TECHNICAL REPORT (DRAFT)

Reference P054
Title Round 2 Strategic Noise Mapping – Data Production Process
Version 1.0
Status Final
Date 19 January 2015
Prepared for Stephen Turner (Defra)
Prepared by Nigel Jones (Managing Director)
Matthew Burdett (Associate Director)
Sarah Joubert (Senior Consultant)
Matthew Williams (Consultant)

Approved by

Nigel Jones (Managing Director)

Submission Statement

Extrium has completed this report with all reasonable skill and care, bearing in mind the agreed project objectives, scope of works, availability of information and the level of resources allocated to the project, as agreed with the Client.

This report is issued in confidence to Defra and Extrium cannot accept any responsibility to any third party to whom this proposal may be circulated, in part or in full, or for any matters arising which may be considered outside the scope of works. Any such parties rely on the contents of this report solely at their own risk.

Unless specifically assigned or transferred within the terms of the contract, Extrium asserts and retains all copyright and other Intellectual Property Rights, in and over this report and its contents. No part of this document can be printed, reproduced or copied without written permission first being granted.
CONTENTS

1 Introduction ........................................................................................................ 4
  1.1 Background ...................................................................................................... 4
  1.2 Aims and Scope ............................................................................................ 5
  1.3 Approach ....................................................................................................... 5

2 Definition of Areas to be mapped ..................................................................... 7
  2.1 Agglomerations ............................................................................................ 7
  2.2 Major roads .................................................................................................... 10
  2.3 Major railways .............................................................................................. 12

3 Calculation Methodology .................................................................................. 14

4 Data Specification ............................................................................................. 15

5 Production of Noise Model Input Datasets ....................................................... 16
  5.1 Supporting ‘Management’ datasets ................................................................ 17
  5.2 Ground Model ............................................................................................... 19
  5.3 Buildings ....................................................................................................... 26
  5.4 Bridges .......................................................................................................... 28
  5.5 Noise Barriers ............................................................................................... 31
  5.6 Ground Cover ............................................................................................... 33
  5.7 Road Traffic Noise sources .......................................................................... 34
  5.8 Railway Noise Sources ................................................................................ 39
  5.9 Industry Noise Sources ................................................................................ 43
  5.10 Noise Model Integration ............................................................................. 43

6 Noise Level Calculations .................................................................................... 44
  6.1 Roads ............................................................................................................. 44
  6.2 Railways ......................................................................................................... 44
  6.3 Industry .......................................................................................................... 44
  6.4 Airports .......................................................................................................... 44

7 Post Processing .................................................................................................. 46
  7.1 Construction of a Residential Population Location Model ......................... 46
  7.2 Noise Exposure Assessment ......................................................................... 47
  7.3 Outputs .......................................................................................................... 47

8 Summary ............................................................................................................ 49

ANNEX 1 – List of Agglomerations ........................................................................ 50

ANNEX 2 – List of Local Highways Authorities who supplied information on road surface types and noise barrier locations ........................................... 51

ANNEX 3 – Round 2 Strategic nosie Mapping High level process flow diagram .......................................................... 52
1 INTRODUCTION

1.1 BACKGROUND

Directive 2002/49/EC\(^1\) relating to the assessment and management of environmental noise, more commonly known as the Environmental Noise Directive (END), places an obligation on European Union (EU) member states to implement noise mapping and action planning for major cities and transport sources in their territories.

The Environmental Noise (England) Regulations 2006 (as amended) (the “Regulations”) transpose the END into law and set out various responsibilities associated with the production of noise maps.

The Secretary of State (SoS) of the Department for Environment, Food and Rural Affairs (Defra) is the Competent Authority charged with the responsibility of producing strategic noise maps for noise sources other than non-designated airports. Airport operators are the Competent Authorities responsible for strategic noise mapping of non-designated airports.

The SoS for Environment (Defra) is responsible for producing strategic noise maps for Road, Railway and Industrial noise sources whilst the SoS for Transport (Department for Transport) is responsible for producing strategic noise maps for designated airports.

The first round of noise mapping in England was completed and the results reported to the European Commission (EC) in 2007. As required by the END, Noise Action Plans were subsequently developed, consulted upon and adopted.

During the first round of mapping Defra adopted a variety of approaches to deliver the required strategic noise maps and results.

For the second round of strategic noise mapping of all the required road and railway sources in England, Defra elected to undertake the noise model data development and exposure assessment as a single project (which was assigned to Extrium), and the noise level calculations as a second single contractor project (awarded to Hepworth Acoustics). For industry, Extrium was also commissioned to carry out the noise calculations for that source. Compared with Round 1, this overall approach reduced the process management burden, whilst delivering economies of scale, increased efficiency, much better consistency and value for money.

---

\(^1\) DIRECTIVE 2002/49/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 25 June 2002 relating to the assessment and management of environmental noise
1.2 AIMS AND SCOPE

Extrium was commissioned by Defra under the Acoustic Modelling/GIS Advisory Contract to support the delivery of the second round of strategic noise maps (the Project).

Project objectives included:

• Defining the extent and scope of sources to be mapped
• Production of noise model input datasets – roads, railways and industry
• Completion of noise level calculations for industrial sources
• Collation of final noise results grids for roads, railways, industry and airports
• Design and production of a strategic residential population location model
• Completion of population/dwelling exposure assessments for roads, railways, industry and airports
• Generation of various output statistics, including for reporting to the European Commission (EC)/European Environment Agency (EEA)

Hepworth Acoustics was separately commissioned by Defra to carry out the strategic noise mapping calculations for road and rail sources using the input datasets provided by the Extrium workflow, as described above.

The implementation of the project was controlled through routine project management meetings which were chaired by Defra and where relevant also attended by Hepworth Acoustics. Key project decisions were agreed between the parties through this controlled management framework.

The complex nature of the project coupled with limitations in data availability and time and budget constraints meant that various technical assumptions had to be taken during the project. Assumptions were taken in consultation with and agreed by Defra, with the aim of maintaining the integrity of the project results and policy outcome.

This report provides details of the work undertaken by Extrium during their project in supporting the delivery of round 2 strategic noise maps.

1.3 APPROACH

The combined project to deliver the second round of END strategic noise maps in England was undertaken by a team consisting of Defra (retaining overall responsibility for governance and direction of the project), Extrium and Hepworth Acoustics.
The project employed an approach to the generation of strategic noise maps which can be summarised by a seven stage process, as shown in Figure 1.1 below.

Each stage of the process is defined by a preceding stage such that requirements and specifications are captured ahead of the datasets. These datasets are then processed and combined to develop the model datasets, which are checked and tested prior to the final assessment of noise levels.

Data processing commenced within a Geographic Information System (GIS) environment, then passed to the noise software environment for final sign-off and the assessment of noise levels. The results of this assessment were then passed back to the GIS environment for post processing, analysis and mapping.

Following the assessment of noise levels, the analysis is undertaken using datasets developed to represent dwelling and population locations in order to deliver the statistics required by the EC for the reporting requirements of the Directive.

Figure 1.1: Overview of the strategic noise mapping process
2 DEFINITION OF AREAS TO BE MAPPED

There is a requirement under the END to assess the noise levels from roads, railways, industry and airports at locations within agglomerations. In addition, there is also a requirement to assess the noise levels from “major roads”, “major railways” and “major airports”, both inside and outside agglomerations.

The mapping requirements of the END in the second round of strategic noise mapping have increased in comparison to those of the first round and can be summarised as follows:

- Agglomerations, as defined in the Regulations are areas having a population in excess of 100,000 persons (compared with 250,000 for round 1) and a population density equal to or greater than 500 people per km², which the SoS considers to be urbanised.

