Appendix 7

APPENDIX 7-1
NOISE TECHNICAL TERMS

Sound is produced by mechanical vibration of a surface, which sets up rapid pressure fluctuations in the surrounding air.

Between the quietest audible sound and the loudest tolerable sound there is a million to one ratio in sound pressure level. It is because of this wide range that a noise level scale based on logarithms is used in noise measurement. This is the decibel or dB scale.

Audibility of sound covers a range of about 0 to 140 decibels (dB) corresponding to the intensity of the sound pressure level. The ability to recognise a particular sound is dependent on the pitch or frequencies present in the source. Sound pressure measurements taken with a microphone cannot differentiate in the same way as the ear, consequently a correction is applied by the noise measuring instrument in order to correspond more closely to the frequency response of the ear which responds to sounds from 20 Hz to 20000 Hz. This is known as 'A weighting' and written as dB(A).

The use of this unit is internationally accepted and correlates well with subjective annoyance to noise.

The logarithmic basis of noise measurements means that when considering more than one noise source their addition must be undertaken in terms of logarithmic arithmetic. Thus, two noise sources each of 40 dB(A) acting together would not give rise to 40 + 40 = 80 dB(A) but rather 40 + 40 = 43 dB(A). This 3 dB(A) increase represents a doubling in sound energy but would be only just perceptible to a human ear.

The attached chart gives typical noise levels in terms of dB(A) for common situations.

Noise levels can vary with time according to source activity and indices have been developed in order to be able to assign a value to represent a period of noise level variations and to correspond with subjective response.

The definition in layman's terms is given below for terminology used in the measurement and results obtained during the survey work.

A-weighting: Normal hearing covers the frequency (pitch) range from about 20Hz to 20,000 Hz but sensitivity of the ear is greatest between about 500Hz and 5000Hz. The "A-weighting" is an electrical circuit built into noise meters to mimic this characteristic of the human ear.

Ambient noise: The totally encompassing sound in a given situation at a given time usually composed of sound from many sources near and far.

Attenuation: Noise reduction

Background noise: The general quiet periods of ambient noise when the noise source under investigation is not there.

Decibel (dB): The unit of measurement for sound based on a logarithmic scale. 0dB is the threshold of normal hearing; 140dB is the threshold of pain. A change of 1dB is only detectable under controlled laboratory conditions.

dB(A) [decibel A weighted]: Decibels measured on a sound level meter incorporating a frequency weighting (A weighting) serves to distinguish sounds of different frequency (or pitch) in a similar way to how the human ear responds. Measurements in dB(A) broadly agrees with an individual's assessment of loudness. A change of 3dB(A) is the minimum perceptible under normal everyday conditions, and a change of 10dB(A) corresponds roughly to doubling or halving the loudness of sound.

dB(C): [decibel C weighted]: Frequency weighting which does not alter low frequency octave band levels by very much compared to `A' weighting. Similar to linear reading (i.e. linear does not alter frequency spectra at all)

Frequency (Hz): The number of sound waves to pass a point in one second.

L_{Aeq}: This is a noise index used to describe the "average" level of a noise that varies with time (T). It allows for the different sensitivities of the human ear to different frequencies (pitch), and averages fluctuating noise levels in a manner, which correlates well with human perceptions of loudness.

$L_{A10,T}$: This noise index gives an indication of the upper limit or peak levels of the fluctuating noise. It is the "A weighted" noise level exceeded for 10 per cent of the specified measurement period (T). e.g. If the measurement period was over 10 hours and the L_{A10} reading was say 60dB, then this means that for 1 hour out of 10 the level went above 60dB.

$L_{A90,T}$: This noise index gives an indication of the lower limit or levels of the fluctuating noise. It is the "A weighted" noise level exceeded for 90 per cent of the specified measurement period (T). e.g. If the measurement period was over 10 hours and the L_{A90} reading was say 50dB, then this means that for 9 hours out of 10 the level went above 50dB.

L_{Amax}: This is the highest A weighted noise level recorded during a noise measurement period.

$L_{night,outside}$: This is the A-weighted long-term average sound level measured outside as defined in ISO 1996-2: 1987, determined over all the night periods of a year.

Residual noise: The ambient noise remaining at a given position in a given situation when the noise source under investigation is not there.

Specific noise: The noise source under investigation for assessing the likelihood of complaints

Examples of typical noise levels

Source/Activity	**Indicative noise level [dB(A)]**
Threshold of hearing	0
Rural night-time background	20-40
Quiet bedroom	35
Wind farm at 350m	35-45
Busy road at 5km	35-45
Car at 65km/h at 100m	55
Busy general office	60
Conversation	60
Truck at 50km/h at 100m	65
City Traffic at 5m	75-85
Pneumatic drill at 7m	95
Jet aircraft at 250m	105
Threshold of pain	140

APPENDIX 7-2

NOISE INSTRUMENTATION & SURVEY DETAILS

Instrumentation

Manufacturer	***Description***	***Type***	***Calibration Due date***	***Serial No.***
Cirrus	Real time Analyser	CR:1710	May 2021	G066350
Cirrus	Integrating Sound Level Meter	171A	January 2021	G061253
Cirrus	Real time analyser	171B	January 2021	G056142
Cirrus	Electronic Calibrator	CR: 513A	August 2020	031523

The noise meters used during the survey are precision grade type 1 meters to IEC 651 standard and accuracy.

Calibration Setting: 94dB

Meter Setting: Fast Response

Fieldwork Details:

Date of tests: Wednesday 3rd June 2020

Monitoring Period: 15 minutes

Calibration: Before and after: 94dB

Noise meters were mounted in a weatherproof box with extension lead to microphone mounted on a tripod fixed to a height of approximately 1.5m above ground level and fitted with a wind shield.

Instruments were calibrated before and after monitoring to calibration level of 94dB. No drift in calibration was recorded.

Meteorological Conditions

Wednesday 3rd June 2020

Weather conditions were dry, sunny periods, light west to northwest winds (1-2m/s) and temperature ranging between 14deg to 17degC.

APPENDIX 7-3

BACKGROUND SOUND SURVEY RESULTS

Noise Survey Results

Date: Wednesday 3rd June 2020

Location: Connon Bridge RTS Facility, Liskeard, Cornwall **TABLE 1**

Client: Suez Recycling and Recovery UK Ltd

Project: Food Waste Handling Facility

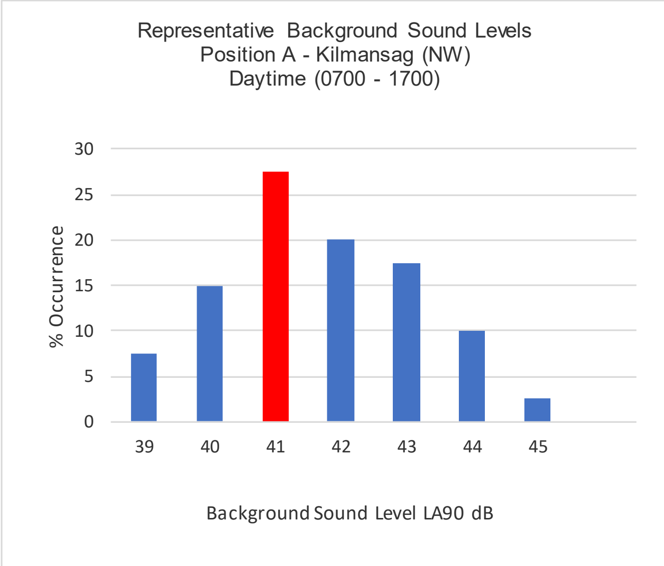
Data: **Baseline Sound Survey: Position A - Kilmansag (northwest)**

