Guidance Note for Strategic Noise Mapping (02/2025 May Draft)

Part 2: Calculation Methodology & Noise Modelling

For the

European Communities (Environmental Noise) Regulations 2018 (amended)

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Purpose and scope of this Document

The objective of this guidance note is to provide practical information, advice and guidance to designated Noise Mapping Bodies on the development of strategic noise maps under the Environmental Noise Regulations.

Guidance is issued as applicable only to the development of strategic noise maps under the Regulations. The guidance updates, revises and replaces the previous Version 3 guidance of January 2025, and the revised Section 10 guidance of October 2017.

This second part of the guidance note provides a review of the common noise assessment method for Europe (CNOSSOS-EU) calculation methodology to be used for strategic noise mapping from Round 4, and information on the input data required. It also sets out recommendations on input data requirements, preparing noise model datasets in GIS and the Predictor noise mapping software, and running the calculations.

This second part of the guidance is to be read alongside the other parts:

- Part 1: Requirements
- Part 3: Assessment of Noise Exposure and Harmful Effects
- Part 4: Publication and Reporting

This document should also be read in conjunction with the following:

- European Communities (Environmental Noise) Regulations 2018, S.I. No. 549 of 2018;
- European Communities (Environmental Noise) (Amendment) Regulations 2021, S.I. No. 663 of 2021;
- 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, OJ L189/12-25, 18 July 2002;
- Directive (EU) 2015/996 of 19 May 2015 establishing common noise assessment methods according to Directive 2002/49/EC, OJ L168/1-823 of 1st July 2015;
- Corrigendum to Commission Directive (EU) 2015/996, OJ L5/35-46 of 10th January 2018;
- Commission Delegated Directive (EU) 2021/1226 of 21.12.2020 amending, for the purpose of adapting to scientific and technical progress, Annex II of Directive 2002/49/EC of the European Parliament and the Council as regards common noise assessment methods, OJ L269/65-142 of 28th July 2021;

This Guidance Note should not be considered as a legal document, nor does it purport to provide comprehensive legal advice or guidance on all acoustical matters. If, in any circumstance, the recommendations contained in this guidance seem to be at variance with the Directive, or Regulations, then the text of the Directive must be applied in the first instance, or the Regulations in the second. In many situations it may be necessary to seek expert advice and assistance.

Contents

1 Introduction

1.1 Background

This guidance is designed to help relevant Noise Mapping Bodies (NMBs) designated under Article 6 of the European Communities (Environmental Noise) Regulations 2018, S.I. No. 549 of 2018, (Regulations), as amended, with their strategic noise mapping duties under Article 11 of the Regulations.

It aims to support those noise mapping bodies in carrying out some of their duties under the Regulations. In particular, it covers the requirements for making strategic noise maps for agglomerations, major roads, major railways, and aircraft departing from and arriving at major airports. Strategic noise maps have to be developed in the context of the Regulations and should have particular regard to the requirement to provide a suitable basis for the development of noise action plans.

A glossary of acoustic and technical terms used is set out in Appendix A.

1.2 Role of this Guidance

This document is designed to provide a guide to noise mapping bodies about the process and requirements of strategic noise mapping and the submission of the strategic noise maps to the Environmental Protection Agency (EPA).

This second part of the guidance is to be read alongside the other parts, namely:

- Part 1: Requirements
- Part 3: Assessment of Noise Exposure and Harmful Effects
- Part 4: Publication and Reporting

This document should also be read in conjunction with the following:

- European Communities (Environmental Noise) Regulations 2018, S.I. No. 549 of 2018[1];
- European Communities (Environmental Noise) (Amendment) Regulations 2021, S.I. No. 663 of 2021[2];
- 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, OJ L189/12-25, 18 July 2002[3];
- Directive (EU) 2015/996 of 19 May 2015 establishing common noise assessment methods according to Directive 2002/49/EC, OJ L168/1-823 of 1st July 2015;
- Corrigendum to Commission Directive (EU) 2015/996, OJ L5/35-46 of 10th January 2018[4]; and

[1] Available at: https://www.irishstatutebook.ie/eli/2018/si/549/made/en/print [Accessed June 2022]
[2] Available at: https://www.irishstatutebook.ie/eli/2021/si/663/made/en/print [Accessed June 2022}
[3] Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A32002L0049 [Accessed June 2022]
[4] Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32015L0996 [Accessed June 2022]

- Commission Delegated Directive (EU) 2021/1226 of 21.12.2020 amending, for the purpose of adapting to scientific and technical progress, Annex II of Directive 2002/49/EC of the European Parliament and the Council as regards common noise assessment methods, OJ L269/65-142 of 28th July 2021[5].

1.3 Structure of this Guidance

This second part of the guidance covers the implementation of the CNOSSOS-EU calculation methodology in Ireland. The document is set out in the following sections:

- Section 2: Background and Development of CNOSSOS-EU;
- Section 3: General Provisions of CNOSSOS-EU;
- Section 4: Road Traffic Source;
- Section 5: Railway Traffic Source;
- Section 6: Industry Source;
- Section 7: Propagation Model for Road, Railway and Industry Sources;
- Section 8: Aircraft Noise;
- Section 9: Exposure to Noise;
- Section 10: Input Data Requirements;
- Section 11: Input Data Preparation;
- Section 12: Noise Model Preparation;
- Section 13: Noise Level Calculations.

- Appendix A provides a short glossary of acoustic terms.
- Appendix B provides a list of background reference material and information sources.
- Appendix C provides long term mean values for relevant meteorological variables in Ireland, by county.
- Appendix D provides a look-up table of buildings

[5] Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A32021L1226 [Accessed June 2022]

2 Background and Development of CNOSSOS-EU

The Environmental Noise Directive 2002/49/EC (END) requires EU Member States to determine the exposure to environmental noise through strategic noise mapping and elaborate action plans to reduce noise pollution. Since June 2007, EU countries have been obliged to produce strategic noise maps for all major roads, railways, airports and agglomerations, on a five-year basis.

2.1 DG JRC Common Noise Assessment Methods in Europe 2009-2012

The END foresaw the development of a harmonised methodological framework for noise assessment (Article 6.2). In 2009, the European Commission determined to develop CNOSSOS-EU (Common NOise aSSessment MethOdS for EUrope) for noise mapping of road traffic, railway traffic, aircraft and industrial noise.

CNOSSOS-EU was developed during the period 2009-2012 by the European Commission DG Joint Research Centre (DG JRC) in a cooperative process involving the European Environmental Agency, the World Health Organization Europe, the European Aviation Safety Agency and experts nominated by EU countries.

The DG JRC *Reference Report Common Noise Assessment Methods in Europe*[6] (CNOSSOS-EU), was published in August 2012. The report presents the outputs from each of the working groups (WG) established under the framework of CNOSSOS-EU.

2.2 Develop and Implement Harmonised Noise Assessment Methods 2013 -2015

The next step in the development and implementation of CNOSSOS-EU was undertaken by a project team led by Extrium Ltd between 2013 and 2015 for DG Environment. The three main tasks undertaken were:

- Task 1: Design and creation of an appropriate set of input values
- Task 2: Implementation of the CNOSSOS-EU software based on the methodological framework described in the associated JRC Reference Report
- Task 3: Development of guidelines for the competent use of CNOSSOS-EU and creation of a website to present them.
- Under Task 1 road, rail and industry source catalogues were developed, alongside guidance on conversion of models developed for existing calculation methods to CNOSSOS-EU.

Under Task 2 software tools were developed and tested which implemented the road, railway and industry source models. Point-to-point (P2P) propagation software tools were

[6] Common Noise Assessment Methods in Europe (CNOSSOS-EU), DG JRC, August 2012. Available at: https://publications.jrc.ec.europa.eu/repository/handle/JRC72550 [Accessed May 2022]

also developed for the NMPB 2008[7], ISO9613-2[8] and Harmonoise[9] methodologies.

Under Task 3 relevant text was to be developed for publication on the CNOSSOS-EU Guidelines website in order to support users in the application of the CNOSSOS-EU methods. The structure developed was based on 5 user levels. It was recognised that the draft of the Guidelines developed would need to be further refined and developed as users gain further experience of the CNOSSOS-EU method and as further validation of the method is undertaken by researchers. An initial version of the guideline's website was developed during the project; however, this has subsequently gone off-line.

During the project, the team raised a series of technical clarifications with the Commission. These were captured within a series of Issues Logs which help to outline the development of the CNOSSOS-EU methodology between the DG JRC Reference Report and the published Directive.

The project deliverables were published on the EC CIRCABC[10] website in February 2015, however they are no longer available on the website.

2.3 Directive 2015/996

In July 2015 the Commission published Directive 2015/996 establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council. This replaced Annex II of the END, removed the recommended Interim Methods, and established the common noise assessment methods.

The Directive sets out the noise calculation methods in the Annex, and some guidance on aircraft modelling, and database tables of input data for roads, railways and aircraft in a series of Appendices. The Directive is an EC legal document which was to be transposed into law within each Member State by 31 December 2018. The CNOSSOS-EU methods set out within the Directive were to be used for strategic noise maps under the END from 31 December 2018. European Communities (Environmental Noise) Regulations 2018[11] (S.I. 549/2018) transpose Commission Directive (EU) 2015/996 into Irish law.

It is understood that the methodologies set out within the Annex are mandatory, whilst the guidance and database tables within Appendices are advisory, however it is advised that legal opinion should be sought on this interpretation.

The CNOSSOS-EU methodologies within Directive 2015/996 may be summarised as follows:

- Road traffic source

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[7] Road noise prediction 2 -Noise propagation computation method including meteorological effects (NMPB 2008). Available at: https://www.researchgate.net/publication/263920715_Road_noise_prediction_2_-_Noise_propagation_computation_method_inclu_ding_meteorological_effects_NMPB_2008 [Accessed June 2022]

[8] ISO 9613-2:1996 Acoustics — Attenuation of sound during propagation outdoors — Part 2: General method of calculation. Available at: https://www.iso.org/standard/20649.html [Accessed June 2022]

[9] Harmonoise project. Available at: https://cordis.europa.eu/project/id/IST-2000-28419 [Accessed June 2022]

[10] https://circabc.europa.eu/ui/welcome [Accessed May 2022]

[11] https://www.irishstatutebook.ie/eli/2018/si/549/made/en/print [Accessed July 2022]

  - Derived from the Harmonoise & IMAGINE projects road traffic model, simplified for strategic noise mapping with fewer emission heights and octave band input data and emissions rather than third-octave bands;
- Railway traffic source
  - Derived from the Harmonoise & IMAGINE projects railway traffic model, simplified for strategic noise mapping with fewer emission heights;
- Industrial noise sources
  - Based on sound power emissions for point, line and area sources considered appropriate to represent the industrial noise sources being assessed.
- Propagation model for road, railway and industrial sources
  - Derived from the outdoor sound propagation methodology within the SETRA report *Road noise prediction 2 - Noise propagation computation method including meteorological effects* (NMPB 2008);
- Aircraft
  - The source and propagation model are based on ECAC Doc 29[12] *Report on Standard Method of Computing Noise Contours around Civil Airports,* 3rd Edition, including some amendments proposed by AIRMOD ahead of preparing the 4th Edition.
- Exposure assessment
  - The exposure of people in dwellings exposed to noise is derived from the German VBEB method, placing receiver points around the facades of buildings.

Details of the methodology set out in Sections 4 to 9 below.

2.4 Corrigendum 2018

Shortly after the Directive was published in 2015 a number of typographical and formatting errors were identified. The majority of these related to the railway source model, and particularly the railway source database tables in Appendix G.

These errors were addressed within the Corrigendum[13] published in January 2018.

2.5 Amendments for CNOSSOS-EU 2019

The Netherlands National Institute for Public Health and the Environment (RIVM) had been undertaking research into the CNOSSOS-EU methodology set out in Directive 2015/996, during which it had identified a number of ambiguities and errors. With the approval of the Commission, during 2018 RIVM established a technical working group consisting of representatives nominated by a number of EU member states. The purpose of this working group was to propose refinements to the CNOSSOS-EU:2015 method.

During the first working group meeting, issues were identified which represented a challenge to the successful implementation of CNOSSOS-EU:2015, each were assigned to one of the

[12] https://www.ecac-ceac.org/documents/ecac-documents-and-international-agreements [Accessed May 2022]
[13] Corrigendum to Commission Directive (EU) 2015/996 of 19 May 2015 establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council, OJ L5/35 to L5/46 of 10th January 2018.

following three categories:

1. An error, unclear text or necessary improvement that needs to be corrected in Annex II;
2. An improvement that may lead to a better method but is not strictly necessary to correct Annex II (wish list); or
3. An issue that does not need to be addressed in Annex II but which should be addressed in a subsequent guidance document.

The output from the working group was published as *Amendments for CNOSSOS-EU Description of issues and proposed solutions*, RIVM Letter report 2019-0023, April 2019. The report includes proposed wording for each of the recommended amendments to the Directive legal text.

The working group **only** addressed issues that fell under category 1. The list of suggested improvements or issues for categories 2 and 3 were presented at the end of the report, but no recommended amendment to Annex II were provided.

Within the category 1 issues which were addressed, there were three classes for the proposed amendments:

1. A clarification of text or fixing a clear error;
    a. To prevent implausible results or different interpretations of the text.
2. An improvement to the method;
    a. Mostly minor changes to the method considered to improve the quality of the results.
3. An issue that was worked on but no final improvement has been decided upon.
    a. A known issue but without a satisfactory solution which could be identified within the time frame of the working group.

The proposed amendments included aspects of the road and railway source models and database tables, and the propagation method. The aircraft noise method was not considered.

2.6 ISO/TR 17534-4:2020

A number of the members of the RIVM working group were members of the ISO working group for the ISO 17534 series of standards on *Acoustics — Software for the calculation of sound outdoors*.

ISO 17534-1 describes the general approach of the ISO 17534 series, aiming to facilitate a standardized interpretation and a verifiably consistent software implementation of outdoor sound calculation methods. ISO/TR 17534-2 contains general recommendations for test cases and for a quality assurance interface. Further parts of the ISO 17534 series each address a specific outdoor sound calculation method for which they provide an agreed interpretation of ambiguous aspects, a set of illustrative test cases along with reference solutions, and an example of a template form for the declaration of conformity for software developers.

This ISO Technical Report[14] sets out a number of agreed interpretations of ambiguities to the propagation methodology within the 2015 Directive. These amendments are consistent with the proposals within the 2019 RIVM report.

It also sets out a range of 28 test cases with detailed known solutions to enable software developers to self-certify compliance with the methodology. Calculation software which is certified to ISO/TR 17534-4 meets the Directive quality criteria for software within the Quality Framework, as discussed in Section 4 below.

2.7 Commission Delegated Directive (EU) 2021/1226

Following the publication of the RIVM report proposing amendments to Directive 2015/996, the Commission prepared a draft Delegated Directive for discussion within the Noise Expert Group[15].

In parallel, the expert group of the European Civil Aviation Conference (ECAC) called AIRMOD (for "Aircraft Modelling"), where the Commission and interested parties from the EU Member States are members, adopted a new version of the European Civil Aviation Conference noise calculation method, called ECAC Doc 29 4th version. The Noise Expert Group requested to the Commission to keep the method of the ECAC and the method of the Annex II of Directive 2002/49/EC aligned.

A draft Delegated Directive went to public consultation between 5th August and 2nd September 2020[16] and received 54 contributions. Eight contributions were then taken into account by refining minor elements, mostly concerning the definition of roads and railways in agglomerations and the distribution of dwellings.

The Commission then consulted the Noise Expert Group[17] on the 12 October 2020. The experts agreed with the draft presented by the Commission after very few additional refinements, and gave their positive opinion as a group. The Council and the European Parliament were notified via the internal register of expert groups.

The final text of the Commission Delegated Directive[18] was published in December 2020, and published in the Official Journal on 28th July 2021. The consolidated version of Directive 2002/49/EC[19], includes the amended Annex II. European Communities (Environmental Noise)

[14] ISO/TR 17534-4:2020, Acoustics — Software for the calculation of sound outdoors — Part 4: Recommendations for a quality assured implementation of the COMMISSION DIRECTIVE (EU) 2015/996 in software according to ISO 17534-1, November 2020

[15] https://circabc.europa.eu/ui/group/7ee2560e-7a0d-4e16-8c61-f3a05ee2dd6f/library/580f55aa-93d3-4737-af03-f37480e7c0a1 [Accessed May 2022]

[16] https://ec.europa.eu/info/law/better-regulation/have-your-say/initiatives/11697-Assessment-and-management-of-environmental-noise_en [Accessed May 2022]

[17] Noise Expert Group. Available at: https://ec.europa.eu/transparency/expert-groups-register/screen/expert-groups/consult?do=groupDetail.groupDetail&groupID=2809&Lang=EN [Accessed June 2022]

[18] Commission Delegated Directive (EU) 2021/1226 of 21.12.2020 amending, for the purpose of adapting to scientific and technical progress, Annex II of Directive 2002/49/EC of the European Parliament and the Council as regards common noise assessment methods, OJ L269/65 to L269/142 of 28th July 2021.

[19] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02002L0049-20210729 [Accessed May 2022]

(Amendment) Regulations 2021[20] (S.I. 663/2021) transpose, inter alia, Commission Delegated Directive (EU) 2021/1226 into Irish law.

Within this guidance, the consolidated version of CNOSSOS-EU, including Directive 2015/996, the 2018 Corrigendum and the 2020 Delegated Directive, is referred to as CNOSSOS-EU:2020 to clarify that it includes the revisions, as opposed to CNOSSOS-EU:2015 denoting the original version.

An overview of the CNOSSOS-EU:2020 methodology is set out in Sections 4 to 9 below.

[20] https://www.irishstatutebook.ie/eli/2021/si/663/made/en/print [Accessed July 2022]

3 General Provisions of CNOSSOS-EU

Chapter 2.1 of Directive 2015/996 on *General provisions — Road traffic, railway and industrial noise* has been amended in parts by the Corrigenda of January 2018, and the Delegated Directive of December 2020. The advice below is based on the consolidated text[21].

Chapter 2.6 of Directive 2015/996 on *General provisions — Aircraft noise* sets out the definitions, symbols and quality framework for aircraft noise. Chapter 2.6 has not been amended by the Corrigendum or Delegated Directive.

The L_{den} and L_{night} noise indicators are to be determined at the assessment positions by computation according to the common noise assessment methods set out in Chapter 2 and the data described in Chapter 3. Measurements may be performed according to Chapter 4.

The Chapter 2 common noise assessment methods are discussed in detail in Sections 5 to 9 of this report, in Chapter 4 the structure, general provisions, quality framework, input data and measurement methods will be outlined.

3.1 Structure

The CNOSSOS-EU:2020 methods consist of separate modelling parts:

- There are separate emission models for road, rail, industry and aircraft noise, which describe the sound power emitted by the source as a function of vehicle or source type, traffic intensity and composition, operating conditions and local characteristics (e.g., pavement or track type);

- The propagation model for road, rail and industry noise is derived from the French NMPB 2008 model. It specifies the noise attenuation due to the distance, air absorption, terrain heights, reflections and diffraction from barriers and buildings, and the influence of the ground depending on its composition. Typical for the CNOSSOS-EU:2020 propagation model is the calculation of two meteorological scenarios, for homogeneous conditions (straight noise paths) and favourable conditions (downward curved paths), the results of which are combined with a location-specific fraction based on the occurrence of favourable propagation.

- For aircraft noise, a separate 3D propagation model is available based, together with the emission model, on the ECAC Doc29 4th Edition.

- For the receivers, it is specified how the area exposed to noise should be assessed from receiver grids, how the receiver points should be placed on the dwelling façades, and how the number of people in buildings and dwellings should be attributed to the calculated façade noise levels (L_{den} and Lnight).

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[21] Consolidated text: 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. Available at: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A02002L0049-20210729 [Accessed June 2022]

3.2 General Provisions

Under CNOSSOS-EU:2020 calculations are to be undertaken in the frequency range from 63 Hz to 8 kHz in octave bands. Calculations are performed in octave bands for road traffic, railway traffic and industrial noise, except for the railway noise source sound power, which uses third octave bands.

For roads and railway traffic in agglomerations, the A-weighted long-term average sound level is determined by the contribution from road and railway segments therein, including major roads and major railways.

3.3 Quality Framework

3.3.1 Accuracy of input values

The CNOSSOS-EU:2020 method includes a quality framework in Chapter 2.1.2 for road, railway and industrial noise, and Chapter 2.6.2 for aircraft noise.

Chapter 2.1.2 includes the following on the accuracy of input values:

> *"All input values affecting the emission level of a source shall be determined with at least the accuracy corresponding to an uncertainty of ±2 dB(A) in the emission level of the source (leaving all other parameters unchanged)."*

Chapter 2.6.2 includes the following on the accuracy of input values for aircraft:

> *"All input values affecting the emission level of a source, including the position of the source, shall be determined with at least the accuracy corresponding to an uncertainty of ± 2dB(A) in the emission level of the source (leaving all other parameters unchanged)."*

This defines an acceptable range of uncertainty in the emission sound power level due to the influence of any specific uncertainty in the input values. This enables default values to be used for certain source input parameters provided that they have less than ±2 dB(A) influence on the output sound power level.

Guidance Note 1: The recommended interpretation of the quality criteria is that the input data to be used should introduce less than ±2.0 dB(A) 95% C.I. influence on the output, where the 95% confidence interval is the mean ±2 standard deviations for a normal distribution.

This interpretation comes from the DG JRC CNOSSOS-EU Reference Report 2012, and is consistent with the accuracy statements within the WG-AEN GPG v2[22], 2007.

[22] http://sicaweb.cedex.es/docs/documentacion/Good-Practice-Guide-for-Strategic-Noise-Mapping.pdf [Accessed May 2022]

3.3.2 Use of default values

It is required that the input data shall reflect the actual usage, and in general there shall be no reliance on default input values or assumptions, unless the collection of real data is associated with disproportionately high costs.

Guidance Note 2: Where it is proposed to use default input values or assumptions within the noise model, it is recommended that a brief high-level estimation is made of the impact on the calculated noise level results, alongside the practicality, time and cost implications of collecting actual data, or licensing available data.

3.3.3 Quality of software used for the calculations

It is required that software used to perform the CNOSSOS-EU:2020 calculations shall prove compliance by means of certification of results against test cases, as set out in Chapters 2.1.2 and 2.6.2 also include:

> *"Software used to perform the calculations shall prove compliance with the methods herewith described by means of certification of results against test cases."*

Guidance Note 3: Software certified by the developers under ISO/TR 17534-4:2020 would meet this requirement for the road, railway and industry propagation method. ECAC Doc 29 4th Edition includes reference cases and a verification framework for aircraft in flight which may be used to confirm compliance with the method.

3.4 Input Data

Chapter 3 states that input data to be used as appropriate with the CNOSSOS-EU:2020 methods are presented in Appendix F to Appendix I.

In cases where the data in Appendix F to Appendix I are not applicable, or cause deviations from the true value that do not meet the quality framework, other values can be used. This is providing that the values used, and the methodology used to derive them, are sufficiently documented, including demonstrating their suitability and the information is made publicly available.

This means that noise mapping bodies may use alternative data to that set out in Appendix F to Appendix I of the CNOSSOS-EU:2020 methodology, providing that it is considered more appropriate, is fully documented, and is publicly available.

Guidance Note 4: TII and Irish Rail have undertaken research into CNOSSOS-EU and have published reports which include; road surface corrections, railway vehicle source terms, and meteorological correction values, relevant to the situation in Ireland. It is recommended that this published data is used where applicable.

To date, TII research publications on meteorological corrections[23], road surface corrections[24,25] and light rail[26] noise sources have been published, and Irish Rail research of rail vehicles[27].

3.5 Measurement Methods

Chapter 4 states that when measurements are performed, for any reason, they shall be in accordance with the principles governing long term average measurements stated in ISO 1996-1:2003 and ISO 1996-2:2007, or ISO 20906:2009 for aircraft noise.

Guidance Note 5: It is recommended that the latest versions of ISO 1996 and ISO 20906 are used, rather than the dated versions in the Directive. The current versions are ISO 1996-1:2016, ISO 1996-2:2017, and ISO 20906:2013.

The original version of Annex II stated that suitable noise emission data for the assessment of industrial noise could be obtained using ISO 8297, ISO 3744 or ISO 3746. The three standards referenced in CNOSSOS-EU:2020 are not appropriate for obtaining suitable emission data for industrial noise sources, however the phrase "for any reason" appears to preclude the use of other measurement standards.

Guidance Note 6: When measurements are performed to collect suitable noise emission data for the assessment of industrial noise, it is recommended that the data is obtained in line with the latest versions of ISO 8297, ISO 3744 or ISO 3746 as appropriate.

It should be noted that CNOSSOS-EU:2020 Chapter 2.5.1 on the calculation of sound propagation states that *"Industrial infrastructures that emit impulsive or strong tonal noises as described in ISO 1996-2:2007 do not fall within the scope of this method."*

[23] Common Noise Assessment Methods in Europe (CNOSSOS-EU): Meteorological Correction Factors for Ireland, RE-ENV-07007, TII, October 2022. Available at: https://www.tiipublications.ie/advanced-search/results/document/?id=3214 [Accessed September 2024]
[24] Determination of Irish Road Surface Correction Factors for CNOSSOS, GE-ENV-01108, TII, May 2024. Available at: https://www.tiipublications.ie/advanced-search/results/document/?id=3328 [Accessed September 2024]
[25] TII CNOSSOS Road Surface Corrections. Available at: https://www.tii.ie/en/technical-services/environment/noise-maps/ [Accessed September 2024]
[26] TII Luas Vehicle and Track Coefficients. Available at: https://www.tii.ie/en/technical-services/environment/noise-maps/ [Accessed September 2024]
[27] Link to IR rail vehicle noise report, when published.

4 Road Traffic Source

Chapter 2.2 of Directive 2015/996 on *Road traffic noise* has been amended in parts by the Corrigenda of January 2018, and the Delegated Directive of December 2020. The advice below is based on the consolidated text referred to as CNOSSOS-EU:2020.

4.1 Traffic Composition by Vehicle Category

CNOSSOS-EU:2020 describes the sound power of a single vehicle as the respective contributions from the tyre / road interaction and of the propulsion. CNOSSOS-EU:2020 has five vehicle categories (Table 4.1):

- Category 1: Light motor vehicles.
- Category 2: Medium heavy vehicles.
- Category 3: Heavy vehicles.
- Category 4: Powered two-wheelers (separated into two sub-classes for mopeds and powered motorcycles).
- Category 5: Open category (new vehicles developed in the future, for example, electric or hybrid vehicles or other future developments).

Table 4.1: CNOSSOS-EU vehicle class definition

Vehicle classes

Category	Name	Description		Vehicle category in EC Whole Vehicle Type Approval (1)
1	Light motor vehicles	Passenger cars, delivery vans ≤ 3,5 tons, SUVs (2), MPVs (3) including trailers and caravans		M1 and N1
2	Medium heavy vehicles	Medium heavy vehicles, delivery vans > 3,5 tons, buses, motorhomes, etc. with two axles and twin tyre mounting on rear axle		M2, M3 and N2, N3
3	Heavy vehicles	Heavy duty vehicles, touring cars, buses, with three or more axles		M2 and N2 with trailer, M3 and N3
4	Powered two-wheelers	4a	Two-, Three- and Four-wheel Mopeds	L1, L2, L6
		4b	Motorcycles with and without sidecars, Tricycles and Quadricycles	L3, L4, L5, L7
5	Open category	To be defined according to future needs		N/A

(1) Directive 2007/46/EC of the European Parliament and of the Council of 5 September 2007 establishing a framework for the approval of motor vehicles and their trailers, and of systems, components and separate technical units intended for such vehicles (OJ L 263, 9.10.2007, p. 1).
(2) Sport Utility Vehicles.
(3) Multi-Purpose Vehicles.

It is envisaged that additional vehicle categories would be added to CNOSSOS-EU:2020 as technology develops. It is currently expected that Category 5 may be used for electric and hybrid (EV/HV) Category 1 light vehicles which have a lower sound emission below approximately 35 km/h. A recent study by M+P for Defra[28] provided an outline methodology for determining the relevant emission factors for EV/HV light vehicles. In the future, it may be relevant to define electric buses and heavy delivery vehicles.

Guidance Note 7: Where it is not possible to identify medium heavy and heavy vehicles separately from traffic count data, it is recommended to split the heavy vehicles 50:50 between categories 2 and 3.

Guidance Note 8: Where it is expected that powered two-wheelers will have negligible effect on the overall sound power emission from major roads, it is recommended that they may be ignored. Where powered two-wheelers may be expected to have an effect on urban roads inside agglomerations, it is recommended that the ratio is based on national registration statistics, which were approximately 7% Category 4a and 93% Category 4b.

The ratio was derived from CSO statistics for first licensed motorcycles from 2015 to 2020, "TEA22 - Motor Cycles Licensed for the First Time"[29].

4.2 Number and Position of Equivalent Sources

Each vehicle category is represented by a single point located 5 cm above the road surface. The first reflection on the road surface directly under the source is treated implicitly as part of the source emission terms and road surface correction.

The traffic flow is represented by a source line. When modelling a road with multiple lanes, each lane should ideally be represented by a source line placed in the centre of each lane. However, it is also acceptable to model one source line in the middle of a two-way road or one source line per carriageway in the outer lane of multi-lane roads.

Guidance Note 9: It is recommended that OSi PRIME2 WAY GDF1 data is used for the road source geometry. It has one source line for one-way and regular 2-way roads, and a source line per carriageway for dual-carriageway and motorway roads.

4.3 Traffic Flow and Vehicle Speed

For the CNOSSOS-EU:2020 methodology, it is required to assign traffic flow values and speeds:

- to each road source line included in the model;

[28] De Graaff E., Peeters B., Road Traffic Noise Modelling: Development of a Methodology to Define Category 5 Vehicles, M+P report M+P.DEFRA.18.01.2, revision 2, 20 January 2020. Available at: https://randd.defra.gov.uk/ProjectDetails?ProjectId=20479 [Accessed September 2024]
[29] Dataset: TEA22 - Motor Cycles Licensed for the First Time. Available at: https://datasetguide.com/dataset/7d3564711621e20a39bce48367fa2f16/ [Accessed May 2022]

- for each vehicle category;
- for each time period:
    - Day 07:00-19:00 hrs,
    - Evening 19:00-23:00 hrs, and
    - Night 23:00-07:00 hrs.

Guidance Note 10: Each traffic flow value should be the annual average number of **vehicles per hour**, within each time period.

Guidance Note 11:
a) The minimum value of annual average speed which should be assigned is 20 km/h, any lower measured values should be changed to 20 km/h;
b) Where annual average speed is not known, it is recommended to assign the speed limit for the section of road; and
c) Where the speed limit is assigned, the lower of the speed limit and the maximum vehicle speed should be assigned, e.g., HGVs on motorways, or Cat 4a mopeds on all roads.

4.4 Total Sound Power Level (SWL) of Single Vehicle

In the traffic flow, each vehicle is modelled by a set of mathematical equations representing the two main noise sources:

1. Rolling noise due to the tyre/road interaction;
2. Propulsion noise produced by the driveline (engine, exhaust, etc.) of the vehicle.

Aerodynamic noise is incorporated in the rolling noise source. For two-wheelers (Category 4a and 4b) rolling noise is not considered, only the propulsion noise.

4.5 Reference Conditions

The source equations and coefficients are valid for the following reference conditions:

- A constant vehicle speed;
- A flat road;
- An air temperature τ_{ref} = 20 °C;
- A dry road surface;
- No studded tyres; and
- A virtual reference road surface, consisting of an average of dense asphalt concrete 0/11 and stone mastic asphalt 0/11, between 2 and 7 years old and in a representative maintenance condition.