- Major roads are those trunk roads, other motorways, principal or classified roads with sections of road a flow above the threshold of 3,000,000 vehicle passages per year (compared with 6,000,000 for round 1).

- Major railways are those sections of rail route above a flow threshold of 30,000 vehicle passages per year (compared with 60,000 for round 1).

- Major airports are those which have more than 50,000 movements per year (a movement being a take-off or a landing), excluding those purely for training purposes on light aircraft.

2.1 AGGLOMERATIONS

The definition of the extent of agglomerations in England in the first round was based upon work commissioned by the Department of the Environment Transport and the Regions, The Scottish Executive, The National Assembly for Wales and the Department of Environment for Northern Ireland for the purposes of noise mapping.

The application of this approach to the DCLG Urban Settlements 2001 data in round 1 resulted in 23 first round agglomerations across an area of approximately 5,200 km².

The same approach was followed in the second round of mapping, which resulted in 65 agglomerations covering a total area of approximately 6,850 km².

In order to generate representative noise level results at all receptor points within agglomerations, there is a requirement to consider noise sources and

---

other noise model input information located outside the calculation area which may contribute to noise levels inside the agglomeration. Therefore, for the agglomerations, input data for the noise calculation process was required for the entire area within the agglomeration boundaries, as well as a 1 km buffer area outside the agglomeration boundary. In addition to the 1 km agglomeration buffer, all major road sources within 3 km of the agglomeration were also incorporated in the noise modelling process.

The incorporation of a 1 km buffer area increased the required noise model area for agglomerations to approximately 13,750 km². Figure 2.1, below provides an overview of the location and extent of the 65 agglomerations that had to be mapped in the second round. Annex 1 contains a list of the 65 agglomerations.
**Figure 2.1:** Map showing the location of the 65 agglomerations in England
2.1.1 Roads in agglomerations
Within agglomerations there is a requirement to assess the noise levels from road traffic sources. For the second round, noise calculations within agglomerations were made for all Motorways and A roads regardless of flow, therefore including also those roads defined as ‘major roads’ (see below).

2.1.2 Railways in agglomerations
Within agglomerations there is a requirement to assess noise levels from railway sources. For the second round, noise calculations within agglomerations were completed for all ‘mainline’ (defined as those routes identified in the Network Rail ACTRAFF (ACTual TRAFFic) database and HS1 rail sources regardless of flow, therefore also including those railways defined as ‘major railways’ (see below).

2.1.3 Industry in agglomerations
Within agglomerations there is a requirement to assess noise levels from industrial sources, such as those defined in Annex I to Council Directive 96/61/EC of 24th September 1996. Consequently for the second round, noise calculations within agglomerations were completed for all industrial sites regulated by the Environment Agency (“Part A(1) activities”) as defined by the EA “Environmental Permitting Regulations – Industry, National Dataset”.

2.2 MAJOR ROADS
Major Roads in the second round were identified as those Motorways and A Roads from the 2010 Department for Transport, Transport Statistics Major Roads database meeting the relevant criterion. This method resulted in approximately 25,400 km of major road to be modelled (both inside and outside the agglomerations).

Figure 2.2, below identifies the location of the major roads in England. The major roads sources were buffered\(^3\) by 3 km in order to define the model extent, and the noise assessment area required for the project. The area of the resulting assessment model was approximately 80,000 km\(^2\).

---
\(^3\) The buffer distance was chosen to cover the range of noise levels required by the END to be reported
Figure 2.2: Map showing the location of major roads in England (Motorways in blue; “A” roads in red)
2.3 MAJOR RAILWAYS

In the second round, major railways have been identified as those rail corridors meeting this criterion as defined by a query output from the Network Rail ACTRAFF database (for the calendar year from September 2010 to September 2011). This method resulted in approximately 5,200 km of major rail corridor to be modelled (both inside and outside agglomerations).

Figure 2.3, below identifies the location of the major railways in England. The major railway sources were buffered\(^4\) by 1 km in order to define the model extent and the noise assessment area required for the project. The area of the resulting assessment model was approximately 10,000 km\(^2\).

\(^4\) The buffering distance was chosen to cover the range of noise levels required by the END to be reported
Figure 2.3: Map showing the location of major railways in England
3 CALCULATION METHODOLOGY

The Regulations set out the assessment methodology to be used. In summary these are:

Road Traffic Noise

Calculation of Road Traffic Noise (CRTN)\(^5\), adapted using “Method for converting the UK road traffic noise index LA10,18h to the EU noise indices for road noise mapping”\(^6\).

Railway Noise

Calculation of Railway Noise (CRN)\(^7\) or, where appropriate, Calculation of Railway Noise 1995, Supplement No.1\(^8\), both adapted as shown in Figure 6.5 of the report “Rail and wheel roughness – implications for noise mapping based on the Calculation of Railway Noise procedure”\(^9\).

Industry Noise

The source noise levels used were derived using the default value approach as set out in Toolkit 10 of the “Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure Version 2”\(^10\). The propagation method used was that described in ISO 9613-2\(^11\).

---

\(^5\) Department of Transport, 7th June 1988, HMSO
\(^6\) DEFRA, 24th January 2006
\(^7\) Department of Transport, 13th July 1995, HMSO
\(^8\) “Procedure for the calculation of noise from Eurostar trains class 373” (Department for Transport, 20th October 1996, Stationery Office)
\(^9\) DEFRA, March 2004
The calculation of noise from roads, railways and industry requires a 3D acoustic modelling environment. This is composed of a number of input datasets which are integrated, usually within proprietary noise modelling software packages.

To facilitate the generation and exchange of noise model input datasets in a consistent format, a dataset specification was agreed. This specification was based on the various features contained within a noise model, the object definitions required by the noise calculation software and the assessment method being applied. Such specifications can only be completed once the noise calculation software is known. In this case, the data specification was tailored to the Noise Level Calculation Contractor’s chosen noise mapping target environment: LimA.

The following section describes how the noise model input data were produced to meet the data specification.
5 PRODUCTION OF NOISE MODEL INPUT DATASETS

In general, the calculation of environmental noise levels using the above methodologies takes place in two stages:

- The assessment of the level of noise emitted from a source, the “source noise emission”; and
- The assessment of the attenuation of the emitted noise en-route from the point of emission to the receptor, the “propagation attenuation”.

Following this concept, the required input datasets can be classified into:

- **Source data** which defines the position and characteristics of the noise sources; and
- **Pathway data** which defines the environment within which propagation occurs.

Acoustic calculation methods for road, rail and industry require similar information for the definition of the pathway environment, whilst the source information required is unique to each source. The similarity of the datasets required for defining the acoustic pathway can allow for the development of a single unified 3D model environment, within which the various noise emission sources are located, and propagation to the receptors is assessed. This approach is the basic premise of most of the commercial noise mapping software tools, which enable a variety of noise sources to exist within a single 3D environment.

The 3D environment which was required to support the assessment of noise from roads, railways and industry comprised the following five key groups of data:

- **Digital ground model data** – consisting of 3D polylines and equal height contours defining the height and profile of terrain;
- **Buildings data** – describing the location and height of buildings within the modelling extent;
- **Bridges data** – defining the position and height of bridges carrying or supporting relevant sources;
- **Noise barrier data** – defining the position and height of noise barriers; and
- **Ground cover data** – defining the acoustic absorbency of the ground over which noise will be propagating from source to receiver.
For each noise model input dataset, the following sections outline in further detail the technical methods used in the generation of the complete 3D modelling environment and noise emission sources:

- Sections 5.2 to 5.8 present further detail of the raw input datasets used and processing employed in the generation of input data comprising the 3D Model environment.
- Sections 5.9 to 5.10 provide a summary of the noise emission sources for roads, railways and industry.
- In order to complete the assessment, additional supporting data is required to define the geographical extent of the assessment, this information is summarised in Section 5.1.