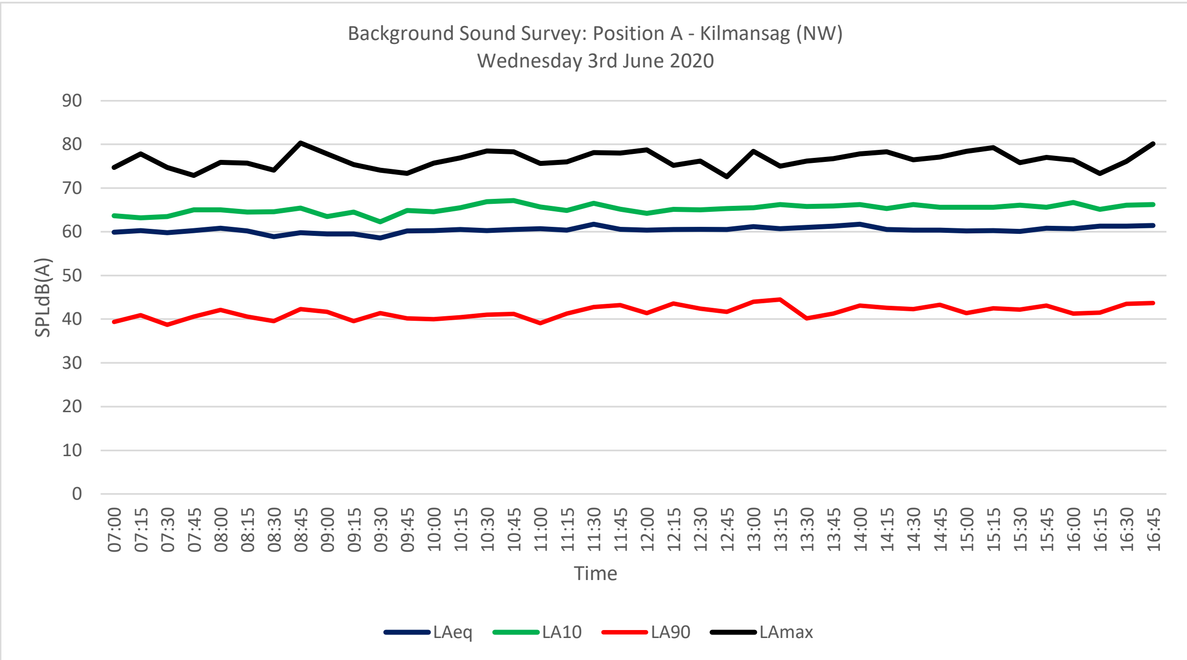
Instrumentation: Cirrus 171B Real Time Analyser (G056142)

Calibration: 94dB

Start Time	Run Time (mins.)	LAeq (dB)	LA10 (dB)	LA90 (dB)	LAmax (dB)	Observations
07:00	15:00	59.9	63.7	39.4	74.7	
07:15	15:00	60.3	63.2	40.9	77.8	
07:30	15:00	59.8	63.5	38.7	74.7	
07:45	15:00	60.3	65.0	40.6	72.9	
08:00	15:00	60.8	65.0	42.1	75.9	
08:15	15:00	60.2	64.5	40.6	75.7	
08:30	15:00	58.9	64.6	39.6	74.1	
08:45	15:00	59.8	65.4	42.3	80.3	
09:00	15:00	59.5	63.5	41.7	77.8	
09:15	15:00	59.5	64.5	39.6	75.4	
09:30	15:00	58.6	62.3	41.4	74.1	
09:45	15:00	60.2	64.9	40.2	73.4	
10:00	15:00	60.3	64.6	40.0	75.7	
10:15	15:00	60.5	65.5	40.4	76.9	
10:30	15:00	60.3	66.9	41.0	78.5	
10:45	15:00	60.5	67.1	41.2	78.3	
11:00	15:00	60.7	65.7	39.1	75.6	
11:15	15:00	60.4	64.9	41.3	76.0	
11:30	15:00	61.7	66.5	42.8	78.1	
11:45	15:00	60.6	65.2	43.2	78.0	
12:00	15:00	60.4	64.2	41.4	78.7	Lunchtime break
12:15	15:00	60.5	65.1	43.6	75.2	Lunchtime break
12:30	15:00	60.6	65.0	42.4	76.2	
12:45	15:00	60.5	65.3	41.7	72.6	
13:00	15:00	61.2	65.5	44.0	78.4	
13:15	15:00	60.7	66.2	44.5	75.0	
13:30	15:00	61.0	65.8	40.2	76.2	
13:45	15:00	61.3	65.9	41.3	76.7	
14:00	15:00	61.7	66.2	43.1	77.8	
14:15	15:00	60.5	65.3	42.6	78.3	
14:30	15:00	60.4	66.2	42.3	76.5	
14:45	15:00	60.4	65.6	43.3	77.1	
15:00	15:00	60.2	65.6	41.4	78.4	
15:15	15:00	60.3	65.6	42.5	79.3	
15:30	15:00	60.1	66.1	42.2	75.8	
15:45	15:00	60.8	65.6	43.1	77.0	
16:00	15:00	60.7	66.7	41.3	76.4	
16:15	15:00	61.3	65.1	41.5	73.3	
16:30	15:00	61.3	66.1	43.5	76.1	
16:45	15:00	61.4	66.2	43.7	80.1	
Log Average 0700-1700		60.4	65.3	41.8	73-80	
Average 0700-1700		60.5	65.2	41.6	73-80	

LA90	% Occurrence
39	7.5
40	15
41	**27.5**
42	20
43	17.5
44	10
45	2.5





Noise Survey Results

Date: Wednesday 3rd June 2020

Location: Connon Bridge RTS Facility, Liskeard, Cornwall **TABLE 2**

Client: Suez Recycling and Recovery UK Ltd

Project: Food Waste Handling Facility

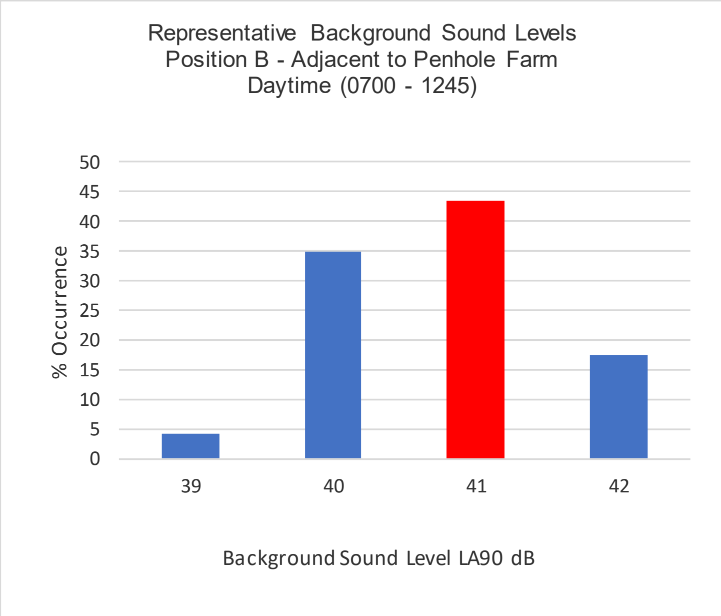
Data: **Baseline Sound Survey: Position B - Penhole Farm (southeast)**

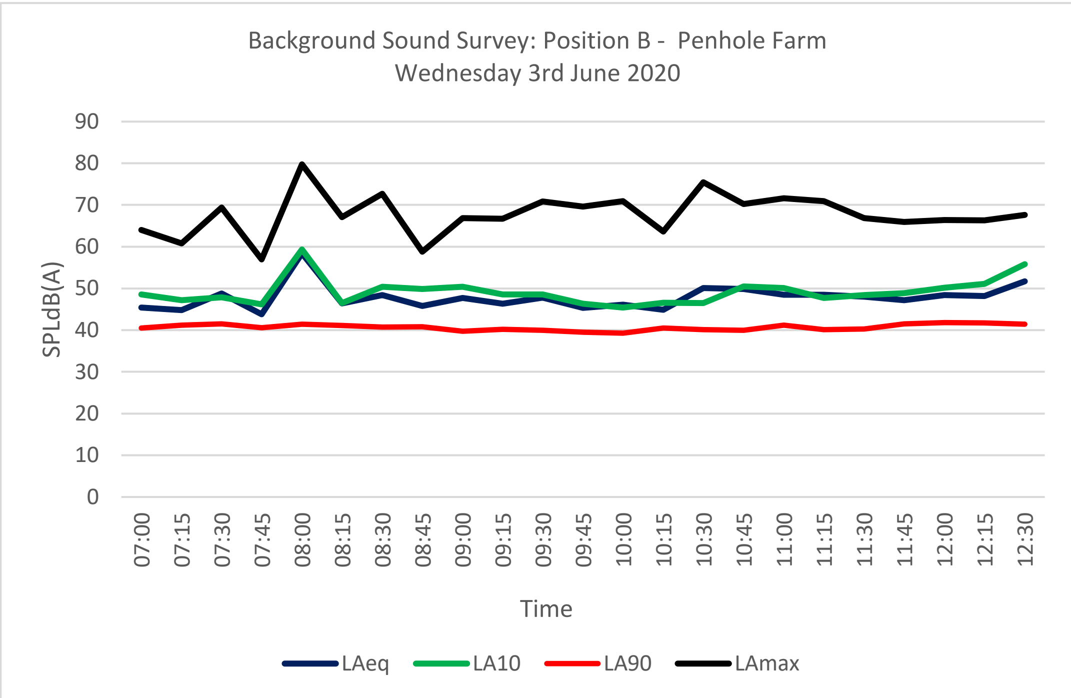
Instrumentation: Cirrus 171A Real Time Analyser (G061253)

