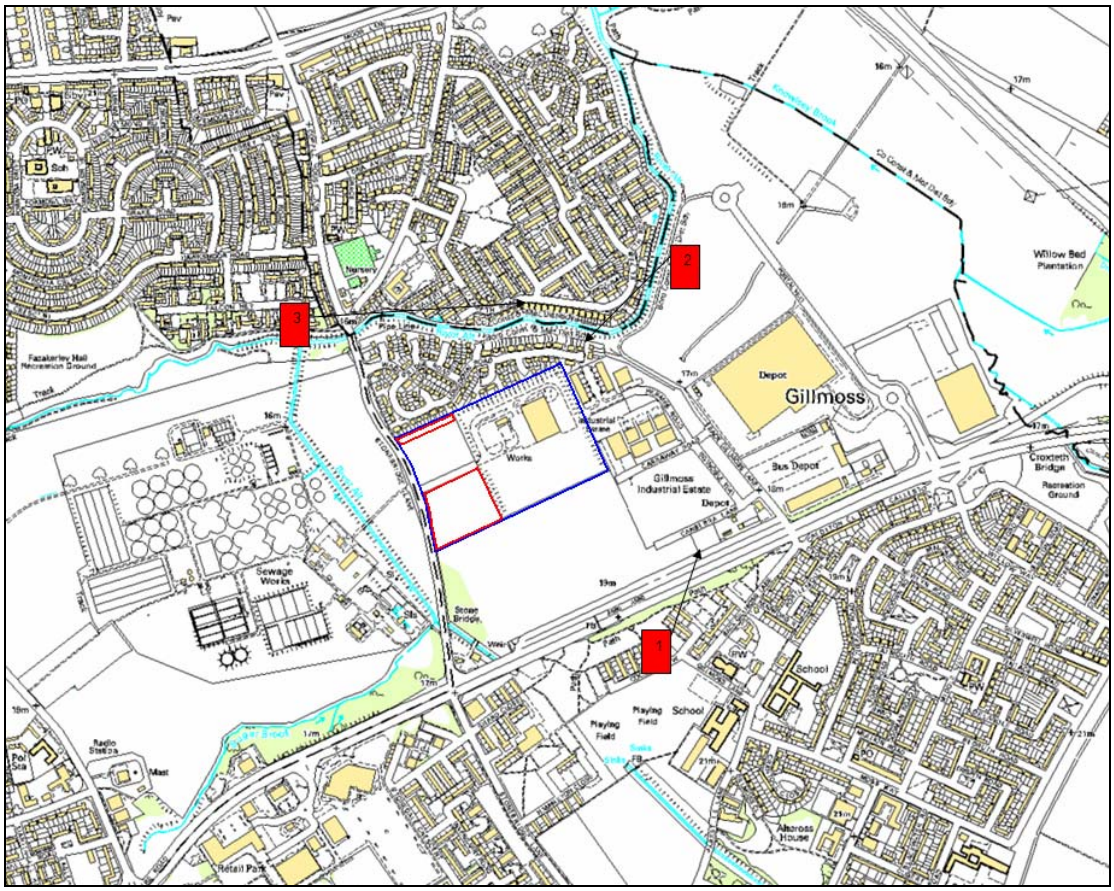

Figure 3.1 – Noise Monitoring Locations[i]

3.2.1 Description of Existing Noise Climate

3.2.1.1 Day-time

At all measurement positions, road traffic from the A580 and industrial noise from Gillmoss Industrial Estate and the WTS were deemed to be the predominant noise sources. Road traffic represents a relatively constant source of noise. Industrial noise is more intermittent and could be characterised by screeches, bangs and clatters.

At M01 and M02, road traffic noise from the A580 and M57 are the dominant noise sources. The ambient noise levels were significantly affected by changes in traffic flow on these roads. Traffic on the A580 is often queuing at traffic lights at the junctions with Back Gillmoss Lane and Stonebridge Lane.

At M03, day-time noise from the existing Waste Transfer Station (WTS) is dominant due to the distance to the A580 and relatively low background levels.

[i] Mapping correct for dates of surveys.

During the monitoring periods a high proportion of heavy goods vehicles (HGVs) were observed on the A580, Stonebridge Lane and Back Gillmoss Lane.

There were other minor sources that contributed to the background noise levels which included:

- Emergency sirens;
- Aircraft flyover; and
- Urban noise from Fazakerley, Croxteth and surrounding urban areas.

The noise level at the monitoring locations varied with time. This can be attributed to the following:

- Changes in the traffic volume, HGV percentage, distribution or speed of traffic on the local road network, and during periods of congestion;
- Changes in wind direction and speed, causing noise to 'come and go';
- Sources of distant non-road traffic noise, such as aircraft; and
- Sources of noise local to the monitoring point, for example car door slamming, car horns, pedestrians and barking dogs.