A high level flow diagram summarising the process of the second round of strategic noise mapping from the data inputs, through the model preparation, and noise level calculations to the statistics outputs can be seen in Annex 3.

5.1 SUPPORTING ‘MANAGEMENT’ DATASETS

Due to the scale of the task of completing strategic noise level calculations on a 10 m grid at a national level within proprietary noise calculation software for roads, railways and industry the country was split into a tiled structure consisting of, 92 individual model areas (see Figure 5.1, below).

The supporting ‘management’ datasets used to define the extent requirements for each of the 92 project areas consisted of 4 datasets:

1. A project area dataset – defining the extent of the tile boundary,
2. a model area dataset - defining the extent of the model area exchanged with the noise level calculation contractor, incorporating a 3 km buffer of additional data beyond the tile extent,
3. a road calculation area dataset – defining the extent of noise level calculations for roads, formatted to reflect the nature of the required 10 m grid of noise level results, and
4. a rail calculation area dataset – defining the extent of noise level calculations for railways, formatted to reflect the nature of the required 10 m grid of noise level results.

Splitting the country up into a set of tiles allowed the data production and noise level calculation process to work in parallel, therefore allowing for an efficient and fast delivery of data and results. However, this approach did necessitate that data within 3 km of a tile boundary was handled at least twice.
Figure 5.1: Map showing the tiled project area structure
5.2 GROUND MODEL

A representative ground model is important for developing a noise model; all other objects in the modelling environment are described in relation to the ground model. The ground model also determines propagation distances and the attenuation attained due to screening from land features. Noise calculation software can incorporate digital ground model input information in a variety of formats including, spot heights, equal height contour lines, and embankment edges or 3D polylines.

The ground model for this project consisted of

- 3D polylines near to the source and for other terrain features; and
- equal height contours for a more generalised description of the terrain away from the source.

Where possible 3D breakline data, as opposed to contour models, were used as this is generally a more accurate, efficient and representative method of representing height data (for locations near to transport corridors) in a noise calculation model.

This section of the report describes the various elements of data including data that were able to be re-used from the first round of mapping, that contributed to the single national, yet composite, ground model used in this project.

For areas in the immediate vicinity to modelled rail sources the ground model consisted of the following five components, in order of priority:

1. Re-use of the IBM/Infoterra Central Data Service (CDS) round 1 rail breaklines, where modelled in round 1 (as described in 5.2.1),
2. HS1 as-built CAD models (as described in 5.2.2),
3. a pair of heighted ‘rail-bed’ lines offset 3 m either side of the rail centreline, where CDS or HS1 data were not available (as described in 5.2.3),
4. additional 3D breaklines representing terrain features such as embankments and cuttings, where CDS or HS1 data were not available (as described in 5.2.5), and
5. equal height contours, in the absence of any other ground model feature (as described in 5.2.6).

The majority of the ground model in close proximity to the road traffic noise sources had to be newly generated for this project and consisted of the following three components, in order of priority:

1. A pair of heighted ‘road-bed’ lines offset 3 m either side of the road centreline (as described in 5.2.4),
2. additional 3D breaklines representing terrain features such as embankments and cuttings (as described in 5.2.5), and

3. equal height contours, in the absence of any other ground model feature (as described in 5.2.6).

Once each of the components in the ground model covered below had been generated, object geometry and attribution were checked to ensure compliance with the specification. Geometrical rules that were checked including the incidence of overlapping breaklines, checks in 3D and distance tolerances on neighbouring vertices. The integration of multiple datasets in a single modelling environment required further modifications to the dataset relative to further features in the 3D environment such as contours, bridges and also the source emission datasets.

5.2.1 CDS round 1 rail breaklines – 3D polylines

During the first round of strategic noise mapping, completed in 2007, rail strategic noise maps were developed using ground model input datasets provided by the CDS. This ground model comprised 3D polyline strings (at the top and bottom of slopes, top and bottom of retaining walls, crests, ditches, edges, other ground surface changes over 0.5m, top and bottom of slope around tunnel portals and the railbed line) captured through photogrammetry.

It is understood that this data in turn was derived from various pre-existing Digital Terrain Model (DTM) grids, LiDAR DTMs and stereo colour imagery.

Due to the nature of the method of capture and the associated accuracy of the data, the CDS round 1 breaklines took joint-priority over any other ground model feature. These data were therefore used where possible in preference to any other ground model data where they co-existed.

The pre-existing round 1 breaklines were compared to the data specification and further processed and cleaned to meet the requirements of this project. The derived dataset underwent a series of post-processing steps in the generation of the breaklines and also in the formatting of the dataset in accordance with the noise model input dataset specification. Figures 5.2 and 5.3, below show two 3D examples of the round 1 rail breaklines used in this project.
Figure 5.2: Image showing an example of CDS round 1 rail breaklines modelling a rail cutting in Liverpool.

Figure 5.3: Image showing an example of round rail break lines (and bridges) modelling a rail embankment in Liverpool.
5.2.2 HS1 breaklines – 3D polylines

In order to incorporate terrain data in close proximity to relevant sections of the High Speed 1 (HS1) route, the project was supplied with as-built CAD data by HS1\textsuperscript{12} for both section 1 and section 2 of HS1.

The CAD models contained 3D breaklines which were extracted and further processed to meet the project requirements and data specification. Due to the nature of the data source and the method of capture, HS1 breaklines took joint-priority with CDS round 1 breaklines over any other ground model feature.

5.2.3 ‘Rail-bed’ - 3D polylines

‘Rail-bed’ features were generated in a similar manner to the approach used for ‘road-bed’ features (as described in 5.2.4, below). The process of generating 3D polylines for railways was simplified due to the nature of the height of rail sources, in that relatively rapid change in height tended not to occur for rail sources, compared to roads.

‘Rail-bed’ features were generated by combining and processing two data sources: the modelled rail traffic noise sources defined by Network Rail Geometric Measure Line centre lines and the NextPerspectives 5 m DTM grid.

The resulting 3D ‘rail-bed’ lines were then used for sections of rail where pre-existing CDS or HS1 breaklines were not available and were subsequently updated to reflect the real world height of the railway, particularly at locations where the source interacts with terrain features, other modelled sources, or locations with pre-existing data.

\textsuperscript{12} Supplied by London and Continental Railways (LCR) on behalf of HS1
5.2.4 ‘Road-bed’ - 3D polylines

‘Road-bed’ features were generated for all modelled road traffic noise sources in order to act as the platform for the source to be positioned, allowing propagation through the 3D model environment from that location. ‘Road-bed’ features were generated in this project by combining and processing two data sources: the modelled road traffic noise sources defined by Ordnance Survey MasterMap Integrated Transport Network (OSMMITN) road centre lines and the NextPerspectives 5 m DTM grid\textsuperscript{13}.

Prior to adding height information to the data the road centre lines were pre-processed; ensuring they had consistent and appropriate vertex densities and intervals, and that they were buffered by 3 m either side of the centre line.

The 5 m DTM product was also processed in advance of preparing the ‘road-bed’ data to identify and resolve any inconsistencies. The DTM data were then pre-processed and extracted for grid cells located on or within approximately 3 m of the road centre line to avoid incorporating an influence from potentially inappropriate grid cells in the resulting data.