Whilst it is not specified within CNOSSOS-EU:2020, the road traffic emission model is derived from the model output from the Harmonoise & IMAGINE projects, which additionally specified that the reference conditions include:

- A vehicle fleet representing the average of vehicles over the whole of Europe:
    - 187mm tyre width for Category 1;
    - 19% diesel for Category 1;
    - 10.5% delivery vans in Category 1;
    - No studded tyres;
    - 4 axles for Category 3; and
    - 35% IRESS (illegal replacement exhausts) for Category 4, 1% for other categories.

Where the reference road surface or average fleet components are considered to be unrepresentative of the situation, it may be appropriate to develop rolling and propulsion coefficients, and road surface correction factors which more closely align with the local situation.

4.6 Rolling Noise

The rolling noise component accounts for the noise emitted from the interaction of the vehicle tyres with the road surface.

The rolling noise coefficients are given in octave bands for each vehicle category at a reference speed of V_{ref} = 70 km/h and under reference conditions.

Correction terms then account for variation away from reference conditions for:

- Road surface types with properties different from the virtual reference surface, including the effects of both generation and propagation;
- Studded tyres resulting in higher rolling noise;
- Acceleration/deceleration effects on rolling noise of a crossing with traffic lights or a roundabout. It integrates the effect on noise of the speed variation, meaning that the speed is modelled as the same speed as a section of the road away from the crossing; and
- Air temperature correction for the local average temperature where it is different from the reference temperature τ_{ref} = 20 °C.

Guidance Note 12: TII have published research reports which include road surface corrections relevant to the situation in Ireland. It is recommended that this published data is used where applicable.

The TII research publication on road surface corrections[30,31] sets out additional road surface correction factors applicable for road surface construction commonly in use on the National roads network in Ireland.

4.6.1 *Correction for studded tyres*

Guidance Note 13: Studded tyres are forbidden in Ireland, and therefore may be excluded from the noise assessment by setting the fraction of studded tyres to zero.

4.6.2 *Effect of air temperature on rolling noise correction*

The effect of air temperature is represented in the temperature correction term. The correction term is positive (i.e., noise increases) for temperatures lower than 20 °C and negative (i.e., noise decreases) for higher temperatures.

The temperature correction term only applies to the rolling noise component, and is applied equally on all octave bands. The change in emission is only small; 0.08 dB/°C for light vehicles (Cat. 1), and 0.04 dB/°C for heavy vehicles (Cat. 2 and 3).

Guidance Note 14: TII have published a research report which includes meteorological correction values for each County in Ireland. It is recommended that this published data is used where applicable.

The TII research publications on meteorological corrections[32] sets our long-term annual average temperature, humidity, pressure and occurrence of favourable propagations values for each County in Ireland, derived from long term meteorological data.

4.7 Propulsion Noise

The propulsion noise component accounts for the noise emitted from the vehicle engine, exhaust, gears, air intake etc.

The propulsion noise coefficients are given in octave bands for each vehicle category and for a reference speed V_{ref} = 70 km/h and under reference conditions.

Correction terms then account for variation away from reference conditions for:

- Road surface type with absorption effects on the propulsion noise different from the virtual reference surface;

[30] Determination of Irish Road Surface Correction Factors for CNOSSOS, GE-ENV-01108, TII, May 2024. Available at: https://www.tiipublications.ie/advanced-search/results/document/?id=3328 [Accessed September 2024]
[31] TII CNOSSOS Road Surface Corrections. Available at: https://www.tii.ie/en/technical-services/environment/noise-maps/ [Accessed September 2024]
[32] Common Noise Assessment Methods in Europe (CNOSSOS-EU): Meteorological Correction Factors for Ireland, RE-ENV-07007, TII, October 2022. Available at: https://www.tiipublications.ie/advanced-search/results/document/?id=3214 [Accessed September 2024]

- Gradient effect on propulsion noise; and
- Acceleration / deceleration effects on propulsion noise at intersections.

4.7.1 *Effect of road gradients*

In practice, the road gradient has two effects on the noise emission of the vehicle: (1) it affects the vehicle speed and thus the rolling and propulsion noise emission of the vehicle; (2) it affects both the engine load and the engine speed via the choice of gear and thus the propulsion noise emission of the vehicle. CNOSSOS-EU:2020 only considers the effect on the propulsion noise, a steady speed is assumed as the effect of slope on speed is included implicitly in the correction.

The effect of the road gradient on the propulsion noise is taken into account by the correction term which is a function of the slope in %, the representative vehicle speed in km/h, and the vehicle category. The correction term is attributed to all octave bands equally.

The correction term is applied differently for each vehicle category and depends on whether the slope is positive or negative relative to the direction of traffic flow. In the case of a bi-directional traffic flow, it is necessary to split the flow into two components and correct half for uphill and half for downhill. The maximum slope correction is achieved at ±12%.

- For Category 1 vehicles, the gradient correction is zero between -6% and +2%, the correction decreases with speed downhill, and increases with speed uphill, and has a correction value of +2 dB at -12% or more, and +1 dB at +12% or more at 50 km/h.
- For Category 2 vehicles, the gradient correction is zero between -4% and 0%, the correction increases with speed, and has a correction value of approximately +5 dB at -12% or more, and +7.5 dB at +12% or more at 80 km/h.
- For Category 3 vehicles, the gradient correction is zero between -4% and 0%, the correction increases with speed, and has a correction value of +4.5 dB at -12% or more, and +9 dB at +12% or more.
- Category 4a and 4b vehicles are unaffected by road gradient according to the method.

Guidance Note 15: It is recommended that an accurate digital terrain model (DTM) and digital surface model (DSM) are used to assign height data to the road centrelines, and this is used in turn to calculate the gradient of the road segments, with checks put in place to identify and fix any unrealistic values caused by the DTM. It is also recommended to confirm that the calculation software used correctly splits the traffic flow into uphill and downhill portions when determining the gradient correction.

4.8 Effect of the acceleration and deceleration of vehicles

Before and after crossings with traffic lights and roundabouts a correction shall be applied for the effect of acceleration and deceleration as described below.

The correction terms for rolling noise and for propulsion noise are linear functions of the distance in metres to the nearest intersection of the respective source line with another source line. The correction includes the effect of change in speed when approaching or moving away from a crossing or a roundabout. The rolling and propulsion corrections are both zero for distances ≥ 100 m.

CNOSSOS-EU:2020 database values for the rolling and propulsions correction coefficients are provided in Table F-3 in Appendix F, reproduced below as Table 4.2. It can be seen from Table 4.2 that there is no correction for powered two-wheelers (Category 4a and 4b).

The EPA has undertaken a technical investigation[33] into the effects of the correction for indicative traffic flows which may be experienced on a range of road types. This investigation indicates that the correction factors increase the noise levels for the examples with lower traffic flows, and decreases the noise levels for the examples with higher traffic flows.
The results indicate that the effect is less than 2 dBA in many cases, and therefore could be ignored, however at low speeds and low traffic flow levels the correction factor can exceed 2 dBA, as illustrated in Figures 4.1 and 4.2.

Table 4.2: Coefficients the C_r and C_p for acceleration and deceleration

Category	k	Cr	Cp
1	1 = crossing 2 = roundabout	− 4,5 − 4,4	5,5 3,1
2	1 = crossing 2 = roundabout	− 4 − 2,3	9 6,7
3	1 = crossing 2 = roundabout	− 4 − 2,3	9 6,7
4a	1 = crossing 2 = roundabout	0 0	0 0
4b	1 = crossing 2 = roundabout	0 0	0 0
5	1 = crossing 2 = roundabout		

[33] Link to EPA technical investigation into junctions and roundabouts

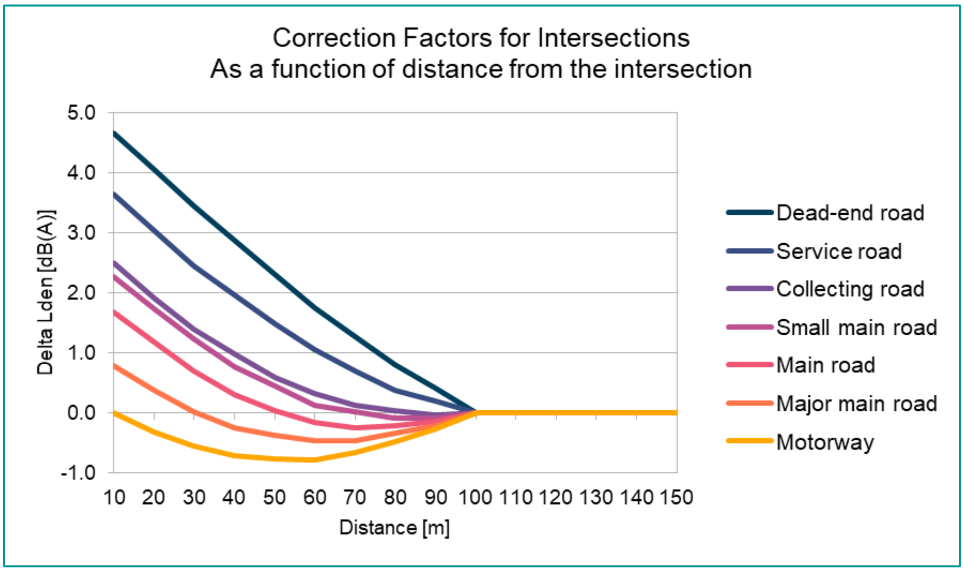


Figure 4.1: Change in L_{den} near to traffic light-controlled junctions

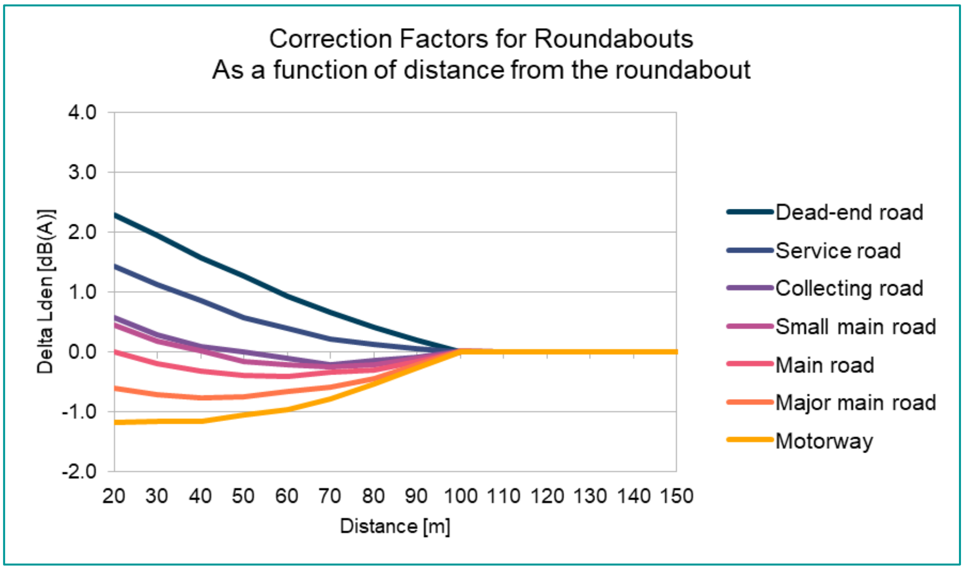


Figure 4.2: Change in L_{den} near to roundabouts

Guidance Note 16: The change in noise level due to the traffic light junction correction exceeds 2 dBA for roads with a traffic flow below approximately AADT 4,000 vehicles per 24 hours. It is recommended that if such roads are included within the R4 strategic noise mapping of agglomerations, the model should include the correction for traffic light-controlled junctions.

4.9 Effect of the type of road surface

For road surfaces with acoustic properties different from those of the reference surface, a spectral correction term for both rolling noise and propulsion noise shall be applied.

The CNOSSOS-EU:2020 model defines the road surface corrections for rolling noise and propulsion noise. Absorbing surfaces decrease the propulsion noise, while non-absorbing surfaces do not increase it.

The coefficients are different for each vehicle category: light, medium, heavy vehicles. For powered two-wheelers (4a/4b) corrections are zero.

Table F-4 provides road surface correction factors for 14 surface types, and includes a description of the surface, being an unofficial translation from Dutch, with the speed range for which it is considered valid.

The noise characteristics of road surfaces vary with age and the level of maintenance, with a tendency to become louder over time. CNOSSOS-EU:2020 road surface parameters are derived to be representative for the acoustic performance of the road surface type averaged over its typical lifetime and assuming proper maintenance.

Guidance Note 17: TII have published research reports which include road surface corrections for a number of pavements typically used on the National roads network in Ireland. It is recommended that this published data is used where applicable.

The TII research publication on road surface corrections[34,35] sets out additional road surface correction factors applicable for road surface construction commonly in use on the National roads network in Ireland.

[34] Determination of Irish Road Surface Correction Factors for CNOSSOS, GE-ENV-01108, TII, May 2024. Available at: https://www.tiipublications.ie/advanced-search/results/document/?id=3328 [Accessed September 2024]
[35] TII CNOSSOS Road Surface Corrections. Available at: https://www.tii.ie/en/technical-services/environment/noise-maps/ [Accessed September 2024]

5 Railway Traffic Source

Chapter 2.3 of Directive 2015/996 on *Railway noise* has been amended in parts by the Corrigenda of January 2018, and the Delegated Directive of December 2020. The advice below is based on the consolidated text referred to as CNOSSOS-EU:2020.

5.1 Source Description

CNOSSOS-EU:2020 describes the sound power of a single rail vehicle, defined as any single railway sub-unit of a train (typically a locomotive, a self-propelled coach, a hauled coach or a freight wagon) that can be moved independently and can be detached from the rest of the train. For the purpose of this calculation method, a train consists of a series of coupled vehicles.

The number of vehicles for each type shall be determined:

- On each of the track sections,
- For each of the time periods,
- As an average number of vehicles per hour, and
- All vehicle types travelling on each track section shall be used.

Guidance Note 18: It is recommended that a catalogue is prepared which details the number and type of rail vehicles which make up each train running on the track sections being modelled.

5.1.1 Equivalent Sources

Two equivalent sources are defined for each vehicle, at heights of 0.5 m (Source A) and 4 m (Source B) above the railhead, as shown in Figure 5.1. These are both to be placed as line sources on the centreline of the railway track, with the height taken from the upper surface of the railheads.

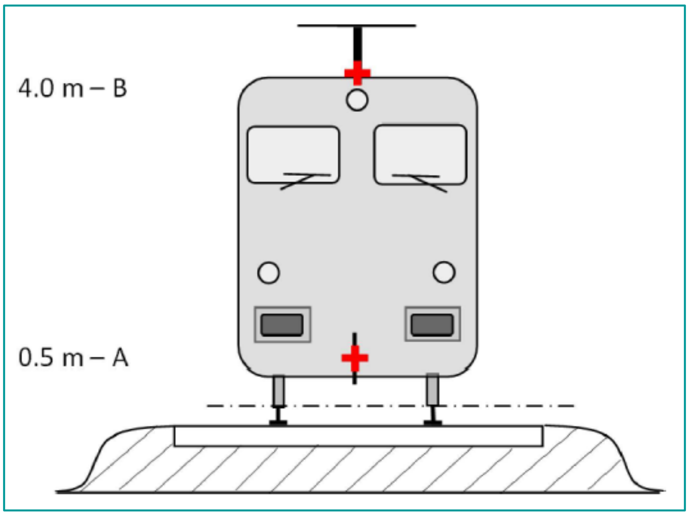


Figure 5.1: Equivalent source positions
(Figure [2.3.a] from CNOSSOS-EU:2020)

Individual physical emission sources are assigned to one or both equivalent source positions as follows:

(1) The rolling noise is allocated to Source A at 0.5 m, and includes roughness of wheels and railheads, through three transmission paths to the radiating surfaces (rails, wheels and superstructure).

(2) The traction noise is allocated to both Source A at 0.5 m to represent low sources such as gear transmission and electric motors, and Source B at 4.0 m typically representing louvres, cooling outlets or diesel exhausts.

(3) Aerodynamic effects are allocated to both Source A at 0.5 m representing the shrouds and the screens, and Source B at 4.0 m typically representing over roof apparatus and pantographs.

(4) Impact noise due to joints, switches and turnouts is allocated to Source A at 0.5 m.

(5) Squeal noise is allocated to Source A at 0.5 m.

(6) Bridge structure re-radiated noise is allocated to Source A at 0.5 m.

Guidance Note 19: It is recommended that OSi PRIME2 RAIL NETWORK SEGMENT LINE, GDF_LEVEL = 1 data is used for the railway source geometry. It has one source line mid-way between the railheads of each rail line within the route corridor.

5.1.2 *Traffic Flow and Vehicle Speed*

For the CNOSSOS-EU:2020 methodology, it is required to assign traffic flow values and speeds:

- To each railway source line included in the model;
- For each railway vehicle type;
- For each time period:
  - Day 07:00-19:00 hrs,
  - Evening 19:00-23:00 hrs, and
  - Night 23:00-07:00 hrs.

Guidance Note 20: For each railway vehicle type, the traffic flow value should be the annual average number of **vehicles per hour**, within each time period.

5.2 Sound power emission

The sound power level (SWL) per metre of the two emission sources are calculated in third-octave bands based on sum of all individual rail vehicles along a track section in an hour. Two running conditions are considered, constant speed and idling (stationary).

The idling condition is only to be used for temporary halts of less than 30 minutes; otherwise, longer periods of idling should consider the rail vehicle as a fixed-point source as described in Section 6 on industrial noise below.

Guidance Note 21: TII and Irish Rail have undertaken research into CNOSSOS-EU and have published reports which include railway vehicle source terms for light and heavy rail vehicles relevant to the situation in Ireland. It is recommended that this published data is used where applicable.

The TII research publication on light rail[36], and Irish Rail research of heavy rail vehicles[37] includes additional database entries to be used with CNOSSOS-EU:2020 to more accurately model LUAS light rail and Irish Rail heavy rail vehicles.

5.2.1 Rolling Source

Rolling source emission results from the roughness of the wheels and track surface (rails), resulting in vibrations from which radiate through the rails, wheels, and superstructure (in freight vehicles), and transform into airborne sound. These sources are allocated to equivalent Source A. The rolling source emission is only included when the vehicle is moving not idling.

The rolling source comprises vibration excitation caused by wheel and rail roughness at the contact point, combined with transfer functions representing the complex system of the other connected elements of the vehicle and track. These spectra and functions will be dependent on the rail vehicle and track type.

$$L_{R,TOT,i} = 10 \cdot \lg(10^{L_{r,TR,i}/10} + 10^{L_{r,VEH,i}/10}) + A_{3,i}$$

The total effective roughness level, $L_{R,TOT,i}$, is provided in terms of roughness levels in the form of wavelength spectra for both rail, ($L_{r,TR,i}$) and wheel ($L_{r,VEH,i}$) as well as a contact filter wavelength spectrum, $A_{3,i}$. These wavelength spectra, λ, are to be converted to frequency spectra, f, according to $f=v/\lambda$, where v is the speed of the vehicle in m/s. The subscript, i, refers to each 1/3 octave band.

In the equation above and the remainder of this report, "lg( )" is equivalent to logarithm base 10 ("$\log_{10}$()").

Transfer functions for track, $L_{H,TR,i}$, wheels, $L_{H,VEH,i}$, and vehicle superstructure, $L_{H,VEHSUP,i}$, (the latter only applies to freight vehicles) relate $L_{R,TOT,i}$ with the L_W (i.e., SWL) of these elements, where i is the 1/3 octave band.

They are added to $L_{R,TOT,i}$ and the resulting rolling noise SWL also accounts for the number of axles, N_a, on the vehicle, as shown below. These relationships are demonstrated in the diagram in Figure 4, where i is the 1/3 octave band.

$$L_{W,0,TR,i} = L_{R,TOT,i} + L_{H,TR,i} + 10 \times \lg(N_a)$$

$$L_{W,0,VEH,i} = L_{R,TOT,i} + L_{H,VEH,i} + 10 \times \lg(N_a)$$

[36] TII Luas Vehicle and Track Coefficients. Available at: https://www.tii.ie/en/technical-services/environment/noise-maps/ [Accessed September 2024]
[37] Link to IR rail vehicle noise report, when published.

$$L_{W,0,VEHSUP,i} = L_{R,TOT,i} + L_{H,VEHSUP,i} + 10 \times \lg(N_a)$$

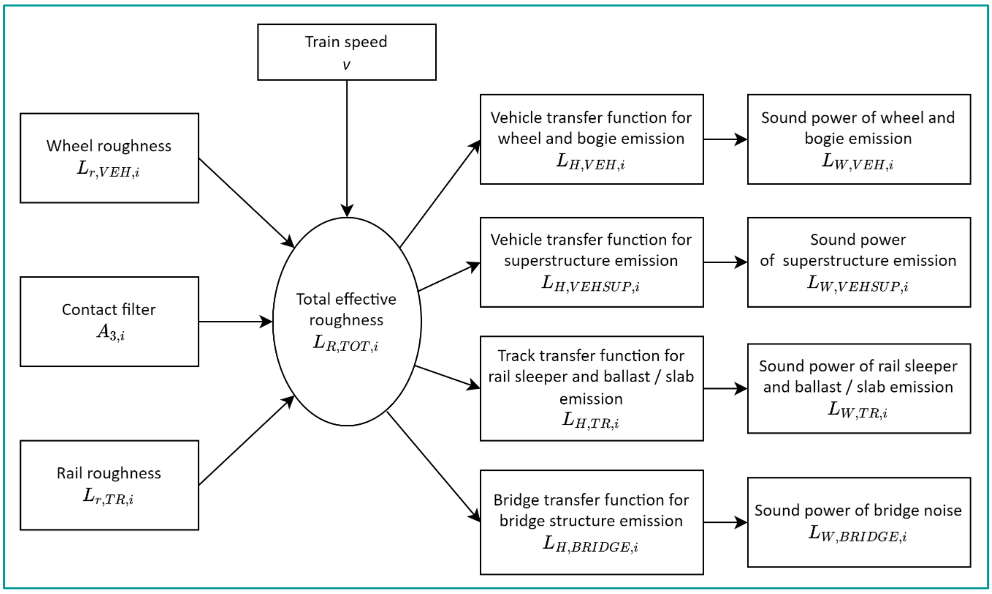


Figure 5.2: Scheme of the use of the different roughness and transfer function definitions (adapted from Figure [2.3.c] from CNOSSOS-EU:2020)

Figure 5.2 has been adapted to include relevant amendments from the Annex to the 2020 Delegated Directive. This update expanded the bridge transfer function, $L_{H,BRIDGE,i}$, as described below, which is now included in parallel to the other transfer functions to form the sound power of the bridge emission.

A minimum speed of 50 km/h (30 km/h only for trams and light metro) shall be used to determine the total effective roughness, and therefore the sound power of the vehicles, to compensate for the potential error introduced by the simplification of rolling noise definition, braking noise definition, and impact noise from crossings and switches definition. However, this minimum speed does not affect the vehicle flow calculation.

5.2.2 Impact Source (crossings, switches and junctions)

Impact sound emission results from wheel impacts with rail joints, rail junctions, crossings and switches. It does not apply under the idling running condition, nor is it valid for heavy rail speeds less than 50 km/h, or light rail speeds less than 30 km/h.

Impact sources are allocated to equivalent Source A by adding an impact roughness level to the total effective roughness for each track section where it is present:

$$L_{R,TOT+IMPACT,i} = 10 \times \lg(10^{L_{R,TOT,i}/10} + 10^{L_{R,IMPACT,i}/10})$$

CNOSSOS-EU:2020 Appendix G Table G-4 gives a default third-octave spectrum for a single joint per 100m, $L_{R,IMPACT\text{-}SINGLE,i}$, as the total impact noise will depend on the number of impact per 100m this value is then scaled by the joint density, n_i:

$$L_{R,IMPACT,i} = L_{R,\ IMPACT\ -\ SINGLE,i} + 10 \times \lg\left(\frac{n_l}{0{,}01}\right)$$

A default joint density of n=0.01 on jointed tracks represents one joint per 100 m of track. For a single joint the emitting track section should be 50 m long either side of the joint, and for a series of joints close together the segment should be 50 m longer either side the series of joints.

Guidance Note 22: When the locations of joints, switches, turnouts, junctions and crossings are known, it is recommended to buffer these locations by 50m to create a 100m long track segment with 1 joint per 100m. Where these buffers overlap, they should be merged to form a longer track segment assigned with the appropriate joint density.

5.2.3 Squeal

Curve squeal is an element of rolling sound emission that results from friction between the wheel and rail on curved tracks, and is allocated to equivalent Source A.

Curve squeal is generally dependent on curvature, friction conditions, train speed, track-wheel geometry and dynamics. The excess noise may be specific to each type of rolling stock, as certain wheel and bogie types may be significantly less prone to squeal than others. If measurements of the excess noise are available that take sufficiently the stochastic nature of squeal into account, these may be used.

Guidance Note 23: Where measurement data for track squeal is available, it should be used rather than the default values. Where rolling stock is known to either squeal or not squeal at specific locations the model should replicate the actual situation.

Where no appropriate measurements are available, a simple approach can be taken. In this approach, squeal noise shall be considered by adding the following excess values to the rolling noise sound power spectra for all frequencies, as shown in Table 3.

The applicability of these sound power spectra or excess values shall normally be verified on-site, especially for trams and for locations where curves or turnouts are treated with measures against squeal.

Table 5.1: CNOSSOS-EU:2020 default curve squeal corrections

Train	5 dB for curves with 300 m $< R \leq$ 500m and $l_{track} \geq$ 50m 8 dB for curves with $R \leq$ 300m and $l_{track} \geq$ 50m 8 dB for switch turnouts with $R \leq$ 300m 0 dB otherwise
Tram	5 dB for curves and switch turnouts with $R \leq$ 200 m 0 dB otherwise

where l_{track} is the length of track along the curve and R is the curve radius.

5.2.4 Traction Noise

Traction noise emissions are specific to the running condition, but CNOSSOS-EU:2020 assumes traction sound emission during acceleration and deceleration is equivalent to that of constant speed under maximum load conditions.

The idling condition is only to be used for temporary halts of less than 30 minutes; otherwise, longer periods of idling should consider the rail vehicle as a fixed-point source as described in Section 6 on industrial noise.

Five default traction sound emission spectra are provided in Appendix G, Table G-5 of the CNOSSOS-EU:2020 source database, derived from the IMAGINE project[38]. These are:

- Diesel locomotive (c. 800 kw; or c. 2200 kw);
- Diesel multiple unit;
- Electric locomotive; and
- Electric multiple unit.

A EuroNoise (2015) article[39] describes an initial approach to categorising rolling stock within existing national methods in terms of the CNOSSOS-EU categories. However, ideally sources are measured under controlled conditions, either individually according to ISO 3095:2013[40], or in unison at each running condition according to the forthcoming draft standard for the measurement of railway source terms being developed within the CEN working group relating to railway noise (TC 256 WG3).

Guidance Note 24: Where possible, traction noise spectra for the most common rail vehicles in the modelled area should be determined following appropriate measurements.

5.2.5 Aerodynamic Source

Aerodynamic sound emission is typically only relevant for speeds greater than> 200 km/h. Its applicability above those speeds is dependent on the vehicle design and is sometimes not needed below 250 km/h if rolling sound power is significantly dominant.

Guidance Note 25: As there are currently no trains in Ireland which operate above 200 km/h the aerodynamic source may be ignored for Round 4 strategic noise mapping.

[38] Beuving M., Hemsworth B., Jones R.R.K. (2008) IMAGINE Rail Noise Sources – A Practical Methodology. In: Schulte-Werning B. et al. (eds) Noise and Vibration Mitigation for Rail Transportation Systems. Notes on Numerical Fluid Mechanics and Multidisciplinary Design, vol 99. Springer, Berlin, Heidelberg. Available at: https://doi.org/10.1007/978-3-540-74893-9_46 [Accessed June 2022]
[39] Paviotti, M., Shilton, J., Jones, R., Jones, N., Conversion of existing railway source data to use CNOSSOS-EU. EuroNoise. 2015. EAA-NAG-ABAV, ISSN 226-5147. Available at: https://www.conforg.fr/euronoise2015/proceedings/data/articles/000537.pdf [Accessed June 2022]
[40] ISO 3095:2013 Acoustics - Railway applications — Measurement of noise emitted by railbound vehicles. Available at: https://www.iso.org/standard/55726.html [Accessed July 2022]

5.2.6 Source Directivity

The angle of the source directivity is defined relative to the direction of travel; the directional sound power is calculated by adding corrections for both the vertical, ψ, and horizontal components, φ.

The horizontal directivity is assumed to be a dipole in CNOSSOS-EU:2020 and is applied to all source types, except the monopole bridge correction source (reflecting the change in the Annex to the 2020 Delegated Directive). The vertical directivity is applied differently for each of the two equivalent source emission heights, but at equivalent Source B it only applies to the aerodynamic source, and all others are assumed to be omnidirectional.

Directional sound power levels are considered for each vehicle and track, track section, vehicle speed, and running condition combination. The directivity of the source is taken into consideration within the calculation software when the angle from source to receiver is determined prior to the point-to-point propagation calculation.

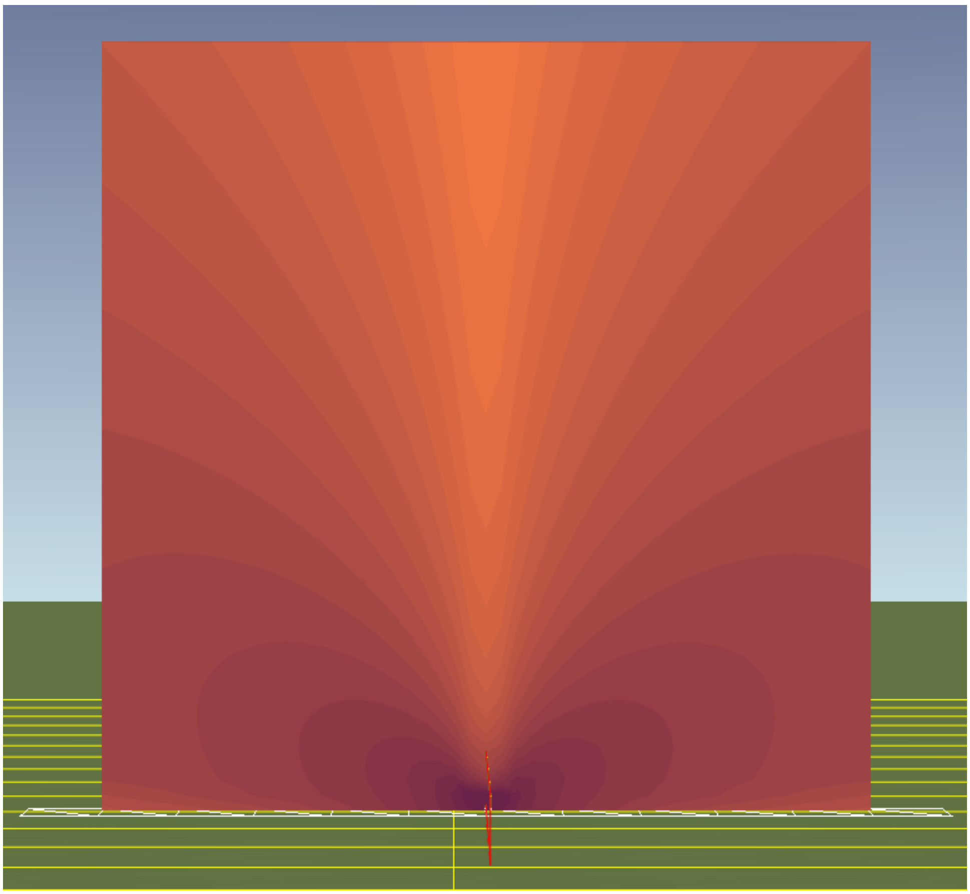


Figure 5.3: Effect of vertical directivity shown in 2 dB bands, across a 50 x 50 m area

5.3 Additional effects

5.3.1 Correction for structural radiation (bridges and viaducts)

Where a track section is located on a bridge, it is necessary to consider the additional noise generated by the vibration of the bridge as a result of the excitation caused by the presence of the train. The bridge correction is allocated to equivalent Source A and omni-directionality is assumed.