3.2.1.2 Night-time

During the night-time monitoring periods, road traffic was the dominant noise source at all the locations. In the periods of low traffic flow, industrial noise from a premise on Back Gillmoss Lane was audible. Humming, clangs and bangs were distinctly audible from M02.

At M03, in the housing estate to the north of the site, noise levels were low. Here local, sporadic noise contributed significantly to the background noise levels. These included cars on Longdown Road and a helicopter overhead.

The WTS was not operational during the night-time monitoring periods. The WTS does not operate during night-time.

3.2.1.3 Weekend

During the weekend monitoring periods, road traffic from the A50 and M57 was a constant steady noise source at all the monitoring locations. The WTS weekend operational hours are (for normal operations) 0800 – 1230 on Saturday only. On weekends following public holidays Saturday and Sunday operations are allowed from 0800 – 1730. The WTS is also allowed to open for receipt of waste from civic amenity sites on Saturday and Sunday from 0800 – 2000.

The WTS was operational during the weekend monitoring periods and industrial clangs, bangs and reversing sirens were audible from M02 and M03.

At M03, local noise sources within the housing estate, such as local cars, dogs barking and lawn mowers, contributed sporadically but significantly to the background noise levels.

3.2.2 Results

The data obtained during the noise level survey are presented in Table 3.1. A brief definition of the descriptors used, namely of the L_{A10}, L_{A90}, and $L_{Aeq\,T}$ values is given below.

L_{A10} is the A-weighted sound level that is exceeded for 10% of the sample period; this parameter givens an indication of the upper limit of fluctuating noise such as that from road traffic.

L_{A90} is the A-weighted sound level that is exceeded for 90% of the sample period; generally used to quantify background noise.

$L_{Aeq,T}$ is the A-weighted equivalent continuous sound level during the sample period (T) and effectively represents an average value.

Table 3.1 - Summary of Baseline Noise Levels in the Vicinity of the Site

Site	Site Location	Site Description and Microphone Position	Noise Climate	Meteorological Conditions	Date	Measurement Duration (hrs)	Time	Overall Level (dB)			Comments
								L_{Aeq}	L_{A10}	L_{A90}	
Day-time Weekday											
M01	Croxteth Housing Estate, Preesall Way	1m from façade, 1.2m high, soft ground in front hard ground to the north, east facing	Dominated by road traffic noise (A580), banging/clanging of HGVs on A580, industrial humming and banging, frequent aircraft flyover	Dry, sunny spells, 18°C, wind=gusty 3.5m/s NE direction	08/09/2007	3	10:30 - 13:30	58.6	62.0	51.4	Helicopter landing to east, siren, brakes screeching, van banging, horn beep, ice cream van, falling rubble (demolition)
M02	Gillmoss Industrial Estate, Hermes Road (rear of site)	Free-field, 1.2m above soft ground, mixture of soft and hard ground, east facing	Dominated by road traffic (A580) and M57 in distance, industrial noise from Industrial Estate and WTS (clangs, bangs, lorries reversing), frequent aircraft flyover	Dry, sunny spells, 18°C, wind negligible, occasional gusts NE direction	08/09/2007	3	14:00 - 17:00	52.5	54.9	47.6	Banging of refuse trucks, dog barking, hydraulic tool (drill, sawing) horn beep, siren
M03	3 Carland Close, housing estate off Stonebridge Lane	1m from façade, 1.5m high, mixed ground cover, facing east outside ground floor window (2 storey), 2m wooden fence on site boundary (mature trees screening existing building on site)	Industrial noise from WTS (clangs, bangs, lorries reversing, refuse trucks moving), distant noise of road traffic on A580 (40 mph), frequent sirens (for Fazakerley Hospital)	Dry, sunny spells 15°C, negligible wind	02/10/2007	3	10:30 - 13:00	50.4	53.4	46.7	Aircraft flyover (frequent), dog barking, siren, car pull up and door slam, helicopter, talking
Day-time Weekend											
M01	Croxteth Housing Estate, Preesall Way	Free-field. 1.5m above ground, mixed ground cover, facing north	Traffic on A580 and M57, frequent aircraft flyover	Dry, 100% cloud, 17°C, 2m/s wind N direction	07/09/08	1	13:00 - 14:00	59.5	62.6	52.3	Motorbike
M02	Gillmoss Industrial Estate, Hermes Road (rear of site)	Free-field. 1.5m above ground, mixed ground cover, facing west	Distant traffic on A580 and M57, clangs from inside WTS, frequent aircraft flyover	Dry, 100% cloud, 17°C, 2m/s wind N direction	07/09/08	1	14:15 – 15:15	50.2	50.5	45.0	Bangs form WTS, motorbike
M03	1 Carland Close, housing estate off Stonebridge Lane	Free-field. 1.5m above ground, mixed ground cover, facing west	Distant traffic on A589 and M57, clangs from inside WTS, 'local' noise sources	Dry, 90% cloud cover, less than 1m/s wind speed, 18°C	14/09/08	1	14:30 – 15:30	46.4	48.4	42.9	Bangs from WTS, dog barking, aircraft flyover, siren
Night-time Weekday											
M01	Croxteth Housing Estate, Preesall Way	Free-field. 1.5m above ground, mixed ground cover, facing north	Traffic on A580 and M57, occasional vehicle on Back Gillmoss Lane, hum from industrial premises on Back Gillmoss Lane (north of A580)	Dry, no wind, 9°C	08/09/08	0.5	23:15 – 23:45	47.9	51.3	41.7	Siren
M02	Gillmoss Industrial Estate, Hermes Road (rear of site)	Free-field. 1.5m above ground, mixed ground cover, facing west	Hum/occasional clangs from industrial premises on Back Gillmoss Lane, traffic on A580 and M57	Dry, no wind, 9°C	09/09/08	0.5	00:00 – 00:30	46.4	48.0	44.7	Aircraft flyover, car door slam
M03	Carland Close, housing estate off Stonebridge Lane	Free-field. 1.5m above ground, mixed ground cover, facing west, 2m wooden fence on site boundary (mature trees screening existing building on site)	Distant A580, occasional car on Longdown Road	Dry, no wind, 9°C	09/09/08	0.5	00:45 – 01:15	35.8	37.5	33.8	Helicopter flyover