The 3 m offset polylines were then combined with and ‘heighted’ from the pre-processed 5 m DTM. Due to the nature of the filtered DTM (where objects such as buildings, trees and other objects located on the earth’s surface are filtered from the result) the resulting 3D ‘road-bed’ lines inherited these trends in the height data. Further manual intervention was therefore required to edit and update the ‘road-bed’ lines where the source height was not representative of the real world. Examples where these instances occurred included locations where the source ‘dropped’ down to the terrain beneath the real world height of the source at locations such as bridges over rivers or locations where more than one source crossover at a bridge or junction (i.e. a grade separated junction). Manual intervention was therefore required to edit and update the ‘road-bed’ lines. Manual updates to the 3D environment were also performed at this time to ensure the ‘road-bed’ lines interacted appropriately with the other 3D data, such as where roads interact with railway locations where round 1 rail breaklines pre-existed.

This process of manually updating the ‘road-bed’ lines was performed in conjunction with the generation of 3D bridge polygon objects to carry a noise source over one or more modelled sources at different heights. Where a modelled source crossed a source that was not modelled during the project, for example a Motorway or A-road going over a B-road, a bridge object was not created and the source height was maintained at the height appropriate for the modelled source.

Figure 5.4, below shows a 3D example of the heightened ‘road-bed’ lines used in this project.

\textsuperscript{13} As supplied under a PGA license by Astrium, April 2012. (NB. Astrium have now rebranded as Airbus)
5.2.5 Terrain feature breaklines - 3D polylines

Additional terrain features were incorporated in the 3D ground model in the form of 3D breaklines. These terrain features were generated in this project by combining and processing two data sources: selected terrain features identified from the Ordnance Survey MasterMap Topography layer\textsuperscript{14} and the NextPerspectives 5 m DTM grid.

The terrain features, extracted in two dimensions, were pre-processed and subsequently heighted from the 5m DTM.

\textsuperscript{14} As supplied from Defra/SPIRE under a PSMA license by Astrium, June 2012 (MasterMap COU version 27/01/2012)
5.2.6 Equal height contours – 2.5d polylines

The final element of the ground model, used only in absence of any other height data, was the inclusion of equal height contours. Contour features were incorporated in this project from two data sources: the NextPerspectives 5 m interval contour polyline product\textsuperscript{15} supplemented with newly generated contours (where the contour product contained missing or incomplete data) derived from the NextPerspectives 5 m DTM grid.

The contour data was pre-processed, cleaned and formatted in accordance with the agreed data specification. Figure 5.5, below shows a 3D example of the equal height contours used in this project.

\textbf{Figure 5.5}: Image showing an example of 3D ‘road-bed’ lines combined with additional terrain features and equal height contours for the M4 in Somerset.

\textsuperscript{15} As supplied under a PGA license by Astrium, May 2012.
5.3 BUILDINGS

The buildings dataset is an important layer for the development of a 3D noise model. Buildings are potential acoustic screens which not only attenuate noise levels, but can also reflect noise. Furthermore, buildings and their associated classifications are also relevant within the process of assessing the population exposure to noise.

OS MasterMap building footprint geometries were extracted from the OS MasterMap Topography Layer\(^\text{16}\) and pre-processed in accordance with the agreed noise model data specification. As in the first round of strategic noise mapping, buildings with a footprint smaller than 20 m\(^2\) were removed.

A building height data product was not available for use on the project, therefore it was agreed that buildings would be integrated into the 3D model environment through the use of a default building height of 8 m, as indicated in WG-AEN Good Practice Guide Version 2, Toolkit 15.

Upon completion of the required data pre-processing, the GIS datasets were constructed in line with the noise modelling dataset specification. A series of checking procedures were also undertaken to ensure the geometry and attribution were acceptable within the modelling environment. Checks included verification of the geometric integrity of the data and the distance tolerances on neighbouring vertices.

The integration of multiple datasets in a single modelling environment also necessitated that the dataset underwent further modifications as required relative to further features in the 3D environment such as bridges as well as the source emission datasets. Figure 5.6, below, presents an example of how buildings were represented within the 3D acoustic model environment.

\(^{16}\) As supplied from Defra/SPIRE under a PSMA license by Astrium, June 2012 (MasterMap COU version 27/01/2012)
Figure 5.6: Image showing an example of buildings superimposed upon the terrain model and extruded with a height of 8 m.
5.4 BRIDGES

Bridge objects are required in a 3D acoustic modelling environment to carry and support road and rail source emission lines over cuttings or junctions. It is therefore crucial that bridge objects are incorporated in the acoustic model in relation to both the 3D terrain model and the location of source line to which they refer.

3D polygon bridge objects were incorporated in the project from 3 sources:

1. Re-use of CDS round 1 rail bridges (where modelled in round 1),
2. HS1 as-built CAD models, and
3. Newly generated bridge objects.

Prior to incorporating the pre-existing CDS and HS1 data, a series of checks and updates were made to reflect the requirements of the data specification and the interaction with the other datasets contributing to the noise model.

Where bridges were newly generated, 3D bridge objects were manually generated in the 3D model environment through the assessment of the source networks relative to the terrain environment. Bridge locations were targeted and assessed in conjunction with the ground model datasets, aerial photography, and background mapping. Internet mapping sources were also used to support the generation of bridge objects.

The agreed specification required a series of geometry and attribute rules including verification of the direction of digitisation of the bridge polygon objects and the determination of the number and location of vertices for each object. Figures 5.7 to 5.9, below show three 3D examples of bridges incorporated into the 3D model environment in this project.
Figure 5.7: Image showing an example of 3D bridge objects from the CDS round 1 rail project incorporated into the 3D acoustic model environment.

Figure 5.8: Image showing an example of newly generated 3D bridge objects incorporated into the 3D acoustic model environment for a grade-separated junction.
Figure 5.9: Image showing an example of newly generated 3D bridge objects incorporated into the 3D acoustic model environment for a grade-separated junction.
5.5 NOISE BARRIERS

Noise barrier objects are required in a 3D acoustic model environment as they act as acoustic screens which not only attenuate noise levels, but can also reflect noise. Noise barrier objects were incorporated within this project derived from seven different sources:

1. Re-use of Central Data Service (CDS) round 1 rail 3D polyline noise barriers (where modelled in round 1).

2. Re-use of Round 1 noise barrier 2.5d polylines previously identified during strategic noise mapping undertaken in the first round.

3. Incorporation of noise barrier locations provided by HS1, as shown in the as-built HS1 CAD models.

4. Inclusion of additional, newly generated 2.5d polyline noise barriers on the strategic road network, targeted using information provided by the Highways Agency, including the so-called Hansard site locations and output from the Highways Agency Environmental Information System (ENVIS).

5. Inclusion of additional, newly generated 2.5d polyline noise barriers on the Transport for London Route Network, targeted using information provided by Transport for London (TfL), including output from the TfL Network Asset Management System (NAMS).

6. Inclusion of additional, newly generated 2.5d polyline noise barriers on the rail network, targeted using information provided by the Rail Noise Policy Working Group.

7. Inclusion of additional, newly generated 2.5d polyline noise barriers on the local highways authority network, targeted using information provided by individual local highway authorities (listed in Annex 2).

Noise barriers from the above sources were updated and incorporated into the 3D noise model environment in line with the requirements of the noise modelling dataset specification. Noise barriers were targeted and assessed in conjunction with the ground model datasets, aerial photography, and background mapping. Internet mapping sources were also used to support the generation of newly created or updated noise barrier objects.

A series of checking procedures were also undertaken to ensure the geometry and attribution was acceptable within the modelling environment. Checks included verification of the geometric integrity of the data and the distance tolerances on neighbouring vertices. Figures 5.10 to 5.12, below show three 3D examples of noise barriers incorporated into the 3D model environment in this project.
Figure 5.10: Image showing an example of a noise barrier incorporated in the 3D noise model environment, for a road on an embankment.