The bridge transfer function, $L_{H,bridge,i}$, is added to the total effective roughness level, $L_{R,TOT,i}$, along with a factor to account for the number of axels on the vehicle, N_a, to calculate its SWL (from equation 2.3.18 in CNOSSO-EU:2020):

$$L_{W,0,bridge,i} = L_{R,TOT,i} + L_{H,bridge,i} + 10 \text{ x } \lg(N_a) \text{ dB}$$

The CNOSSOS-EU:2020 database for railway source, Appendix G, includes Table G-7 with two bridge correction spectra for +10 dB(A) and +15 dB(A).

The rolling noise from a vehicle on the bridge is calculated in the usual way, with the track transfer function chosen that corresponds to the track system present on the bridge. Barriers on the edges of the bridge are generally not taken into account.

The 2019 RIVM report presents results from 21 steel structure bridges in the Netherlands which suggests that the bridge gain is most relevant for steel structure bridges without ballasted track on a concrete deck plate. The bridge correction was relevant for bridges with steel decks and direct fastenings of the track to the deck, and among the noisiest types were steel bridges with wooden sleepers directly on top of the girders (no ballast layer).

The bridge correction is generally not relevant for high mass solid bridge structures in such as those in stone, concrete or brick, as they do not radiate significantly.

Guidance Note 26: It is recommended that the bridge correction is only applied to steel structure bridges which do not have ballasted track on a thick concrete deck plate. The higher correction should only be applied for steel bridges with wooden sleepers directly on top of the girders (no ballast layer), or unless measurement data suggests it should be applied. The bridge correction should not generally be applied for high mass concrete or brick bridge structures.

5.3.2 Correction for other railway-related noise sources

If relevant for the annual average strategic noise mapping, other source of noise associated with the railways are to be treated as industrial noise sources, and modelled as described in Section 6 below. These sources may include depots, loading/unloading areas, stations, bells, station loudspeakers, etc.

Guidance Note 27: It is recommended that other railway-related noise sources are included within the strategic noise mapping when they result in regular complaints, indicating that they are relevant to the long-term annual average noise situation. In such cases it is recommended that they are modelled as industrial sources, and reported as part of the industry noise results.

6 Industry Source

6.1 Source Description

6.1.1 Classification of source types (point, line, area)

Noise from sites of industrial activity affecting the three noise agglomeration areas may be modelled as point sources, source lines or area sources, as considered appropriate, depending on the dimensions and distribution of sources across the site, and the distance from the site to the nearest noise sensitive locations.

6.1.2 Number and position of equivalent sources

For simplicity it may be possible to use equivalent point sources which emit the total sound power for line or area sources, providing the largest dimension of the line or area sources is less than 1/2 of the distance between the source and the receiver.

The position of the equivalent sound sources cannot be fixed, given the large number of configurations that an industrial site can have. Best practices will normally apply.

Guidance Note 28: It is recommended that sites of industrial activity included within strategic noise maps are modelled using equivalent point sources where there are a small number of discrete sources within the site boundary, or using zonal or global horizontal area sources where there are multiple noise sources, or access to the site to measure specific sources is not practical. Suitable SWL/m^2 emission values for zonal or global area sources may be developed from measurements undertaken following ISO 8297.

6.1.3 Sound power emission

The following information constitutes the complete set of input data for defining the sound power emission of industrial sources to be used for strategic noise mapping:

- Emitted sound power level spectrum in octave bands;
- Working hours (day, evening, night, on a yearly averaged basis);
- Location (coordinates x, y) and elevation (z) of the noise source;
- Type of source (point, line, area);
- Dimensions and orientation;
- Operating conditions of the source; and
- Directivity of the source.

The working hours are an essential input for the calculation of noise levels for each of the annual average day, evening and night periods. For the more dominant sources, the yearly average working hours correction shall be estimated at least within 0.5 dB tolerance in order to achieve an acceptable accuracy (this is equivalent to an uncertainty of less than 10 % in the definition of the active period of the source).

Guidance Note 29: This 0.5 dB tolerance for annual average working hours is considered a specific exemption to the overall quality framework criteria of ±2 dBA uncertainty in the source emission. Where possible, it is recommended that the annual average working hours are determined per site, based on site specific information in order to meet the 0.5 dB tolerance.

6.1.4 Source directivity

The source directivity is strongly related to the position of the equivalent sound source next to nearby surfaces. Because the propagation method considers the reflection of the nearby surface as well its sound absorption, it is necessary to consider carefully the location of the nearby surfaces. Where sources are located near to reflecting surfaces which may influence their directivity, the modelling of the source, including its directivity, and nearby obstacles should be included where appropriate.

7 Propagation for Roads, Railways and Industry

Chapter 2.5 of Directive 2015/996 on *Calculation of noise propagation for road, railway, industrial sources* been amended in parts by the Corrigenda of January 2018, and the Delegated Directive of December 2020. The advice below is based on the consolidated text referred to as CNOSSOS-EU:2020.

7.1 Scope and applicability of the method

The methodology calculates the attenuation of sound during propagation outdoors for two atmospheric conditions

- Downward-refraction propagation conditions from the source to the receiver
- Homogeneous atmospheric conditions over the entire area of propagation

The method of calculation does not provide results in upward-refraction propagation conditions (negative vertical gradient of effective sound speed) but these conditions are approximated by homogeneous conditions when computing L_{den}. This is a simplification adopted from the NMPB 2008 method which forms the basis for the CNOSSOS-EU propagation methodology.

Guidance Note 30: TII have published a research report which includes meteorological correction values for each County in Ireland. This report is recommended as a useful overview of the effects of meteorology on sound propagation, and within the CNOSSOS-EU methodology.

The TII research publications on meteorological corrections[41] sets our long-term annual average temperature, humidity, pressure and occurrence of favourable propagations values for each County in Ireland, derived from long term meteorological data.

The methodology applies to:

- Industrial infrastructure, and
- Land transport
    - Road infrastructure
    - Railway infrastructure
    - Ground operations from air transport
        - Excluding take-off and landing.

Industrial infrastructures that emit impulsive or strong tonal noises as described in ISO 1996-2 do not fall within the scope of this method.

[41] Common Noise Assessment Methods in Europe (CNOSSOS-EU): Meteorological Correction Factors for Ireland, RE-ENV-07007, TII, October 2022. Available at: https://www.tiipublications.ie/advanced-search/results/document/?id=3214 [Accessed September 2024]

Attenuation due to atmospheric absorption, due to temperature and humidity conditions, is calculated according to ISO 9613-1:1996.

The method provides results per octave band, from 63 Hz to 8 000 Hz. The calculations are made for each of the nominal centre frequencies.

Objects sloping more than 15° in relation to the vertical are not considered as reflectors, but are taken into account in all other aspects of propagation, such as ground effects and diffraction.

7.2 Geometrical considerations

The method assumes that line and area sources have been split into point sources and states that this is outside the scope of the method. It is typically undertaken automatically by the pathfinder component in the noise calculation software, but if it is of interest Section 4.1 of NMPB 2008 describes potential approaches to source segmentation.

The method operates on a geometrical model containing a set of ground and obstacle surfaces. A vertical propagation path is identified on a plane which is vertical with respect to the horizontal plane. Reflections may give rise to additional vertical planes, which are then flattened, like an unfolded Chinese screen, in combination with the direct vertical plane.

The equivalent heights of propagation above ground are derived from the mean ground plane between source and receiver, which replaces the actual ground with this fictitious plat plane, as shown in Figure 7.1.

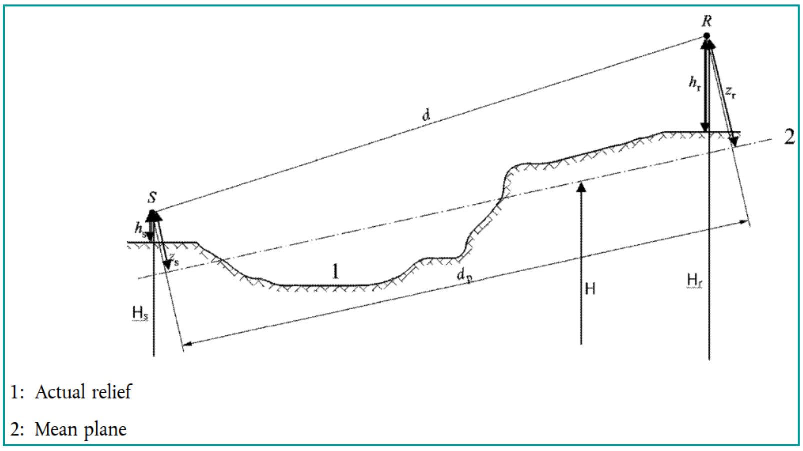


Figure 7.1: Equivalent heights in relation to ground

The equivalent height of a point is its orthogonal height in relation to the mean ground plane. If the equivalent height of a point becomes negative, i.e., if the point is located below the mean ground plane, a null height is retained, and the equivalent point is then identical with its possible image.

Reflections from building facades and other vertical obstacles are taken into account by the introduction of image sources.

7.3 Sound propagation model

For a receiver the calculations are made according to the following steps:

1) Calculate the long-term sound level due to each source, along each propagation path:
    - Calculate the attenuation in favourable conditions;
    - Calculate the attenuation in homogeneous conditions; and
    - Calculate the long-term sound level for each path.
2) The total sound level at the receiver point is the accumulation of the long-term sound levels for all paths from all sources affecting a specific receiver.

Only the attenuations due to the ground effect and diffraction are affected by meteorological conditions, not attenuation due to geometrical divergence or atmospheric absorption.

7.4 Calculation process

For each source to receiver propagation path, for each of the two propagation conditions, favourable and homogeneous, the sound pressure level at the receiver is obtained from the directional sound power of the source and the attenuation due to propagation.

Where the total attenuation is the sum of:

- Attenuation due to geometrical divergence;
- Attenuation due to atmospheric absorption; and
- Attenuation due to the ground in favourable or homogeneous conditions, if there is no diffraction; or
- Attenuation due to diffraction in favourable or homogeneous conditions, where ground effect is also taken into consideration.

The long-term sound pressure level at the receiver is then obtained from the logarithmic sum of the sound energy in homogeneous conditions and the sound energy in favourable conditions, weighted by the mean occurrence of favourable propagation conditions in the direction of the source to receiver path.

The total long-term unweighted sound pressure level at the receiver for each octave band is then the logarithmic sum of the contributions from all paths at the receiver.

The total sound level in decibels (dBA) is obtained from the logarithmic sum of each frequency band, including the A-weighting corrections shown in Table 4.

Table 7.1: A-weighting corrections (Annex to the Delegated Directive 2020)

Frequency [Hz]	63	125	250	500	1 000	2 000	4 000	8 000
$AWC_{f,i}$ [dB]	-26,2	-16,1	-8,6	-3,2	0	1,2	1,0	-1,1’

7.5 Calculation of noise propagation for road, railway, industrial sources

7.5.1 Geometrical divergence

Attenuation due to geometrical divergence corresponds to a reduction in the sound level due to the propagation distance, at a rate of 6 dB per doubling of 3D slant distance, from Equation 2.5.12:

$$A_{div} = 20 \times \lg(d) + 11$$

7.5.2 Atmospheric absorption

The attenuation due to atmospheric absorption during propagation is calculated in line with ISO 9613-1. Long- term average temperature and humidity shall be used if meteorological data is available.

> **Guidance Note 31:** TII have published a research report which includes meteorological correction values for each County in Ireland. It is recommended that this published data is used where applicable.

The TII research publications on meteorological corrections[42] sets our long-term annual average temperature, humidity, pressure and occurrence of favourable propagations values for each County in Ireland, derived from long term meteorological data.

7.5.3 Ground effect

The attenuation due to the ground effect is mainly the result of the interference between the reflected sound and the sound that is propagated directly from the source to the receiver. It is physically linked to the acoustic absorption of the ground above which the sound wave is propagated. However, it is also significantly dependent on atmospheric conditions during propagation, as ray bending modifies the height of the path above the ground and makes the ground effects and land located near the source more or less significant.

In case the propagation between the source and the receiver is affected by any obstacle in the propagation plane, the ground effect is calculated separately on the source and receiver side. This is shown in Figure 7.2 showing the reflected rays intersecting the mean ground plane of the source and receiver side of the obstacle.

[42] Common Noise Assessment Methods in Europe (CNOSSOS-EU): Meteorological Correction Factors for Ireland, RE-ENV-07007, TII, October 2022. Available at: https://www.tiipublications.ie/advanced-search/results/document/?id=3214 [Accessed September 2024]

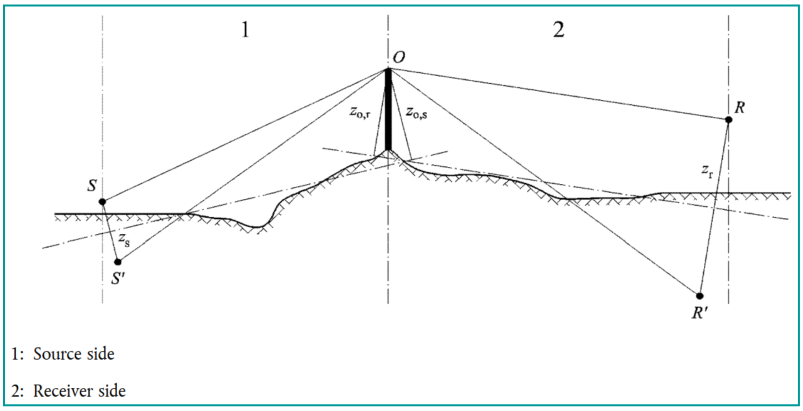


Figure 7.2: Geometry of diffraction, showing ground effect being calculated separately on the source and receiver side of the obstacle *O*

Acoustic characterisation of ground

The acoustic absorption properties of the ground are mainly linked to its porosity. Compact ground is generally reflective and porous ground is absorbent. In the calculation model, the acoustic absorption of ground cover areas is represented by a dimensionless coefficient G, between 0 and 1. G is independent of frequency.

Table 7.2 presents CNOSSOS-EU Table 2.5a which sets out the G values for the ground outdoors. In general, the average of the coefficient G over a path takes values between 0 and 1.

In addition, the CNOSSOS-EU also states:

- G_s = 0 for road platforms (the absorption of porous road pavements is taken into account in the emission model), slab tracks.
- G_s = 1 for rail tracks on ballast.
- There is no general answer in the case of industrial sources and plants.

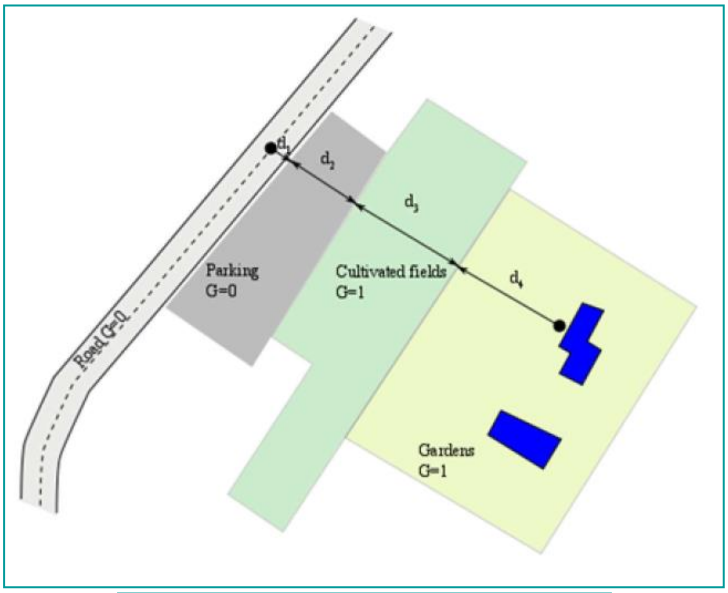
G may be linked to the flow resistivity (kPA.s/m^2).

> **Guidance Note 32:** As CNOSSOS-EU Table 2.5a is within the main Annex, and not the Appendices which contain the database tables, it may be the case that Table 2.5a is mandatory, and therefore no other values of G may be assigned to ground areas. However, the statement *"G may be linked to the flow resistivity"*, could imply that the table may be extended with additional value of flow resistivity, and therefore G, if available.

G_{path} is defined as the fraction of absorbent ground present over the entire path covered. As shown in the example Figure 7.3, the propagation distance over each area of ground with a different G value are combined in ratio to the total propagation distance.

Table 7.2: G values for different types of ground

G values for different types of ground			
Description	Type	(kPa · s/m²)	G value
Very soft (snow or moss-like)	A	12,5	1
Soft forest floor (short, dense heather-like or thick moss)	B	31,5	1
Uncompacted, loose ground (turf, grass, loose soil)	C	80	1
Normal uncompacted ground (forest floors, pasture field)	D	200	1
Compacted field and gravel (compacted lawns, park area)	E	500	0,7
Compacted dense ground (gravel road, car park)	F	2 000	0,3
Hard surfaces (most normal asphalt, concrete)	G	20 000	0
Very hard and dense surfaces (dense asphalt, concrete, water)	H	200 000	0



$$d_p = d_1 + d_2 + d_3 + d_4$$

$$G_{path} = {(0 \cdot d_1 + 0 \cdot d_2 + 1 \cdot d_3 + 1 \cdot d_4)}/{d_p} = {(d_3 + d_4)}/{d_p}$$

Figure 7.3: Determination of the ground coefficient G_{path} over a propagation path

The attenuation due to the ground effect, in the absence of diffraction, is calculated using two different approaches for homogeneous and favourable propagation conditions.

Where diffraction is present, the ground effect is included within the calculation for the diffraction effect, and ground effect is not determined on its own.

Guidance Note 33: In the RIVM report on proposed amendments to Annex II, it was identified that under favourable propagation, the CNOSSOS-EU formulas make a distinction between two cases: $G_{path} > 0$ and $G_{path} = 0$. In the original NMPB model the special case $G_{path} = 0$ is not considered, so this case has been added to CNOSSOS-EU. Unfortunately, this leads to a discontinuity at very low values of *G* at low frequencies. The RIVM report suggest the original NMPB wording is preferable, and to avoid the discontinuity, where $G = 0$ would be assigned, the value $G = 0.0001$ is assigned instead. The Delegated Directive did not remove this special case; therefore, it is recommended to follow the RIVM report and set a minimum value of $G = 0.0001$.

7.5.4 Diffraction

As a general rule, diffraction effects occur at the top of each obstacle located on the propagation path. If the path passes 'high enough' over the diffraction edge, there is no diffraction effect, and direct view calculated, in particular by evaluating the ground effect.

Diffraction effects may still occur for an unblocked path if the diffraction edge is close enough to the direct path. Therefore, the edge is sought which produces the smallest negative path length difference. The assessment as to whether diffraction occurs is undertaken in each frequency band, and if the path length difference between the direct path and the potential diffraction path is larger than $-\lambda/20$ (i.e., wavelength/20), and if the "Rayleigh-criterion" is fulfilled, then a diffraction effect is calculated, otherwise it is determined to be 'high enough' and calculated as a direct view.

The methodology is used to process the diffraction on thin screens, thick screens, buildings, earth berms (natural or artificial), and by the edges of embankments, cuttings and viaducts.

When several diffracting obstacles are encountered on a propagation path, they are treated as a multiple diffraction by applying the procedure described below.

The procedures are used to calculate the attenuations in both homogeneous and favourable conditions. Under favourable conditions, ray bending is taken into account in the calculation of the path difference and to calculate the ground effects before and after diffraction.

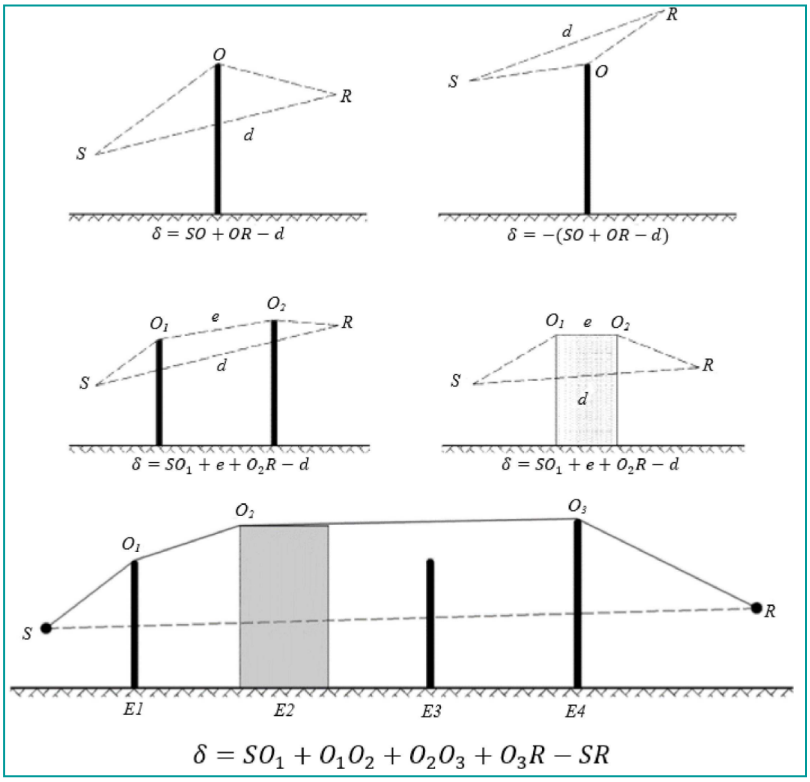


Figure 7.4: Calculation of the path difference in homogeneous conditions.
O, O_1, O_2 and O_3 are the diffraction points

Calculation of path difference

The path difference is calculated in a vertical plane containing the source and the receiver.

The path difference under homogeneous conditions is calculated as shown in Figure 7.4, based on the situations encountered. For multiple diffractions, the total distance along the path is assessed using the 'rubber band method'.

Under favourable conditions, the propagation path in the vertical propagation plane always consists of segments of a circle whose radius is given by the 3D-distance between source and receiver. All segments of a propagation path have the same radius of curvature.

If the direct arc connecting source and receiver is blocked, the propagation path is defined as the shortest convex combination of arcs enveloping all obstacles. Convex in this context means that at each diffraction point, the outgoing ray segment is deflected downward with respect to the incoming ray segment.

The path difference under favourable conditions is calculated using curved rays as shown in Figures 7.5 and 7.6, based on the situations encountered.

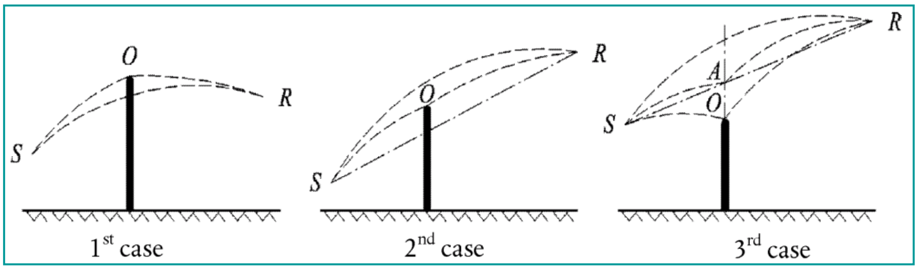
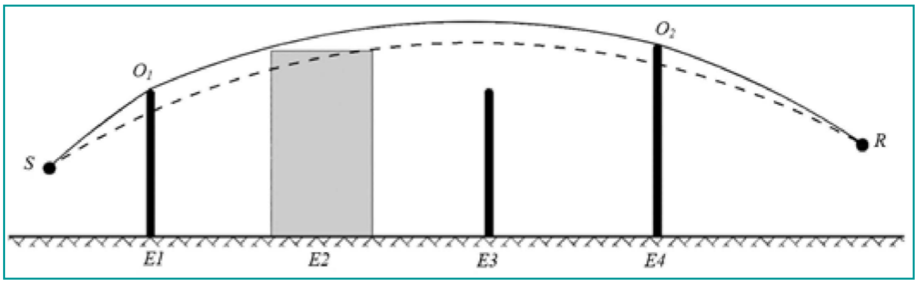


Figure 7.5: Calculation of the path difference in favourable conditions (single diffraction)



$$‘\delta_F = \hat{S}O_1 + O_1\hat{O}_2 + \hat{O}_2R - \hat{S}R$$

Figure 7.6: Example of calculation of the path difference in favourable conditions, in the case of multiple diffractions

Vertical edge scenarios

Attenuation due to diffraction from vertical edges (lateral diffraction) is calculated using the same general approach as for horizontal edges, but under CNOSSOS-EU it only applies to industrial sources when certain conditions are met.

7.5.5 Reflections on vertical obstacles

Attenuation through absorption

The reflections on vertical obstacles are assessed using image sources, Figure 7.7, including reflections on building façades and noise barriers, when certain conditions are met.

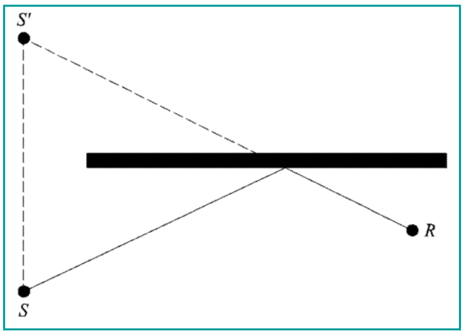


Figure 7.7: Specular reflection on an obstacle dealt with by the image source method (S: source, S’: image source, R: receiver)

Attenuation through retrodiffraction

In cases where there is a potential for multiple reflections between two vertical walls (or barriers), at least the first reflection shall be considered.

In the case of a trench (see for example in Figure 7.8), the attenuation through retrodiffraction shall be applied to each reflection on the retaining walls.

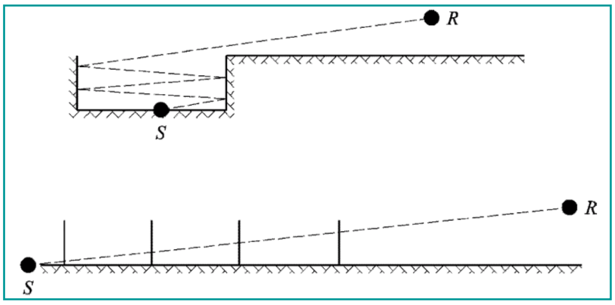


Figure 7.8: Sound ray reflected to the order of 4 in a track in a trench: actual cross-section (top), unfolded cross-section (bottom)

Guidance Note 34: It is not clear if in the example case in Figure 13 if it is mandatory to use 4th order reflections in all trench situations, or if this is only an example of how it could be calculated, however only the first order reflection must be considered. It is recommended to discuss whether it is possible to model trenches for the inclusion of retrodiffraction with the developers of the noise calculation software.

In this representation, the sound ray reaches the receiver 'by successively passing through' the retaining walls of the trench in the unfolded cross-section, which can therefore be compared to openings.

When calculating propagation through an opening, the sound field at the receiver is the sum of the direct field and the field diffracted by the edges of the opening. This diffracted field ensures the continuity of the transition between the clear area and the shadow area. When the ray approaches the edge of the opening, the direct field is attenuated. The calculation is identical to that of the attenuation by a barrier in the clear area, as shown in Figure 7.9.

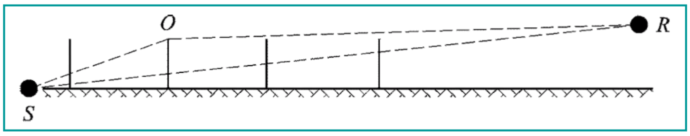


Figure 7.9: The path difference for the second reflection

In complex propagation configurations, diffractions may exist between reflections, or between the receiver and the reflections. In this case, the retrodiffraction by the walls is estimated by considering the path between source and first diffraction point *R'*. This principle is illustrated in Figure 7.10. In case of multiple reflections, the reflections due to each reflection are added.

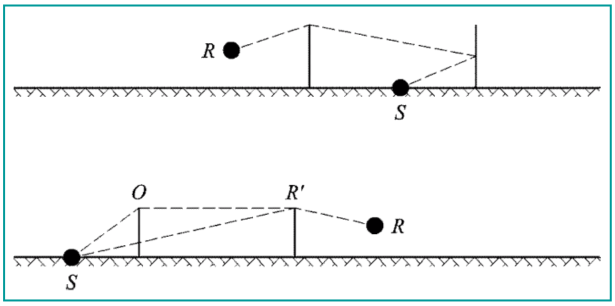


Figure 7.10: The path difference in the presence of a diffraction: actual cross-section (top), unfolded cross-section (bottom)

Guidance Note 35: For strategic noise mapping it is recommended that the calculations are undertaken with the order of reflection = 1. It is accepted that there may be situations, such as behind buildings or within enclosed courtyards, where this may lead to an underestimation of the total noise level, however the increasing the order of reflections to 2 or more has been found to increase calculation times by an order of magnitude due to the complexity of reflection treatments discussed above. It may be considered appropriate to use an order of reflections of 2 or 3 when undertaking a specific localised site calculation, such as during a detailed assessment within action planning.

The Annex to the Delegated Directive introduced an additional procedure for the retrodiffraction between a railway vehicle body and a track side barrier.

When there is a reflecting noise barrier or obstacle close to the railway track, the sound rays from the source are successively reflected off this obstacle and off the lateral face of the railway vehicle. In these conditions, the sound rays pass between the obstacle and railway vehicle body before diffraction from the top edge of the obstacle, except in the case of an open flat-bed wagon when it is largely ignored.

To take multiple reflections between railway vehicle and a nearby obstacle into account, the sound power of a single equivalent source is calculated. The absorption coefficients for the trackside face of the obstacle and the rail vehicle body are required.

Guidance Note 36: Where there are trackside obstacles, such as reflecting barriers or retaining walls, which may give rise to multiple reflections, it is recommended to discuss with the noise software developers on how to define the relevant obstacle and rail vehicle parameters to ensure that this new aspect of the method is correctly calculated.

8 Aircraft Noise

Chapter 2.7 of Directive 2015/995 on *Aircraft noise* has been amended in parts by the Annex to the Delegated Directive of December 2020. The advice below is based on the consolidated text referred to as CNOSSOS-EU:2020.

The European Civil Aviation Conference (ECAC) publishes ECAC Doc 29 4th Edition in three volumes:

- Volume 1: Application Guide
- Volume 2: Technical Guide
- Volume 3: Reference Cases and Verification Framework

The text within the amended CNOSSOS-EU:2020 methodology has been mainly based on ECAC Doc 29 4th Edition Volume 2: Technical Guide, whilst the remaining parts of the ECAC documentation provided extensive guidance on application and verification of the model.

Guidance Note 37: It is recommended that the extensive guidance within the ECAC Application Guide and Technical Guide are followed. It is also recommended that the proposed Volume 3 Part 2 guidance on validation of models using noise measurements is followed following publication.

The Civil Aviation Authority (CAA) have also published *CAA Policy on Minimum Standards for Noise Modelling*[43], which sets out the minimum acceptable level of sophistication of noise modelling that can be used to provide the CAA with outputs.

Guidance Note 38: It is recommended that the strategic noise maps are developed which meet CAA Noise Modelling Category C or above, including the use of radar data for flight tracks, and noise measurement data for validation where available. Any requirements set out by ANCA with regard to strategic noise mapping of Dublin Airport should also be met.

8.1 Quality framework

8.1.1 Accuracy of input values

The CNOSSOS-EU:2020 method includes a quality framework in Chapter 2.6.2 for aircraft noise, which includes the following on the accuracy of input values:

> *"All input values affecting the emission level of a source, including the position of the source, shall be determined with at least the accuracy corresponding to an uncertainty of ± 2dB(A) in the emission level of the source (leaving all other parameters unchanged)."*

[43] CAA Policy on Minimum Standards for Noise Modelling, Civil Aviation Authority, January 2021, CAP 2091. Available at: https://publicapps.caa.co.uk/modalapplication.aspx?catid=1&pagetype=65&appid=11&mode=detail&id=10124 [Accessed May 2022]

The advice in Section 3.3.1 above on interpretation of this criteria remains relevant for aircraft noise.