3.3 Existing MRF Site - Bidston

At the time of assessment, plant and operational noise data pertaining to the proposed MRF were not available. Therefore, in order to establish the noise level of the proposed MRF, a noise level survey was undertaken at an existing MRF (owned by MWDA), similar to the facility proposed at Gillmoss. The existing MRF is located at Bidston, Wirral.

On 16th and 17/18th March 2008, attended noise measurements and frequency data were taken at six locations inside the MRF for a period of 1 hour. These were undertaken to determine the noise level associated with specific parts of the MRF process. Measurements were also taken at four external locations. These determine the noise level outside of the MRF during the night-time operational period when background noise is at its lowest.

The meteorological conditions during the measurement periods were dry, with a temperature of 5ºC and wind speeds of between 2 and 4 m/s.

The baseline survey was undertaken in accordance with the principles of BS 7445 and following the guidance given in BS 4142 by Mouchel's Acousticians certified as competent in environmental noise monitoring.

Two Norsonic 118 Type 1 Sound Level Meters (serial numbers 31786 and 31787) were used to undertake the measurements and calibrated in the field before and after each measurement with Norsonic 1251 Calibrators (serial numbers 31460 and 31461). No calibration drift was recorded. The relevant calibration certificates are contained in Appendix A of this report.

3.3.1 Description of Noise at Existing Bidston MRF Site

The MRF at Bidston processes approximately 85,000 tonnes per annum which equates to an average of 300 tonnes of material per day. The building is 2800 m² and comprises of single clad corrugated iron walls with a 3 m high concrete skirting around the base of the building. The building has a concrete hard-standing.

The existing MRF processes material for 20 hours per day, 6 days a week. Maintenance work is carried out on the facility for 4 hours each day and all day on Sunday. The MRF receives deliveries of materials from 60 vehicles per day. The MRF has been operational since 2006 and there are no known complaints relating to noise.

The machinery is estimated to be running 80% of the time; the 20% 'down-time' is attributable to planned (e.g. maintenance) and unplanned (e.g. blockages, detection of high risk material) stoppages. The MRF process comprises conveyor belts, hand sorting cabins, a v-screen, balers for specific material and post-sorting cabins. The process operates as a complete entity; individual parts of the process cannot operate alone.

Noise within the enclosed MRF building is characterised by distinct impulses (e.g. industrial clangs, bangs and sirens). The process creates a mechanical whirring noise forming a distinguishable, discrete, continuous note.

Noise measurements were taken outside the MRF building at night-time when contribution from other sources (road traffic, industrial) is at its lowest.

Specific parts of the process were clearly audible from outside the building such as;

- JCB bucket scraping along the concrete floor; and
- Emergency / warning sirens.

During 'downtime', the running of the conveyor belts was audible from outside the building.

At M09b and M10b, to the south of the MRF, the noise climate was influenced by the configuration of the doors. At the start of the measurement period, two of the delivery bays were open. One was closed during the monitoring period which reduced noise transmitted from within the building to the measurement position.

At M09b and M10b, the noise level was also influenced by movements of forklift trucks, JCBs and HGVs collecting material. This comprised of reversing sirens, clanging and tipping of materials

It should be noted that during the external measurement periods, the MRF was not receiving deliveries from collection vehicles.

This information was used to inform the underlying assumptions used in the production of the noise model to ensure a robust conservative assessment.

3.3.2 Results

The data obtained during the noise level survey are presented in Table 3.2.