Calibration: 94dB

Start Time	Run Time (mins.)	LAeq (dB)	LA10 (dB)	LA90 (dB)	LAmax (dB)	Observations
07:00	15:00	45.4	48.6	40.5	64.0	
07:15	15:00	44.8	47.2	41.2	60.8	
07:30	15:00	48.8	47.9	41.5	69.4	
07:45	15:00	43.8	46.2	40.6	56.9	
08:00	15:00	58.4	59.3	41.4	79.7	
08:15	15:00	46.4	46.5	41.1	67.1	
08:30	15:00	48.4	50.4	40.7	72.7	
08:45	15:00	45.8	49.9	40.8	58.8	
09:00	15:00	47.7	50.4	39.7	66.8	
09:15	15:00	46.3	48.6	40.2	66.7	
09:30	15:00	47.8	48.6	40.0	70.8	
09:45	15:00	45.3	46.3	39.5	69.6	
10:00	15:00	46.1	45.4	39.3	70.9	
10:15	15:00	44.9	46.6	40.5	63.6	
10:30	15:00	50.1	46.5	40.1	75.4	
10:45	15:00	49.9	50.5	40.0	70.2	
11:00	15:00	48.5	50.1	41.2	71.6	
11:15	15:00	48.5	47.7	40.1	70.9	
11:30	15:00	48.0	48.4	40.3	66.8	
11:45	15:00	47.2	48.9	41.5	65.9	
12:00	15:00	48.4	50.2	41.8	66.4	Lunchtime break
12:15	15:00	48.2	51.1	41.7	66.3	Lunchtime break
12:30	15:00	51.7	55.8	41.4	67.6	
Log Average 0700-1245		49.4	50.8	40.7	57-80	
Average 0700-1245		47.8	49.2	40.7	57-80	

LA90	% Occurrence
39	4.3
40	34.8
41	43.5
42	17.4





Noise Survey Results

Date: Wednesday 3rd June 2020

Location: Connon Bridge RTS Facility, Liskeard, Cornwall **TABLE 3**

Client: Suez Recycling and Recovery UK Ltd

Project: Food Waste Handling Facility

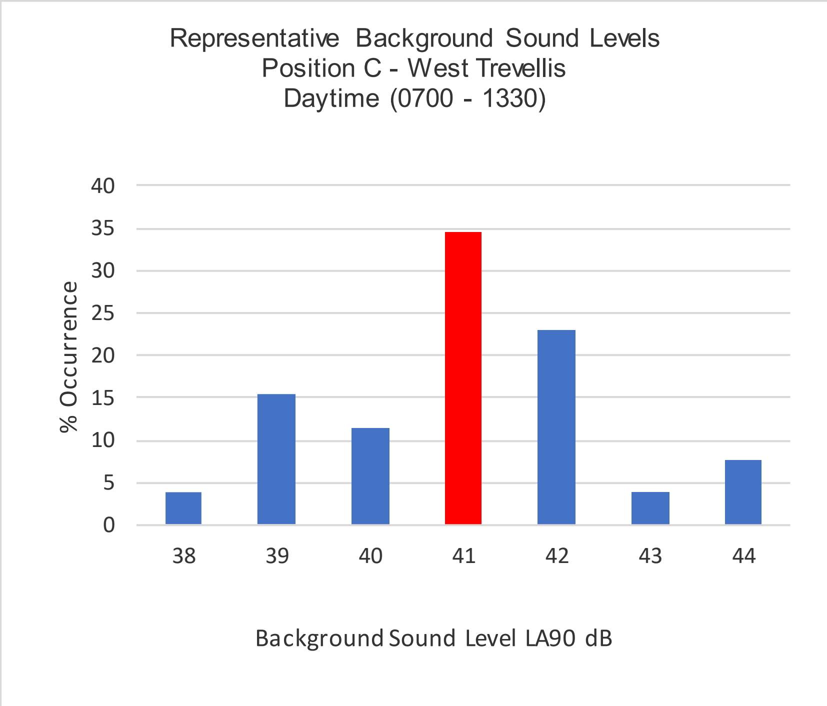
Data: **Baseline Sound Survey: Position C - West Trevellis (southeast)**

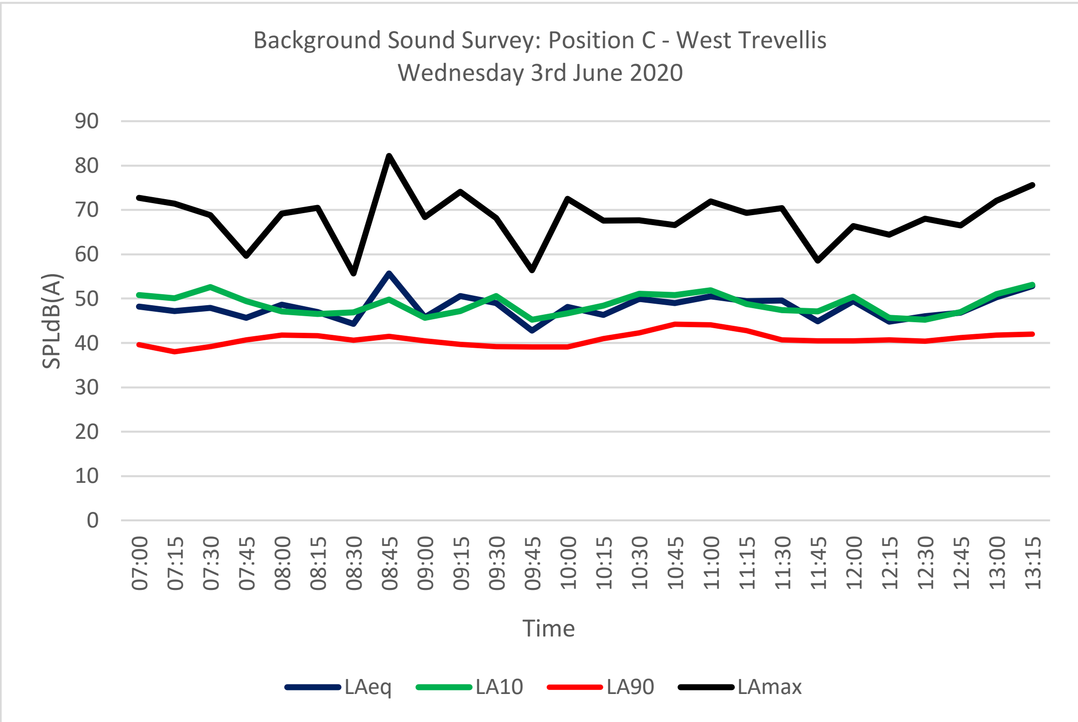
Instrumentation: Cirrus 1710 Real Time Analyser (G066350)