Figure 5.11: Image showing an example of a noise barrier incorporated in the 3D noise model environment, for a road at grade, in close proximity to buildings.

Figure 5.12: Image showing an example of noise barriers incorporated in the 3D noise model environment.
5.6 GROUND COVER

Ground cover defines the acoustic absorbency of the ground cover over which noise propagates from source to receiver.

Across the model area it is necessary to incorporate a ground cover dataset to identify areas of acoustically absorbent and reflective ground. To replicate the approach used in the first round of mapping for railways the strategic European Environment Agency (EEA) CORINE Land Cover 2006 data product was identified as the most appropriate dataset to be used for modelling the ground cover in a strategic noise mapping environment. However, at the point of scoping and designing this project, this dataset was not complete for the UK. Consequently the CORINE Land Cover 2000 data product (CLC2000 © EEA, Copenhagen, 2005) was used instead.

The CORINE dataset is a Strategic European-wide vector land parcel product derived from satellite imagery using Raster to Vector (R2V) software processing. It was developed in the framework of the CORINE programme to establish a computerised inventory of land cover. The dataset is used for multiple purposes including developing environmental, agriculture and regional development policies. For noise level calculations the CORINE dataset offers significant calculation time benefits compared to alternative datasets.

The following processing procedure was adopted in the generation of ground cover objects consistent with the data specification. The CORINE polygons for the project extent were extracted and re-projected into the British National Grid (OSGB36) projection system. Land cover classifications were then categorised and aggregated according to their acoustic relevance, and assigned an absorption coefficient attribute of between 0 and 1. Neighbouring objects with identical absorbency attributes were merged to further simplify the object structure. The data were processed in line with the noise modelling input data specification and further geometrical and attribute verifications were carried out to ensure the data adhered to the required specifications.
5.7 ROAD TRAFFIC NOISE SOURCES

To develop noise source emission data for roads in accordance with CRTN and the agreed noise model input data specification the following information was required:

- Road centreline location attributed with:
  - Total traffic volume of all vehicles;
  - Percentage of the total flow which were Heavy Goods Vehicles (HGV) as defined in CRTN;
  - Direction of vehicle flow;
  - Average vehicle velocity;
  - Road surface type (Bituminous, pervious tarmac, concrete) and, where relevant, the corresponding Texture Depth\(^{17}\);
  - Road classification, including identification of Major Roads and Motorway roads;
  - Road gradient; and
  - Carriageway width.

In accordance with the Regulations the assessment of noise levels at receptors was undertaken using an 18 hour Annual Average Weekly Traffic (06:00 to 24:00) in accordance with the method defined\(^{18}\) to derive an \(L_{Aeq}\) result for each of the time periods required.

Road centreline geometry extracted from OSMMITN\(^{19}\) was used as supplied to define the spatial location of the road source emission for all roads in agglomerations and for major roads outside. Information about the type and class of road was incorporated in the attribution of road information to support a number of different attribute fields. The class and type of road was derived from OSMMITN attribution (for example ‘A road dual carriageway’). This information was crucial to support representative attribution of flow, flow direction, speed and road width attributes.

The roads dataset for major roads and agglomeration roads were treated as a single entity but major roads were flagged in the data and modelled results were generated separately.

The following paragraphs provide an explanation of the process followed to create a road noise source emission dataset for the purposes of the second round of strategic noise mapping.

5.7.1 Source height and position

\(^{17}\) Texture Depth is a measure of the road surface properties

\(^{18}\) Method for Converting the UK Road Traffic Noise Index \(L_{A10,18h}\) to the EU Noise Indices for Road Noise Mapping, (Defra - st/05/91/AGG04442, 24th January 2006)

\(^{19}\) As supplied from Defra/SPIRE under a PSMA license by Astrium, June 2012 (MasterMap COU version 17/12/11)
Road centrelines are required to position the noise emission from roads in the correct geographical location. In GIS, they are also used to store additional attributes and information regarding the roads such as: traffic volumes, average speed and traffic composition.

Additional processing of the OSMMITN road centreline geometry was undertaken on object definitions, attribute structure and segmentation in order to create the required information for noise mapping.

The source height was set to the required default value which automatically positions the road source onto the underlying ground terrain within the 3D noise calculation environment. Where road centrelines run over bridges, the centrelines have their height attributed relative to the bridge height. This configuration ensures that the road passes over the bridge and does not follow the line of the underlying terrain. A manual splitting procedure was undertaken within GIS to segment road centrelines at bridges, and height attribution was set as required. This manual segmentation also ensured that road centrelines running below bridges were not mistakenly configured as running over the bridge.

The effect of tunnels on the propagation of noise was also taken into consideration. Where road centrelines were located inside a tunnel, the road was effectively taken out of the modelling process by flagging the relevant section. A manual splitting procedure was undertaken within GIS to segment road centrelines where a tunnel starts and ends.

5.7.2 Total Traffic Volume

Road traffic flow information was incorporated into the road centreline dataset from the 2010 Department for Transport, Transport Statistics Major Roads database.

This traffic flow information described the traffic flow on a node to node basis. In contrast, the geometry structure of OSMMITN generally corresponds to a carriageway centreline. Where roads were dual carriageways, slip roads or other classifications a proportion of the total flow was assigned to the specific section of road. The road nature classification for each link was obtained from the OSMMITN attribution and the traffic flow adjustments were achieved according to Table 5.1.

<table>
<thead>
<tr>
<th>Road Nature</th>
<th>Proportion of traffic (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Single carriageway</td>
<td>100</td>
</tr>
<tr>
<td>Dual Carriageway</td>
<td>50</td>
</tr>
<tr>
<td>Traffic Island</td>
<td>50</td>
</tr>
<tr>
<td>Roundabout</td>
<td>50</td>
</tr>
<tr>
<td>Slip Roads</td>
<td>5</td>
</tr>
</tbody>
</table>

DfT traffic flow information was assigned to the road network geometry and statistics from multiple roads were combined from the raw data sources.
across a variety of complex junction layouts, such as that shown below in Figure 5.13.

![Image of a complex junction](image)

**Figure 5.13: Example of a complex junction**

Traffic flow information assignment was carried out for a 24 hour period. Conversion factors derived from WG-AEN GPGv2 were used to convert from 24 hour flow to 18 hour flow (06:00 to 24:00) in order to comply with the modelling specifications and calculation method.

5.7.3 Percentage of Heavy Goods Vehicles (HGV)

CRTN requires data on the percentage of HGV (defined as vehicles weighing more than 1,525 kg) within the total traffic volume. DfT flow information was provided across different vehicle types. The percentage of HGV was calculated by combining the HGV, buses and light good vehicles (LGV) categories from the DfT dataset. 50% of LGV (Goods vehicles up to 3,500 kgs gross vehicle weight) were assumed to weigh more than 1,525 kg.

5.7.4 Direction of Traffic Flow

The direction of road traffic flow is required by CRTN in order to apply the gradient correction which applies only to traffic travelling uphill on a one-way road. Aerial photography, internet mapping sources and Ordnance Survey Colour raster data were used to support the identification of the direction of flow according to the data specification.
5.7.5 Traffic Speed

Traffic speed is an important factor in determining Basic Noise Levels (BNLs). CRTN defines traffic speed as the mean speed along the modelled route in kilometres per hour (km/h).

In order to be consistent with approaches followed in previous mapping projects and due to the unavailability of actual speed data, default values were assigned to road segments taking location (urban or rural), road type (dual or single carriageway) and road class into consideration.

Traffic speed values were derived using the default values set out in paragraph 14.2 of CRTN as a guideline. The Urban Settlements data was used to identify road segments that fall within an urban area. For the purposes of this project the speed values set out in Table 5.2 were assigned to the Road Centre Line data.