Table 3.2 - Summary of Baseline Noise Levels at Existing MRF

Site	Site Location	Microphone Position	Noise Climate	Meteorological Conditions	Date	Measurement Duration (hrs)	Time	Overall Level (dB)		Comments
								L_{Aeq}	L_{A90}	
Internal Noise Measurements										
M01b	V-Screen	1.5m above suspended walkway (7m above ground)	V-Screen sorting waste types	-	16/04/08	1	12:30-13:30	92.9		Machinery stops once, warning sirens
M02b	Glass Separator	1.5m above suspended walkway (7m above ground)	Glass separator knocking glass materials together	-	16/04/08	1	12:30-13:30	90.1		Machinery stops once, warning sirens
M03b	Input Conveyor	1.5m above suspended walkway (7m above ground); 1.5m from corrugated facade	Conveyor belt and compressor, clanging and banging of materials on belt	-	16/04/08	1	16:00-17:00	86.9		Machinery stops 3 times
M04b	Glass Crusher	1.5m above suspended walkway (7m above ground)	Conveyor belt, breaking glass	-	16/04/08	1	16:00-17:00	90.4		Machinery stops 3 times
M05b	Tipping Floor/ Delivery Bay	1.5m above concrete floor, 0.5m from façade	JCB moving and scraping bucket on concrete floor, tipping waste from refuse trucks, reversing sirens	-	17/04/08	1	11:45-12:45	85.2		Machinery stops once, warning sirens, JCB stops operating once
M06b	Out-loading Area	1.5m above concrete floor, 2.5m from façade	Moving vehicles (lorries, forklift trucks), horns, reversing sirens	-	17/04/08	1	11:45-12:24	84.5		Machinery stops once, warning sirens, skips being loaded
External Night-time Noise Measurement										
M07b	North façade of MRF	1.5m above hard ground, 5.5m from façade, free-field	Industrial sounds from inside MRF	Dry, 2m/s easterly wind, 5°C	17/04/08 - 18/04/08	1	23:30-00:30	63.3	61.8	Siren inside MRF, aircraft flyover
M08b	North façade of MRF	1.5m above hard ground, 5.5m from façade, free-field	Industrial sounds from inside MRF	Dry, 2m/s easterly wind, 5°C	17/04/08 - 18/04/08	1	23:30-00:30	66.4	65.6	Siren inside MRF, aircraft flyover
M09b	South of MRF, (in car park)	1.5m above hard ground, free-field	JCB/wagon movements, clanging of bucket on concrete floor, reversing sirens	Dry, 3-4m/s easterly wind, 5°C	18/04/08	1	01:00-02:00	68.5	63.7	Metal dumped in skip, shutter entrance closed (01:15)
M10b	South of MRF, (in car park)	1.5m above hard ground, free-field	JCB/wagon movements, clanging of bucket on concrete floor, reversing sirens	Dry, 3-4m/s easterly wind, 5°C	18/07/08	1	01:00-02:00	65.6	61.4	Metal dumped in skip, shutter entrance closed (01:15)

3.4 Vibration

Subjective observations undertaken during the noise monitoring, at each of the external locations, demonstrated that there were no major sources of vibration in the vicinity of the proposed MRF.

At the existing MRF, vibration was detectable by acousticians on the suspended walkways inside the building. Vibration was not observed on the concrete hard-standing or at locations outside the MRF building.

Therefore, due to observations made at the existing Bidston MRF, it has been concluded that baseline vibration monitoring or a detailed assessment of vibration is not required for the proposed MRF as the potential for vibration impact is deemed to be insignificant.

4 Potential Environmental Effects

4.1 Construction Phase

The construction period is expected to last 12 months. A detailed assessment of the area subject to construction noise impact will be undertaken by the Contractor as part of their Construction Environmental Management Plan (CEMP) when the details of the construction programme are available. This will include any Temporary Traffic Management (TTM) plan, for example traffic re-routing and diversions.

4.1.1 Assessment of Construction Noise and Vibration

The typical plant and equipment that may be used during the construction phase of the development are mechanical excavators, cranes, pile-drivers, scrapers, graders and dump trucks, generators, ready-mixed concrete vehicles, road rollers and compaction plant, pumps, hand tools and site staff vehicles.

Table 2.1 of this report gives recommended noise limits for construction activities based on guidance in BS 5228 and Advisory Leaflet 72. These limits are indicative only and it may be appropriate to apply more stringent limits in areas where ambient noise levels are low.

Table 2.2 and Table 2.3 of this report give indicative vibration thresholds for construction activities based on BS 7385 and BS 6472 for structural damage to buildings and human detection respectively.

It is anticipated that the noise and vibration impact during construction would be restricted to the residents and users of areas, for example on footpaths, in the immediate vicinity of the proposed development. The impact due to construction activities would be temporary in nature.

The proposed work area during the construction phase was not confirmed at the time of writing. However, it is considered that the areas with the potential to be affected by the construction of the proposed MRF are residential properties on Longdown Road and adjoining roads, and commercial offices on Gillmoss Industrial Estate.