Calibration: 94dB

Start Time	Run Time (mins.)	LAeq (dB)	LA10 (dB)	LA90 (dB)	LAmax (dB)	Observations
07:00	15:00	48.2	50.8	39.6	72.7	
07:15	15:00	47.2	50.1	38.0	71.4	
07:30	15:00	47.9	52.6	39.2	68.8	
07:45	15:00	45.7	49.4	40.7	59.7	
08:00	15:00	48.6	47.1	41.8	69.2	
08:15	15:00	47.0	46.5	41.6	70.5	
08:30	15:00	44.3	46.9	40.6	55.7	
08:45	15:00	55.7	49.8	41.5	82.2	
09:00	15:00	45.8	45.7	40.5	68.4	
09:15	15:00	50.6	47.2	39.7	74.1	
09:30	15:00	49.0	50.6	39.2	68.2	
09:45	15:00	42.8	45.2	39.1	56.4	
10:00	15:00	48.1	46.7	39.1	72.5	
10:15	15:00	46.3	48.4	41.0	67.6	
10:30	15:00	49.9	51.1	42.3	67.7	
10:45	15:00	49.0	50.8	44.2	66.6	
11:00	15:00	50.5	51.9	44.1	71.9	
11:15	15:00	49.4	48.8	42.8	69.3	
11:30	15:00	49.6	47.4	40.7	70.4	
11:45	15:00	44.9	47.1	40.5	58.6	
12:00	15:00	49.4	50.4	40.5	66.4	Lunchtime break
12:15	15:00	44.8	45.7	40.7	64.4	Lunchtime break
12:30	15:00	46.0	45.2	40.4	68.0	
12:45	15:00	46.8	47.0	41.2	66.5	
13:00	15:00	50.3	51.0	41.8	72.1	
13:15	15:00	52.8	53.1	42.0	75.6	
Log Average 0700-1330		49.0	49.3	41.1	56-82	
Average 0700-1330		48.1	48.7	40.9	56-82	

LA90	% Occurrence
38	3.8
39	15.4
40	11.5
41	**34.5**
42	23.1
43	3.8
44	7.7





APPENDIX 7-4

Construction Plant Inventory

Soil Movements:

Plant Type	Sound Power Level	% Operating Time	Distance Ratio
Dozer	106	80	1.0
Excavator/Loader	103	80	1.0
Dump Truck	107	80	1.0
8 Wheel Tipper	107	80	1.0
Lorry	98	10	1.0

Piling:

Plant Type	Sound Power Level	% Operating Time	Distance Ratio
Piling Rig (percussive)	116	100	1.0
Truck Mixer	107	100	1.0
Concrete Pump	110	100	1.0
Poker Vibrator	106	100	1.0
Lorry	103	20	1.0

General Site Noisy Activities:

Plant Type	Sound Power Level	% Operating Time	Distance Ratio
Excavator	104	100	1.0
HGV	103	20	1.0
Dumper	104	100	1.0
Telehandler	105	100	1.0
Compressor	95	100	n/a
Generator	103	100	n/a
Mobile Crane	97	100	1.0

Infrastructure Construction:

Plant Type	Sound Power Level	% Operating Time	Distance Ratio
Asphalt Melter	103	100	1.0
Asphalt Spreader	96	100	1.0
Road Roller	102	100	1.0
Lorry	103	100	1.0
Poker Vibrator	106	100	n/a
Concrete pump	103	100	n/a
Compressor	95	100	n/a

Building Construction:

Plant Type	Sound Power Level	% Operating Time	Distance Ratio
Excavator	106	100	1.0
Steelwork Erection	108	100	1.0
Concrete Pump	103	100	1.0
Concrete Vibrators	106	100	1.0
HGV	103	50	1.0
Cutting/Grinding	107	100	n/a
Hydraulic Pump	106	100	n/a

APPENDIX 7-5

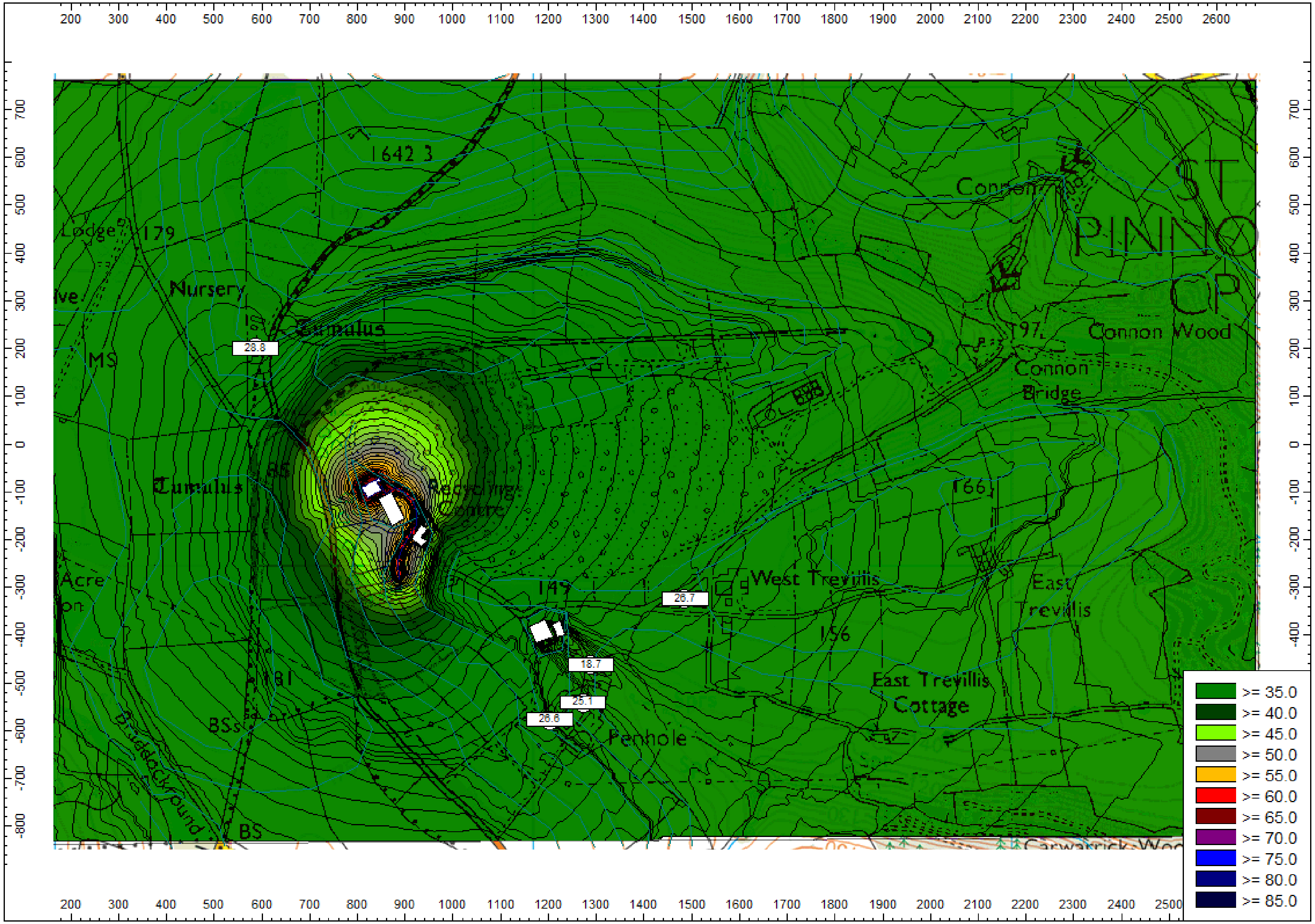
Assumed Noise Levels for Site Plant & Cladding Performance

Plant Type or Area	Treatment (Cladding Performance Rw) dB	Sound Power (SWL) Reverberant Sound Pressure Level (SPL) at roof/walls	Assumed % Operating Time	Period of Operation
Waste Food Building walls & roof	Cladding to Rw 24dB	80-82 (SPL)	100	Daytime
Mobile Plant	Fitted with non-tonal reversing alarms	76-80 (SPL)	Variable	Daytime
RDF Shredder (inside)	Inside Building	80-82 (SPL)	100	Daytime
HGV (waste food related)	-	103 (SWL)	18 movements per hour	Daytime
Ventilation louvres (as applicable)	15dB SRI reduction acoustic louvres	-	100	Daytime
Doors	Doors Insulated Roller Type Rw 18dB	-	100	Daytime