8.1.2 Use of default values

It is required that the input data shall reflect the actual usage, and in general there shall be no reliance on default input values or assumptions. Specifically, flight paths derived from radar data to derive the flight paths shall be used whenever they exist and is of sufficient quality. Default input values and assumptions are accepted, for example, to be used for modelled routes instead of radar derived flight paths, if the collection of real data is associated with disproportionately high costs.

If flight paths can be derived from radar data they must be used for the modelling providing they are of sufficient quality, however modelled routes may be used if the cost of real data is too costly.

> **Guidance Note 39:** It is recommended that the flight paths derived from the daa noise and flight track monitoring system area used as the basis of the noise mapping.

8.1.3 Quality of software used for the calculations

It is required that software used to perform the CNOSSOS-EU:2020 calculations shall prove compliance by means of certification of results against test cases.

> **Guidance Note 40:** Software certified by the developers under ISO/TR 17534-4:2020 would meet this requirement, as would the FAA AEDT software.

The Federal Aviation Authority (FAA) Aviation Environmental Design Tool (AEDT)[44] implements ECAC Doc 29 4th Edition, documents results against test cases, and is used to mimic noise certification flight tests to check the certified noise and performance data.

8.2 Aim and scope

The noise at points on the ground from aircraft flying into and out of a nearby aerodrome depends on many factors, including: the types of aeroplanes and their powerplant; the power, flap and airspeed management procedures used on the aeroplanes themselves; the distances from the points concerned to the various flight paths; and local topography and weather. Airport operations generally include different types of aeroplanes, various flight procedures and a range of operational weights.

Where noise generating activities associated with airport operations do not contribute materially to the overall population exposure to aircraft noise and associated noise contours, they may be excluded. These activities include: helicopters, taxiing, engine testing and use of auxiliary power-units. This does not necessarily mean that their impact is insignificant and

[44] Federal Aviation Administration Aviation Environmental Design Tool. Available at: https://aedt.faa.gov/3d_information.aspx [Accessed May 2022]

where these circumstances occur assessment of the sources can be undertaken.

If helicopter noise is considered to contribute to the overall population exposure, the same calculation method used for fixed-wing aircraft may be used, provided helicopters are treated as propeller aircraft and engine-installation effects, associated with jet aircraft are not applied.

If ground operational noise such as: taxiing; engine testing; and use of auxiliary power-units (APU); is considered to contribute to the overall population exposure, they are to be modelling using the methodology for industrial noise.

Guidance Note 41: It is recommended that noise generating activities associated with airport operations, include: helicopters, taxiing, engine testing and use of auxiliary power-units; are reviewed to determine if they have contributed to the overall population exposure of the airport, or the overall exposure of specific communities near the airport. Where relevant, the noise should be assessed in line with 2.7.21 and 2.7.22 of the Directive.

8.3 Outline of the method

The noise contour process is outlined in Figure 16. Contours that depict historical noise impact might be generated from actual records of aircraft operations — of movements, weights, radar-measured flight paths, etc. Contours used for future planning purposes of necessity rely more on forecasts — of traffic and flight tracks and the performance and noise characteristics of future aircraft.

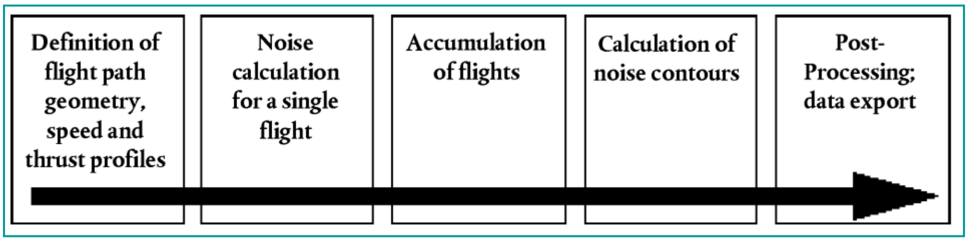


Figure 8.1: The noise contour generation process

Each different aircraft arrival or departure movement is defined in terms of its flight path geometry, and the noise emission from the aircraft as it follows that path. The noise emission depends on the characteristics of the aircraft — mainly on the power generated by its engines. The recommended methodology involves dividing the flight path into segments.

Determining the event level for a single aircraft movement at a single observer point is the core calculation. It has to be repeated for all aircraft movements at each of a prescribed array of points covering the expected extent of the required noise contours. At each point the event levels are aggregated or averaged in some way to arrive at a 'cumulative level' or noise index value.

8.4 Concept of segmentation

For any specific aircraft, the database contains baseline Noise-Power-Distance (NPD) relationships. These define, for steady straight flight at a *reference speed* in specified *reference atmospheric conditions* and in a specified flight configuration, the received sound event levels, both maximum and time integrated, directly beneath the aircraft as a function of distance. For noise modelling purposes, the propulsive power is represented by a noise-related power parameter; the parameter generally used is corrected net thrust. Baseline event levels determined from the database are adjusted to account for:

- Differences between actual (i.e., modelled) and reference atmospheric conditions; and
- Aircraft speed (in the case of sound exposure levels); and
- Differences between downwards and laterally radiated noise, for receiver points that are not directly beneath the aircraft.

Segmentation adapts the infinite path NPD and lateral data to calculate the noise reaching a receiver from a non-uniform flight path. The flight path is represented by a set of contiguous straight-line segments.

8.5 Flight paths: Tracks and profiles

The *ground track* is the projection of the flight path on level ground. This is combined with the vertical *flight profile* to construct the 3-D flight path. The flight path of every different aircraft movement is to be described by a series of contiguous straight segments. The extent of segmentation balances accuracy and efficiency i.e.: more segments will be more accurate, but also requires more data, and will increase the computational burden. Synthesis of the flight path requires knowledge of (or assumptions for) ground tracks and their lateral dispersions, aircraft weight, speed, flap and thrust-management procedures, airport elevation, and wind and air temperature.

In an ultimate noise modelling application, each individual flight could, theoretically, be represented independently; this would guarantee accurate accounting for the spatial dispersion of flight paths — which can be very significant. But to keep data preparation and computer time within reasonable bounds it is normal practice to represent flight path swathes by a small number of laterally displaced 'subtracks'. Vertical dispersion is usually represented satisfactorily by accounting for the effects of varying aircraft weights on the vertical profiles. Aircraft weights are usually estimated based on stage length, which affects fuel load at take-off.

8.6 Aircraft noise and performance

The Aircraft Noise Performance (ANP) database provided in Appendix I of CNOSSOS-EU:2020 contains aircraft and engine performance coefficients, departure and approach profiles as well as NPD relationships for a substantial proportion of civil aircraft operating from European Union airports. For aircraft types or variants for which data are not currently listed, they can best be represented by data for other, normally similar, aircrafts that are listed. This database may be supplemented using the online ANP database hosted by Eurocontrol[45].

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[45] Eurocontrol Aircraft Noise and Performance Database. Available at: https://www.aircraftnoisemodel.org/ [Accessed May 2022]

Guidance Note 42: It is recommended that the Eurocontrol ANP database is used where possible for aircraft models not defined within CNOSSOS-EU:2020. Where specific aircraft operating from the airport are not specified within the CNOSSOS-EU or Eurocontrol ANP, alternative suitable sources may be used, or the movements may be substituted with suitable alternative aircraft, provided that all relevant details are documented.

This data was derived to calculate noise contours for an average or representative fleet and traffic mix at an airport. The ANP database includes one or several default take-off and landing profiles for each aircraft type listed. The applicability of these profiles to the airport under consideration shall be examined, and either the fixed-point profiles or the procedural steps that best represent the flight operations at this airport shall be determined.

Where noise monitoring and track-keeping data is available it is possible to adapt the noise model using the data collected. Where the noise monitoring stations are appropriately positioned, to conform with guidance provided in ISO 209068 and SAE-ARP-47219, the collected data can be used to identify measured noise levels due to specific types of aircraft, which can then be used to make amendments to both flight profile and noise data within the Aircraft Noise and Performance (ANP) database to reflect the local situation.

Guidance Note 43: Where the noise model is adapted using noise monitoring and track-keeping data collected by the airport, details of any changes to both the flight profile and ANP data should be included within the report to the EPA alongside information on how this affected the noise model results.

9 Exposure to Noise

Chapter 2.8 of Directive 2015/996 on *Assigning noise levels and population to buildings* has been replaced by 2.8 *Exposure to noise* in the Annex to the Delegated Directive of December 2020. The advice below is based on the consolidated text referred to as CNOSSOS-EU:2020.

9.1 Determination of the area exposed to noise

The assessment of the area exposed to noise is based on receiver points 4 m above the ground, corresponding to the receiver points as defined in Section 7 *Calculation of noise propagation for road, railway, industrial sources*, and Section 8 *Aircraft noise*.

Grid points that are located inside buildings shall be assigned a noise level result by assigning the quietest nearby noise receiver points outside buildings, except for aircraft noise where the calculation is performed without considering the presence of buildings and in which case the noise receiver point falling within a building is directly used.

Depending on the grid resolution, the corresponding area is assigned to each calculation point in the grid. For example, with a 10 m × 10 m grid, each assessment point represents an area of 100 square metres that is exposed to the calculated noise level.

CNOSSOS-EU:2020 does not describe how the *"quietest nearby receiver points outside buildings"* should be selected for ground-based sources. It is also unclear if noise contour areas should be generated from the raw calculation grids, or the grids including these values assigned to the inside of buildings. The EEA have published reporting guidelines on strategic noise maps[46], within Annex II a recommended methodology is described for assigning noise levels to grid points inside buildings, and a second methodology is recommended for the production of noise contour areas from grid points.

Guidance Note 44: For road, railway and industry sources it is recommended that;

1) grid points inside buildings are assigned noise levels in line with the guidelines published by the EEA,
2) the area exposed to noise is determined using the grid after assignment of noise levels inside buildings; and
3) noise contours are generated in line with the EEA guidelines using the grid before assignment of noise levels inside buildings.

It is important to note that the grid with low noise levels assigned inside buildings is only used for the assessment of area exposed to noise, it is not to be used for the creation of noise contours.

[46] Reporting guidelines Strategic Noise Maps (DF4_8), European Environment Agency. Available at: https://www.eionet.europa.eu/reportnet/docs/noise/guidelines [Accessed May 2022]

Guidance Note 45: For aircraft sources the noise level calculations are performed without considering the presence of buildings, therefore it is not required to assign noise levels inside buildings. It is recommended that the area exposed to noise is determined using the grid of calculated receiver points, and that the contours are generated in line with the methodology set out within CNOSSOS-EU:2020 and relevant ECAC Doc 29 guidance.

9.2 Assigning noise assessment points to buildings not containing dwellings

The assessment of the exposure of buildings not containing dwellings, such as schools and hospitals, to noise is based on receiver points at 4 m above the ground, corresponding to the receiver points for road, railway, industrial and aircraft sources.

For the assessment of buildings not containing dwellings, and exposed to aircraft noise, each building is associated to the receiver point with the highest level falling within the building or, if not present, on the grid surrounding the building.

For the assessment of buildings not containing dwellings, and exposed to land-based noise sources, receiver points are placed at approximately 0.1 m in front of building façades. Reflections from the façade being considered shall be excluded from the calculation. The building is then associated to the receiver point on its façades with the highest noise level.

Guidance Note 46: It is recommended that school and hospital buildings are identified using An Post GeoDirectory, and the noise exposure is determined in line with the Directive.

9.3 Determination of the dwellings and people living in dwellings exposed to noise

For the assessment of the noise exposure of dwellings, and the exposure of people living in dwellings, only residential buildings shall be considered. No dwellings or people shall be assigned to other buildings without residential use, such as buildings exclusively used as schools, hospitals, office buildings or factories. The assignment of the dwellings, and people living in dwellings, to the residential buildings shall be based on the latest official data.

For the calculation of the number of dwellings, and people living in dwellings, either the following Case 1 procedure or the Case 2 procedure shall be used, depending on the availability of data.

- **Case 1:** the data on the number of dwellings and people living in dwellings is available;
- **Case 2:** no data on the number of people living in dwellings is available.

Case 1A

The number of people living in dwellings is known or has been estimated on the basis of the number of dwelling units. In this case the number of people living in dwellings for a building is the sum of the number of people living in all dwelling units in the building:

$$Inh_{building} = \sum_{i=1}^{n} Inh_{dwelling_{unit_i}}$$

CNOSSOS-EU:2020 then provides a number of other approaches for assigning dwellings and people in dwellings to buildings, based upon having less detailed information available.

The An Post GeoDirectory[47] data provides detailed information on building use, which enables residential buildings to be identified. It also provided details on the number of occupied and unoccupied dwellings within each building. This dataset enables Case 1A to be followed as the number of dwelling units is known and the number of people living in each occupied dwelling may be estimated based on the Central Statistics Office (CSO) Small Area Population Statistics (SAPS) data, therefore it is not considered relevant to describe the other methods here.

Guidance Note 47: In view of the data available from An Post GeoDirectory on the number of occupied and unoccupied dwellings in residential buildings, it is recommended that Case 1A procedure is followed for assignment of dwellings to buildings.

9.4 Assigning noise assessment points to dwellings and people living in dwellings

The assessment of the exposure of dwellings, and people living in dwellings, to noise is based on receiver points at 4 m above the ground, corresponding to the receiver points for road, railway, industrial and aircraft sources.

9.4.1 Assignment of aircraft noise

For the calculation of the number of dwellings, and people living in dwellings for aircraft noise, all dwellings, and people living in dwellings, within a building are associated to the receiver point with the highest level falling within the building itself or, if not present, on the grid surrounding the building.

9.4.2 Assignment of road, railway and industry noise

For the calculation of the number of dwellings, and people living in dwellings, for land-based noise sources, receiver points are placed at approximately 0.1 m in front of building façades of residential buildings. Reflections from the façade being considered shall be excluded from the calculation.

Either the following Case 1 procedure or the Case 2 procedure shall be used to locate the receiver points. (**Note:** These Cases a separate from the Cases in Section 9.3 above)

[47] An Post GeoDirectory. Available at: https://www.geodirectory.ie/ [Accessed June 2022]

Guidance Note 48: The two Cases in Section 9.4 are separate from the two cases in Section 9.3 above, as they relate to different steps in the process. It is unfortunate that the Directive uses the same names.

Case 1: façades split up in regular intervals on each façade

(a) Segments of a length of more than 5 m are split up into regular intervals of the longest possible length but less than or equal to 5 m. Receiver points are placed in the middle of each regular interval.
(b) Remaining segments above a length of 2.5 m are represented by one receiver point in the middle of each segment.
(c) Remaining adjacent segments with a total length of more than 5 m are treated as polyline objects in a manner similar to that described in a) and b).

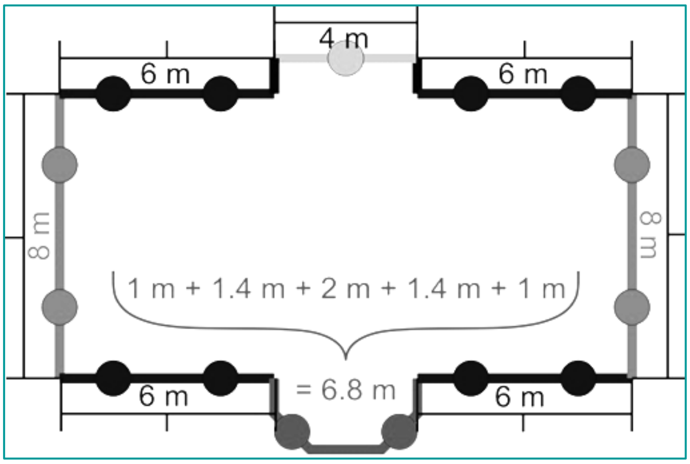

Figure 9.1: Example of location of receiver points around a building following Case 1 procedure

Case 2: façades split up at set distance from start of polygon

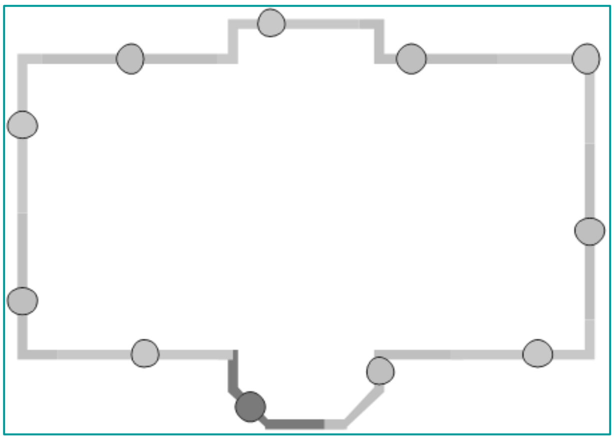

Figure 9.2: Example of location of receiver points around a building following Case 2 procedure

(a) Façades are considered separately or are split up every 5 m from the start position

onwards, with a receiver position placed at the halfway distance of the façade or the 5m segment
(b) The remaining section has its receiver point in its mid-point.

> **Note 49:** The noise calculation software used for the strategic noise mapping is able to generate the building façade receivers automatically to align with these cases.

Case 2 can be seen to contain two alternatives, on the basis of the "or" statement within 2(a) *"Façades are considered separately **or** are split up every 5 m from the start position"*.

- CASE 2a
  - Facades are considered separately, with a receiver being placed in the middle of each segment.
- CASE 2b
  - Facades are divided every 5 m from the starting position. Receivers are placed in the middle of each 5m segment.
  - A last receiver is placed on the remaining building segment.

> **Guidance Note 50:** It is recommended that building façade receiver points are generated following the Case 2a methodology.

9.5 Assigning dwellings and people living in dwellings to receiver points

Single dwelling buildings, & buildings where the location of dwellings is known
Where information is available on the location of dwellings within building footprints, the dwellings and the people living in the dwellings are assigned to the receiver point at the most exposed façade of that dwelling.

For example, for detached houses, for semi-detached and terrace houses, or apartment buildings, where the internal division of the building is known, or for buildings with a floor size that indicates a single dwelling per floor level, or for buildings with a floor size and height that indicates a single dwelling per building.

Multi-dwelling buildings where location of dwellings is not known
Where no information on the location of dwellings within building footprints is available, one of the two following methods shall be used, as appropriate, on a building-by-building basis to estimate the exposure to noise of the dwellings and people in dwellings within the buildings.

1. Available information shows that dwellings are arranged within an apartment building such that they have a single façade exposed to noise

In this case, the allocation of the number of dwellings, and people living in dwellings, to receiver points, shall be weighted by the length of the represented façade according to the procedure under either Case 1 or Case 2 described in Section 9.4 above, with Case 2a recommended, so that the sum of all receiver points represents the total number of dwellings, and people living in dwellings, assigned to the building.

2. Available information shows that dwellings are arranged within an apartment building such that they have more than one façade exposed to noise, or no information is available on how many facades of the dwellings are exposed to noise.

In this case, for each building, the set of associated receiver locations, created following Case 2a as recommended, shall be split into a lower and upper half based on the median[48] value of the calculated assessment levels for each building. In case of odd number of receiver points, the procedure is applied excluding the receiver location with the lowest noise level.

For each receiver point in the upper half of the data set, the number of dwellings, and people living in dwellings, shall be distributed equally, so that the sum of all receiver points in the upper half of the data set represents the total number of dwellings and people living in dwellings. No dwellings or people living in dwellings will be assigned to receivers in the lower half of the data set[49].

9.5.1 Summary of approach to assigning noise levels from roads, railways and industry to dwellings and people in dwellings

The CNOSSOS-EU:2020 methodology describes three specific types of buildings, and three different methods by which the noise exposure of the dwellings and people in dwellings within those buildings should be assessed. This represents the most significant change from both the original END approach, and the approach set out within Directive 2015/996.

The exposure of dwellings and people in dwellings are to be assessed separately for each building type following the three different methods, and summed to provide the overall total within the area of assessment.

Each building with residential use should be assigned to one of these three building types, see Section 11.7.8 below, however there is currently no available dataset which can be used to identify the layout of dwellings within buildings.

[48] The medium value is the value separating the higher half (50%) from the lower half (50%) of a data set.
[49] The lower half of the data asset may be assimilated with the presence of relatively calm façades. In case it is known in advance, e.g., based on the location of buildings relative to the dominant noise sources, which receiver locations will give way to the highest / lowest noise levels, there is no need to calculate noise for the lower half.

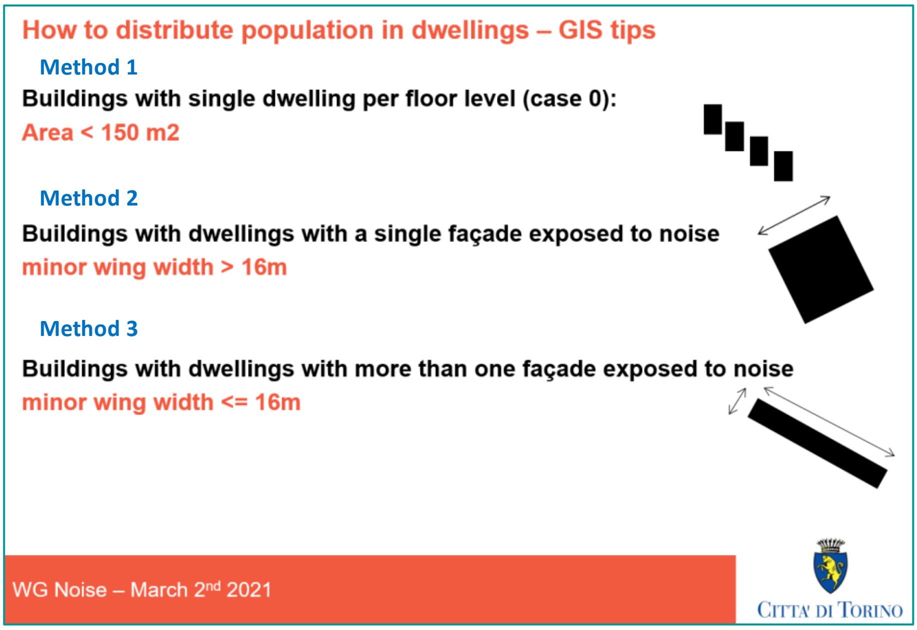

Figure 9.3: Proposal for the estimation of dwelling layout within buildings.

It may be expected that long and narrow apartment blocks may fit Method 3, and that apartment blocks with a square footprint may fit Method 2, which may make it possible to estimate the internal layout from the footprint. At Eurocities Working Group Noise in March 2021, the approach shown in Figure 9.3 was proposed.

The three different methods for the assessment are to be used with the following types of buildings:

Method 1: "single dwellings"

The location of individual dwellings is known:

a. Detached house; or

b. Semi-detached houses, or terrace houses, or apartment buildings, where the internal division of the buildings are known; or

c. Buildings with a floor size that indicates a single dwelling per floor level, or

d. Buildings with a floor size and height that indicates a single dwelling per building.

The dwelling and people living in that dwelling are assigned to the receiver point at the most exposed façade of that dwelling.

Guidance Note 51: This is the same as the approach used during R1 to R3 in Ireland, and will account for most buildings in Round 4.

Method 2: "multi-dwellings - single exposed facade"

Available information shows that dwellings are arranged within an apartment building such that they have a single façade exposed to noise.

a. Apartment blocks where all windows within each apartment only face in one direction;

Guidance Note 52: The dwellings and people in dwellings are assigned to all receivers around the building, weighted by the façade length the receiver represents. This will result in dwellings and people being assigned the lowest, median and highest noise levels calculated around the building facades.

Method 3: "multi-dwellings - >1 facade, or not known"

Available information shows that dwellings are arranged within an apartment building such that they have more than one façade exposed to noise, or no information is available on how many facades of the dwellings are exposed to noise.

a. Buildings where all windows within each dwelling face in more than one direction;

b. Buildings with internal light wells or courtyards; or

c. Buildings where apartments traverse the width of the building and have facades exposed to both sides of the building, or to courtyard or lightwell; or

d. Buildings where the internal layout of dwellings is not known.

Guidance Note 53: This third approach is to be the default approach if the layout of dwellings within a building is not known. This will result in dwellings and people being assigned the median or higher noise levels calculated around the building facades.

Overall, this is a significant change in approach for the assessment of exposure for dwellings and people in dwellings, and is likely to have a noticeable effect on the distribution of dwellings and people in dwellings across the 5 dB noise level bands, all other factors staying the same.

Guidance Note 54: It is recommended that:
- Method 1 is assigned for buildings with one dwelling, or multiple dwellings where the building footprint is less than 150 m^2,
- Method 2 is assigned where it is known that dwellings have single facades;
- Method 3 is assigned to all other multi-dwelling residential buildings.

10 Input Data Requirements

Tables 10.1 to 10.6 below set out a high-level review of the input data required for the implementation of CNOSSOS-EU:2020 for strategic noise mapping. Where known sources of data have been identified, and comments by way of further explanation.

For the Round 4 strategic noise mapping, the date and version of certain input datasets has been agreed across noise mapping bodies to help ensure a consistent approach. These are detailed below:

- Agglomeration boundaries
  - As defined in the 2021 amended Regulations
- OSI PRIME 2 – Q1-2022 dataset
  - https://osi.ie/services/national-mapping-agreement/knowledgebase/what-osi-data-and-services-are-available/
- GeoDirectory – Q4-2021 dataset
  - https://www.geodirectory.ie/
- CSO Census - 2016 Small Area Population Statistics data
  - https://data.cso.ie/
- OSI Census Small Area - Ungeneralised 2015 boundaries
  - https://data.gov.ie/dataset/small-areas-ungeneralised-osi-national-statistical-boundaries-20153?package_type=dataset
- SoftNoise GmbH Predictor-LimA noise calculation software – v2022.11 of 07/04/2022
  - https://softnoise.com/downloads/

Guidance on the approach to preparing the input data in GIS are set out in Section 11 below.

In the following tables, symbols represent the following:

CNOSSOS-EU	Comments	Available in Ireland	Comments
✓	Data is required by CNOSSOS-EU	✓	Data is available
?	It is not known if data is required by CNOSSOS-EU	?	It is not known if data is available
X	Data is not required by CNOSSOS-EU	**X**	Data is not available

Table 10.1: Input Datasets – Road Traffic Noise

Dataset	CNOSSOS-EU	Available in Ireland	Source	Comments
Road carriageway lines	✓	✓	OSI PRIME2 WAY GDF1	Road centrelines are the centre of roads or multi-lane carriageways, however CNOSSOS-EU requires “outer lane of a multi-lane road”
Traffic flows (day, evening, night)				
- Light vehicles	✓	✓	TII, RMO MapRoad, LA counts, default flows	Work required to integrate traffic flow sources
- Medium heavy vehicles	✓	✓	TII, RMO MapRoad, LA counts, default flows	Where traffic count data has one heavy vehicle class, split 50:50
- Heavy vehicles	✓	✓	TII, RMO MapRoad, LA counts, default flows	Where traffic count data has one heavy vehicle class, split 50:50
- Mopeds	✓	?		Where not known it may be assumed as 7% of all powered two wheels, except on motorways.
- Motorcycles, Tricycles & Quadricycles	✓	?	TII, RMO MapRoad, LA counts, default flows	
- EV/HV	optional	X		Not available. May be available in future from ANPR surveys.
Direction of traffic flow	✓	✓	OSI PRIME2 WAY GDF1	
Average speed (day, evening, night)				
- Light vehicles	✓	✓		
- Medium heavy vehicles	✓	✓		
- Heavy vehicles	✓	✓		
- Mopeds	✓	?		Not relevant on major roads, it may be assumed as 7% of all powered two wheels in agglomerations
- Motorcycles, Tricycles & Quadricycles	✓	?		May be part of traffic count data
- EV/HV	optional	X		Not available

Gradient	✓	✓	GIS/Predictor	Gradient calculated within noise mapping software during R3
Junction Type				
- Traffic light controlled	✓	✓	"Traffic_signals" layer in OpenStreetMap	
- Roundabout	✓	✓	OSI PRIME2	
Distance to junction	✓	✓		If less than 100m, can be generated in GIS
Road surface type	✓	✓	RMO MapRoad	Default CNOSSOS-EU road surface types based on Dutch surfaces, supplemented by TII research report
Percentage studded tyres	✓	✓		Not relevant in Ireland

Table 10.2: Input Datasets – Railway Traffic Noise

Dataset	CNOSSOS-EU	Available	Source	Comments
Railway line centrelines	✓	✓	OSI PRIME2 – Rail Network Segment Line GDF_LEVEL = 1	Rail lines are mid-way between the railheads horizontally, and on the same plane as the railheads vertically
Traffic flows (day, evening, night)				
- Per train	✓	✓	TII, IR	Hourly average traffic flow per train
- Train composition (per vehicle)	✓	✓	TII, IR	Rail vehicle types per train
- Running condition per vehicle	✓	?	TII, IR	Constant (including accelerating and decelerating), or Idling for less than 30 minutes
- Vehicle speed	✓	✓	TII, IR	Vehicle speed per line section
- Vehicle squeal	✓	?	TII, IR	Does the vehicle tend to squeal, or not
Major rail	✓	✓	TII, IR	Is total flow of all tracks within the rail corridor above 30,000 trains per year?
Station	✓	✓	TII, IR	Is rail section in a station
Line Type (Light or Heavy)	✓	✓	TII, IR	Luas (light) or Irish Rail (heavy)
Railpad type	✓	?	TII, IR	Acoustic stiffness of railpad, if known
Track Base	✓	?	TII, IR	Ballast, Concrete, Wood, mono-blocks, steel
Embedded Rail	✓	?	TII, IR	Is rail embedded, or not?
In Tunnel or Underground	✓	✓	TII, IR	Rail section is disabled from calculation when in tunnels or underground
Bridge	✓	✓	TII, IR	Is rail section on a bridge
Bridge type	✓	?	TII, IR	Type of bridge, i.e. concrete, brick, steel, steel with direct attached rails
Max Line Speed	✓	?	TII, IR	Speed limit for section of line
Joints	✓	?	TII, IR	Joints per 100 m of line section
Curve	✓	?	TII, IR	Radius of curvature of line section i.e.: 200, 300, 500, 1000, 10000

Length	✓	✓	TII, IR	Length of line segment
Rail Roughness	✓	?	TII, IR	Railhead roughness spectrum per line section
Track Transfer Function	✓	?	TII, IR	Track transfer function per line section

Table 10.3: Input Datasets – Industrial Noise

Dataset	CNOSSOS-EU	Available in Ireland	Source	Comments
Point sources	✓	?	Site measurement survey	May be possible to derive from noise reports
Line sources	✓	?	Site measurement survey	May be possible to derive from noise reports
Area sources	✓	?	Site measurement survey	May be possible to derive from noise reports
Octave band spectra	✓	?	Site measurement survey	May be possible to derive from noise reports
Working hours	✓	✓	Site survey questionnaire	Essential information for day, evening & night period. Should be available from EPA license details
Location	✓	✓	Site measurement survey	EPA license details
Type of source	✓	?	Site survey questionnaire	May be possible to derive from noise reports
Dimensions & orientation	✓	?	Site measurement survey	May be possible to derive from noise reports
Operating conditions	✓	?	Site measurement survey	May be possible to derive from noise reports
Directivity	✓	X	Site measurement survey	Not required for omni-directional sources

Table 10.4: Propagation model for road and industrial sources

Dataset	CNOSSOS-EU	Available in Ireland	Source	Comments
Digital terrain model				
- Spot heights	✓	✓	OSI LiDAR, OSI 2m DTM, OSI 10m DTM, Bluesky 1m DSM, Bluesky 2m DSM, Bluesky 5m DTM	
- Contours	✓	✓	OSI LiDAR, OSI 2m DTM, OSI 10m DTM, Bluesky 1m DSM, Bluesky 2m DSM, Bluesky 5m DTM	
- Breaklines	✓	✓	OSI LiDAR, OSI 2m DTM, OSI 10m DTM, Bluesky 1m DSM, Bluesky 2m DSM, Bluesky 5m DTM, OSI PRIME2	
- Escarpment edges	✓	✓	OSI LiDAR, OSI 2m DTM, OSI 10m DTM, Bluesky 1m DSM, Bluesky 2m DSM, Bluesky 5m DTM, OSI PRIME2	
- Bridges & tunnels	✓	✓	OSI PRIME2	
- Barriers	✓	✓	R3 data	Manually developed during R1, R2 & R3 – review and update for R4
Buildings				
- Building footprint	✓	✓	OSI PRIME2	
- Building height	✓	✓	OSI LiDAR, Bluesky 1m DSM, GeoDirectory	
- Façade reflection	✓	✓	Default value	WG-AEN GPG v2 Toolkit, with assumed spectra

Topography	✓	✓	OSI / EPA Irish National Landcover Dataset	
Meteorological data				
- Temperature	✓	✓	TII research report	
- Humidity	✓	✓	TII research report	
- Occurrence of favourable propagation	✓	✓	TII research report	

Table 10.5: Input Datasets – Aircraft Noise

Dataset	CNOSSOS-EU	Available in Ireland	Source	Comments
Movement Data (per aircraft)	✓	✓	Daa	
Arrival / Departure dates and times				
- S.O.R. (Not Stand Times)	✓	✓	Daa	
- Provided in local time	✓	✓	Daa	
Aircraft types				
- ICAO (International Civil Aviation Organization) Codes	✓	✓	Daa	Difficult to identify variants of the same aircraft types.
- Engine variant details	✓	✓	Registration database	Lookup based on aircraft registration code (where available)
Destination of aircraft (used as an indication of fuel load)	✓	✓	Daa	Used to derive stage length. Could be improved by using ICAO Code for airports.
Runway direction	✓	✓	Daa	Monthly totals
Departure Route per aircraft	✓	✓		Estimated per movement based on percentage of route use
Arrival route per aircraft	✓	✓		Estimated per movement based on percentage of route use
Runway centre point	✓	✓	Daa	
Runway end points	✓	✓	Daa	
Runway width	✓	✓	Daa	
Take off / Landing data per movement				
- Start of roll coordinates	✓	✓	Daa	
- Approach threshold coordinates	✓	✓	Daa	
- Glide slope	✓	✓	Daa	

- Threshold crossing height	✓	✓	Daa	
Route definitions				
- Radar track data	✓	✓	Daa	
- Flight track elevation data	✓	✓	Daa	
- Plan view drawing from statistical distribution	✓	✓	Daa	
- AIP routing diagrams	✓	✓	IAA	
Terrain data	✓	✓	OSI LiDAR, OSI 2m DTM, OSI 10m DTM, Bluesky 1m DSM, Bluesky 5m DTM	
Average meteorological data				
- Temperature	✓	✓	Daa, Met Eirann	
- Pressure	✓	✓	Daa, Met Eirann	
- Relative humidity	✓	✓	Daa, Met Eirann	
- Headwind direction and speed	✓	✓	Daa, Met Eirann	
Measurement Data	✓	✓	Daa	Daa noise monitoring terminals, results to be used for validation of aircraft types in FAA AEDT software.