4.1.2 Construction Noise Mitigation Measures

The contractor would be required to incorporate specific noise and vibration abatement measures as part of their CEMP and to be associated with the Considerate Construction Scheme (CCS). The typical measures that are implemented on a construction site include:

- Best practicable means, including maintenance of plant, would minimise the noise produced by operations on site;
- All vehicles and mechanical plant to be fitted with effective exhaust silencers and maintained in good working order;
- Machinery that is used intermittently would be shut down or throttled back to a minimum during periods when not in use;

- Static plant known to generate significant vibration levels to be fitted with acoustic dampening;
- Construction vehicles to only access and exit the site from the A580, south of the site;
- Noise and vibration levels at the nearest sensitive receptor to be checked through a regular monitoring programme;
- In agreement with the local EHO, working hours limited to the hours of 07:00 – 19:00 weekdays, and 07:00 – 16:00 on weekends and bank holidays.
- In agreement with the local EHO, any plant, such as generators or pumps that are required to operate before 07:00, after 19:00 or at weekends are surrounded by an acoustic enclosure or portable screen.

During the course of the construction programme, supervision of the works would include ensuring compliance with the limits detailed in Table 2.1 or those set down by LCC.

It is considered that with the appropriate mitigation measures implemented, the potential for adverse noise impacts from the construction phase of the proposed MRF is not significant.

4.2 Operational Phase

Liverpool City Council (LCC) has a noise policy for the borough which states that:

'*The Rating Level of the noise emitted from any plant shall not exceed the existing background noise level. The noise level shall be determined at the nearest noise sensitive premises. The measurements and assessments shall be made according to BS4142:1997. 'Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas'*.

4.2.1 Assessment of Operational Noise

4.2.1.1 BS4142 Assessment

In order to determine the Rating Level, a 5 dB correction has been added to the Specific Noise Level of the MRF. The Rating Level has then been added to the measured L_{Aeq} background noise level. The assessment of impact has been undertaken by comparing the Rating Level and the measured L_{A90}. This is referred to as the Assessment Noise Level in this assessment.

Day-time

Table 4.1 shows the difference between the predicted Rating Level and the measured $L_{A90\ (1\ hour)}$ daytime; the Assessment Noise Level.

Table 4.1 - Assessment Noise Level from MRF (Day-time)

Receptor	Predicted SPL from MRF day-time L_{Aeq} dB(A)	Measured $L_{A90\ (1hour)}$ dB(A)	Rating Level L_{Aeq} dB(A)	BS 4142 Assessment Noise Level (dB(A))
Croxteth Housing Estate, Preesall Way	46.0	51.4	58.8	+7.4
Gillmoss Industrial Estate, Hermes Road (rear of site)	53.5	47.6	56.0	+8.4
3 Carland Close, housing estate off Stonebridge Lane	43.4	46.7	51.2	+4.5

Night-time

Table 4.2 shows the difference between the Rating Level and the measured $L_{A90\ (30\ min)}$ night-time; Assessment Noise Level.

Table 4.2 - Assessment Noise Level of MRF (Night-time)

Receptor	Predicted SPL from MRF night -time L_{Aeq} dB(A)	Measured $L_{A90\ (30\ min)}$ dB(A)	Rating Level L_{Aeq} dB(A)	BS 4142 Assessment Noise Level (dB(A))
Croxteth Housing Estate, Preesall Way	31.9	41.7	48.0	+6.3
Gillmoss Industrial Estate, Hermes Road (rear of site)	37.0	44.7	46.9	+2.2
3 Carland Close, housing estate off Stonebridge Lane	26.3	33.8	36.3	+2.5

4.2.1.2 Noise Level Increase

The LCC criterion for assessing noise emitted from industrial plant is different to the BS 4142 method for assessing the likelihood of complaints. In order to assess the contribution of the MRF to the ambient noise level, it is necessary to consider the difference between the measured L_{Aeq} and L_{A90} noise levels. The difference has then been compared to the Assessment Noise Level to determine the noise level increase.

Day-time

Table 4.3 shows the noise level increase for the day-time period.

Table 4.3 - Noise Level Increase (Day-time)

Receptor	Rating Level	BS 4142 Assessment Noise Level	Measured L_{Aeq} - $L_{A90\ (1hour)}$ dB(A)	Noise Level Increase dB(A)
Croxteth Housing Estate, Preesall Way	58.8	+7.4	+7.2	+0.2
Gillmoss Industrial Estate, Hermes Road (rear of site)	56.0	+8.4	+4.6	+3.8
3 Carland Close, housing estate off Stonebridge Lane	51.2	+4.5	+3.7	+0.8

Night-time

Table 4.4 shows the noise level increase for the night-time period.