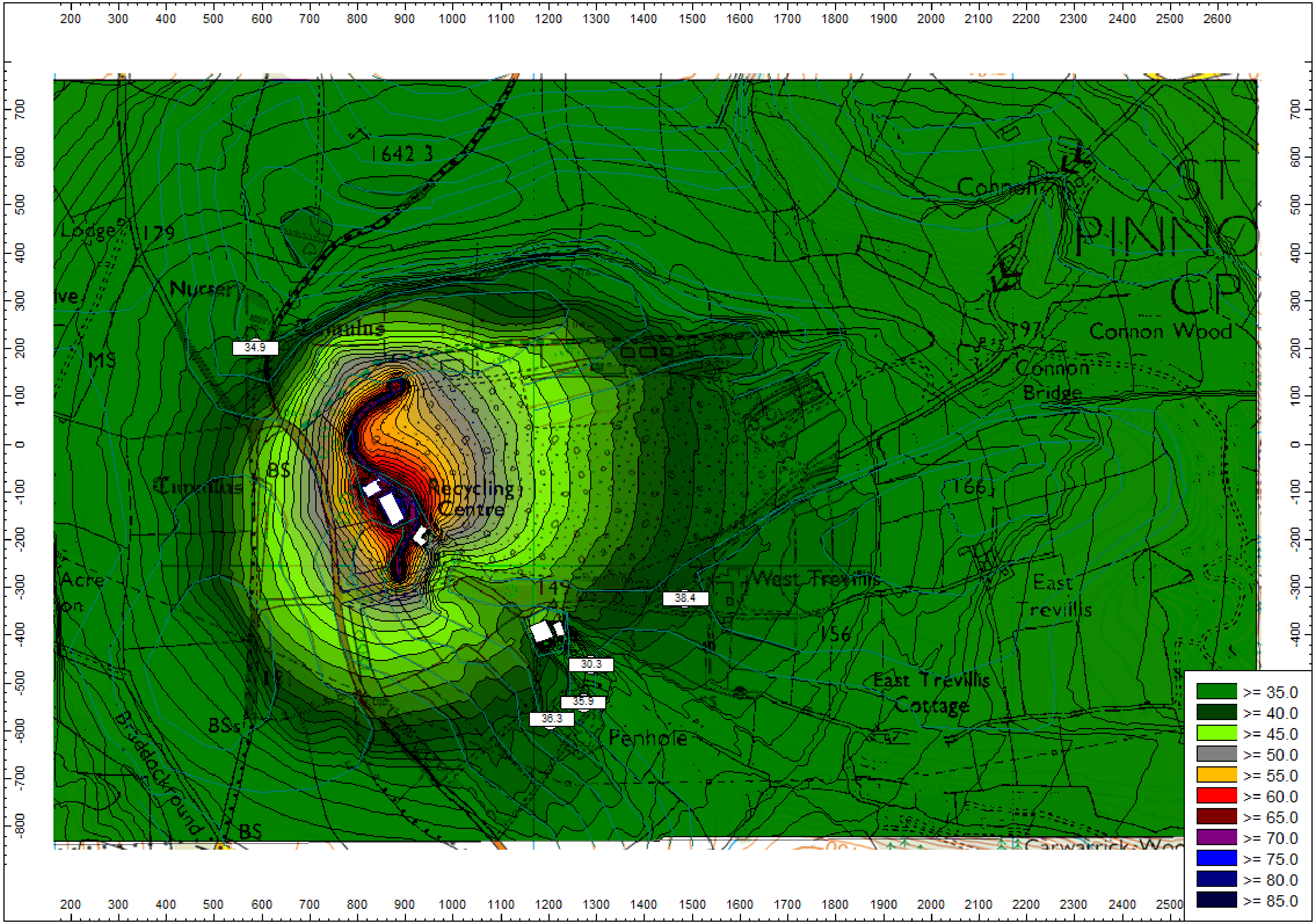
APPENDIX 7-6

NOISE MAPPING

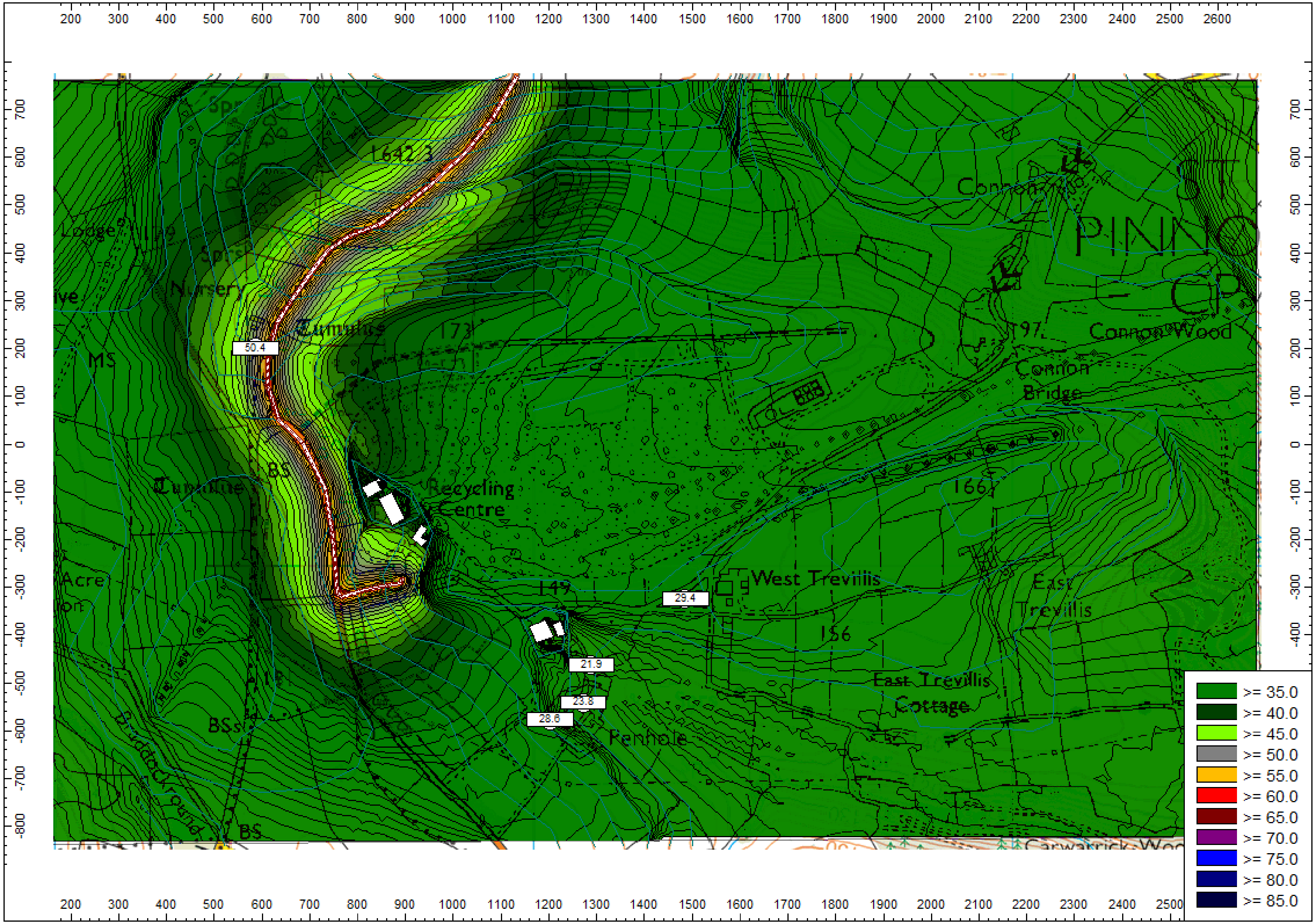
NOISE MAP 1: NOISE CONTOURS OF SITE OPERATIONS (FOOD WASTE)