<table>
<thead>
<tr>
<th></th>
<th>Regular Road</th>
<th>Slip road / Roundabout / Traffic Island</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motorways</td>
<td>Rural 108</td>
<td>81</td>
</tr>
<tr>
<td></td>
<td>Urban 97</td>
<td>81</td>
</tr>
<tr>
<td>A Roads</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dual carriageway</td>
<td>Rural 97</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Urban 60</td>
<td>50</td>
</tr>
<tr>
<td>Single carriageway</td>
<td>Rural 81</td>
<td>50</td>
</tr>
<tr>
<td></td>
<td>Urban 50</td>
<td>50</td>
</tr>
</tbody>
</table>

5.7.6 Road Surface Type and Texture Depth

Different road surface types have different acoustic performances. CRTN takes into account three different types of road surface, namely impervious bituminous, pervious macadam and concrete. Texture depth is also required for the concrete and bituminous surfaces if mean traffic speed is greater than 75 km/h. Texture depth is measured in millimetres.

Using previous research conducted by Defra, it was determined that the project should use three road surface types, as follows:

1. **A default road surface type** - impervious surface with a texture depth of 2 mm;

2. **A concrete road surface** – to be used as a generic concrete road surface type with a texture depth of 2 mm; and,

3. **A low noise surface type** - a pervious surface to be used as a generic low-noise road surface type with a texture depth of 2 mm.

Information from the Highways Agency and TfL was used to identify locations of low noise surfaces and concrete roads on their network. This information was also requested from local highways authorities. A list of those local authorities who provided information can be found in Annex 2. In all other cases the default road surface was used.
5.7.7 Road classification

Two sets of road classifications are required in order to undertake the calculations using the adapted method of CRTN and allow the results required by the Regulations to be generated. These classifications and the methods used to assign them during this project are set out below:

- Major and non-major road sources - assigned from the identification of major sources, as described in section 2.2
- Motorway and non-motorway roads – assigned from the road classification scheme contained within OSMMITN

5.7.8 Road gradient

CRTN uses road gradient values to model the additional traction noise generated by vehicles moving up an incline. This is only required for one-way roads where the traffic is running uphill.

No specific road gradient information was provided for the purposes of this project. As an alternative, the noise mapping software allows gradient to be calculated from the ground model. The road network was overlaid on the terrain model, allowing the gradient to be calculated by the noise level calculation contractor during the modelling process.

5.7.9 Carriageway width

Carriageway width in CRTN is used to assist with correctly positioning the effective noise source emission line of the road. The effective emission line is located 3.5 m from the nearside carriageway edge. As roads were represented by road centrelines, carriageway width was specified to allow the location of the effective source emission line to be identified.

None of the data provided included information on the width of roads. A default value of 3.75 m per lane and 7.5 m per centreline was adopted for all roads. Locations on the strategic road network with more than 2 lanes per carriageway were identified from information provided by the Highways Agency and were attributed in the road source emission data.
5.8 RAILWAY NOISE SOURCES

To develop a railway noise source emission dataset in accordance with CRN and compliant with the agreed noise model input data specification the following information was required:

- Rail centreline, incorporating information identifying the following:
  - Total vehicle volume of all vehicles along centreline,
  - Train speed information,
  - Maximum line speed information,
  - The extent to which Diesel Locomotives were on Full Power,
  - Bridges and elevated tracks,
  - Track type and support, and
  - Acoustic Track Quality (ATQ).

The railways dataset for major railways and agglomeration railways were treated as one entity but major railways were flagged using the major rail attribution field and modelled separately.

The following paragraphs provide a summary of the inputs and processes used to generate a suitable dataset for the purposes of the second round of strategic noise maps.

5.8.1 Rail centrelines

Rail centrelines are required to position the noise emission from the railway. In GIS, they are also used to store additional attributes and information regarding the railway such as the number of vehicle movements, speed information and track type and support.

The Network Rail Geographic Measure Line Data rail route data product, which represents rail routes at a corridor level as opposed to track or railhead level, was used in the first round noise mapping project. It was decided that the Geographic Measure Line data should be re-used from Round 1 to define the spatial location of rail centrelines both inside agglomerations and for major rail sources.

Corridor level representation depicts the railway as a single source, the rail corridor centreline. This, theoretically, simplifies many tracks or lines into a single noise emission line which reduces data processing and manipulation. However, it effectively positions all trains onto a single route and source. The consequences of this modelling approach are varied; both for emission level and the location of the noise source. The approach also introduced additional assumptions and simplifications when assigning track level data to the route e.g. line speeds, traffic and track support types. The project decided that this approach provided a reasonable compromise given the overall objective of the strategic noise mapping.
The geometry of the Geographic Measure Line data product underwent a series of spatial processing steps to clean and correct the topology of the data and also to edit the position of the polyline in relation to the 3D terrain environment. It is important to note that the corridor-level nature of the centreline geometry cannot accurately reflect reality, and there are situations which arise where there is a conflict between the centreline and the 3D terrain, such as the examples shown in Figure 5.14 at split tunnel entrances and Figure 5.15 at split bridge pairs, near a station platform.

**Figure 5.14:** Example showing conflict between Geographic Measure Line corridor centre line geometry (shown in red) and the terrain environment at a tunnel entrance (circled in yellow).

**Figure 5.15:** Example showing a conflict between Geographic Measure Line corridor geometry (shown in red) and the terrain environment at a station where the corridor centre line runs between two bridges (shown in black).
5.8.2 Total vehicle movements

Total vehicle movement data are required by CRN in order to calculate noise levels based on the number of rail vehicle passages on a given section of track. In addition to the information on the number of train passages provided from the Network Rail ACTRAFF database to identify the location of major sources (as described in section 2.3) a further output was generated from that dataset to provide the number of vehicle passages on the rail network, classified by CRN rolling stock categories and separated for individual time periods in order to allow the calculation of diurnal noise indicators required by the Regulations.

ACTRAFF information is based on a node to node level geometry, defining corridors between locations on the rail network called Timing Point Locations (TIPLOCs). A geo-referencing process was required in order to attribute centreline geometry with flow information. The positional accuracy of the ACTRAFF node to node geometry does not on its own support such a geo-referencing process. Additional Network Rail data on the spatial location of TIPLOCs was used to aid the geo-referencing process.

HS1 provided additional movement statistics for their network based upon timetabled statistics scaled to a calendar year notionally for 2011.

5.8.3 Train and line speed information

Speed information is required by CRN in order to calculate noise emission levels. In the absence of real train speed information, it was decided that the calculations would be based upon taking the lower of the maximum line speed and maximum vehicle speed, based upon the guidance provided in Toolkit 9 of the Good Practice Guide for noise mapping.

Maximum line speed information for the mainline network was provided by output generated from Network Rail’s ACTRAFF system and additional information was provided by HS1 for their asset.

Maximum vehicle speeds were allocated based upon estimates for each vehicle class produced for the first round of mapping. These assumed maximum speed values were generated by rail industry noise experts.

5.8.4 Diesel locomotives on power

Due to the lack of availability of data defining the proportion of diesel locomotives on power across the network, the same approach that was used in the first round of mapping was followed in this project. The proportion of diesel locomotives on power was assumed to be constant across the network, where 30% of all diesel locomotives were assumed to be on full power.

5.8.5 Bridges and elevated track

Locations of specific types of bridges are required by CRN in order to calculate the noise emission levels. This information was incorporated in the second round of noise mapping using two sources. Firstly, the IBM/Infoterra CDS Noise Mapping England railways polygon bridge data produced for the
first round of mapping was used for rail routes included in both rounds of mapping. For railways newly mapped in the second round, this data was supplemented with a desk-based survey of the additional proportion of the network using aerial photography, and internet based mapping products.