Table 4.4 - Noise Level Increase (Night-time)

Receptor	Rating Level	BS 4142 Assessment Noise Level	Measured L_{Aeq} - $L_{A90\ (1hour)}$ dB(A)	Noise Level Increase dB(A)
Croxteth Housing Estate, Preesall Way	48.0	+6.3	+6.2	+0.1
Gillmoss Industrial Estate, Hermes Road (rear of site)	46.9	+2.2	+1.7	+0.5
3 Carland Close, housing estate off Stonebridge Lane	36.3	+2.5	+2.0	+0.5

The results from Table 4.3 and Table 4.1 indicate that the predicted noise level increase is greater during the day-time period. This is due to the presence of delivery vehicles and the opening of the 5 doors on the eastern façade. A worst case scenario, of 17 delivery vehicles per hour and the doors being left open throughout the day-time period, was modelled.

4.2.2 Operational Noise Mitigation Measures

The maximum contribution of the MRF to the ambient noise level is 3.8 dB(A) at Gillmoss Industrial Estate during the day-time period as a consequence of the access doors being open.

In order to reduce this noise level at the Gillmoss Industrial Estate, the existing barrier (overplanted earth bund) at the eastern site boundary will be increased in height from 2 m to 6 m with a suitable barrier. This would provide a reduction in noise level of 1.6 dB(A) (Table 4.5)..

Table 4.5 - Noise Level Increase with Mitigation (Day-time)

Receptor	Barrier Height (m)	Rating Level dB(A)	BS 4142 Assessment Noise Level dB(A)	Measured L_{Aeq} - L_{A90} $_{(1hour)}$ dB(A)	Noise Level Increase dB(A)
Gillmoss Industrial Estate, Hermes Road (rear of site)	6.00	54.4	+6.8	+4.6	+2.2

A change in noise level of 3 dB(A) is considered to be not usually perceptible by the general public.

Noise level increases at other receptor positions are less than 3 dB(A), it is therefore not considered necessary to provide additional mitigation measures to that stated above...

It is considered that with the installation of the proposed noise barrier to provide appropriate mitigation, the potential impact of noise during the operation of the proposed MRF is not significant at any sensitive receptors. Using the conservative assessment methodology adopted for the purposes of this study, the predicted 2.2 dB(A) increase at the Gillmoss Industrial Estate is considered to be ‘slight adverse’, although is unlikely to be perceptible by the general public.

5 Conclusions and Recommendations

An assessment of the potential noise and vibration impacts associated with the proposed development of a Materials Recovery Facility (MRF) at Gillmoss, Liverpool has been undertaken.

A detailed assessment of the area subject to construction noise impact will be undertaken by the Contractor as part of the Construction Environmental Management Plan (CEMP).

A detailed assessment of the impacts associated with the construction phase of the proposed development has not been undertaken as a construction contractor has not yet been appointed. Best construction practice will be followed to ensure that any impact will be minor. Any construction noise mitigation measures deemed to be appropriate will be implemented (Section 4.1.2).

Following a site visit, no sources of vibration were identified in the vicinity of the proposed MRF development. The need for baseline vibration monitoring and a detailed vibration assessment is therefore considered unnecessary as the potential for adverse impact from vibration during the operational phase is considered to be insignificant.

The assessment of potential noise impacts associated with the operational phase of the MRF has been carried out using BS 4142 guidance and worst case assumptions regarding the number of vehicles entering and leaving the site each hour, and the doors remaining open throughout the day-time. BS 4142 requires the difference between the background noise level and the noise associated from the industrial source (i.e. the MRF) to be calculated. This allows the likelihood of complaints arising as a result of noise from the proposed development to be established.

Liverpool City Council (LCC) has a noise policy for the borough which states that:

'The Rating Level of the noise emitted from any plant shall not exceed the existing background noise level. The noise level shall be determined at the nearest noise sensitive premises. The measurements and assessments shall be made according to BS4142:1997. 'Method for Rating Industrial Noise Affecting Mixed Residential and Industrial Areas'.

The BS 4142 method for assessing the impact of industrial noise sources uses a comparison between a predicted L_{Aeq} and a measured L_{A90} value. However, LCC require these values to be the same. A L_{Aeq} and a L_{A90} value will only be the same if the background noise level is constant i.e. no fluctuations in noise. However, from the noise monitoring results it is evident that in the vicinity of this scheme, the L_{Aeq} and L_{A90} values differ by between 1.7 and 7.2 dB(A). As a result, the LCC noise criterion should not be solely relied upon in assessing the impact of industrial noise at this location.

In order to ascertain the contribution of noise from the MRF to the existing background noise level, it has been necessary to subtract the difference in the measured L_{Aeq} and L_{A90} values from the Assessment Noise Level.

The results from the assessment indicate that the maximum exceedence of the background L_{A90} noise level is 3.8 dB(A) at Gillmoss Industrial Estate. In order to reduce the noise level, a 6 m barrier will be erected at the eastern site boundary. This would provide a reduction in noise level of 1.6 dB(A). This would result in an increase in noise level of 2.2 dB(A) as a result of the proposed development, a level which is not usually perceptible to the general public..

It is not considered necessary to provide additional mitigation measures to that stated above as the noise level increase is less than 3 dB(A). A change in noise level of 3 dB(A) is considered to be not usually perceptible by the general public.