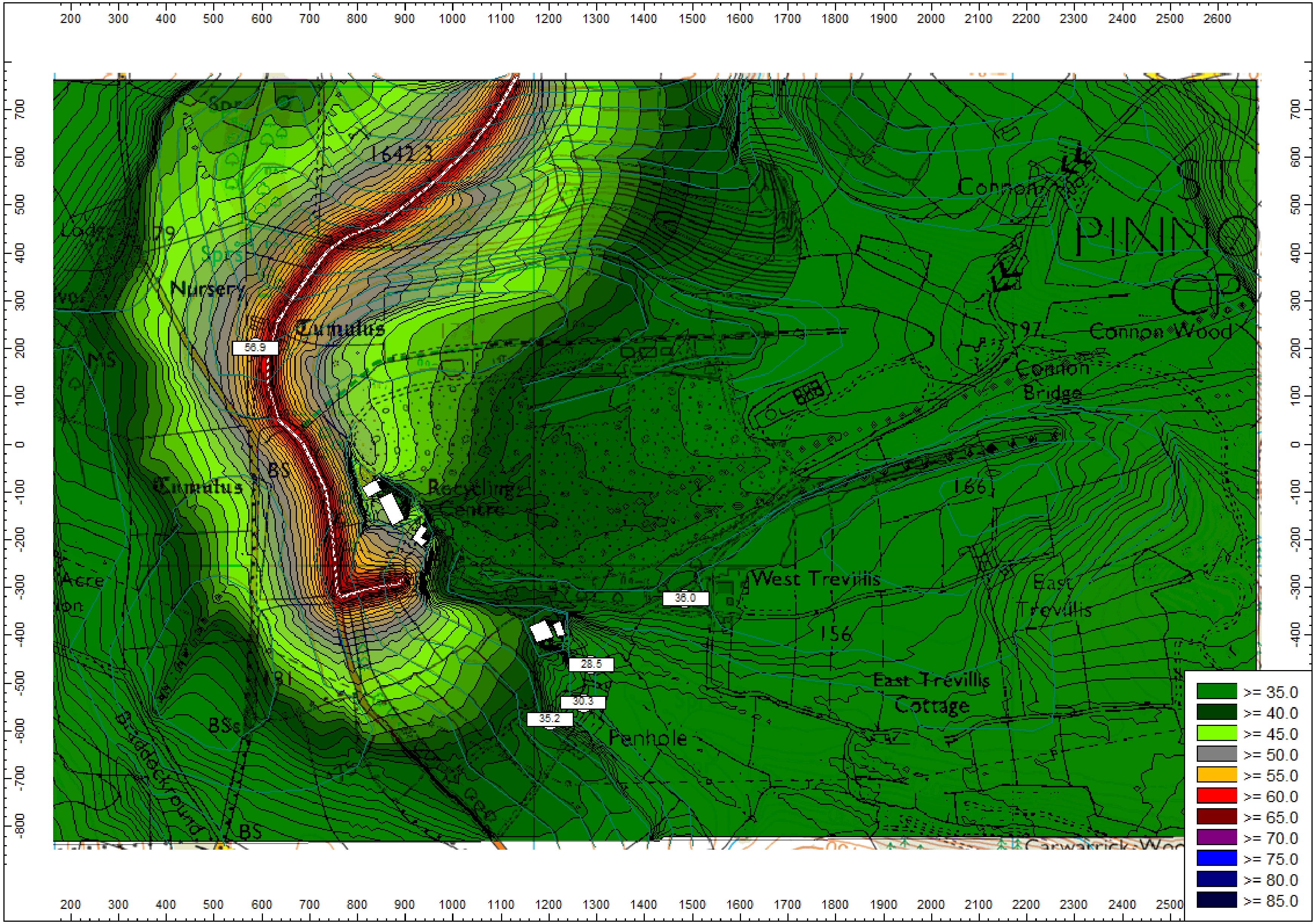
NOISE MAP 2: NOISE CONTOURS OF SITE OPERATIONS WITH RTS FACILITY



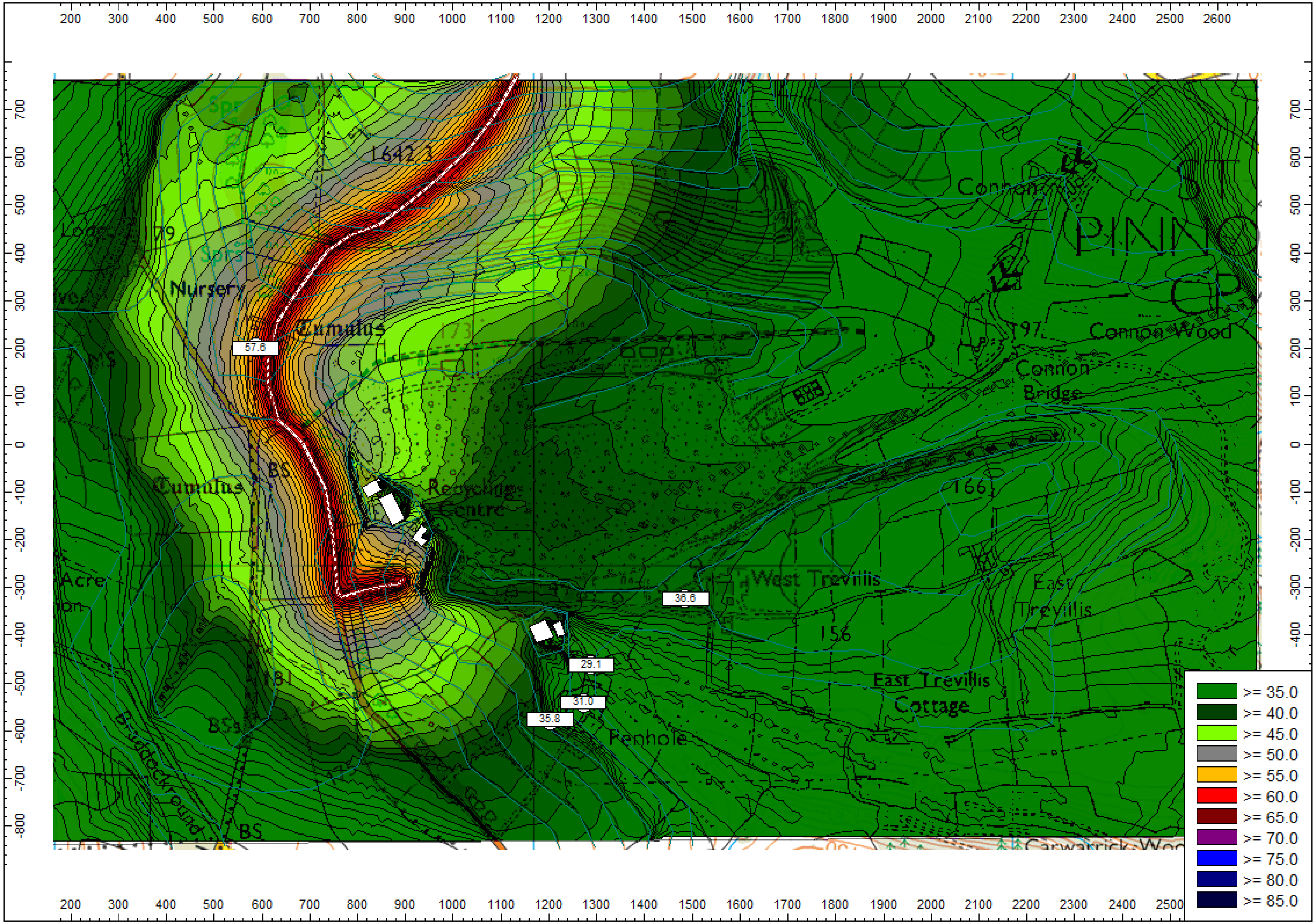
NOISE MAP 3: NOISE CONTOURS OF WASTE FOOD FACILITY HGVs OFF SITE – AVERAGE FLOW



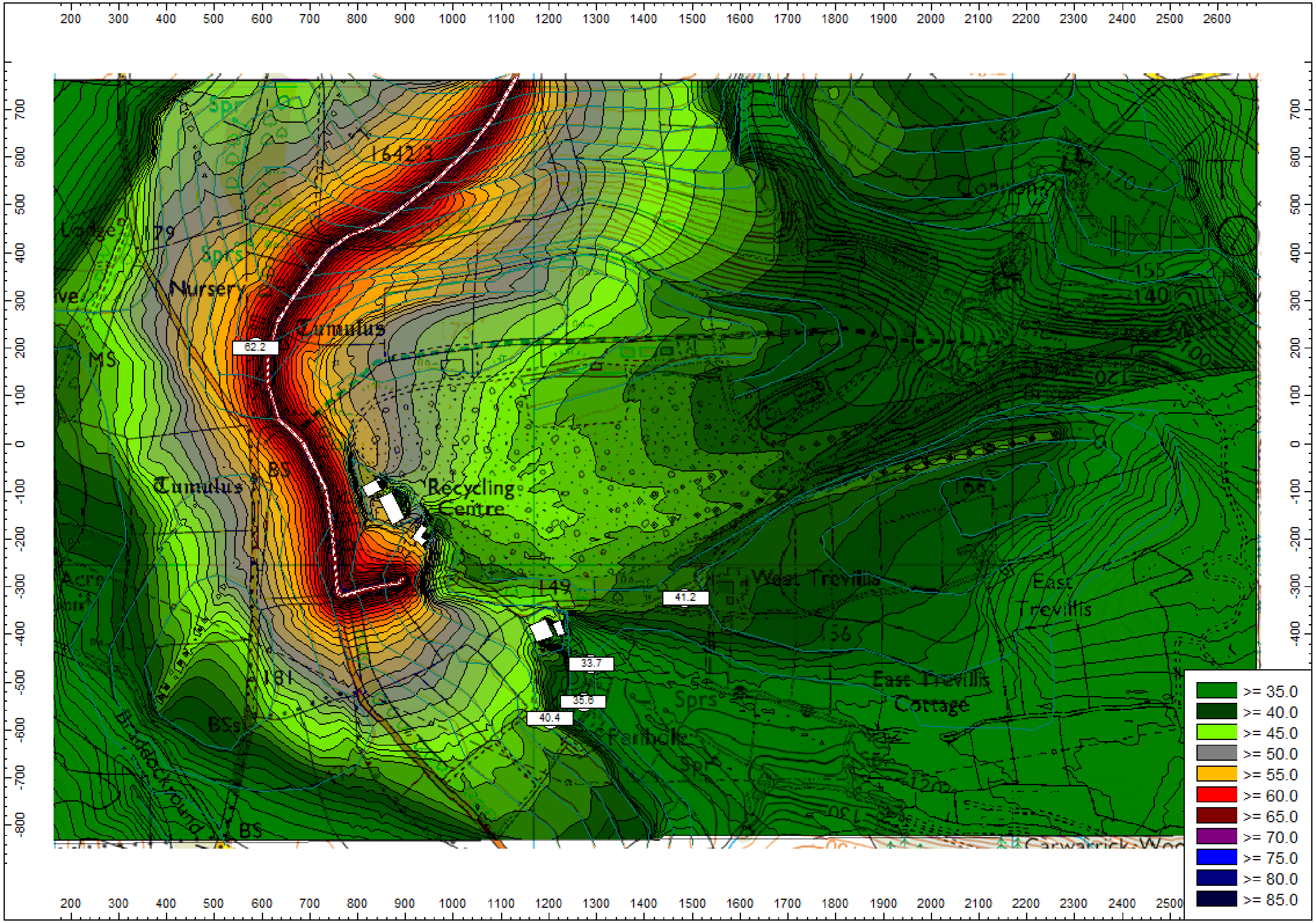
NOISE MAP 4: NOISE CONTOURS OF WASTE FOOD FACILITY HGVs OFF SITE – PEAK HOUR FLOW



NOISE MAP 5: NOISE CONTOURS OF WASTE FOOD & RTS FACILITY HGVs OFF SITE – AVERAGE FLOW



NOISE MAP 6: NOISE CONTOURS OF WASTE FOOD & RTS FACILITY HGVs OFF SITE – PEAK HOUR FLOW



APPENDIX 7-7

VIBRATION TECHNICAL TERMS

Ground Borne Vibrations

For any source of vibration on or near the surface of the ground, energy propagates away from the source via:

a) Elastic body (or compression) waves – which radiate energy into the ground in all directions

b) Surface (or shear) waves – which carry energy along the ground surface, caused when body waves are reflected back into the ground at the ground-surface interface

Thus, at any point away from that source, the ground motion is the sum of all the wave motions at that point. When wave motion has been generated, the waves will be attenuated as they travel away from the source. The two main mechanisms for attenuation are:

a) Enlargement of the wavefront as the distance from the source increases, and

b) Internal damping of the transmitting medium (the ground)

Ground borne vibration is therefore made up of a combination of different waves, travelling in different directions, at different speeds and at different frequencies. The frequency component of the vibration will affect the rate at which attenuation occurs since the internal damping of the ground is frequency dependent.

Since vibration enters buildings through the foundations, the hard structure of the building is normally affected to a greater degree than by air borne vibration. Often ground borne vibrations are more noticeable when standing or sitting near the middle of suspended wooden floors.

Ground Borne Vibration Measurement Units

Ground borne vibration is caused when the individual particles making up the strata are caused to oscillate by the passage of a pressure wave. The resulting vibration can be summarized in terms of 4 main parameters:

a) **Velocity** – how fast the particles move when they are oscillating. Since the velocity of these particles continually change as the pressure wave passes the most useful value that is often reported is the maximum or peak particle velocity (PPV). PPVs are usually expressed in terms of ms^{-1} or mms^{-1}.

b) **Acceleration** – is the rate at which the particle velocity changes during oscillation. It is usually measured in ms^{-2} mms^{-2} or “g’s”. 1g is that acceleration imparted to an object by the earth’s gravitational pull and is approximately 9.81 ms^{-2}.

c) **Displacement** – is the distance moved by oscillating particles. This is usually very small and measured in mm or even µm.

d) **Frequency** – is the number of oscillations per second which a particle undergoes due to the passage of a vibration wave. It is measured in cycles per second or Hertz (Hz).