Table 10.6: Input Datasets – Exposure to Noise

Dataset	CNOSSOS-EU	Available in Ireland	Source	Comments
Grid results	✓	✓	10m grid calculations	L_{den}; L_{night}; major roads; agglomeration roads, industry and aircraft; mandatory or optional level bands
Façade results	✓	✓	Façade calculations	L_{den}; L_{night}; major roads; agglomeration roads, industry and aircraft; mandatory or optional level bands
Building type	✓	?	Not known	Single dwellings; single dwelling per floor; multi-dwellings with single façade per dwelling; multiple dwellings with multiple facades per dwelling
Building use	✓	✓	GeoDirectory, OSi PRIME2	Dwellings, hospitals, schools, other noise sensitive types, or others
Dwellings per building	✓	✓	GeoDirectory	
People in dwellings per building	✓	✓	CSO SAPS	Last Census 2016 Next Census 3rd April 2022
Agglomeration boundary	✓	✓	Cork, Dublin & Limerick noise agglomerations	As amended in 2021 Regulations
Quiet area boundaries	✓	✓	DCC	
Major roads assessment boundary	✓	✓	TII & DCC Noise mapping projects	

11 Input Data Preparation

Following the identification and collation of the input datasets required for the strategic noise mapping, it is recommended that the initial stages of preparing the noise model input datasets are undertaken with a geographical information system (GIS).

A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. GIS can show many different kinds of data on one map, such as streets, buildings, and vegetation. This enables people to more easily see, analyse, and understand patterns and relationships.

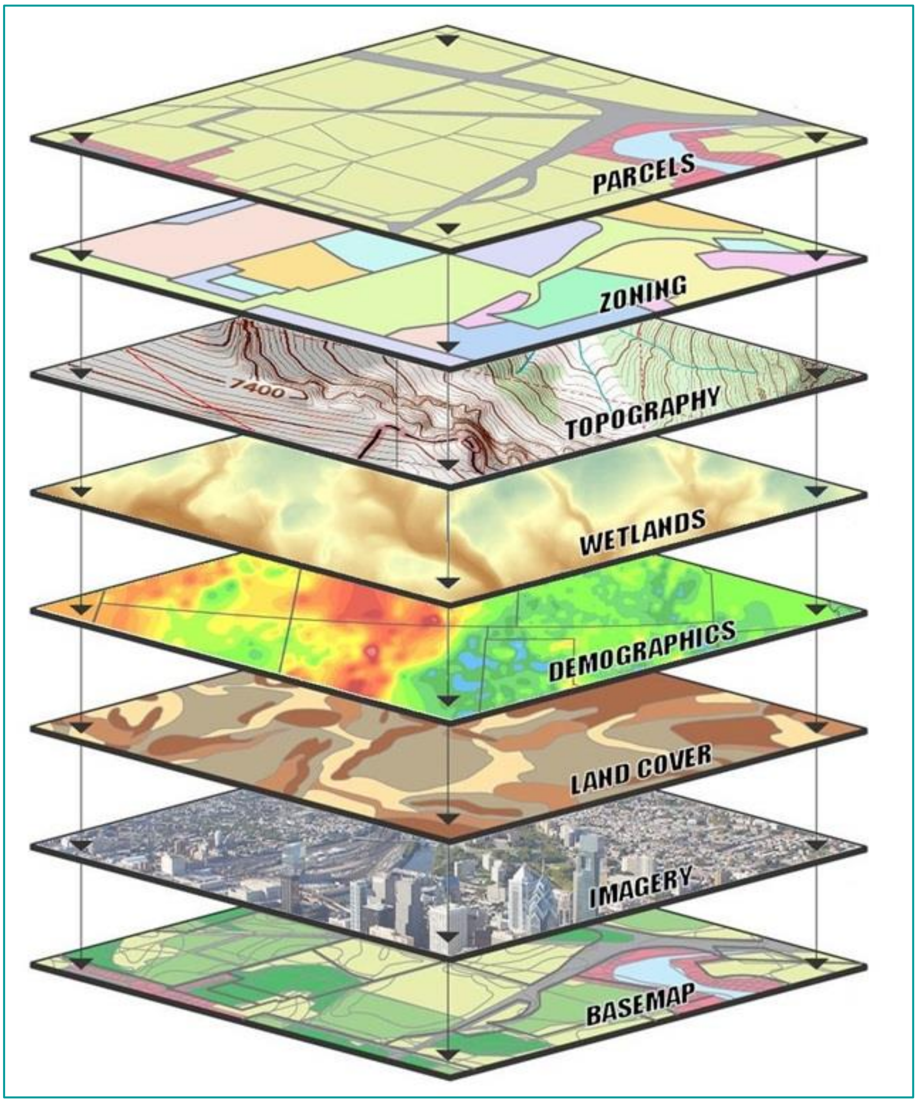

Figure 11.1: Multiple data layers displayed in priority from top to bottom at the heart of GIS (source: USGS.gov)

There are a wide range of GIS, both proprietary and open source, with a range of features and functionality. There is no particular recommendation for GIS software to be used, and it may be necessary to use a number of different software tools, however it would be very useful if the GIS can work with 3D datasets and spatial queries. A few GIS software tools which have previously been used to help prepare strategic noise mapping datasets have included:

- ArcGIS from Environmental Systems Research Institute (ESRI)[50]
- Feature Manipulation Engine (FME) from Safe Software[51]
- Quantum GIS (QGIS) from QGIS Development Team[52]
- Global Mapper by Blue Marble Geographics[53]

The CNOSSOS-EU calculation methodology for ground-based sources is described in sections covering the source sound emission, the propagation from source to receiver, and the assessment of exposure to noise at the receiver, and may also be helpful when considering the development of the noise calculation model.

- Develop emission model datasets
    - Roads
    - Railways
    - Industrial facilities
- Develop propagation model
    - DTM – 3D terrain model;
    - DSM – 3D surface model, including tops of buildings and tree canopies;
    - Drape roads, railways and industrial facilities onto the DTM;
    - Embankments & Cuttings;
    - Breaklines;
    - Bridges / Underpasses;
    - Barriers;
    - Ground cover; and
    - Meteorology
- Develop exposure model datasets
    - Residential school & hospital buildings;
    - Dwellings; and
    - People in dwellings.

The propagation datasets create a virtual three-dimensional model of the city, or other area of interest. Into this model are introduced the road, railway and industry sources, and the locations of dwellings, noise sensitive buildings, and people living in dwellings.

An example of the types of processing steps which could be undertaken to develop the noise

[50] https://www.arcgis.com/
[51] https://www.safe.com/
[52] https://www.qgis.org/
[53] https://www.bluemarblegeo.com/

mapping datasets are set out below. Depending on the available data, and the purpose of the mapping, there may be other suitable approaches, but this is presented as an example.

11.1 Define Areas of Interest

The first stage is to define the areas of interest for the requirements of the Round 4 mapping, which include:

- The area to be mapped:
    - The specific geographical area for which noise calculation results are required;
    - For agglomerations the areas are defined in the Sixth Schedule of the Regulations[54]; and
    - For major roads, major railways and major airports the sources which must be included are those designated under the Regulations[55]; the area to be mapped is less specific as it is effectively defined by the noise levels which must be reported under the Regulations, and possibly also any lower noise levels of interest to the Noise Mapping Bodies and Action Planning Authorities.

Guidance Note 55:
Some local authorities may wish noise mapping results to be provided for noise levels that are below the mandatory reporting requirements set out in the Firth Schedule of the Regulations. As a result, the areas mapped for these local authorities will be a combination of those mandatory levels required under the regulations, and reported to EEA, and those separate areas that are of specific interest to the Noise Mapping Bodies and Action Planning Authorities that are mapping to lower noise levels

- The area to be modelled:
    - In order for the noise levels on the edge of the agglomeration area to be calculated accurately, it is important to consider the noise sources, and propagation screening objects, from an area beyond and outside the actual area to be mapped; and
    - For major roads, railways and airports the noise source is specifically spatially located, and the area to be modelled in generally the same area as the area to be mapped.

[54] European Communities (Environmental Noise) (Amendment) Regulations 2021, S.I. No. 663 of 2021
[55] European Communities (Environmental Noise) Regulations 2018, S.I. No. 549 of 2018

Guidance Note 56:

1. For agglomerations:
    a. The area to be mapped is defined within the Regulations;
    b. It is recommended that the area to be modelled should be the agglomeration extent plus a buffer of 2.0 km.
2. For major roads and major railways:
    a. The extent of sources to be mapped are identified by the Noise Mapping Bodies and reported to the EPA;
    b. It is recommended that the area to be modelled should be the extent of the major sources plus a buffer of 2.0 km.
3. For major airports:
    a. The airport to be mapped is defined within the Regulations;
    b. It is recommended that the area to be modelled should extend to at least the noise level thresholds for reporting under the Regulations, plus any additional requirements which may have been established by ANCA under the Aircraft Noise (Dublin Airport) Regulation Act 2019.

Figures 11.2 to 11.6 below present illustrations of the expected areas to be mapped for the Round 4 strategic noise mapping, and the buffered model areas, for the three noise agglomerations, and the major roads, major railways and major airport.

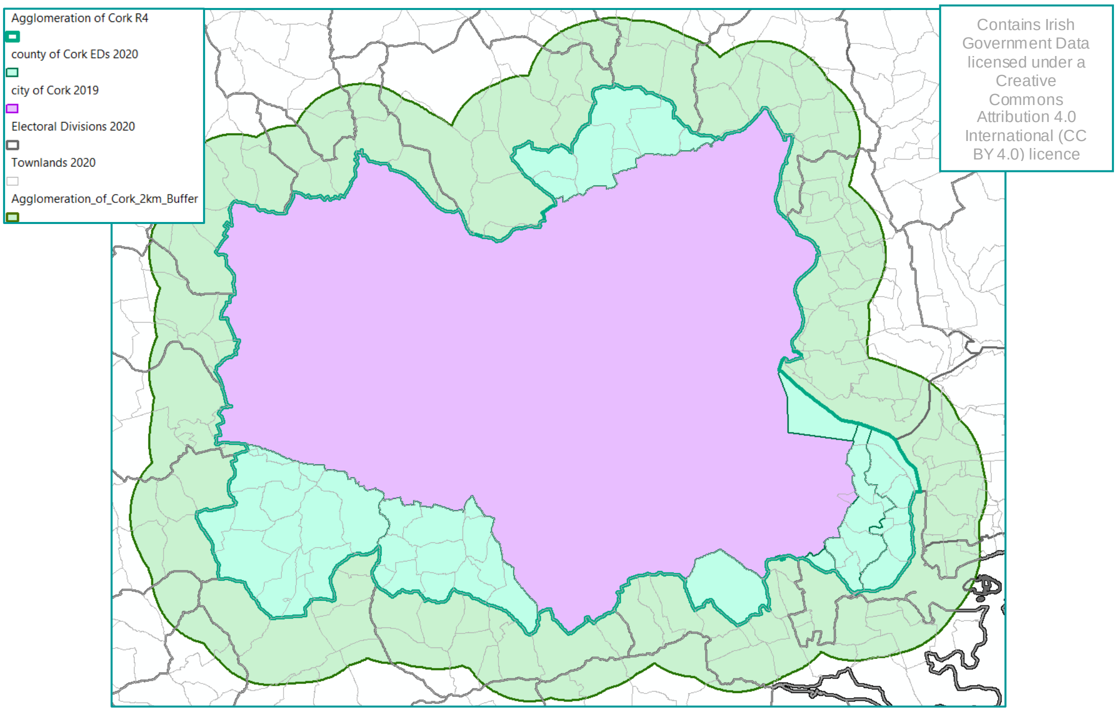

Figure 11.2: Cork noise agglomeration plus 2 km buffer model

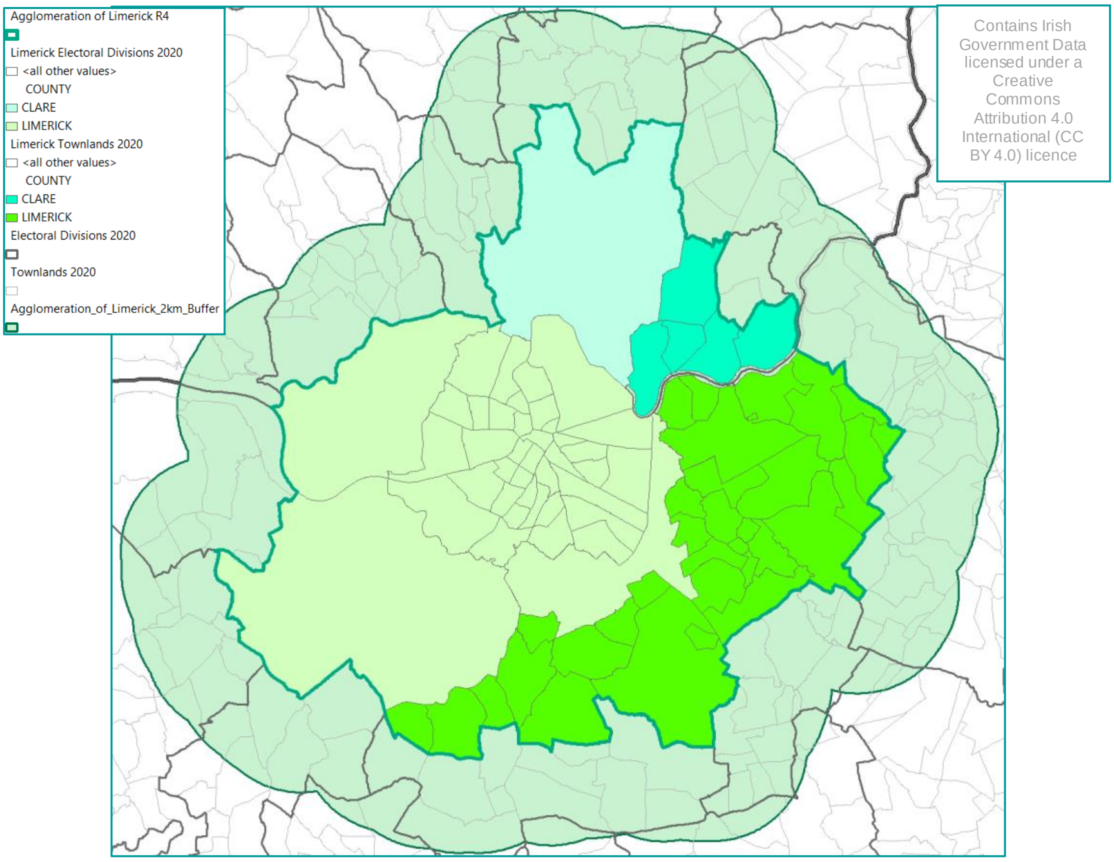

Figure 11.3: Limerick noise agglomeration plus 2 km buffer model area

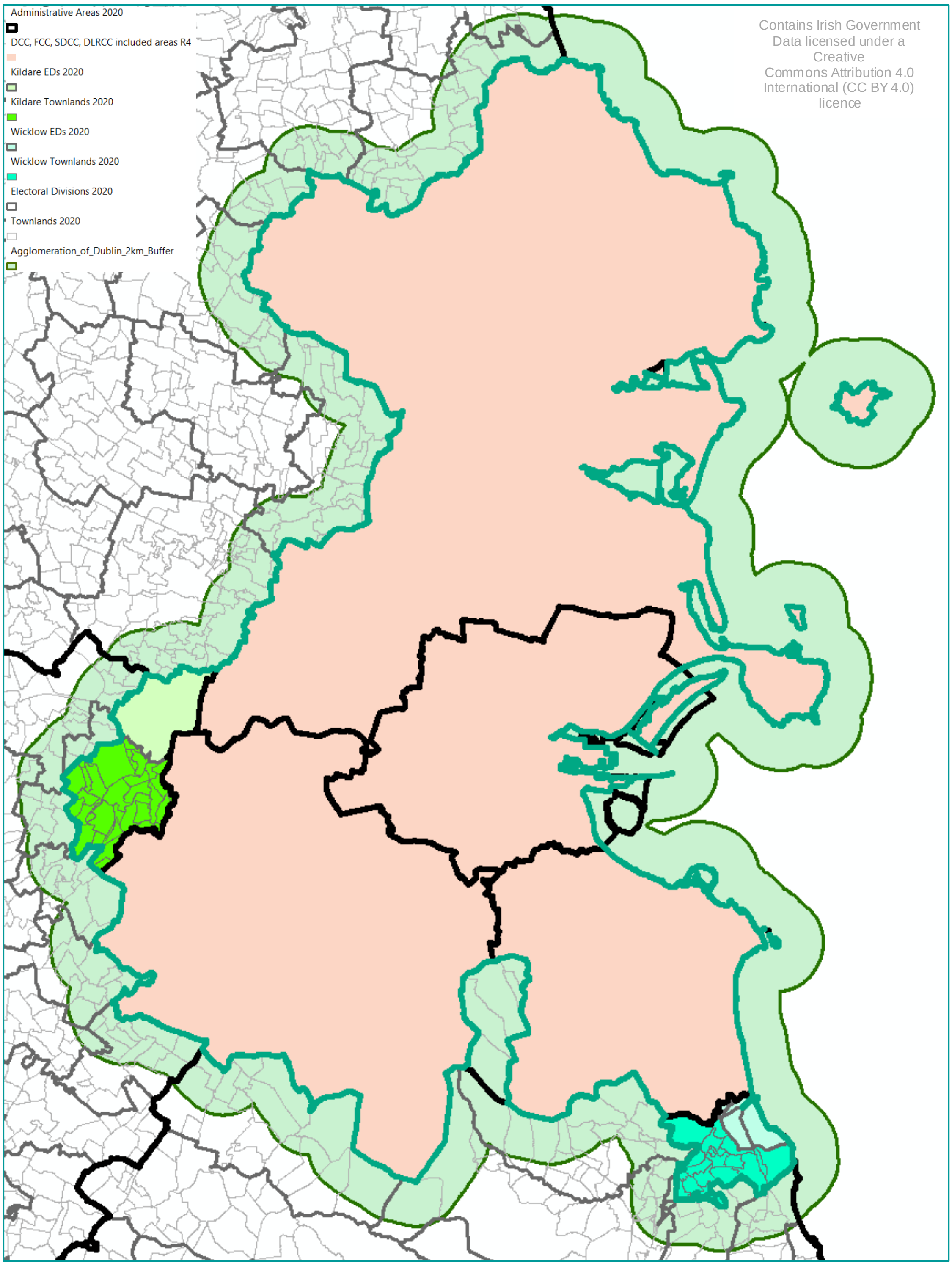

Figure 11.4: Dublin noise agglomeration plus 2 km buffer model area

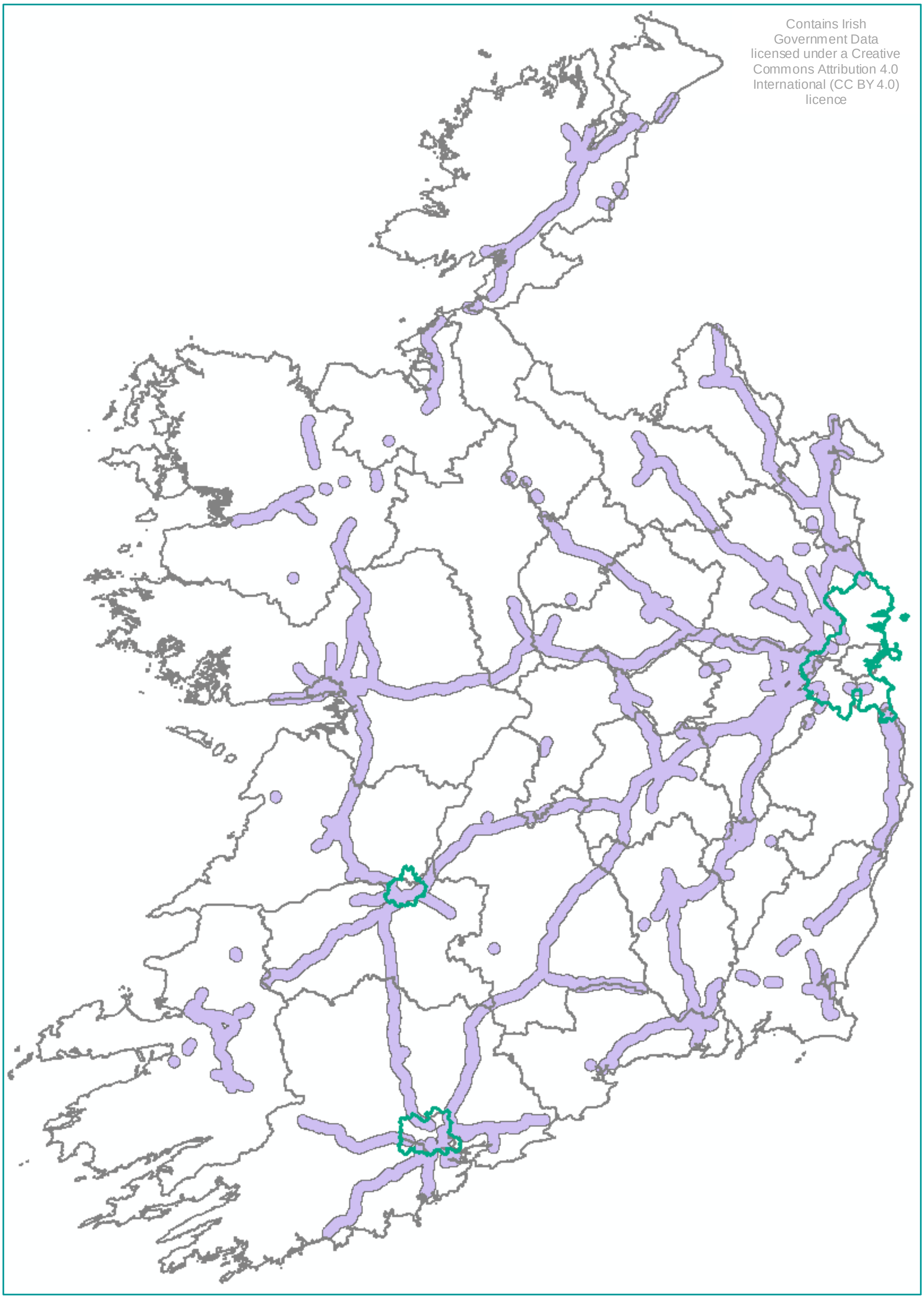

Figure 11.5: Major roads and major railways 2 km buffer model area

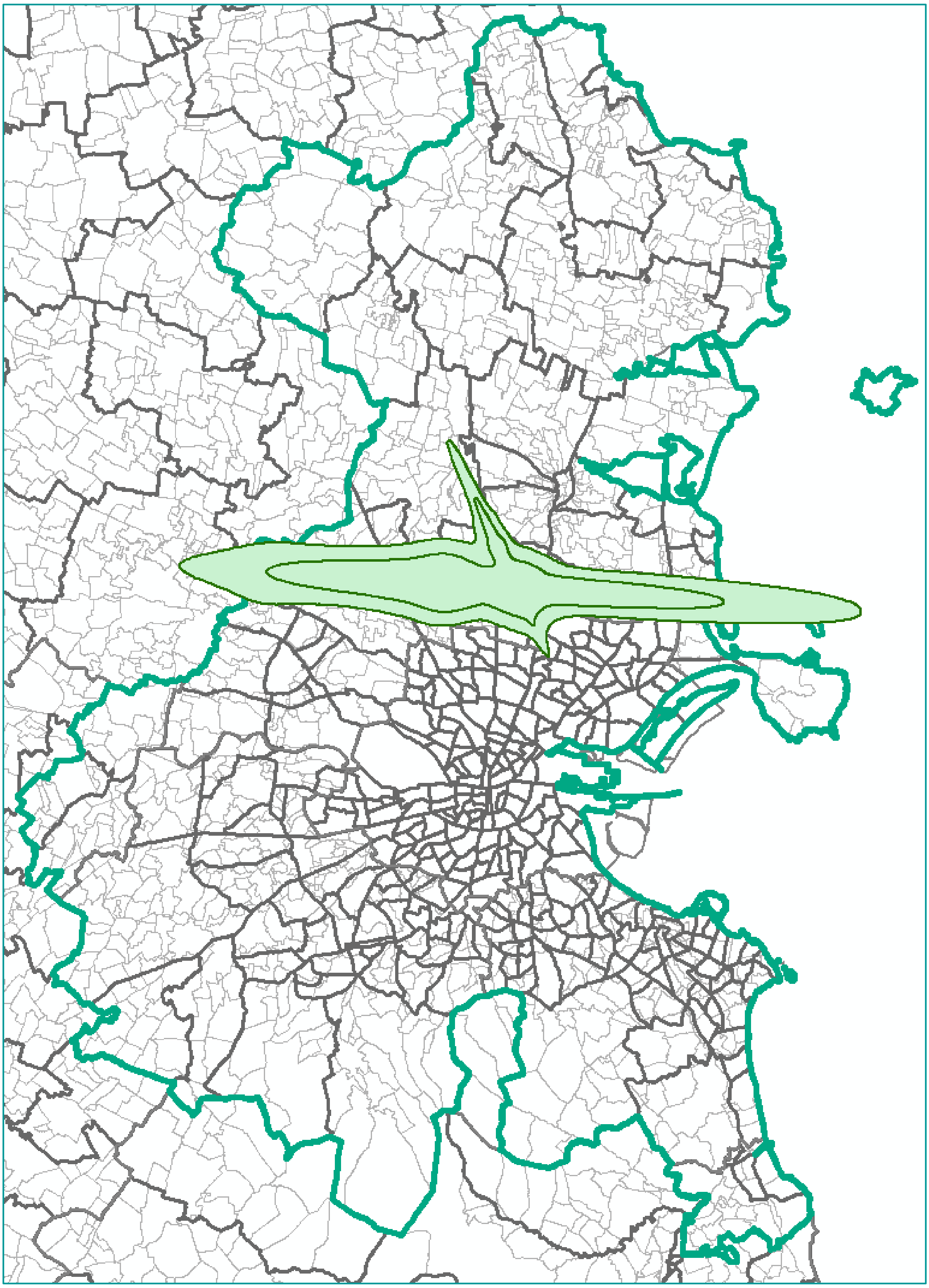

Figure 11.6: Estimated major airport model area (based on R3 L_{den} noise contours)

11.2 Road Traffic Source Model

This section provides advice on the input datasets recommended to develop the road traffic source noise emission model for strategic noise mapping.

11.2.1 Road carriageway lines

As previously advised in Guidance Note 9, it is recommended to use OSi PRIME2 WAY_GDF1 data as the road centreline geometry for the road traffic source model.

> **Guidance Note 9:** It is recommended that OSi PRIME2 WAY GDF1 data is used for the road source geometry. It has one source line for one-way and regular 2-way roads, and a source line per carriageway for dual-carriageway and motorway roads.

The OSI PRIME2 WAY GDF1 data includes all forms of way which may be used by motor vehicles and pedestrians, but not railbound vehicles. For this reason, there will be a number of links which will not be required for the noise modelling of road traffic. The PRIME2 data includes a number of attributes which can be used to select roads relevant to the noise modelling. These attributes are FORM_ID and FUNC_ID, a list of possible values is shown in Table 11.1. Not all types of FORM_ID are assigned to every FUNC_ID, but analysis across the main agglomeration areas provides a list of possible combinations shown in Table 11.2.