It is considered that with the installation of the proposed noise barrier to provide appropriate mitigation, the potential impact of noise during the operation of the proposed MRF is not significant at any sensitive receptors. Using the conservative assessment methodology adopted for the purposes of this study, the predicted 2.2 dB(A) increase at the Gillmoss Industrial Estate is considered to be ‘slight adverse’, although is unlikely to be perceptible by the general public.

6 Appendices

6.1 Calibration Certificates

Calibration Report

Certificate No.:4131

Norsonic Type : 118 Serial no : 31786

Customer:	Mouchel Ltd
Department:	Acoustics
Place:	St. John's House, Queen Street
City:	Manchester, M2 5JB
Order No:	Letter
Contact Person:	Mr Mark Harrison
Phone/Mail:	

Microphone :	Norsonic	Type : 1225	Serial no : 91775	Sens:-26.73dB
Pre amplifier	Norsonic	Type : 1206	Serial no : 30810	
Calibrator :	Norsonic	Type : 1251	Serial no : 31460	Level:114.08dB

Measured with Pre Amplifier
Microphone cable was included
Mains adapter was included
RS232 cable was included

This sound level meter has been calibrated as specified in BS 7580. PART 1 : 1997.
Measurement Results:

Noise test - BS 7580 #5.5.2	Passed
Level Linearity Test - BS 7580, #5.5.3	Passed
Frequency weightings: A Network - BS 7580 #5.5.4	Passed
Frequency weightings: C Network - BS 7580 #5.5.4	Passed
Time weightings F and S - BS7580 #5.5.5	Passed
Peak response - BS7580 #5.5.6	Passed
RMS accuracy - BS7580 #5.5.7	Passed
Time weighting I - BS7580 #5.5.8	Passed
Integrating Test : Time averaging - BS7580 #5.5.9	Passed
Integrating Test : Pulse range - BS7580 #5.5.10	Passed
Integrating Test : Sound exposure level - BS7580 #5.5.11	Passed
Overload SPL Test - BS 7580 #5.5.12	Passed
Overload Leq Test - BS 7580 #5.5.12	Passed
Acoustic tests - BS 7580 #5.4 and 5.6	Passed
Summation of acoustic tests - BS 7580 #5.5.4	Passed

The overall frequency response of the sound level meter including case reflections, microphone response and wind screen has shown to confirm with the requirements in #6 of the BS EN 60651 and #5.5.4 in BS 7580 Part 1.

Comment :
Correct calibration setting with associated calibrator is 113.9 dB(A)

Environmental conditions:

Pressure :	Temperature :	Relative humidity :
101.325 kPa	23.0 °C	50.0 %RH

Date of calibration: 24/07/2008
Date of issue: 24/07/2008
Supervisor: Ian Campbell MSC MIOA
Engineer

David Egan

Campbell Associates
www.campbell-associates.co.uk

Calibration Report

Certificate No.:4130

Manufacturer:	Norsonic
Type :	1225
Serial no:	91775

Customer:	Mouchel Ltd
Department:	Acoustics
Place:	St. Johns House, Queen Street
City:	Manchester. M2 5JB
Contact Person:	Mark Harrison

Measurement Results:

	Sensitivity : (dB re 1V/Pa)	Capacitance : (pF)
1:	-26.73	20.6
2:	-26.74	20.6
3:	-26.73	20.6
Result (Average):	**-26.73**	**20.6**
Expanded Uncertainty:	0.10	2.00
Degree of Freedom:	>100	>100
Coverage Factor:	2.00	2.00

The following correction factors have been applied during the measurement:
Pressure :-0.010 dB/kPa Temperature :-0.007 dB/°C Relative humidity :0.000 dB/%RH

Reference Calibrator: WSC1 - Nor1253-24269. Volume correction: 0.000 dB

Records :K:\C A\Calibration\Nor-1504\Nor-1017 MicCal\2008\NOR1225_91775_M1.nmf

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA publication EA-4/02.

Comment:

Environmental conditions:

Pressure :	Temperature :	Relative humidity :
101.176 ± 0.003 kPa	24.0 ± 1.2 °C	54.7 ± 5.9 %RH

Date of calibration:24/07/2008
Date of issue:24/07/2008

Supervisor : Ian Campbell MSc MIOA
Engineer :

David Egan

Campbell Associates
www.campbell-associates.co.uk

Calibration Report

Certificate No.:4132

Norsonic Type : 118 Serial no : 31787

Customer:	Mouchel Ltd
Department:	Acoustics
Place:	St. John's House, Queen Street
City:	Manchester, M2 5JB
Order No:	Letter
Contact Person:	Mr Mark Harrison
Phone/Mail:	

Microphone :	Norsonic	Type : 1225	Serial no : 69918	Sens:-25.61dB
Pre amplifier	Norsonic	Type : 1206	Serial no : 30878	
Calibrator :	Norsonic	Type : 1251	Serial no : 31461	Level:114.10dB