5.8.6 Track type and support

For the purposes of the second round of strategic noise mapping, the same approach was used to that adopted in round 1, whereby it was assumed that all rail types were continuously welded rail.

5.8.7 Acoustic Track Quality

Similar to the approach used in the first round of strategic noise mapping, a single value of Acoustic Track Quality (ATQ) was used across the whole network. The value of ATQ was provided by Network Rail and was updated from the value used in the first round based upon further research and measurements, following implementation of the Noise Action Plan for round 1. The project agreed with Network Rail that an ATQ value of 0 dB for the second round of strategic noise mapping in comparison to the value of +4 dB that was used in the first round.

5.8.8 Source emission calculation

Prior to the supply of the rail corridor noise model input datasets, the noise emission levels were calculated for each segment of the network. The noise level calculation contractor was subsequently supplied with a source line assigned with pre-calculated emission levels for rolling noise, diesel emission levels and Eurostar train emissions. Emission levels were provided for five time periods across an annual average twenty four hour period.
5.9 INDUSTRY NOISE SOURCES

To develop an industrial noise emission dataset in accordance with the defined calculation method, the following information was required:

- the location of the industrial area;
- the description of industrial process in operation; and
- the sound power emission level for operations on the site.

As stipulated by the END, industrial sites were considered only in the assessment of noise inside agglomerations. Information on the point location and primary activity by process type of Pollution Prevention & Control Part A(1) industrial sites within the agglomeration buffer areas was defined using the Environment Agency Permitting Regulations National Dataset (2011).

A default sound power noise emission level was assigned to each site on the basis of the process type in operation. The default levels were based on information provided by the Environment Agency in the first round of strategic noise mapping. This approach followed information contained in Toolkit 10.5 in the Good Practice Guide for noise mapping, version 2.

5.10 NOISE MODEL INTEGRATION

The complete 3-dimensional noise modelling environment was a composite of the above individual datasets. The process of noise modelling and noise level calculations integrated these data sources into a single model environment. In order to avoid relative inconsistencies and potential model errors between the datasets it was therefore critical that input datasets were not developed in isolation of each other. The integrated development of noise model datasets occurred at two distinct levels. Firstly the data was prepared in isolation of the other components of the model (as shown in the second level of the diagram in Annex 3). Secondly, in order to provide a single coherent three dimensional model, noise model input datasets were prepared and integrated in conjunction with one another (as shown in the third level of the diagram in Annex 3).

For example, the road emission dataset was developed in conjunction with the 3D model environment to ensure that upon integration the complete model environment would be representative. This process required the integrated development of the road network dataset, the terrain model, and the identification of bridges and tunnels. In addition, checks were made between the various layers to ensure there were no conflicts. For example noise barrier locations and heights were compared with source line and building locations to ensure no conflicts were identified.
6 NOISE LEVEL CALCULATIONS

6.1 ROADS
Using the noise model input data described in chapter 5, and in accordance with the Regulations, road noise level calculations were completed by the noise level calculation contractor for six noise level indicators ($L_{A10,18h}$, $L_{day}$, $L_{evening}$, $L_{night}$, $L_{den}$ and $L_{Aeq,16h}$). Two distinct sets of results were generated, firstly for major sources only and secondly for all mapped road sources for locations inside agglomerations. Noise level results were generated on a 10 m grid, as required by Regulations.

6.2 RAILWAYS
Using the noise model input data described in chapter 5, and in accordance with the Regulations, rail noise level calculations were completed by the noise level calculation contractor for seven noise level indicators ($L_{Aeq,18h}$, $L_{day}$, $L_{evening}$, $L_{night}$, $L_{den}$, $L_{Aeq,16h}$ and $L_{Aeq,6h}$). Two distinct sets of results were generated, firstly for major sources only and secondly for all mapped rail sources for locations inside agglomerations. Noise level results were generated on a 10 m grid, as required by Regulations.

6.3 INDUSTRY
Using the noise model input data described in chapter 5, and in accordance with the Regulations, industry noise level calculations were completed for five noise level indicators ($L_{day}$, $L_{evening}$, $L_{night}$, $L_{den}$, and $L_{Aeq,16h}$). A single set of results was generated for locations inside agglomerations. Noise level results were generated on a 10 m grid, as required by Regulations.

6.4 AIRPORTS
Strategic noise mapping calculations for airports were not completed as part of this project, but were carried out by the competent authority for airport noise mapping, defined in the Regulations as either the airport operator or, for the designated airports, the Secretary of State (for Transport). In order to complete the reporting requirements under the Directive, aviation noise mapping results were supplied to Defra by the various airports to collate and analyse.

Results were received from 19 airports. 10 of these airports have been defined by Defra as ‘major airports’ under the END. The 10 second round major airports are:

1. Birmingham
2. Bristol
3. East Midlands
4. London City
5. London Gatwick  
6. London Heathrow  
7. London Stansted  
8. London Luton  
9. Manchester  
10. Newcastle

Results have also been received and incorporated in the second round of strategic noise mapping for 9 further airports that impact an agglomeration, including:

1. Blackpool  
2. Bournemouth  
3. Cambridge  
4. Leeds-Bradford  
5. Liverpool  
6. London Southend  
7. Manston  
8. Norwich  
9. Southampton
7 POST PROCESSING

Following the assessment of noise levels, secondary analysis was undertaken utilising the results from the noise calculation process to prepare the required outputs. The primary focus of post processing and analysis was to facilitate the completion of the EC recommended Electronic Noise Data Reporting Mechanism (ENDRM) for the submission of Data Flow 4_8 results to the EC, and to comply with both the Directive and Regulatory requirements.

The following sections summarise:

- the process of generating a strategic residential population location model used for generating the required output statistics,
- the process of completing the noise exposure assessment, and
- the statistical outputs generated.

7.1 CONSTRUCTION OF A RESIDENTIAL POPULATION LOCATION MODEL

To enable the population exposure assessment to be completed, a strategic residential population location model was constructed. Residential buildings and the number of dwellings were defined by Ordnance Survey (OS) MasterMap Topography and AddressLayer2 data products\textsuperscript{20}. Population statistics were defined using information from the 2011 Census. The process of generating this population model is summarised below.

The first stage in constructing the dataset was to extract all building features from the OS MasterMap Topography Layer. Criteria were then applied to the MasterMap Address Layer 2 to extract relevant and valid residential address locations using the address function and land use identified in the data.

These residential addresses (or dwellings) were then matched and assigned to a corresponding building using the OS Reference to Topography Layer TOID (Topographic Identifier). Where a TOID match was not successful, a secondary match for each address point to a building polygon was attempted using their spatial location. Address points failing both methods of assignment to a building location were discarded. The final residential population location model, therefore, contained only residential, valid addresses that were matched and assigned to a building polygon.

Population data was available for the 2011 Census at Census Output Area (COA) level from the data table PHP01\textsuperscript{21}. Census 2011 data were joined from this table to 2011 COA boundaries within a GIS. Census Output Area code identifiers were spatially assigned to each MasterMap Address point held within the residential population location model. It is of note that ‘All People’ includes those living outside of what is classified a dwelling, such as

\textsuperscript{20} As supplied from Defra/SPIRE under a PSMA license by Astrium, June 2012 (MasterMap COU version 27/01/2012)

\textsuperscript{21} 2011 Census: population and household estimates for Wards and Output Areas in England and Wales, Published 23 November 2012
those living within a communal establishment. These factors could not be accommodated within the assessment due to lack of parameters/resolution within MasterMap and Census data.