The movement of particles induced to oscillate by vibration waves are usually measured in three mutually perpendicular directions to fully describe the vibration intensity, as particles will be oscillating in three dimensions. These are:

a) **Longitudinal** – back and forth particle movement in the same direction that the vibration wave is travelling.

b) **Vertical** – up and down movement perpendicular to the direction the vibration wave is travelling.

c) **Transverse** – left and right particle movement perpendicular to the direction the vibration wave is travelling.

APPENDIX 7-8

EXAMPLE OF RESULTS FROM VIBRATION MONITORING & REFERENCES

Waste Management Facility

HGV Vibration Measurements

Measurements of ground borne vibration were undertaken at site at positions close to the nearest residential property (i.e. rear garden boundary of nearest receptor). The methodology described below was employed during the vibration survey.

Measurement Technique

Vibration measurements were made, in the three mutually perpendicular axes, during the monitoring period. The Nomis seismograph was set to the `continuous' and `trigger' mode settings (trigger level of 0.3 mm/sec) and was placed at a distance of approximately 2 metres from the garden boundary (circa 10m from kerbside). Some additional measurements were taken at a distance of 2 metres from the kerbside of the access road for additional information.

The seismograph has monitored the ground borne vibration in terms of Peak Particle Velocity (PPV).

Results of Survey

During the vibration survey, the seismograph transducer triggered during HGV movements when certain vehicles were travelling over the speed `hump'. The maximum levels of vibration recorded ranged between 0.45mm/s to 0.83mm/s at the rear garden boundary position. Readings taken at closer distance (i.e. within 2 metres of the kerbside) showed the maximum vibration to be between 0.51mm/s and 1mm/s. Results provided below:

Table of Vibration Results:

Position	Vibration Magnitude (mm/sec)			Peak Frequency (Hz)	Activity
	Horizontal x	Tranverse y	Vertical z		
Adjacent to nearest dwelling (in car park)	0.445	0.191	0.318	512	HGV waste into site
" " "	0.318	0.191	0.445	11.6	HGV into site
" " "	0.254	0.254	0.381	14.2	HGV out of site
" " "	0.318	0.191	0.381	15.5	HGV out
" " "	0.826	0.191	0.381	512	1 x HGV in, 2 x HGVs out
" " "	0.381	0.191	0.381	11.3/256	HGV in
" " "	0.318	0.254	0.318	2.8/12.4	HGV out
" " "	0.318	0.191	0.445	14.6	HGV in
" " "	0.254	0.254	0.318	15.5	HGV out
" " "	0.699	0.445	0.318	512	3 x HGVs in, 1 x HGV out
" " "	0.318	0.191	0.318	2.9/13.4	HGV in
" " "	0.445	0.191	0.254	512	HGV in
" " "	0.318	0.191	0.318	11.9/128	HGV out
" " "	0.254	0.191	0.508	14.6	HGV & skip wagon in
" " "	0.254	0.191	0.445	11.6	HGV waste out
" " "	0.318	0.191	0.572	-	Continuous mode (48 HGV movements over 1hour)
Within 5m of kerbside	0.508	0.254	1.016	10.6	2 x HGVs into site
" " "	0.318	0.127	0.318	13.1	HGV in
" " "	0.318	0.127	0.381	12.8	HGV out
" " "	0.381	0.191	0.572	10.8	HGV in

Monitoring of HGVs and other vehicles at kerbside

The seismograph only triggered when some of the vehicles passed the monitoring positions. The following tables detail the results of the ground vibration survey.