Measured with Pre Amplifier
Microphone cable was included
Mains adapter was included
RS232 cable was included

This sound level meter has been calibrated as specified in BS 7580. PART 1 : 1997.
Measurement Results:

Noise test - BS 7580 #5.5.2	Passed
Level Linearity Test - BS 7580, #5.5.3	Passed
Frequency weightings: A Network - BS 7580 #5.5.4	Passed
Frequency weightings: C Network - BS 7580 #5.5.4	Passed
Time weightings F and S - BS7580 #5.5.5	Passed
Peak response - BS7580 #5.5.6	Passed
RMS accuracy - BS7580 #5.5.7	Passed
Time weighting I - BS7580 #5.5.8	Passed
Integrating Test : Time averaging - BS7580 #5.5.9	Passed
Integrating Test : Pulse range - BS7580 #5.5.10	Passed
Integrating Test : Sound exposure level - BS7580 #5.5.11	Passed
Overload SPL Test - BS 7580 #5.5.12	Passed
Overload Leq Test - BS 7580 #5.5.12	Passed
Acoustic tests - BS 7580 #5.4 and 5.6	Passed
Summation of acoustic tests - BS 7580 #5.5.4	Passed

The overall frequency response of the sound level meter including case reflections, microphone response and wind screen has shown to confirm with the requirements in #6 of the BS EN 60651 and #5.5.4 in BS 7580 Part 1.

Comment :
Correct calibration setting with associated calibrator is 114.0dB(A)

Environmental conditions:

Pressure :	Temperature :	Relative humidity :
100.916 kPa	23.6 °C	57.1 %RH

Date of calibration: 24/07/2008
Date of issue: 24/07/2008
Supervisor: Ian Campbell MSC MIOA
Engineer

David Egan

Campbell Associates
www.campbell-associates.co.uk

Calibration Report

Certificate No.:4115

Manufacturer:	Norsonic
Type :	1225
Serial no:	69918

Customer:	Mouchel Ltd
Place:	St. Johns House, Queen Street
City:	Manchester. M2 5JB
Contact Person:	Mark Harrison

Measurement Results:

	Sensitivity : (dB re 1V/Pa)	Capacitance : (pF)
1:	-25.61	19.9
2:	-25.60	19.9
3:	-25.61	19.9
Result (Average):	**-25.61**	**19.9**
Expanded Uncertainty:	0.10	2.00
Degree of Freedom:	>100	>100
Coverage Factor:	2.00	2.00

The following correction factors have been applied during the measurement:
Pressure :-0.010 dB/kPa Temperature :-0.007 dB/°C Relative humidity :0.000 dB/%RH

Reference Calibrator: WSC3 - Nor1253-27765 (1k Hz). Volume correction: 0.000 dB

Records :K:\C A\Calibration\Nor-1504\Nor-1017 MicCal\2008\NOR1225_69918_M1.nmf

The reported expanded uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k = 2, which for a normal distribution corresponds to coverage probability of approximately 95%. The standard uncertainty of measurement has been determined in accordance with EA publication EA-4/02.

Comment:

Environmental conditions:

Pressure :	Temperature :	Relative humidity :
101.538 ± 0.003 kPa	21.8 ± 1.9 °C	53.2 ± 5.0 %RH

Date of calibration:21/07/2008
Date of issue:21/07/2008

Supervisor : Ian Campbell MSc MIOA
Engineer :

Michael Tickner

Campbell Associates
www.campbell-associates.co.uk

7 References

[1] British Standard (1990). BS 4142: *Method for rating industrial noise affecting mixed residential and industrial areas*. British Standards Institution

[2] British Standard (1997). BS 5228: *Noise and vibration control on construction and open sites: Parts 1-3.* British Standards Institution

[3] International Organisation for Standards (1996). ISO 9613: *Acoustics – Attenuation of sound during propagation outdoors: Part 1 – General method of calculation*. International Organisation for Standards.

[4] Department of Environment (1976); *Advisory Leaflet 72 'Noise Control on Building Sites'.*

[5] British Standard Institute (1990). BS 7385: *Evaluation and measurement for vibration in buildings. Part 1- Guide for measurement of vibrations and evaluation of their effects on buildings.* British Standards Institution.

[6] British Standard Institute (1992). BS 6472: *Evaluation of Human Exposure to Vibration in Buildings'* (1Hz to 80Hz). British Standards Institution.

[7] International Standards Organisation (1996). ISO 9613: Ac*oustic – Attenuation of sound during propagation outdoors. Part 2 – General Method of Calculation.*

[8] Euroclad. *Euroseam Technical Manual: B5 Acoustic Systems – Standard Twin Skin Liner Acoustics Absorption System.*

[9] British Standards (1991). *BS 7445: Description and Measurement of Environmental Noise: Parts 1-3*. British Standards Institution.

[10] Department of Transport (1988). *Calculation of Road Traffic Noise (CRTN*) *Memorandum*. Welsh Office; HMSO.