Table 11.1: OSI PRIME2 FUNC_ID and FORM_ID values

FUNC_ID		FORM_ID	
Value	Legend	Value	Legend
144	Domestic Vehicular	122	Dual Carriageway
177	Fifth Class	130	Entrance Only Point
179	First Class	131	Entrance/Exit Point
191	Fourth Class	138	Ferry Line
266	Main Road	146	Ford
409	Second Class	162	Walk General
475	Third Class	212	Lane
632	Not Applicable	215	Level Crossing
659	Motorway On-ramp	246	Motorway
660	Motorway Off-ramp	281	Pedestrian Zone
661	National Road On-ramp	330	Roundabout
662	National Road Off-ramp	333	Runway
667	Third Class (Access Only)	345	Service Road
669	Sixth Class (Managed)	362	Single Carriageway
670	Seventh Class (Managed)	369	Sliproad
671	Eighth Class (Managed)	398	Taxiway
		411	Motorway Toll Plaza
		412	Tow Path
		416	Tractor Road
		426	Walk Unmarked
		492	Link Road
		510	Turning Circle
		654	National Road Toll Plaza
		655	Regional Road Toll Plaza

Table 11.2: Combinations of FUNC_ID and FORM_ID values in use across the three noise agglomerations

Function Value	Function Description	Form Value
Main Road	Motorway and National Primary as designated by TII (Transport Infrastructure Ireland). These are the highest category of road classification in Ireland. The Motorway network (Prefix M) may consist of 2, 3 or 4 lane dual carriageways. The National Primary roads (Prefix N) form the major routes between the major urban centres.	Causeway
		Contraflow
		Dual Carriageway
		Entrance or Exit Service Areas
		Ford
		Level Crossing
		Motorway
		Roundabout
		Service Road
		Single Carriageway
		Sliproad
		Toll Plaza
		Weighbridge Road Section
		Drawbridge Road Section
		Link Road
First Class	National Secondary as designated by TII. These are secondary to the main arterial routes of Motorway and National Primary but still retain the Prefix N, greater than 50. Almost entirely formed by single Carriageway with some exceptions.	Causeway
		Contraflow
		Dual Carriageway
		Entrance or Exit Generic
		Entrance or Exit Service Areas
		Ford
		Level Crossing
		Roundabout
		Service Road
		Single Carriageway
		Slip road
		Weighbridge Road Section
		Drawbridge Road Section
		Link Road
Second Class	Regional roads as designated by TII (Prefix R), form an essential link in the national route network but are not major routes. Almost entirely formed by single carriageways with some exceptions.	Causeway
		Contraflow
		Dual Carriageway
		Entrance or Exit Generic
		Entrance or Exit Service Areas
		Ford
		Level Crossing
		Roundabout
		Service Road
		Single Carriageway
		Slip road
		Traffic Square
		Drawbridge Road Section
		Link Road
Third Class	Third Class Road. A public street or road, that is not a Motorway, National or Regional road, and that facilitates vehicular traffic flow at both ends, where each end of the road is connected to either a Motorway, National, Regional or another Third Class road.	Causeway
		Contraflow
		Dual Carriageway
		Entrance or Exit Car Park
		Entrance or Exit Generic

		Entrance or Exit Service Areas Ford Level Crossing Pedestrian Zone Roundabout Service Road Single Carriageway Slip road Traffic Square Link Road
Third Class (Access Only)	A public street or road which provides access within housing estates, business and industrial parks etc. It forms a thoroughfare between two adjoining ways which are Third Class or higher however this is not its primary purpose. A Third Class (Access Only) Way will never start or end at another Third Class (Access Only) Way	Single Carriageway
Link Road	A model depiction of a short section of the area of junction between a Dual Carriageway and another road(s). It straddles the break in the Dual Carriageway's median that facilitates traffic crossing from one Carriageway to the other. Traffic joining or leaving the Dual Carriageway or passing through the junction will flow across the Link Road.	
Fourth Class	A public street or road that is not a Motorway, National or Regional road. A connected end of this road class may be connected to either a Motorway, National, Regional, Third Class, Third Class (Access Only) or another Fourth Class road. Generally not intended for through traffic, it includes roads in Housing Estates, Industrial Estates and Cul-de-sacs.	Entrance or Exit Car Park Entrance or Exit Generic Entrance or Exit Service Areas Ford Level Crossing Roundabout Dual Carriageway Single Carriageway Traffic Square Link Road
Fifth Class	Ways which provide restricted public access to addressable buildings within complexes such as hospitals, hotels, stately homes and golf courses. It also includes Ways within gated communities, pedestrianised zones with serviced vehicular access only. (access mode = restricted)	Entrance or Exit Generic Entrance or Exit Service Areas Pedestrian Zone Level Crossing Roundabout Single Carriageway Link Road
Sixth Class	An accessible road which provides access to a building or buildings. Driveways - private ways to buildings (driveways to residences within housing estates are excluded), lane (urban areas) - at the rear of buildings, tractor roads or harvest roads (rural areas) - leading to outbuildings. (access mode = restricted)	Lane Level Crossing Tractor Road Driveway
Sixth Class (Managed)	An accessible road which provides access to a building or buildings, lane - at the rear of buildings, tractor roads or harvest roads - leading to outbuildings. (access mode = restricted)	Lane Level Crossing Tractor Road
Seventh Class	Must not provide access to any buildings. Roads or tracks with non-metalled surfaces of packed earth, small stones, hard-core, gravel, sand etc., that are generally drivable by Off-road vehicles. These mainly occur within	Level Crossing Tow Path Tractor Path

	or through Farms, Forestry, Quarries, etc. (access mode = restricted)	
Seventh Class (Managed)	Must not provide access to any buildings. Roads or tracks with non-metalled surfaces of packed earth, small stones, hard-core, gravel, sand etc., that are generally drivable by Off-road vehicles. These mainly occur within or through Farms, Forestry, Quarries, etc. (access mode = restricted)	Level Crossing Tow Path Tractor Path
Eighth Class	Paved or hard paths suitable for pedestrians or bicyclists e.g. paths in parks or traversing green spaces in housing estates. They are not wide enough for vehicle access. They also include the Way element under steps (access mode = impossible)	Walk General Bicycle Road Boardwalk Level Crossing Walk Marked and Unmarked Tow Path
Eighth Class (Managed)	Paved or hard paths suitable for pedestrians or bicyclists e.g. paths in parks or traversing green spaces in housing estates. They are not wide enough for vehicle access. They also include the Way element under steps (access mode = impossible)	Walk General Bicycle Road Boardwalk Level Crossing Walk Marked and Unmarked Tow Path
Ninth Class	A walking track, naturally formed through usage. Potentially Sheep Trails - pathway made by and used by sheep, often in rocky or mountainous terrain, and sometimes followed by hikers. These tracks normally start and finish on a road, track or other path and generally lead to a specific place of interest, e.g. monument or viewpoint	TBC
Tenth Class	Stepping Stones, continuation of a walking track across rivers or streams.	TBC

The Regulations define major road as *"a public road as defined in the Roads Act 1993, as amended, which has more than 3 million vehicle passages per year"*. The Roads Act 1993, as amended[56], defines a public road as *"a road over which a public right of way exists and the responsibility for the maintenance of which lies on a road authority"*.

As the Regulations require that major roads are public roads. On the basis that Local Authorities are the designated noise mapping bodies for agglomerations, it is therefore recommended that any road included within strategic noise maps of agglomerations are public roads, maintained by a road authority.

On reviewing the descriptions of road classes in OSI PRIME2 in Table 11.2 it can be seen that Main Roads through to Fourth Class would meet this requirement, whilst Fifth Class to Tenth Class would not meet this requirement.

For Main Roads through to Fourth Class, the FORM_ID value may then be reviewed in combination with satellite imagery, to draw up a list of roads to be included within the noise

[56] Roads Act 1993, Number 14 of 1993 (as amended). Available at: http://revisedacts.lawreform.ie/eli/1993/act/14/revised/en/html [Accessed July 2022]

model from the WAY GDF1 dataset. If the FORM_ID and FUNC_ID are combined as a new attribute, it is then possible to extract the relevant public roads for the noise mapping based on the compound FORM_FUNC_ID, as indicated in Table 11.3.

Table 11.3: Combined FORM_FUNC_ID for WAY GDF1 road links proposed as public roads for strategic noise mapping

Function Value	FORM_FUNC_ID	Function and Form Combined Value
First Class	362_179	First Class, Single Carriageway
First Class	330_179	First Class, Roundabout
First Class	122_179	First Class, Dual Carriageway
Fourth Class	510_191	Fourth Class, Turning Circle
Fourth Class	369_191	Fourth Class, Sliproad
Fourth Class	362_191	Fourth Class, Single Carriageway
Fourth Class	330_191	Fourth Class, Roundabout
Fourth Class	122_191	Fourth Class, Dual Carriageway
Main Road	369_266	Main Road, Sliproad
Main Road	362_266	Main Road, Single Carriageway
Main Road	330_266	Main Road, Roundabout
Main Road	654_266	Main Road, National Road Toll Plaza
Main Road	411_266	Main Road, Motorway Toll Plaza
Main Road	246_266	Main Road, Motorway
Main Road	492_266	Main Road, Link Road
Main Road	122_266	Main Road, Dual Carriageway
Motorway Off-ramp	362_660	Motorway Off-ramp, Single Carriageway
Motorway On-ramp	362_659	Motorway On-ramp, Single Carriageway
National Road Off-ramp	362_662	National Road Off-ramp, Single Carriageway
National Road On-ramp	362_661	National Road On-ramp, Single Carriageway
Second Class	369_409	Second Class, Sliproad
Second Class	362_409	Second Class, Single Carriageway
Second Class	330_409	Second Class, Roundabout
Second Class	655_409	Second Class, Regional Road Toll Plaza
Second Class	492_409	Second Class, Link Road
Second Class	215_409	Second Class, Level Crossing
Second Class	122_409	Second Class, Dual Carriageway
Third Class	369_475	Third Class, Sliproad
Third Class	362_475	Third Class, Single Carriageway
Third Class	345_475	Third Class, Service Road
Third Class	330_475	Third Class, Roundabout
Third Class	492_475	Third Class, Link Road
Third Class	215_475	Third Class, Level Crossing
Third Class	122_475	Third Class, Dual Carriageway
Third Class (Access Only)	362_667	Third Class (Access Only), Single Carriageway

Guidance Note 57:

1. It is recommended that all roads within strategic noise maps are public roads as defined in the Roads Act 1993, as amended.
2. Where OSI PRIME2 WAY GDF1 data is being used, the polylines identified may include those listed in Table 11.4 below.
3. It is recommended to retain the GUID, GDF2_SEGMENT_GUID, STATUS_ID, Z_ORDER_VALUE, FUNC_ID, ACCESS_ID, DIRECTION_ID, FORM_ID, ENG(GLE)_NAMED_EUROPEAN_ROUTE, ENG(GLE)_NAMED_NATIONAL_ROAD, ENG(GLE)_NAMED_LOCAL_ROAD, ENG(GLE)_NAMED_STREET, from PRIME2 to support further data processing, and provide traceability of the data used in the model.
4. Outside the three noise agglomerations, only those public roads with an annual traffic flow above 3 million vehicles (AADT = 8219) designated as major roads must be included within the noise model.

Table 11.4: QGIS queries for the selection of the objects identified in Table 14 as potential road centreline objects

Layer	Description
WAY_GDF1	"FORM_FUNC_ID" = “362_179” or “330_179” or “122_179” or “510_191” or “369_191” or “362_191” or “330_191” or “122_191” or “369_266” or “362_266” or “330_266” or “654_266” or “411_266” or “246_266” or “492_266” or “122_266” or “362_660” or “362_659” or “362_662” or “362_661” or “369_409” or “362_409” or “330_409” or “655_409” or “492_409” or “215_409” or “122_409” or “369_475” or “362_475” or “345_475” or “330_475” or “492_475” or “215_475” or “122_475” or “362_667”

11.2.2 Road Names

The OSI PRIME2 WAY_GDF1 data includes a number of attributes which provide the road ID numbers and road names in English and Gaelic, including:

- ENG(GLE)_NAMED_EUROPEAN_ROUTE;
- ENG(GLE)_NAMED_NATIONAL_ROAD;
- ENG(GLE)_NAMED_LOCAL_ROAD;
- ENG(GLE)_NAMED_STREET.

As recommended in Guidance Note 54 above, these attributes should be retained in the GIS noise model dataset, and where appropriate imported to the Predictor model, in order to provide contextual information, and the basis of a search facility.

11.2.3 Status of Road

The OSI PRIME2 WAY_GDF1 data includes a STATUS_ID attribute, with the values shown in Table 11.5.

Table 11.5: OSI PRIME2 DIRECTION_ID values

STATUS_ID	
Value	Legend
1	Proposed
2	Under Construction
3	In Use
4	Disused

The attribute can be used to identify links which are in use.

Guidance Note 58:

1. Road links with STATUS_ID = 1, 2 or 4, do not need to be included in the noise model.

11.2.4 Direction of Travel

The OSI PRIME2 WAY_GDF1 data includes a DIRECTION_ID attribute, with the values shown in Table 11.6.

Table 11.6: OSI PRIME2 DIRECTION_ID values

DIRECTION_ID	
Value	Legend
1	Both
2	As Digitised
3	None

The attribute can be used to identify one-way and two-way traffic flows, as required for the noise modelling.

Guidance Note 59:

1. DIRECTION_ID can be used to identify one-way and two-way traffic flow on road links.
2. Road links with a DIRECTION_ID = 3, do not need to be included in the noise model.

11.2.5 Traffic Light Controlled and Roundabout Junctions

The EPA have undertaken a technical investigation into the correction factor to be applied within 100m of traffic light-controlled crossing and roundabouts57.

The technical investigation has shown that the change in noise level due to the traffic light junction correction exceeds 2 dBA for roads with a traffic flow below approximately AADT

[57] Link to EPA technical investigation on junctions and roundabouts

4,000 vehicles per 24 hours. If NMBs include such roads within the R4 strategic noise mapping of agglomerations, the model should include the correction for traffic light-controlled junctions in order to meet the requirements of the Directive, as recommended previously in Guidance Note 16.

Guidance Note 16: The change in noise level due to the traffic light junction correction exceeds 2 dBA for roads with a traffic flow below approximately AADT 4,000 vehicles per 24 hours. It is recommended that if such roads are included within the R4 strategic noise mapping of agglomerations, the model should include the correction for traffic light-controlled junctions.

Conversely, if NMBs are only mapping roads with traffic flows significantly about 4,000 vehicles AADT, inclusion of the correction for junctions and roundabouts is optional as it is below the 2 dBA criteria in the Directive quality framework.

Where the correction factor is to be applied it is necessary to know the locations of roundabouts and traffic light controlled junctions. The EPA technical investigation identified OSI PRIME2 WAY_PNT and a source of data on the location of roundabouts, and OpenStreetMap as a source of data on the location of traffic light controlled junctions. It is not necessary to identify the location of pedestrian crossings.

Guidance Note 60: When the correction factor for roundabouts and traffic light controlled junctions is to be applied, it is recommended that the following approach is taken to prepare the road centrelines:

1. The location of roundabouts is identified using OSI PRIME2 WAY_PNT data.
2. The location of traffic light controlled junctions is identified using OpenStreetMap data.
3. It is not necessary to identify the location of traffic light controlled pedestrian crossing which are not at road intersections.
4. It is recommended that the road centreline is split into a new segment where it is 100m from the roundabout or traffic light controlled junction.
5. It is recommended that the 100m length of road centreline is split into 4 parts, each of 25m in length, and the distance to junction set as the mid-point of the segment, i.e.: 12.5m, 37.5m, 62.5m and 87.5m.

11.2.6 Road Gradient

In general, the gradient of the roads may be derived by draping the centrelines onto the elevation model, this is discussed further below in Section 11.5.
The gradient correction has no effect when the gradient is between -4 and 0 %, it then increases as gradient increases until the maximum correction effect is reached at -12% or +12%. The gradient correction is less than 2 dB between -10% and +5%, this suggests that the gradient correction must be considered for roads with a slope greater than 5%.

The OSI PRIME2 WAY_GDF1 data does not include data on the height of the road, however it does provide some information on the relative height of road links where they intersect

other road links.
The Z_ORDER_VALUE can have the value 1, 0, -1 or -2 indicating when road links are above (1), or below (-1 or -2) other roads links where they intersect. This may be useful when assigning road centrelines to bridges, and determining which road segment passes over or order another.

Guidance Note 61:

1. It is recommended that the gradient of roads is determined by draping the centrelines onto the DSM/DTM elevation datasets, as discussed in section 11.5.
2. It is recommended that gradient values derived from the drape process which are greater than 15%, should be set to 15%.
3. Z_ORDER_VALUE may be useful when assigning road centrelines to bridges, and determining which road segment passes over or under another.

11.2.7 Road Surface

The default database table of road surfaces within CNOSSOS-EU:2020 contains correction factors for fourteen road surfaces relative to the reference road surface, described as:

> *"A virtual reference road surface, consisting of an average of dense asphalt concrete 0/11 and stone mastic asphalt 0/11, between 2 and 7 years old and in a representative maintenance condition"*

The road surfaces within the default database are based upon the noise calculation method used in the Netherlands, and represent pavement types common in that country. Within the context of the Round 4 strategic noise mapping, TII have undertaken research[58,59] to establish road surface corrections for some pavement types commonly in use on the national roads in Ireland, namely HRA medium, SMA new and SMA old. This research has identified that these surfaces common in Ireland typically produce higher noise levels than the CNOSSOS-EU reference surface due to rougher surface texture.

Unfortunately, there is no equivalent measurement data available for regional or Local roads in Ireland, although it is considered likely that the TII research may be applicable to many non-National roads. Of particular interest is the use of surface dressing by local authorities. Although there is no detailed research published about the noise effects of surface dressing, some circumstantial evidence suggests that it may increase noise levels by 1 to 2 dB compared to the surface without dressing, this is thought to be due to the increase in surface roughness.

[58] Determination of Irish Road Surface Correction Factors for CNOSSOS, GE-ENV-01108, TII, May 2024. Available at: https://www.tiipublications.ie/advanced-search/results/document/?id=3328 [Accessed September 2024]
[59] TII CNOSSOS Road Surface Corrections. Available at: https://www.tii.ie/en/technical-services/environment/noise-maps/ [Accessed September 2024]

Guidance Note 62:

1. Where the road surface is HRA or SMA it is recommended that the corrections published in the TII research are used.
2. Where surface dressing has been applied, it is recommended that a correction for the underlying surface is used until further data becomes available on the effect of surface dressing on sound emissions.

11.2.8 Rolling and Propulsion Coefficients

Within the context of the Round 4 strategic noise mapping, TII have undertaken research to establish road surface corrections for some pavement types commonly in use on the national roads in Ireland based on Statistical Pass-By measurements (SPB) and Close Proximity Measurements (CPX). Analysis of these results have indicated that there is currently no need to introduce Irish specific rolling and propulsion noise coefficients into CNOSSOS-EU Appendix F, Table F-1, and that the standard values set out in the Delegated Directive are to be used.

Guidance Note 63:

1. Until either Irish specific values are developed, or the CNOSSOS-EU table is further amended, it is recommended that the rolling and propulsion noise coefficients from Table F-1 of Appendix F set out in Delegated Directive 2021/1226 are used.

11.2.9 Road Traffic Flow

Within a road traffic noise calculation model for CNOSSOS-EU:2020 it is necessary to have average hourly traffic flow data in each of the vehicle categories, for each of the time periods, for an annual average day.

For mapping of major roads outside agglomerations, public roads with more than 3 million vehicle passages per year are to be identified by TII and the relevant Local Authorities, who are then responsible for preparing the road traffic flow data required for the models.

Within agglomerations it is the responsibility of TII and the relevant Local Authorities to prepare road traffic flow data for all of the roads to be included within the calculation models.

Data on road traffic flows are available from a number of sources, including:

- TII Traffic Count Site Data[60]
- NTA Regional Modelling System[61]

[60] https://trafficdata.tii.ie/publicmultinodemap.asp [Accessed May 2022]
[61] https://www.nationaltransport.ie/planning-and-investment/transport-modelling/regional-modelling-system/ [Accessed May 2022]

- NTA Traffic counts[62]
- Traffic Management Software, i.e. SCATS/SCOOT (availability and format dependent)
- Local Authority traffic models
- Local Authority traffic counts
- Default flows (details included in Appendix E and at link below)
    - EPA STRIVE funded Integrated Modelling Project[63]
    - WG-AEN GPGv2[64].

Each of these datasets typically cover a subset of the roads for which traffic flow data is required. It is therefore a key aspect of the noise mapping that the available traffic datasets are integrated and expanded in order to compile a noise model dataset with relevant traffic flow data assigned to all the road links to be included within the model. This is a complex process, and in addition to the source datasets may require suitable methodologies to be developed to fill any gaps in the road network where data from the above sources is not available.

In addition to Guidance Notes 7, 8 and 10, the following is recommended.

Guidance Note 7: Where it is not possible to identify medium heavy and heavy vehicles separately from traffic count data, it is recommended to split the heavy vehicles 50:50 between categories 2 and 3.

Guidance Note 8: Where it is expected that powered two-wheelers will have negligible effect on the overall sound power emission from major roads, it is recommended that they may be ignored. Where powered two-wheelers may be expected to have an effect on urban roads inside agglomerations, it is recommended that the ratio is based on national registration statistics, which were approximately 7% Category 4a and 93%

Guidance Note 10: Each traffic flow value should be the annual average number of **vehicles per hour**, within each time period.

Guidance Note 64: The development of a complete traffic flow dataset for all road links within the noise model is a complex process, it is therefore recommended that suitably experience traffic engineers support the process of noise modelling.

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[62] https://mytrafficcounts.com/ [Accessed May 2022]

[63] https://www.researchgate.net/publication/311690958_Estimating_annual_average_daily_traffic_and_transport_emissions_for_a_national_road_network_A_bottom-up_methodology_for_both_nationally-aggregated_and_spatially-disaggregated_results [Accessed May 2022]

[64] http://sicaweb.cedex.es/docs/documentacion/Good-Practice-Guide-for-Strategic-Noise-Mapping.pdf [Accessed May 2022]

11.2.10 Road Traffic Speed

As with the traffic flow data, under CNOSSOS-EU:2020 it is necessary to have average hourly traffic speed data for each of the vehicle categories, for each of the time periods, for an annual average day.

Typically, the available traffic flow datasets hold some data on traffic speeds, either as measured traffic speed, or average speed based on travel time between nodes on the network. These are not developed on the same basis, so care needs to be taken when integrating a range of datasets.

As with traffic flow data, each of the available datasets typically cover a subset of the roads for which traffic speed data is required. It is therefore a key aspect of the noise mapping that the available traffic datasets are integrated and expanded in order to compile a noise model dataset with relevant traffic speed data assigned to all the road links to be included within the model. This is a complex process, and in addition to the source datasets may require suitable methodologies to be developed to fill any gaps in the road network where data from the above sources is not available.

In addition to Guidance Notes 11, the following is recommended.

Guidance Note 11:
a) The minimum value of annual average speed which should be assigned is 20 km/h, any lower measured values should be changed to 20 km/h;
b) Where annual average speed is not known, it is recommended to assign the speed limit for the section of road; and
c) Where the speed limit is assigned, the lower of the speed limit and the maximum vehicle speed should be assigned, e.g., HGVs on motorways, or Cat 4a mopeds on all roads.

Guidance Note 65: The development of a complete traffic speed dataset for all road links within the noise model is typically a complex process, it is therefore recommended that suitably experience traffic engineers support the process of noise modelling.

11.3 Railway Traffic Source Model

This section provides advice on the input datasets recommended to develop the railway traffic source noise emission model for strategic noise mapping.

11.3.1 Railway track centrelines

The modelling of railway noise under CNOSSOS-EU is to be undertaken at line level, with the emission line modelled as a polyline mid-way between the two railheads. In certain locations there may be multiple railway lines within the rail corridor, in which case each line should be modelled using a separate centreline, and rail vehicle movements assigned to each line as appropriate to represent the annual average flow.

As previously advised in Guidance Note 19, it is recommended to use OSi PRIME2 RAIL NETWORK SEGMENT LINE, GDF_LEVEL=1, data as the railway track centreline geometry for the railway traffic source model. The dataset may include infrequently, or unused, railway lines, such as sidings, shunting yards and disused lines, these may be retained within the model but it may be that vehicle flow data is not assigned.

Guidance Note 19: It is recommended that OSi PRIME2 RAIL NETWORK SEGMENT LINE, GDF_LEVEL = 1 data is used for the railway source geometry. It has one source line mid-way between the railheads of each rail line within the route corridor.

11.3.2 Railway track parameters

The CNOSSOS-EU railway source model requires a range of data related to the physical track infrastructure to be assigned to each section of centreline, including:

- Track transfer function spectrum, related to track support;
- Rail roughness, related to railhead irregularities;
- Impact roughness spectrum, related to presence of joints and switches;
- Bridge correction transfer function spectrum, related to the type of bridge structure;
- Curve radius, related to the squeal correction; and
- Maximum line speed, related to rail vehicle speed.

For each section of track, the selection of appropriate parameters will be based on information related to the physical infrastructure. Irish Rail and TII infrastructure asset management datasets may be used to provide details of track assets along the Irish Rail and LUAS networks respectively, including track type, track support, bridge details, and line speed.

The selection of appropriate parameters for the CNOSSOS-EU model then requires a detailed understanding of railway noise and vibration, and the CNOSSOS-EU calculation model. For the development of the Round 4 strategic noise maps, both TII and Irish Rail contracted ISVR Consulting to develop Irish specific entries for the CNOSSOS-EU railway database tables[65,66] for track parameters.

The Irish specific corrections which have been added to the default CNOSSOS-EU database entries include:

- Rail track
    - Track Transfer
        - LUAS slab (booted)
        - LUAS ballast

[65] CNOSSOS-EU Source Terms for LUAS, Ref: 11089-R01, ISVR, June 2022. Available at: https://www.tii.ie/en/technical-services/environment/noise-maps/ [Accessed September 2024]
[66] ISVR Report and XML files for Irish Rail

    - LUAS embedded
    - LUAS embedded grass
    - Irish Rail ballast – medium stiffness pads
    - Irish Rail ballast – stiff pads
  - Rail Roughness
    - LUAS slab (booted)
    - LUAS ballast
    - LUAS embedded
    - LUAS embedded grass
    - Irish Rail continuously welded track
    - Irish Rail jointed track

Guidance Note 66: It is recommended that Irish specific CNOSSOS-EU rail track database values are reviewed ahead of each round of strategic noise mapping, and revised if necessary to account for any changes in the rail network.

For Round 4 strategic noise mapping, the assignment of appropriate track parameters from the extended CNOSSOS-EU database tables to rail centrelines was undertaken by TII, Irish Rail, for LUAS and heavy rail respectively, and ISVR, ahead of integration into the noise model.

Guidance Note 67: It is recommended that TII and Irish Rail assign appropriate track parameters from the extended CNOSSOS-EU database tables to rail centrelines included within the strategic noise mapping.

11.3.3 Railway traffic parameters

The CNOSSOS-EU railway source model also requires a range of data related to the type and number of rail vehicles which make up the annual average railway traffic flow on each section of line within the model, including:

- Annual average number of each rail vehicle;
- Speed of each rail vehicle;
- Number of axles, per rail vehicle;
- Wheel roughness, related to the brake type per vehicle;
- Contact filter, modifies the total combined wheel and rail roughness;
- Vehicle transfer function, related to the roughness per vehicle axle and sound emission from the vehicle's wheel and bogie;
- Super-structure transfer function, related to the roughness per axle linked to the vehicle's super structure for freight wagons;
- Traction noise source, related to the type of powertrain, such as diesel or electric; and
- Aerodynamic sources, related only to vehicles over 200 km/h.

The information required can be collated from detailed knowledge of the train timetable across the network being modelled; train speed across the network; details of the composition of rail vehicles within each train; the brake types for each rail vehicle; the power source, weight and number of axles for rail vehicle.

The selection of appropriate parameters for the CNOSSOS-EU model then requires a detailed understanding of railway vehicle noise and vibration, and the CNOSSOS-EU calculation model. For the development of the Round 4 strategic noise maps, both TII and Irish Rail contracted ISVR Consulting to develop Irish specific entries for the CNOSSOS-EU railway database tables[67,68] for rail vehicle parameters.

The Irish specific corrections which have been added to the default CNOSSOS-EU database entries include:

- Rail vehicles
    - Vehicle definitions
        - EMU 8500/8600
        - EMU 8100/8300
        - DMU 29000
        - DMU 2800
        - DMU 2600
        - DMU ICR 22000
        - Mk4 – coaches
        - DD90 – coaches
        - 071 – diesel loco – freight
        - 201 – diesel loco – freight
        - Irish Rail wagons (freight, container unloaded)
        - Irish Rail coaches (other)
        - LUAS 44m
        - LUAS 55m
    - Vehicle transfer function
        - LUAS
    - Contact filter wavelength spectra
        - LUAS
    - Wheel roughness wavelength spectra
        - LUAS
        - Acoutrain Composite brake
        - Acoutrain Disc brake
        - Acoutrain Metal sintered brake

Guidance Note 68: It is recommended that Irish specific CNOSSOS-EU rail vehicle database values are reviewed ahead of each round of strategic noise mapping, and revised if necessary to account for any changes in the operational rail vehicles.

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[67] CNOSSOS-EU Source Terms for LUAS, Ref: 11089-R01, ISVR, June 2022. Available at: https://www.tii.ie/en/technical-services/environment/noise-maps/ [Accessed September 2024]
[68] ISVR Report and XML files for Irish Rail

For Round 4 strategic noise mapping, the assignment of traffic flow, speed, and appropriate rail vehicle data from the extended CNOSSOS-EU database tables to rail centrelines was undertaken by TII, Irish Rail, for LUAS and heavy rail respectively, and ISVR, ahead of integration into the noise model.

Guidance Note 69: It is recommended that TII and Irish Rail assign appropriate rail vehicle flow, speed and type parameters from the extended CNOSSOS-EU database tables to rail centrelines included within the strategic noise mapping.

11.4 Industry Source Model

Industrial facilities are included within the strategic noise mapping of the three noise agglomeration areas.

The END does not specify precisely which sites of industrial activity are to be mapped, other than those defined in Annex I of Council Directive 96/61/EC of 24 September 1996 concerning integrated pollution prevention and control[69], which has since been repealed and replaced by Directive 2010/75/EU[70] on industrial emissions (IED).

Additionally, Annex IV of the END indicates that strategic noise maps of agglomerations should include *"industrial activity sites, including ports"*.

CNOSSOS-EU:2020 also indicates that other railway related noise sources, which may include depots, loading/unloading areas, stations, bells, station loudspeakers, etc, should be treated as industrial noise sources.

The modelling of these industry noise sources may be undertaken using point, line or area sources. The level of resolution and detail within the model will be determined by the level of data available, and whether noise from the site is likely to be a high priority within the noise action plan. Guidance Note 28 recommends an approach to strategic noise mapping of industry sources which may be considered relevant to IED licensed facilitates, ports or railway related noise sources.

Guidance Note 28: It is recommended that sites of industrial activity included within strategic noise maps are modelled using equivalent point sources where there are a small number of discrete sources within the site boundary, or using zonal or global horizontal area sources where there are multiple noise sources, or access to the site to measure specific sources is not practical. Suitable SWL/m^2 emission values for zonal or global area sources may be developed from measurements undertaken following ISO 8297.

[69] https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A31996L0061
[70] https://eur-lex.europa.eu/legal-content/en/TXT/?uri=CELEX%3A32010L0075

Guidance Note 27 recommends when railway related sources are included within the strategic noise mapping.

> **Guidance Note 27:** It is recommended that other railway-related noise sources are included within the strategic noise mapping when they result in regular complaints, indicating that they are relevant to the long-term annual average noise situation. In such cases it is recommended that they are modelled as industrial sources, and reported as part of the industry noise results.

The approach to strategic noise mapping of ports could be informed by a similar assessment.

> **Guidance Note 70:** It is recommended that in addition to IED licensed facilities, other port related noise sources are included within the strategic noise mapping when they result in regular complaints, indicating that they are relevant to the long-term annual average noise situation.

Where additional port related sources are to be included within the strategic noise mapping, the sources included may include: roads, including traffic within the port; railways; cranes; and road/rail vehicle loading and unloading.

Specific guidance on strategic noise mapping of ports can be found in the NoMEPorts *Good Practice Guide on Port Area Noise Mapping and Management*, and the associated *Technical Annex*[71].

> **Guidance Note 71:** It is recommended that strategic noise mapping of industrial facilities:
> 1) Included facilities licensed under Directive 2010/75/EU where such sites affect any of the three noise agglomerations.
> 2) Includes other port or railway related activities where relevant to the long-term annual average noise situation.
> 3) Includes facilities located within the agglomeration, and facilities within the buffer outside the agglomeration where they produce a noise emission such that they affect locations inside the agglomeration.
> 4) Particular attention should be paid to identify the working hours of activities within the facilities during the day, evening and night periods on an annual average basis.