Position 1:

Date: 23rd September 2010

Scawby Road Ground Vibration

Measurements - The Maltings

Time:	Location:	Position:	Vibration level X (m/s2)	Y (m/s2)	Z (m/s2)
08:26	Scawby Road (corner) (2m from kerbside)	Cars near & farside	0.191	0.127	0.318
08:26	Scawby Road (corner) (2m from kerbside)	HGV far side	0.191	0.127	0.254
08:38	Scawby Road (corner) (2m from kerbside)	Cars near & farside	0.191	1.27	0.254
08:39	Scawby Road (corner) (2m from kerbside)	Car far side Car	0.191	1.27	0.254
08:39	Scawby Road (corner) (2m from kerbside)	near side	0.254	0.127	0.254
08:43	Scawby Road (corner) (2m from kerbside)	Tractor far side	0.318	0.127	0.254
08:44	Scawby Road (corner) (2m from kerbside)	Car near side	0.191	0.127	0.254
08:45	Scawby Road (corner) (2m from kerbside)	HGV near side	0.318	0.254	0.508
08:46	Scawby Road (corner) (2m from kerbside)	Car near side	0.254	0.191	0.254
08:56	Scawby Road (corner) (2m from kerbside)	Straw Trailer (empty) near side	0.381	0.318	0.381
08:57	Scawby Road (corner) (2m from kerbside)	Car near side	0.254	0.127	0.318
08:57	Scawby Road (corner) (2m from kerbside)	HGV near side	0.381	0.254	0.445
08:58	Scawby Road (corner) (2m from kerbside)	HGV Double Trailer nearside	0.254	0.191	0.445
08:59	Scawby Road (corner) (2m from kerbside)	HGV far side	0.191	0.127	0.254
08:59	Scawby Road (corner) (2m from kerbside)	Car near side	0.254	0.127	0.254
09:00	Scawby Road (corner) (2m from kerbside)	HGV Double Trailer far side	0.254	0.127	0.254
09:01	Scawby Road (corner) (2m from kerbside)	HGV far side	0.445	0.191	0.381
09:03	Scawby Road (corner) (2m from kerbside)	Articulated HGV Far side	0.254	0.127	0.254
09:08	Scawby Road (corner) (2m from kerbside)	Straw Trailer (empty) far side	0.254	0.127	0.254
09:09	Scawby Road (corner) (2m from kerbside)	HGV (Brian Plant) far side	0.191	0.127	0.254
09:11	Scawby Road (corner) (2m from kerbside)	HGV (Brian Plant) near side	0.254	0.127	0.318
09:12	Scawby Road (corner) (2m from kerbside)	Straw Trailer (loaded) near side	0.254	0.127	0.254
09:16	Scawby Road (corner)	HGV Tanker	0.254	0.127	0.254
	Highest Levels	Cars	0.254	0.127	0.318
	Highest Levels	HGVs	0.445	0.254	0.508
	Highest Levels	Straw Trailer	0.381	0.318	0.381
	Highest Levels	HGV near side	0.381	0.318	0.508
	Highest Levels	HGV far side	0.445	0.191	0.381

Position 2

Date: 23rd September 2010

Access Road

Time:	Location:	Position:	Vibration level X (m/s2)	Y (m/s2)	Z (m/s2)
09:29	Access Road (2-3m)	Straw Trailer (loaded) far side	0.254	0.127	0.254
09:30	Access Road (2-3m)	HGV (Tanker) far side	0.318	0.318	0.254
09:31	Access Road (1m)	Straw Trailer (loaded) near side	0.318	0.318	0.318
09:31	Access Road (5m)	Straw Trailer (loaded) leaving junction	0.191	0.127	0.254
09:33	Access Road (1m)	Car near side	0.191	0.127	0.254
	Highest levels	Cars	0.191	0.127	0.254
	Highest levels	HGVs	0.318	0.318	0.254
	Highest levels	Straw Trailer	0.318	0.318	0.318

Position 3:

Date: 23rd September 2010

193 Scawby Road (on pavement)

Time:	Location:	Position:	Vibration level X (m/s2)	Y (m/s2)	Z (m/s2)
10:59	Pavement (1-2m from Scawby Road)	HGV Far Side	0.254	0.127	0.254
11:02	Pavement (1-2m from Scawby Road)	Car near side	0.191	0.127	0.254
11:03	Pavement (1-2m from Scawby Road)	HGV Far Side	0.254	0.127	0.254
11:05	Pavement (1-2m from Scawby Road)	Car near side	0.254	0.127	0.254
11:05	Pavement (1-2m from Scawby Road)	HGV (flat bed) loaded near side	0.445	0.318	0.381
11:06	Pavement (1-2m from Scawby Road)	Car near side	0.191	0.127	0.254
11:07	Pavement (1-2m from Scawby Road)	Car near side	0.191	0.127	0.254
11:07	Pavement (1-2m from Scawby Road)	HGV Near Side	0.445	0.381	0.445
11:07	Pavement (1-2m from Scawby Road)	Car near side	0.191	0.127	0.254
11:07	Pavement (1-2m from Scawby Road)	HGV Near Side	0.254	0.254	0.254
	Highest levels	Cars	0.254	1.270	0.254
	Highest levels	HGVs	0.445	0.381	0.445
	Highest levels	HGV near side	0.445	0.381	0.445
	Highest levels	HGV far side	0.254	0.127	0.254

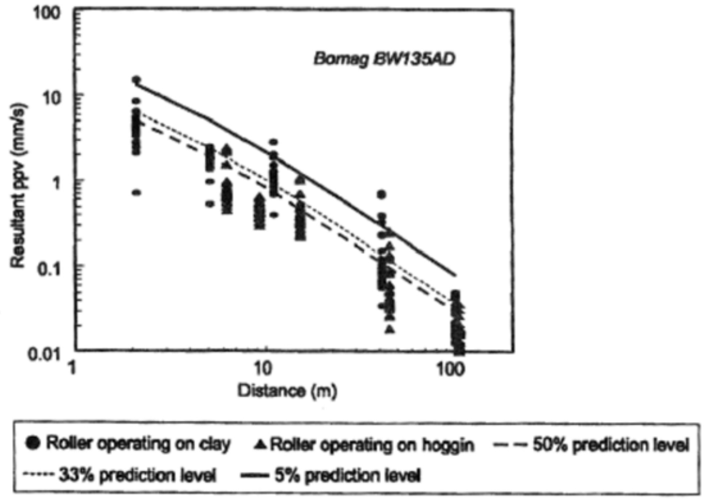
Research Data

The New Zealand Transport Agency published a research paper entitled `Ground Vibration from Road Construction' in May 2012, which includes a table of measured PPV values for different types of plant. The results have been provided below as an extract from the paper for ease of reference.

Measured vibration source levels for construction equipment (adapted from Hanson et al 2006)

Equipment	PPV at 7.6m (mm/s)
Pile driver (impact)	38.6 (upper range)
	16.4 (typical)
Pile driver (sonic)	18.6 (upper range)
	4.3 (typical)
Clam shovel drop (slurry wall)	5.1
Hydromill (slurry wall)	0.2 (in soil)
	0.4 (in rock)
Vibratory roller	5.3
Hoe ram	2.3
Large bulldozer	2.3
Caisson drilling	2.3
Loaded trucks	1.9
Jackhammer	0.9
Small bulldozer	0.1

Measured vibration levels from Bomag vibratory compactor and fitted probability of exceedance curves (Hiller & Crabb 2000)



Vibration Levels from a Range of Construction Activities