The total number of dwellings (i.e. MasterMap address points) was summed for each COA to calculate the average population per dwelling per COA. A total population and count of dwellings was then summed for each building polygon dependent upon the number of dwellings falling within a discrete building polygon. Examples of multiple dwellings located within a single building polygon include buildings containing flats and apartment conversions.

7.2 NOISE EXPOSURE ASSESSMENT

As defined in Annex VI of the END an exposure assessment is required to report results to the European Commission (EC). Annex VI states that the estimated number of people (in hundreds) living in dwellings that are exposed to noise are to be calculated for the various mapping scenarios. There is no definition of a ‘dwelling’ in the END although the term is used within Article 3 (q), Annex I (1), Annex III, Annex IV (1) and Annex VI (1.5, 1.6) and (2.5, 2.6).

Annex I (1) of the END indicates that noise exposure assessments should be at the most exposed façade. The most exposed façade was defined as the external wall facing onto and nearest to the specific noise source. For the purposes of this assessment the highest overall value assigned to a dwelling was considered to be the most exposed façade according to the recommendations set out within the WG-AEN Good Practice Guide v2.

Through combining the strategic residential population location model and the strategic noise mapping results, the highest noise value (for various noise level indicators) was assigned to building polygons by intersecting building polygons with the noise level results grids. Population and dwelling numbers were obtained for discrete buildings and assigned the highest, intersecting noise value.

7.3 OUTPUTS

In addition to the Directive and Regulatory output requirements, the results of the exposure assessment for the second round of strategic noise mapping were also processed and summarised to support a variety of wider applications and uses. At the point of writing, exposure statistics derived from the second round of strategic noise mapping have been generated to support the following applications:

- the population and reporting of Data Flow 4 and 8 of the ENDRM,
- the generation of noise action plans, including statistics on the number of people exposed to noise, for example, by agglomeration,
- the generation and implementation of noise action plans, including the identification of ‘Important Areas’ for roads and railways,
• the publication of a table (csv) of noise exposure statistics on data.gov.uk,

• the provision of airport noise summary statistics by Census Output Areas to the Cabinet Office Wellbeing Programme

• the provision of updated noise exposure summary statistics for inclusion in the Public Health Outcomes Framework

• the generation of airport noise action planning data packs incorporating statistics on the number of people exposed to noise for airport operators to use in developing or revising their noise action plans.
8 SUMMARY

Extrium was commissioned by Defra under the Acoustic Modelling/GIS Advisory Contract to support the delivery of the second round of strategic noise maps required by the END as transposed by the Regulations.

The aims and objectives of the project have been completed successfully through following a seven stage approach to noise mapping, as discussed in this report.

The project approach with Defra, Extrium and the noise level calculation contractor working in collaboration provided an efficient mechanism to deliver the entire strategic noise mapping and reporting requirements for the second round of mapping in England.

Approximately 104,000 km² of noise model was generated and exchanged with the noise level calculation contractor for roads and railways. Noise level results were generated for approximately 80,000 km² of calculation area for roads and approximately 14,000 km² for railways. The noise models contained approximately 52,000 km of road traffic noise sources and approximately 9,000 km of rail noise sources. A national population model was generated and a noise exposure assessment was completed for 53 million people in England. A total of 250 GB of data was exchanged with the noise level calculation contractor, where the noise model input data consisted of approximately 7,000 files comprising 74 million individual GIS objects, which in turn contained approximately 420 million vertices.
### ANNEX 1 – LIST OF AGGLOMERATIONS

<table>
<thead>
<tr>
<th>Greater London Urban Area</th>
<th>Crawley Urban Area</th>
</tr>
</thead>
<tbody>
<tr>
<td>West Midlands Urban Area</td>
<td>Wigan Urban Area</td>
</tr>
<tr>
<td>Greater Manchester Urban Area</td>
<td>Warrington Urban Area</td>
</tr>
<tr>
<td>West Yorkshire Urban Area</td>
<td>Mansfield Urban Area</td>
</tr>
<tr>
<td>Tyneside</td>
<td>Swindon</td>
</tr>
<tr>
<td>Liverpool Urban Area</td>
<td>Burnley/Nelson</td>
</tr>
<tr>
<td>Nottingham Urban Area</td>
<td>Oxford</td>
</tr>
<tr>
<td>Sheffield Urban Area</td>
<td>Slough Urban Area</td>
</tr>
<tr>
<td>Bristol Urban Area</td>
<td>Ipswich Urban Area</td>
</tr>
<tr>
<td>Brighton/Worthing/Littlehampton</td>
<td>Grimsby/Cleethorpes</td>
</tr>
<tr>
<td>Portsmouth Urban Area</td>
<td>Telford Urban Area</td>
</tr>
<tr>
<td>Leicester Urban Area</td>
<td>York</td>
</tr>
<tr>
<td>Bournemouth Urban Area</td>
<td>Blackburn/Darwen</td>
</tr>
<tr>
<td>Reading/Wokingham</td>
<td>Peterborough</td>
</tr>
<tr>
<td>Teesside</td>
<td>Gloucester Urban Area</td>
</tr>
<tr>
<td>The Potteries</td>
<td>Nuneaton Urban Area</td>
</tr>
<tr>
<td>Coventry/Bedworth</td>
<td>Cambridge Urban Area</td>
</tr>
<tr>
<td>Birkenhead Urban Area</td>
<td>Doncaster Urban Area</td>
</tr>
<tr>
<td>Southampton Urban Area</td>
<td>Hastings/Bexhill</td>
</tr>
<tr>
<td>Kingston upon Hull</td>
<td>Thanet</td>
</tr>
<tr>
<td>Southend Urban Area</td>
<td>High Wycombe Urban Area</td>
</tr>
<tr>
<td>Preston Urban Area</td>
<td>Southport/Formby</td>
</tr>
<tr>
<td>Blackpool Urban Area</td>
<td>St Albans/Hatfield</td>
</tr>
<tr>
<td>Plymouth</td>
<td>Torbay</td>
</tr>
<tr>
<td>Aldershot Urban Area</td>
<td>Cheltenham/Charlton Kings</td>
</tr>
<tr>
<td>Derby Urban Area</td>
<td>Exeter</td>
</tr>
<tr>
<td>Luton/Dunstable</td>
<td>Eastbourne</td>
</tr>
<tr>
<td>The Medway Towns Urban Area</td>
<td>Colchester</td>
</tr>
<tr>
<td>Dearne Valley Urban Area</td>
<td>Lincoln Urban Area</td>
</tr>
<tr>
<td>Northampton Urban Area</td>
<td>Bedford/Kempston</td>
</tr>
<tr>
<td>Norwich Urban Area</td>
<td>Basildon/North Benfleet</td>
</tr>
<tr>
<td>Milton Keynes Urban Area</td>
<td>Chesterfield/Staveley</td>
</tr>
<tr>
<td>Sunderland Urban Area</td>
<td></td>
</tr>
</tbody>
</table>
ANNEX 2 – LIST OF LOCAL HIGHWAYS AUTHORITIES WHO SUPPLIED INFORMATION ON ROAD SURFACE TYPES AND NOISE BARRIER LOCATIONS

1. Plymouth City Council
2. Portsmouth City Council (barrier information only)
3. Dorset County Council
4. East Riding of Yorkshire Council
5. Lancashire County Council
6. Leeds City Council
7. Leicestershire County Council
8. Middlesbrough Council
9. Norfolk County Council
10. North Yorkshire County Council
11. Suffolk County Council
12. Wokingham Borough Council
ANNEX 3 – ROUND 2 STRATEGIC NOSIE MAPPING HIGH LEVEL PROCESS FLOW DIAGRAM