[71] *Good Practice Guide on Port Area Noise Mapping and Management - Technical Annex*, Noise Management in European Ports (NoMEPorts), 2008. Available at: https://webgate.ec.europa.eu/life/publicWebsite/index.cfm?fuseaction=search.dspPage&n_proj_id=2870 {Accessed July 2022]

11.5 Propagation Model Environment

11.5.1 Terrain Elevation Data

The first stage is to develop elevation datasets which can be used to assign height information to the other model layers. There are several ways of describing elevation datasets in GIS, including:

- **Digital Elevation Model (DEM)** is a gridded raster data and a three-dimensional representation of a terrain, which filters out and excludes terrain vector features (i.e. streams, breaklines, and ridges) and all ground objects, both built (buildings, and towers) and natural (trees and other types of vegetation).
- **Digital Terrain Model (DTM)** is a three-dimensional, bare-earth representation of a terrain or surface topography, consisting of an array of points each with a defined height, and includes features like rivers, ridges, and breaklines. This model does not include natural or man-made objects located on the earth's surface, such as vegetation and buildings.
- **Digital Surface Model (DSM)** is a three-dimensional representation of the heights of the Earth's surface, including natural or man-made objects located on it. It represents the mean sea level elevations of the reflective surfaces of vegetation, buildings, and other features elevated above the bare earth. It is usually considered as a model of a canopy over the surface of the bare earth.

The relationship between DTM and DSM is illustrated in Figures 11.7 and 11.8.

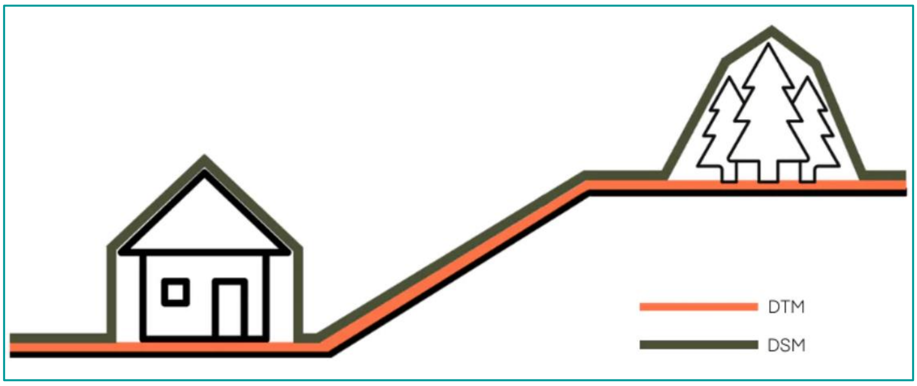

Figure 11.7: Cross section example of the difference between DTM and DSM (source: heliguy.com)

An elevation dataset such as 5m or 10m grid of points would typically be a DEM, as there is not sufficient resolution to identify the landscape features like rivers, ridges, and breaklines which may be identified from a 2m or less grid dataset DTM or DSM.

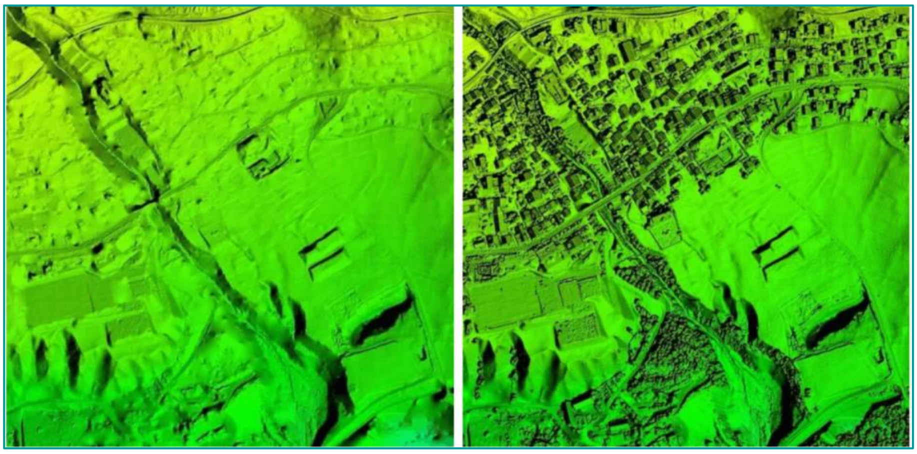

Figure 11.8: Aerial view example of the difference between DTM (left) and DSM (right) (source: heliguy.com)

When considering elevation data for strategic noise mapping, DTM or possibly DEM data can be useful for assigning heights to road and rail centrelines, the base of buildings, the base of barriers, and to polylines or areas which describe the landscape, for example: road edges, edges of cuttings, bottom of cuttings, tops of embankments etc. The DSM can be useful in assigning heights to bridges, and the tops of buildings.

Guidance Note 72:

1. **DTM & DSM**. It is recommended to develop both DTM and DSM datasets, from the highest resolution data available for the area of interest. Ideally this would be 1m or 2m data derived from LiDAR (light detection and ranging) or 3D photogrammetry, however it may be necessary to merge together several datasets, taking particular care over differences in height where the datasets align. These DTM and DSM point datasets can then be used to create DTM and DSM surfaces for use in subsequent steps in the process, which may involve interpolation to a 1m grid or raster, or possibly use of a triangulated irregular network (TIN).
2. It is recommended to create an elevation dataset which is the difference between the DSM and the DTM, giving relative height above ground of the DSM.

11.5.2 Create Contours and Height Points

Using the DTM and DSM surfaces it is possible to develop the terrain elevation datasets used within the noise calculation software. In order to develop an accurate and efficient model, it is recommended to use a combination of equal height contour lines, height points and 3D breaklines. The process discussed below will be based around this approach.

Guidance Note 73:

1. **CONTOURS_1.** The DTM surface can be used to create a 2m interval equal height contour dataset across the model area.
2. **HEIGHT_POINTS_1.** The DTM surface can also be used to create spot height point DEM dataset on a 10m or 20m regular grid across the model area.

11.5.3 Drape Road Centrelines

Using the DTM and DSM surfaces it is possible to assign height data to each vertex in the road centreline dataset to ensure it sits correctly on the ground surface within the model.

The road centreline developed as a 3D dataset helps to ensure that the emission height is correctly aligned with the terrain model, but also enables the road gradient to be calculated.

Guidance Note 74:

1. **ROADS_1.** The DTM surface can be used to assign heights to each vertex of the polylines describing road centrelines, except where they sit on bridges.
2. **ROADS_2.** The DSM surface can be used to assign heights to each vertex of the polylines describing road centrelines where they sit on bridges.
3. Generalise road centrelines, for example:
    a. **ROADS_3** - tolerances 0.1m vertical and 0.2m horizontal

11.5.4 Drape Railway Centrelines

Using the DTM and DSM surfaces it is possible to assign height data to each vertex in the railway centreline dataset to ensure it sits correctly on the ground surface within the model.

The railway centreline developed as a 3D dataset helps to ensure that the source emission heights are correctly aligned with the terrain model.

Guidance Note 75:

4. **RAILWAYS_1.** The DTM surface can be used to assign heights to each vertex of the polylines describing railway centrelines, except where they sit on bridges.
5. **RAILWAYS_2.** The DSM surface can be used to assign heights to each vertex of the polylines describing railway centrelines where they sit on bridges.
6. Generalise road centrelines, for example:
    a. **RAILWAYS_3** - tolerances 0.1m vertical and 0.2m horizontal

11.5.5 Drape Bridges

The location of bridges is useful to support road and rail lines above the terrain.

The OSI PRIME2 STRUCTURE_POLY datasets include a range of objects which describe polygon structures and aspects of the landscape, aspects of the terrain such as the road edges, top and bottom of slopes, earthworks, and embankments.

The PRIME2 data includes a number of attributes which can be used to select objects relevant to the noise modelling. These attributes are FORM_ID and FUNC_ID, a list of assigned values are shown in Table 11.7 for STRUCTURE_POLY.

If the FORM_ID and FUNC_ID are combined as a new attribute, it is then possible to classify the relevant structure polygons and process them in preparation for the noise mapping based on the compound FORM_FUNC_ID.

Combining FORM_ID and FUNC_ID to produce FORM_FUNC_ID there were 13 combinations describing bridges, see table 11.8, which were reviewed to determine those relevant to include within the noise model.

Table 11.7: OSI PRIME2 STRUCTURE_POLY FUNC_ID and FORM_ID values

FUNC_ID

Value	Legend
15	Abbey
21	Altar
27	Antiquity
62	Building Ruin
64	Bullaun
72	Cairn
77	Castle
79	Cathedral
84	Chapel
88	Church
91	Cill
103	Closed Well
112	Convent
152	Electricity Distribution
153	Electricity Generation
157	Elevated Conveyor Belt
158	Embankment
163	Enclosure
183	Flag Pole
186	Flow Control
189	Fort
192	Friary
200	Gas Distribution
203	Gas Tank
204	Gate
214	Grotto
233	House Ruin
251	Kiln
270	Manhole
279	Megalithic Tomb
280	Memorial
287	Mill
290	Monastery
296	Motte
299	Multiple Use
309	Non-Directional beacon
312	Nunnery
314	Obelisk
318	Oil Tank
326	Outdoor Swimming Pool
333	Pedestrian Bridge
335	Phone Kiosk
349	Priory
351	Promontory Fort
362	Rail Tunnel
365	Rath
376	Residence
380	Ringfort
385	Road
389	Rock
391	Round Tower
403	School
406	Sculpture
415	Sewage Settlement Tank
420	Silo
445	Statue
449	Stone Cross
468	Telecommunication
483	Tower
485	Town and City Wall
493	Tumulus
494	Turret
496	Unknown
501	Viaduct
505	Wall Ruin
509	Water Tank Covered
510	Water Tank Open
511	Water Tunnel
514	Way Tunnel
517	Wind Turbine
533	Aqueduct
632	Not Applicable
639	Bus Shelter
640	Carport
641	Bicycle Shelter
642	Covered Walkway
643	Bandstand
644	Building Overhang
645	Covered Sports Terrace
646	Toll Booth
651	Awning
657	Railway Bridge
658	Motorway Bridge

FORM_ID

Value	Legend
6	Air Transmitter Beacon
10	Airshaft/Vent
23	Archway
32	Barrow
35	Baths
50	Breakwater
60	Bus Shelter
64	Butt
70	Canopy
71	Capstan
83	Chimney
86	Cist
99	Conveyor
102	Crane
104	Crannog
107	Cromlech
109	Dam
117	Dolmen
120	Bridge Draw
149	Fort
150	Fountain
152	Fulacht Fia
173	Handball Alley
203	Jetty
209	Landform
219	Linear Earthworks
221	Lock Gate
228	Mast
230	Megalithic Tomb
239	Moat
241	Monument
247	Motte
248	Mound
260	Navigational Post/Beacon
270	Pier Open
272	Open Terrace
280	Passage Tomb
283	Pier Solid
287	Pole
305	Rail Platform
315	Rain Gauge
332	Ruin
383	Stand
386	Steps
387	Stone Circle
392	Subway
395	Swimming Pool
397	Tank
400	Telephone Point
415	Town/City Wall
420	Tunnel
421	Turbine
423	Turntable
427	Utility Box
428	Utility Point
436	Tower Water
442	Weir
443	Well
452	Bridge Fixed
454	Bridge Swing
455	Bridge Foot
487	Cave
497	Mobile Home/Caravan
500	Weighbridge
507	Stone Cross
515	Plinth
516	Pillar
517	Cross
518	Arch
526	Tram Platform

Table 11.8: Potential objects for use as bridges from OSI PRIME2

FORM_ID	Form Value	FUNC_ID	Func Value	FORM_FUNC_ID	Include in model
120	Bridge Draw	299	Multiple Use	120_299	Include
120	Bridge Draw	333	Pedestrian Bridge	120_333	Exclude
120	Bridge Draw	501	Viaduct	120_501	Include
452	Bridge Fixed	299	Multiple Use	452_299	Include
452	Bridge Fixed	333	Pedestrian Bridge	452_333	Exclude
452	Bridge Fixed	501	Viaduct	452_501	Include
452	Bridge Fixed	533	Aqueduct	452_533	Include
452	Bridge Fixed	657	Railway Bridge	452_657	Include
452	Bridge Fixed	658	Motorway Bridge	452_658	Include
454	Bridge Swing	299	Multiple Use	454_299	Include
454	Bridge Swing	333	Pedestrian Bridge	454_333	Exclude
454	Bridge Swing	501	Viaduct	454_501	Include
455	Bridge Foot	333	Pedestrian Bridge	455_333	Exclude

Table 11.9: QGIS queries for the selection of the objects identified in Table 11.8 as potential bridge objects

Layer	Description
STRUCTURE_POLY	"FUNC_FUNC_ID" = '120_299' or '120_501' or '452_299' or '452_501' or '452_533' or '452_657' or '452_658' or '454_299' or '454_501'

The extracted bridge objects are illustrated in Figure 11.9.

Figure 11.9: Illustration of the type of objects extracted as potential bridges

Guidance Note 76:

1. **BRIDGES_1.** The DSM surface can be used to assign heights to each vertex of bridge polygons which intersect road and railway lines which are to be included within the model. Other bridges may be omitted from the model.
    a. Where OSI PRIME2 data is being used, the polygons identified may include those listed in Table XX below
    b. It is recommended to retain the GUID, Z_ORDER_VALUE, FORM_ID and FUNC_ID from PRIME2 to provide traceability of the data used in the model.
    c. Bridges which do not support a road or rail centreline, or which do not pass over a road or rail centreline, may be removed from the bridge dataset.

11.5.6 Drape Breaklines

Using the DTM and DSM surfaces it is possible to develop the terrain elevation datasets used within the noise calculation

The OSI PRIME2 WAY_POLY, ARTIFICIAL_POLY and STRUCTURE_LINE datasets include a range of objects which describe aspects of the terrain such as the road edges, top and bottom of slopes, earthworks, and embankments.

The PRIME2 data includes a number of attributes which can be used to select objects relevant to the noise modelling. These attributes are FORM_ID and FUNC_ID, a list of assigned values are shown in Table 11.10 for WAY_POLY and Table 11.12 for STRUCTURE_LINE.

Table 11.10: OSI PRIME2 WAY_POLY FUNC_ID and FORM_ID values

FUNC_ID

Value	Legend
144	Domestic Vehicular
151	Eighth Class
177	Fifth Class
179	First Class
191	Fourth Class
266	Main Road
409	Second Class
413	Seventh Class
429	Sixth Class
475	Third Class
632	Not Applicable
653	Ninth Class
654	Tenth Class
659	Motorway On-ramp
660	Motorway Off-ramp
661	National Road On-ramp
662	National Road Off-ramp
667	Third Class (Access Only)
669	Sixth Class (Managed)
670	Seventh Class (Managed)
671	Eighth Class (Managed)

FORM_ID

Value	Legend
42	Bicycle Road
44	Boardwalk
122	Dual Carriageway
130	Entrance Only Point
131	Entrance/Exit Point
138	Ferry Line
146	Ford
162	Walk General
212	Lane
215	Level Crossing
246	Motorway
281	Pedestrian Zone
330	Roundabout
333	Runway
345	Service Road
362	Single Carriageway
369	Sliproad
392	Subway
398	Taxiway
411	Motorway Toll Plaza
412	Tow Path
416	Tractor Road
426	Walk Unmarked
492	Link Road
504	Driveway
510	Turning Circle
654	National Road Toll Plaza
655	Regional Road Toll Plaza

Table 11.11: OSI PRIME2 ARTIFICIAL_POLY FUNC_ID and FORM_ID values

FUNC_ID

Value	Legend	Value	Legend
53	Yard Boat	557	Karting Track
69	Bus Depot	558	Lay-by
140	Yard Dock	559	Motor Racing Track
162	Enclosed Traffic Area	560	Pitch GAA
175	Yard Farm	561	Pitch Hockey
207	Yard General	562	Pitch Rugby
209	Yard Goods	563	Pitch Soccer
221	Haulage Depot	564	Playground
239	Yard Industrial	565	Quay/Wharf
277	Median	566	Rail Bed
299	Multiple Use	567	Rail Turntable
320	Reservoir Open	568	Rail Verge
324	Yard Ornamental	569	Ramp
359	Rail Edge	571	Rest Area
404	Yard School	572	Road Verge
405	Yard Scrap	573	Roundabout
439	Sports Arena	574	Service Area
441	Yard Stable	575	Serviced Halting Site
496	Unknown	576	Sewage
498	Yard Utility	577	Sidewalk
537	Apron	578	Silage Pit
538	Area Under Construction	579	Skate Park
539	Athletic Track	580	Slipway
540	Basketball Court	581	Sloping Masonry
541	BMX Track	582	Slurry Pit
542	Bowling Green	583	Sports Surface Multiple Use
543	Brickworks	584	Tailing
544	Built Environment	585	Tennis Court
545	Car Park	586	Traffic Island
546	Cement Works	609	Sports Surface
547	Concrete/Gravel/Tarred/Artificial Area	632	Not Applicable
548	Cycling Track	656	Parking Bay
549	Dog Racing Track	664	Rock Armour
550	Forecourt	665	Plaza Ornamental
551	Garden	666	Turning Circle
552	Gateway	668	Gabion Wall
553	Handball Alley	676	Public Car Park
554	Helipad		
555	Horse Racing Track		

FORM_ID

Value	Legend
462	Man-made Surface
488	Secure Area

If the FORM_ID and FUNC_ID are combined as a new attribute, it is then possible to classify and extract the relevant breaklines and process them in preparation for the noise mapping based on the compound FORM_FUNC_ID.

Table 11.12: OSI PRIME2 STRUCTURE_LINE FUNC_ID and FORM_ID values

FUNC_ID		FORM_ID	
Value	Legend	Value	Legend
15	Abbey	23	Archway
27	Antiquity	32	Barrow
55	Bottom of Slope	46	Bollard
62	Building Ruin	70	Canopy
72	Cairn	86	Cist
77	Castle	103	Crane Rail
84	Chapel	109	Dam
88	Church	149	Fort
152	Electricity Distribution	203	Jetty
163	Enclosure	209	Landform
185	Flood Gate	210	Landform Line
186	Flow Control	219	Linear Earthworks
189	Fort	221	Lock Gate
192	Friary	241	Monument
233	House Ruin	247	Motte
287	Mill	270	Pier Open
290	Monastery	327	Rock Face
312	Nunnery	332	Ruin
349	Priory	373	Sluice Gate
351	Promontory Fort	386	Steps
365	Rath	397	Tank
380	Ringfort	421	Turbine
391	Round Tower	427	Utility Box
403	School	438	Waterfall
418	Side of Slope	442	Weir
481	Top of Slope	462	Man-made Surface
505	Wall Ruin		
509	Water Tank Covered		
517	Wind Turbine		
518	Windmill		
611	Top of Sloping Masonry		
612	Top of Waterfall		
613	Top of Weir		
614	Top of Rock Face		
632	Not Applicable		

Guidance Note 77:

1. **BREAKLINES_1.** The DTM surface can be used to assign the ground height to each vertex of the polylines and areas which have been identified as describing sharp changes in ground profile in the model area. For example, these may be road edges, edges of cuttings, bottom of cuttings, tops of embankments etc.
    a. Where OSI PRIME2 data is being used, the polylines and polygons identified may include those listed in Table XX below.
    b. The polygon areas should then be converted to line or polyline objects to ensure compatibility with the noise mapping software.
    c. It is recommended to retain the GUID, FORM_ID and FUNC_ID from PRIME2 to provide traceability of the data used in the model.

Table 11.13: QGIS queries for the selection of the objects identified in Table 12 as potential breakline objects

Layer	Description
WAY_POLY	"FORM_FUNC_ID" = '122_179' or "FORM_FUNC_ID" = '122_191' or "FORM_FUNC_ID" = '122_266' or "FORM_FUNC_ID" = '122_409' or "FORM_FUNC_ID" = '122_475' or "FORM_FUNC_ID" = '215_409' or "FORM_FUNC_ID" = '215_475' or "FORM_FUNC_ID" = '246_266' or "FORM_FUNC_ID" = '330_179' or "FORM_FUNC_ID" = '330_191' or "FORM_FUNC_ID" = '330_266' or "FORM_FUNC_ID" = '330_409' or "FORM_FUNC_ID" = '330_475' or "FORM_FUNC_ID" = '345_475' or "FORM_FUNC_ID" = '362_179' or "FORM_FUNC_ID" = '362_191' or "FORM_FUNC_ID" = '362_266' or "FORM_FUNC_ID" = '362_409' or "FORM_FUNC_ID" = '362_475' or "FORM_FUNC_ID" = '362_659' or "FORM_FUNC_ID" = '362_660' or "FORM_FUNC_ID" = '362_661' or "FORM_FUNC_ID" = '362_662' or "FORM_FUNC_ID" = '362_667' or "FORM_FUNC_ID" = '369_191' or "FORM_FUNC_ID" = '369_266' or "FORM_FUNC_ID" = '369_409' or "FORM_FUNC_ID" = '369_475' or "FORM_FUNC_ID" = '411_266' or "FORM_FUNC_ID" = '492_266' or "FORM_FUNC_ID" = '492_409' or "FORM_FUNC_ID" = '492_475' or "FORM_FUNC_ID" = '510_191' or "FORM_FUNC_ID" = '654_266' or "FORM_FUNC_ID" = '655_409'
ARTIFICIAL_POLY	"FORM_FUNC_ID" = '462_359' or "FORM_FUNC_ID" = '462_566' or "FORM_FUNC_ID" = '462_568'
STRUCTURE_LINE	"FORM_FUNC_ID" = '210_481' or "FORM_FUNC_ID" = '327_614' or "FORM_FUNC_ID" = '210_55' or "FORM_FUNC_ID" = '210_418'

The type of objects extracted using the queries in Table 11.13 are illustrated in Figure 11.10.

Figure 11.10: Illustration of the type of objects extracted as potential breaklines

Following the initial selection, extraction and height assignment of polylines to be used as breaklines, the polyline dataset should be buffered to create an area around the breaklines, this will be used later in the process.

Guidance Note 78:
1. **BREAKLINES_BUFFER_1.** Buffer BREAKLINES_1 by 5m.

11.5.7 Drape Buildings

Using the DTM and DSM surfaces it is possible to assign height data to the base of each building polygon in the noise model.

Buildings within the noise model can act as barriers to propagation of sound, but can also identify the location of noise sensitive premises, dwellings and inhabitants. The OSi PRIME2 BUILDING_POLY layer contains 2D polygon objects (no height data) for all buildings in Ireland.

Within the PRIME2 BUILDING_POLY theme the following attributes may be useful for the noise mapping process:

- FORM_ID – building type category, e.g. apartment building, hospital etc
- FUNC_ID – building use category, e.g. rectory, convent, residence etc
- STATUS_ID – the status of use of the building
- GEO_ID – GeoDirectory building number
- GUID – unique ID of the building polygon
- WAY_SEG_VALUE – ID of the adjacent road in the WAY theme
- SHAPE_Area – polygon area

The STATUS_ID also provides additional information on the status of the building, as shown in Table 11.14.

Table 11.14: OSI PRIME2 STATUS_ID values

STATUS_ID

Value	Legend
1	Proposed
2	Under Construction
3	In Use
4	Disused
5	Derelict
6	In Ruin
7	Site of
8	Dismantled

Table 11.15: OSI PRIME2 BUILDING_POLY FORM_ID and FUNC_ID values

FORM_ID

Value	Legend
9	Airport Terminal
16	Apartment Building
21	Aquatic Centre
31	Barrack
41	Belfry
55	Building General
75	Castle
82	Chapel
84	Church
90	Clubhouse
92	College
97	Tower Control
112	Detached Building
129	End of Terrace
139	Ferry Terminal
141	Filling Station
142	Fire Station
157	Garda Station
163	Glasshouse
168	Grandstand
190	Hospital
192	Hotel
217	Lifeboat Station
218	Lighthouse
222	Mansion
227	Tower Martello
231	Meteorological Office
235	Mill
240	Monastery
243	Mosque
253	Multi-Storey Car park
263	Observatory
293	Prison
311	Railway Service Shed
312	Railway Signal Box
313	Railway Station
329	Tower Round
332	Ruin
338	School
343	Semi-Detached Building
351	Shop
353	Shopping Centre
360	Tower Signal
381	Stable
382	Stadium
385	State Government Building
403	Terraced Building
409	Toilet
410	Toll Booth
413	Tower General
439	Watermill
446	Windmill
501	Market
508	Gate House
509	Gate Lodge
513	Duplex

FUNC_ID

Value	Legend
14	Abattoir
15	Abbey
16	Adventure Centre
18	Air Corps Barracks
19	Airport Building
22	Ambulance Station
23	Amusement Arcade
25	Anglican Church
26	Animal Pound
27	Antiquity
33	Aquarium
38	Army Barracks
39	Art Gallery
40	Auction House
41	Bakery
42	Bank
45	Basketball Arena
52	Bell Tower
58	Bowling Alley
59	Brewery
69	Bus Depot
70	Bus Station
80	Catholic Cathedral
81	Catholic Church
86	Childrens Home
87	Childrens Hospital
89	Church of Ireland Church
90	Church of Ireland Cathedral
94	Cinema
96	Civil Defence
99	Clinic
101	Clock Tower
106	Coastguard Station
107	Cold Store
108	Community Centre
109	Concert Hall
110	Conference Centre
111	Consulate
112	Convent
115	Courthouse
118	Creamery
119	Credit Union
120	Crematorium
131	Day Centre
133	Dental Hospital
137	Distillery
155	Electricity Station
159	Embassy
171	Equestrian Centre
173	Eye and Ear Hospital
174	Factory
181	Fitness Centre
182	Flag Tower
192	Friary
194	Funeral Home
197	Garage
198	Garda Headquarter
199	Garda Training College
202	Gas Station
206	General Hospital
218	Hall
219	Hangar
222	Health Centre
223	Hearing Impaired School
230	Hospice
231	Hostel
234	Hut
237	Icehouse
242	Institute of Technology
246	Interpretive Centre
249	Jehovah Witness Church
250	Juvenile Detention Centre
252	Laboratory
258	Language School
259	Latter Day Saints Church
260	Laundry
263	Library
265	Local Government Building
267	Male Detention Centre
275	Maternity Hospital
276	Mausoleum
282	Methodist Church
293	Montessori School
295	Mortuary
299	Multiple Use
301	Museum
308	Navy Barracks
313	Nursing Home
316	Oil Depot
322	Oratory
325	Outbuilding
330	Parochial House
332	Pavilion
336	Photographic Gallery
338	Piggery
342	Post Office
343	Pottery
344	Power Station
345	Prayer/Mission Hall
346	Presbyterian Church
347	Presbytery
348	Primary School
349	Priory
350	Private College
352	Psychiatric Hospital
354	Public House
355	Pump House
358	Radio Station
364	Railway Terminus
366	Recreational Complex
367	Rectory
368	Recycling Centre/Depot
369	Recycling Plant
370	Relay Station
371	Research Centre
372	Research Institute
373	Research Laboratory
376	Residence
377	Restaurant
379	Retirement Home
403	School
410	Secondary School
416	Sheltered Accommodation
437	Special Needs School
461	Swimming Pool
463	Synagogue
467	Teacher Training College
468	Telecommunication
469	Telephone Exchange
471	Television Station
474	Theatre
476	Third Level
482	Tourist Office
486	Town Hall
495	University
496	Unknown
500	Veterinary Clinic
504	Visually Impaired School
506	Warehouse
507	Watch Tower
629	Gate Tower
630	Church Tower
632	Not Applicable
636	Office
637	Commercial/Retail
638	Industrial facility
648	Commercial/Livestock/Fruit/Vegetable/Fish
649	Further Education
655	Primary and Secondary School
672	Commercial/Residential
673	Delivery Service Unit

The FORM_ID and FUNC_ID attributes describe the use or purpose of the building as shown in Table 11.15.

If the FORM_ID and FUNC_ID are combined as a new attribute, it is then possible to classify the relevant building polygons and process them in preparation for the noise mapping based on the compound FORM_FUNC_ID.

Combining FORM_ID and FUNC_ID to produce FORM_FUNC_ID there were 231 unique combinations. For each combination the BUILD_USE was manually estimated, and the MINIMUM_HEIGHT value was assigned.

The BUILD_USE was assigned one of the following values based on the descriptions of the FORM_ID and FUNC_ID:

- Hospital
- Non-Residential
- Residential
- School

The Hospital class was assigned where it was expected that there would be ward facilities for inpatients staying overnight therefore, for example, Maternity Hospital was assigned to this group, but Health Centre was not. Table 11.16 shows the list of school buildings, and Table 11.17 shows the list of hospital buildings.

Table 11.16: OSI PRIME2 BUILDING_POLY assigned to School BUILD_USE

FORM_ID	Form Value	FUNC_ID	Func Value	FORM_FUNC_ID	MINIMUM HEIGHT (m)
55	Building General	679	Adult Learning Centre	55_679	5
92	College	17	Agricultural College	92_17	5
92	College	242	Institute of Technology	92_242	5
92	College	350	Private College	92_350	5
92	College	467	Teacher Training College	92_467	5
92	College	476	Third Level	92_476	5
92	College	495	University	92_495	5
92	College	649	Further Education	92_649	5
338	School	223	Hearing Impaired School	338_223	5
338	School	258	Language School	338_258	5
338	School	293	Montessori School	338_293	5
338	School	348	Primary School	338_348	5
338	School	410	Secondary School	338_410	5
338	School	437	Special Needs School	338_437	5
338	School	496	Unknown	338_496	5
338	School	504	Visually Impaired School	338_504	5
338	School	655	Primary and Secondary School	338_655	5

Table 11.17: OSI PRIME2 BUILDING_POLY assigned to Hospital BUILD_USE

FORM_ID	Form Value	FUNC_ID	Func Value	FORM_FUNC_ID	MINIMUM HEIGHT (m)
190	Hospital	87	Childrens Hospital	190_87	5
190	Hospital	133	Dental Hospital	190_133	5
190	Hospital	173	Eye and Ear Hospital	190_173	5
190	Hospital	206	General Hospital	190_206	5
190	Hospital	275	Maternity Hospital	190_275	5
190	Hospital	352	Psychiatric Hospital	190_352	5
190	Hospital	682	Specialised Hospital	190_682	5
190	Hospital	683	Community Hospital	190_683	5
190	Hospital	684	District Hospital	190_684	5
190	Hospital	685	Private Hospital	190_685	5

The Minimum Height was manually assigned for use as a default value where height data is not available or it is below this minimum value. The complete list of FORM_FUNC_LOOKUP, BUILD_USE and MINIMUM_HEIGHT can be found in Appendix D.

Guidance Note 79:

1. **BUILDINGS_1.** Create and assign FORM_FUNC_ID attribute, and assign BUILD_USE and MINIMUM_HEIGHT based on the lookup table in Appendix D. Generalise BUILDINGS with tolerance 0.1m horizontal to remove redundant vertices from the building outline.;
2. **BUILDINGS_2.** The DTM surface can be used to assign the ground height to each vertex of the building footprint polygons.
    a. The vertex with the highest ground height value should be found, and the start point of the polygon moved to this point. (This helps avoid problems during calculations if a vertex falls below the terrain).
    b. Where OSI PRIME2 data is being used, the polygons identified may include those listed in Table 16 below.
    c. It is recommended to retain the GUID, Z_ORDER_VALUE, FORM_ID and FUNC_ID from PRIME2 to provide traceability of the data used in the model.
3. **BUILDINGS_3.** The difference between DSM and DTM surfaces inside building polygons may be used to assign the relative height of buildings above the terrain.
    a. It may be necessary to average height points within each building polygon, and it may be necessary to first remove any which approximate to the ground height below the building;
    b. The assigned building heights can then be checked to avoid unrealistically low (for example below 3.0m), or high (for example above 80m) values being assigned;
    c. Building height should be checked to ensure that it is equal to or greater than the MINIMUM_HEIGHT, and amended where necessary;
    d. All residential, school and hospital buildings then need a second check to ensure that each facade is at least 4.5m high (this would be absolute height of the top of the building minus the ground height at each vertex) in order for the façade receiver points to be created and calculated correctly. If required the relative height of the building should be increased to ensure that all exposed facades are at least 4.5m high above local ground.
4. **BUILDINGS_4.** Building polygons which intersect road or railway lines should be removed from the model dataset, unless they are RESIDENTIAL, SCHOOL or HOSPITAL buildings. In which case, the road or rail line intersecting the buildings should be cut where it intersects the building, and removed or disabled inside the building.
5. **BUILDINGS_5.** In the context of strategic noise mapping, it may be considered appropriate to remove small low height buildings, such as garages, sheds etc. These could be considered as those below approximately 3.5 m in height, and less than 20 m^2 in area, unless they are RESIDENTIAL, SCHOOL or HOSPITAL buildings in which case they should be retained.

Following the initial selection, extraction, and building use and height assignment of polygons to be used as buildings, the polygon dataset should be buffered to create an area around the buildings, this will be used later in the process.

Guidance Note 80:

1. **BUILDINGS_BUFFER_1.** Buffer BUILDINGS_5 by 0.5 m (50 cm).

11.5.8 Drape Noise Barriers

There is currently no specific dataset which describes the location and height of noise barriers in Ireland.

It may be possible to use noise barrier datasets developed for previous rounds of strategic noise mapping, and cross reference this against the TII barrier inventory, which identifies the location, type and extent of barriers along roads under TII management. Otherwise, it may be necessary to manually develop or confirm noise barrier data, potentially with reference to OSi PRIME2 POLY data, aerial imagery and Google Streetview imagery.

Developing the final noise barrier dataset can be time consuming due to the manual nature of identifying, reviewing, and confirming or amending noise barriers.

Using the DTM and DSM surfaces it is possible to assign height data to the base of each barrier polyline in the noise model.

Guidance Note 81:

1. Barrier data may be sourced from previous noise mapping projects, barrier inventory data, field survey, or remote sensing using tools such as OSi PRIME2 POLY data, aerial imagery and Google Streetview.
2. It is likely that barrier data will need to undergo an extensive manual review process to confirm the location, type and height of each barrier in the model.
3. Barrier polyline should not intersect building polygons.
4. The DTM surface can be used to assign the ground height to each vertex of the barrier polylines.
5. Where barriers are located on bridge objects, the ground height of the barrier vertices should be assigned from the bridge deck, all vertices should sit inside the bridge polygon and the barrier assigned as being on a bridge object.
6. Barrier height should be assigned from inventory data, or informed by field survey or Google Streetview data.

11.5.9 Ground Cover Regions

The new Irish landcover classification system has been primarily designed to describe the landscape in terms of its bio-physical properties or landcover, with some exceptions to reflect classes which are inherently characterised by their land use or habitat system.

In-situ vector GIS data has been used in two ways:

a) To aid in the image segmentation, and
b) To aid in the thematic classification of an object.

The only in-situ dataset which is used to both delineate(segment) and classify objects is the OSi's PRIME2 spatial database with the following classes being delineated and classified directly from their respective PRIME2 surface layer:

- Buildings
- Ways
- Rivers and Streams
- Lakes and ponds
- Artificial Waterbodies
- Transitional waterbodies
- Marine water

For these classes there is no set minimum mapping unit (mmu) as they are taken directly from the PRIME2 database and are 'scale less' meaning they exactly represent the dimensions of the feature on the ground. However, these surface types may also include ancillary land of a different landcover type (e.g. verges, embankments, etc.) which are not separated out as part of this project.

Other in-situ data used to aid in the thematic classification of objects includes:

- LPIS (Arable / Cultivated land only)
- Forestry data (Forest Service and COILLTE)
- Various habitat datasets from NPWS, NBDC, Heritage Council, Local Authorities, etc.

In the case of the LPIS and Forestry datasets, the data was assumed to be correct and used to directly classify the segmented objects, except where one of the PRIME2 in-situ layers above overlaid the same area.

The three-tier land classification is set out in Table 11.18. An illustration of the dataset is presented in Figure 11.11.

Table 11.18: Irish Landcover Classification System (V4.1)

Code	Level 1	Code	Level 2	Code	Level 3
100	ABIOTIC SURFACES	110	Artificial Surfaces	111	Buildings
				112	Ways
				113	Other Artificial Surfaces
		120	Exposed Surfaces	121	Exposed rock and sediments
				122	Coastal Sediments
				123	Mud flats
				124	Bare Soil & Disturbed Ground
200	CULTIVATED LAND	210	Cultivated Land	211	Cultivated Land
300	FORESTRY	310	Coniferous and Mixed Forest	311	Coniferous Forest
				312	Mixed Forest
				313	Transitional Forest
		320	Broadleaved, Scrub and Linear Woodland	321	Broadleaved Forest
				322	Scrub
				323	Hedgerows
				324	Treelines
400	GRASSLANDS	410	Improved Grasslands	411	Improved Grassland
				412	Amenity Grassland
		420	Semi-natural Grasslands	421	Semi-natural grasslands (Dry)
				422	Semi-natural grasslands (Wet)
		430	Coastal Grasslands	431	Salt marsh
				432	Sand dunes
		440	Swamps and Fens	441	Swamp
				442	Fens
500	PEATLANDS	510	Intact Peat Bogs	511	Raised bog
				512	Blanket Bog
		520	Degraded Bog	521	Cutover Bog
				522	Bare Peat
600	HEATHLAND, BRACKEN and BURNT AREAS	610	Bracken	611	Bracken
		620	Heathland	621	Dry Heath
				622	Wet Heath
		630	Burnt Areas	631	Burnt Areas
700	WATER	710	Fresh Waterbodies	711	Rivers and Streams
				712	Lakes and ponds
				713	Artificial Waterbodies
		720	Marine and transitional Waterbodies	721	Transitional waterbodies
				722	Marine water

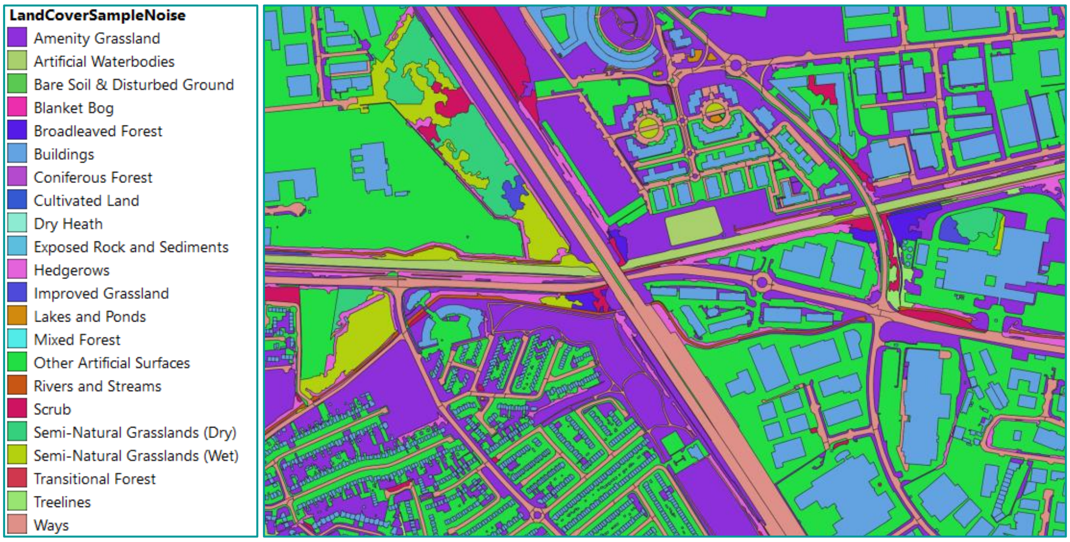

Figure 11.11: Example of land cover classification in Irish National Landcover Dataset

The recommended assignment of ground factor, *G*, for each of the Irish National Landcover Dataset classes is set out in Table 11.19 below.

Table 11.19: Recommendations for assigning G values to National Land Cover Classes

Level3Code	Level3Description	CNOSSOS-EU Description	CNOSSOS-EU Type	Grnd_Factor	Notes
111	Buildings	Hard surfaces (most normal asphalt, con-crete)	G	0.0001	
112	Ways	Hard surfaces (most normal asphalt, con-crete)	G	0.0001	Road surfaces
113	Other Artificial Surfaces	Compacted dense ground (gravel road, car park)	F	0.3	
121	Exposed rock and sediments	Compacted dense ground (gravel road, car park)	F	0.3	
122	Coastal Sediments	Compacted dense ground (gravel road, car park)	F	0.3	
123	Mud flats	Compacted dense ground (gravel road, car park)	F	0.3	
124	Bare Soil & Disturbed Ground	Compacted dense ground (gravel road, car park)	F	0.3	
211	Cultivated Land	Compacted field and gravel (compacted lawns, park area)	E	0.7	
311	Coniferous Forest	Soft forest floor (short, dense heather-like or thick moss)	B	1	
312	Mixed Forest	Soft forest floor (short, dense heather-like or thick moss)	B	1	
313	Transitional Forest	Normal uncompacted ground (forest floors, pasture field)	D	1	
321	Broadleaved Forest	Soft forest floor (short, dense heather-like or thick moss)	B	1	
322	Scrub	Normal uncompacted ground (forest floors, pasture field)	D	1	
323	Hedgerows	Normal uncompacted ground (forest floors, pasture field)	D	1	
324	Treelines	Normal uncompacted ground (forest floors, pasture field)	D	1	
411	Improved Grassland	Normal uncompacted ground (forest floors, pasture field)	D	1	
412	Amenity Grassland	Compacted field and gravel (compacted lawns, park area)	E	0.7	
421	Semi-natural grasslands (Dry)	Normal uncompacted ground (forest floors, pasture field)	D	1	
422	Semi-natural grasslands (Wet)	Normal uncompacted ground (forest floors, pasture field)	D	1	
431	Salt marsh	Compacted field and gravel (compacted lawns, park area)	E	0.7	
432	Sand dunes	Compacted dense ground (gravel road, car park)	F	0.3	
441	Swamp	Normal uncompacted ground (forest floors, pasture field)	D	1	
442	Fens	Uncompacted, loose ground (turf, grass, loose soil)	C	1	
511	Raised bog	Soft forest floor (short, dense heather-like or thick moss)	B	1	
512	Blanket Bog	Soft forest floor (short, dense heather-like or thick moss)	B	1	
521	Cutover Bog	Soft forest floor (short, dense heather-like or thick moss)	B	1	
522	Bare Peat	Soft forest floor (short, dense heather-like or thick moss)	B	1	
611	Bracken	Soft forest floor (short, dense heather-like or thick moss)	B	1	
621	Dry Heath	Soft forest floor (short, dense heather-like or thick moss)	B	1	
622	Wet Heath	Soft forest floor (short, dense heather-like or thick moss)	B	1	
631	Burnt Areas	Uncompacted, loose ground (turf, grass, loose soil)	C	1	
711	Rivers and Streams	Very hard and dense surfaces (dense as-phalt, concrete, water)	H	0.0001	
712	Lakes and ponds	Very hard and dense surfaces (dense as-phalt, concrete, water)	H	0.0001	
713	Artificial Waterbodies	Very hard and dense surfaces (dense as-phalt, concrete, water)	H	0.0001	
721	Transitional waterbodies	Very hard and dense surfaces (dense as-phalt, concrete, water)	H	0.0001	
722	Marine water	Very hard and dense surfaces (dense as-phalt, concrete, water)	H	0.0001	

Whilst Level 3 Code 112 describes “Ways”, which are the road surface areas required by CNOSSOS-EU, there is no National Land Cover Class which specifically describes railways ballast, as also required by the method. In order to define areas most likely to be railway ballast, it is recommended to extract the following features listed in Table 11.20 from OSI PRIME2 ARTIFICIAL_POLY.

Table 11.20: OSI PRIME2 ARTIFICIAL_POLY assigned to *G* = 1 for railbeds

FUNC_ID	Func Value
359	Rail Edge
566	Rail Bed
568	Rail verge

The extracted polygons should then be inserted into the land cover dataset and assigned a value of *G* = 1. It may be necessary to clean the geometry after this process in order to remove fragmented, crossing or duplicate polygons. It is then recommended to split the ground cover polygons on a 500m or 1km regular grid to help avoid large area polygons.

Guidance Note 82: It is recommended that ground cover data required for strategic noise mapping is based upon the OSI National Land Cover dataset, and assigned with ground factors, *G*, as set out in Table X. Areas representing railbeds should be inserted from OSI PRIME2 ARTIFICIAL_POLY. It is recommended to split the ground cover polygons on a 500m or 1km regular grid to help avoid large area polygons.

11.5.10 Meteorology

For strategic noise mapping under CNOSSOS-EU:2020 long term average meteorological data is required for the following aspects of the calculations:

- Correction for the air temperature on the rolling noise component of the road traffic source;
- Effects during outdoor sound propagation:
    - Attenuation due to air absorption; and
    - Occurrence of favourable propagation.
- Corrections during calculation of aircraft noise based on:
    - Air pressure
    - Air temperature

In support of the Round 4 strategic noise mapping, TII let a research project[72] to develop Irish specific meteorological correction factors required to implement CNOSSOS-EU:2020. Within the project meteorology data available from Met Éireann was reviewed to identify a suitable approach to developing meteorological corrections in Ireland.

[72] Common Noise Assessment Methods in Europe (CNOSSOS-EU): Meteorological Correction Factors for Ireland, RE-ENV-07007, TII, October 2022. Available at: https://www.tiipublications.ie/advanced-search/results/document/?id=3214 [Accessed September 2024]

Long term annual average temperature, relative humidity and mean seal level pressure data was determined. The percentage of favourable propagation in 20-degree increments for the day, evening and night periods were also determined from the long-term meteorological data using the Nord2000 methodology.

The results were produced for each County in Ireland and are shown in Appendix C.

Guidance Note 83: It is recommended that long term meteorological and percentage favourable propagation data required for strategic noise mapping is taken from the TII research report. For aircraft noise mapping long term meteorological data may also be taken from the meteorological stations located at the airport.

11.5.11 Integrating Propagation Model Layers

The initial breakline, contour and height point datasets prepared under 11.1.2 above all cover the whole extent of the area to be modelled. In this part of the process, the three datasets will be clipped and erase to ensure they do not overlap. The aim is to have breaklines in the vicinity of the road and railway source and in areas of rapidly changing terrain elevation, height points under the building footprints, and equal height contours in the remaining areas where the terrain elevation changes more gradually.

Guidance Note 84:

1. **WATER_1.** Extract WATER_POLY from PRIME2.
    a. It is recommended to retain the GUID, FORM_ID and FUNC_ID from PRIME2 to provide traceability of the data used in the model.
2. **COUNTIES_1.** Extract OSI_DATACOUNTY_POLYGON layer form PRIME2 and dissolve into a single polygon.
3. **HEIGHT_POINTS_2.** Erase all 10m (or 20m) interval spot heights from HEIGHT_POINTS_1 which are outside the BUILDINGS_BUFFER_1.
4. **CONTOURS_2.** Erase 2m equal height contours from CONTOURS_1 which are inside BUILDINGS_BUFFER_1.
5. **CONTOURS_3.** Erase 2m equal height contours from CONTOURS_2 which are inside BREAKLINES_BUFFER_1.
6. **CONTOURS_3.** Erase all 2m equal height contours from CONTOURS_3 which are inside WATER_1.
7. **CONTOURS_4.** Clip all 2m equal height contours from CONTOURS_3 which are outside COUNTIES_1.
8. **CONTOURS_5.** Remove any very short equal height Contours, for example <10.0m long.

Figure 11.12 illustrates how the breakline, road edges and bridges develop the 3D model.

Figure 11.13 illustrates how the breakline, contour and height point layers will collectively describe the terrain elevation.

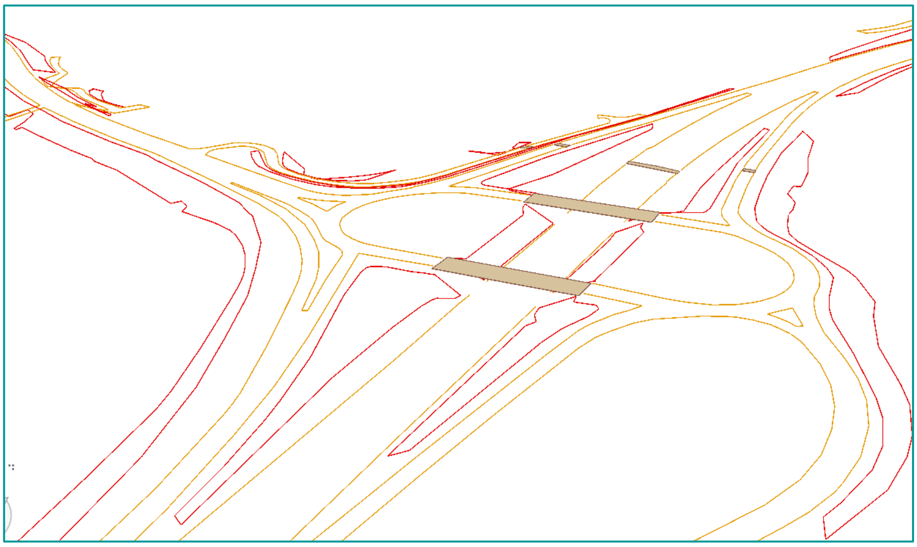

Figure 11.12: Illustration of the 3D terrain described by breaklines (red), roads (orange) and bridge decks (brown)

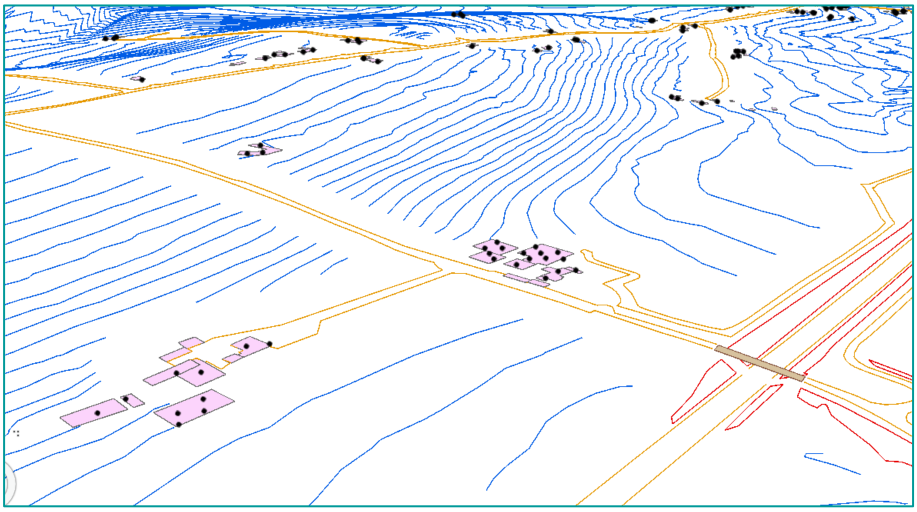

Figure 11.13: Illustration of the terrain described by breaklines, contours and height points

The main propagation model data layers are now prepared. The final step is to ensure that the datasets supplied to the noise mapping software provide an efficient noise calculation model, have clean geometry, and suitable descriptions for heights and coordinates.

Guidance Note 85:

1. Generalise the propagation model datasets in order to reduce the size of the model datasets, but retaining enough detail for the noise mapping, for example:
   a. **CONTOURS_6** – Generalise CONTOURS_4 with tolerance 0.5m horizontal;
   b. **BREAKLINES_2** – Generalise BREAKLINES_1 with tolerances 0.1m vertical and 0.2m horizontal;
   c. **BRIDGES_2** – Generalise BRIDGES_1 with tolerances 0.1m vertical and 0.2m horizontal.
   d. **BARRIERS_2** – Generalise BARRIERS_1 with tolerances 0.1m vertical and 0.2m horizontal.
2. Apply general topology rules to ensure that within each dataset:
   a. There are no duplicate objects
   b. Objects do not self-intersect
   c. Adjacent objects to no intersect
   d. Adjacent vertices on polylines or polygons are at least 5 cm apart, and no polygon has an area less than 10 cm^2
3. Round all heights to 2 dp (1 cm), and all geometry coordinates to 2 dp (1 cm).

The Breaklines, Contours, Height Points, Barriers, Ground Regions and Bridges should now be ready to import to the noise calculation software.

The buildings layer will need to undergo further processing as part of the preparation for the exposure assessment. This is described further in Section 11.6 below.

11.6 Prepare Exposure Assessment Data

The assessment of dwellings and people in dwellings, and school and hospital buildings, exposed to noise from ground-based sources, is to be undertaken on the basis of receiver points located along the facades of the buildings.

Within the Predictor software, the building façade receivers and exposure assessment can be undertaken using tools within the software. In order for these tools to work as designed, it is necessary for buildings to be assigned attributes on building use and layout, and for address points to be created which are assigned with the number of people and dwellings within each building.

The process set out within this section prepares the CSO Census and An Post GeoDirectory datasets, which will be used in Section 11.7 with the buildings prepared earlier in Section 11.5.7.

11.6.1 SAPS Census Data

Central Statistics Office (CSO) publish statistical information on population based upon Census returns. The most recent Census was held on 3 April 2022, with initial release information having been published at a range of levels. The previous Census was held on 24 April 2016, for which all final datasets have been published.

The information available on population is issued according to various political boundaries, namely Province or County, Province County or City, Regional Authority, Constituency, Electoral Division and Small Areas. Data is not made available at Census Output Area level; rather these are merged up to the Small Area Population Statistics (SAPS) level which provides for the highest level of resolution available to the location of the population. There are 18,641 SAPS covering Ireland in the 2016 Census output data[73].

At present, Autumn 2022, the Census 2022 SAPS data has not been published, however an initial release version of Census 2022 population data has been published for Electoral Divisions (ED). The data available includes the total population per ED in 2016 and 2022, and the absolute and percentage change in population per ED between 2016 and 2022. The SAPS areas are one level below EDs, and there is a hieratical link between them, typically with a small number of SAPS within each ED. The following process is therefore based on using the 2016 SAPS data, factored by the percentage change in population between 2016 and 2022 for the ED within which the SAPS area is located. This provides an estimate of the SAPS 2016 total population, which may not be totally accurate for each individual SAPS area, it should equate to the Census 2022 population totals at ED and national level.

Guidance Note 86: The for the Round 4 strategic noise mapping, it is recommended to estimate the total population per SAPS area based on the 2016 SAPS Census data factored by the percentage change in total population per ED between 2016 and 2022 from the initial release of Census 2022 results. Once the Census 2022 SAPS data has been published, it is recommended that this data is used directly.

Census 2022 and Census 2016 data can be downloaded from the CSO website[74]. The complete SAPS dataset is contained in a CSV file, "SAPS2016_SA2017.csv", with each of the entries explained within the glossary file, "SAPS_2016_Glossary.xlsx". The three most relevant totals within the dataset for the END assessment are:

- T1_1AGETT – Total Population
- T5_2_TP – Total of Persons in Private Households
- T7_1_NP – Total of Persons in Communal Establishments

The CSO defines dwellings as a self-contained unit of living accommodation that is occupied or, if vacant, is intended for occupation by one or more households. A dwelling should have a separate access to the street (direct or via a garden or grounds) or to a common space within a building (staircase, passage gallery, etc.). Examples include: a family home, a family home on a farm, a separate flat, apartment or bed-sit, a caravan, a caretaker's accommodation located in an office building, living accommodation over a shop.

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[73] http://www.cso.ie/en/census/census2016reports/census2016smallareapopulationstatistics/ [Accessed August 2022]
[74] https://data.cso.ie/ [Accessed August 2022]

A household is an occupied dwelling and forms the basis of the population in the CSO published Census data T5_2_TP field as part of the Small Area Population Statistics. Almost all of these persons in this field are usually resident in the household.

The CSO also publish SAPS data for Communal Establishments, which are defined as establishments providing managed residential accommodation. Managed means full-time or part-time supervision of the accommodation and generally consist of Hotels, Educational establishments, Prisons, Boarding Houses, Religious communities, Defence establishments, Guest Houses, Children's homes, Civilian ships, boats and barges, Bed and breakfast, Nursing home, Garda station, Hostel, Hospital/Nurses' home and Holiday campsite.

As can be seen some of the people enumerated in Communal Establishments consist of persons who are non-resident and those who are normally residing within the establishment, however they do not fit the CSO definition of dwellings, and are therefore outside the scope of the END assessment. Some of these Communal Establishments may be included within the exposure assessment of schools and hospitals, whilst others may be considered as noise sensitive, and their exposure could be determined separately, or investigated specifically during the development of the Noise Action Plans.

It is suggested that a revised version of the CSV file is created containing the six relevant fields: GUID, GEOGID, GEOGDESC, T1_1AGETT, T5_2_TP and T7_1_NP.

	A	B	C	D	E	F
1	GUID	GEOGID	GEOGDESC	T1_1AGETT	T5_2_TP	T7_1_NP
2	4c07d11e-11d3-851d-e053-ca3ca8c0ca7f	SA2017_017001001	Small Area	395	395	0
3	4c07d11e-123a-851d-e053-ca3ca8c0ca7f	SA2017_017002001	Small Area	344	353	0
4	4c07d11e-14b1-851d-e053-ca3ca8c0ca7f	SA2017_017002002	Small Area	405	409	0
5	4c07d11e-14b2-851d-e053-ca3ca8c0ca7f	SA2017_017002003	Small Area	276	278	5
6	4c07d11d-f709-851d-e053-ca3ca8c0ca7f	SA2017_017003001	Small Area	243	252	0
7	4c07d11e-1237-851d-e053-ca3ca8c0ca7f	SA2017_017003002	Small Area	319	328	0
8	4c07d11e-0a04-851d-e053-ca3ca8c0ca7f	SA2017_017004001	Small Area	321	324	0
9	4c07d11e-1234-851d-e053-ca3ca8c0ca7f	SA2017_017004002	Small Area	241	218	26
10	4c07d11e-1493-851d-e053-ca3ca8c0ca7f	SA2017_017004003	Small Area	155	155	0
11	4c07d11e-10d9-851d-e053-ca3ca8c0ca7f	SA2017_017005001	Small Area	237	246	0
12	4c07d11e-10d7-851d-e053-ca3ca8c0ca7f	SA2017_017005002	Small Area	188	195	0
13	4c07d11d-f701-851d-e053-ca3ca8c0ca7f	SA2017_017006001	Small Area	344	347	0
14	4c07d11d-f663-851d-e053-ca3ca8c0ca7f	SA2017_017007001	Small Area	275	269	0
15	4c07d11e-10d8-851d-e053-ca3ca8c0ca7f	SA2017_017008001	Small Area	183	184	0
16	4c07d11e-10d6-851d-e053-ca3ca8c0ca7f	SA2017_017008002	Small Area	264	267	0
17	4c07d11e-0a22-851d-e053-ca3ca8c0ca7f	SA2017_017008003	Small Area	204	174	28
18	4c07d11e-1d96-851d-e053-ca3ca8c0ca7f	SA2017_017008004	Small Area	400	347	50

Figure 11.14: SAPS data

The Census 2022 Electoral Divisions Population data is dataset FP009 - Population and Actual and Percentage Change 2016 to 2022, as shown in Figure 11.15.

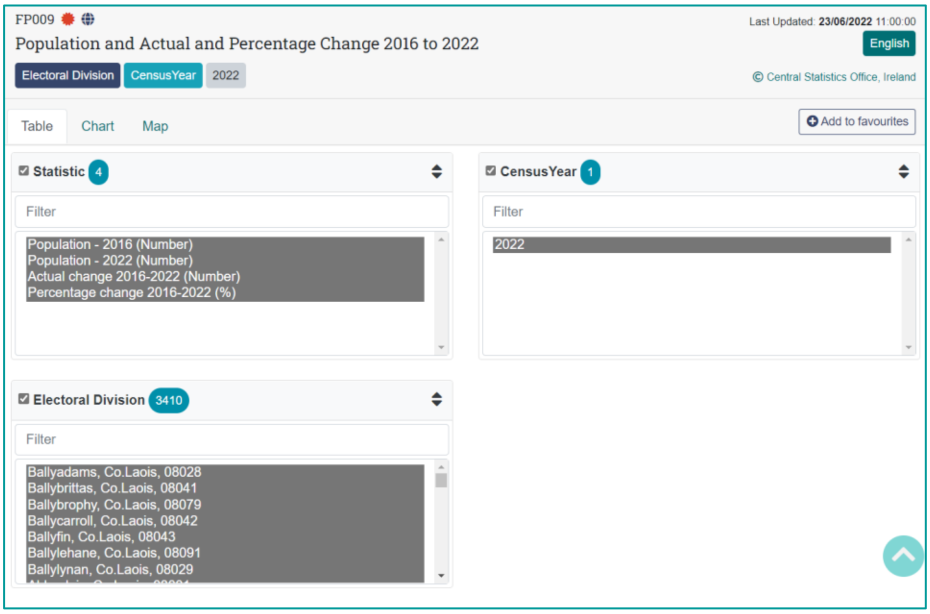


Figure 11.15: Census 2022 population data per Electoral Division

The Census 2022 ED population data includes the EDnumber attribute, however for 39 entries in the dataset two adjacent EDs have been merged, and the value is in the format '13054/13085'. A second EDnumber attribute can be added, and these 39 composite entries given new unique numerical values based on the first EDnumber preceded by 100, e.g. EDno2 = 10013054.

In order to provide an accurate spatial location for the population within each SAPS area it is necessary to have an up to date map of SAPS boundaries which matches the SAPS codes within the population exposure statistics report. The 'Small Areas Ungeneralised OSi National Statistical Boundaries – 2015' dataset is available in various formats from the OSi Open Data Portal[75].

The SAPS boundary data is delivered in WGS 1984 projection, and may need to be projected to Irish Transverse Mercator (ITM) for the noise mapping project.

The SAPS boundary Shapefile may then be joined to the Census 2016 SAPS CSV file based on the GUID, which assigns the three population totals to each of the SAPS boundary polygons. The total of assigned population data may then be determined to confirm that the process has completed correctly.

[75] https://data-osi.opendata.arcgis.com/ [Accessed August 2022]

Guidance Note 87:

1. As this is a national coverage dataset, it is recommended that for specific project areas it is filtered on NUTS3, COUNTY, EDNAME or SMALL_AREA to produce smaller coverage datasets which may be used going forward.
2. It is recommended NOT to run an intersect based on boundary polygons as this can bisect the SAPS polygons and produce erroneous population statistics.

With the Census 2016 total number of people assigned to each SAPS area, it is now necessary to factor these values to reflect the initial Census 2022 ED total population data.

The SAPS dataset includes an attribute CSOED which links the SAPS area to the ED, this will not link directly to the Census 2022 ED data due to the 39 combined entries. Within the SAPS data create an integer attribute CSOED2 and copy the values from CSOED into it. There will be 39 blank entries in the new attribute which can be manually completed with the ID number format previously used for the Census 2022 ED data.

The Census 2022 ED data values can then be joined to the SAPS data using CSOED2 and EDno2. The SAPS spatial data now includes the Census 2016 total population, and the Census 2022 ED percentage population change.

Add a integer fields SAPPOP22, TPPH22 and TPCE22 and calculate the estimated Census 2022 SAPS value:

- Total Population per SAPS area:
  - SAPPOP22 = [**T1_1AGETT**] * (1 + ([POPPCCHG]/100))
- Total of Persons in Private Households:
  - TPPH22 = [**T5_2_TP**] * (1 + ([POPPCCHG]/100))
- Total of Persons in Communal Establishments:
  - TPCE22 = [**T7_1_NP**] * (1 + ([POPPCCHG]/100))

  Note: This takes the percentage change per ED, divides by 100, adds 1, and then multiples the 2016 SAPS population by the result, giving estimated 2022 population for each SAPS area.

The result can be checked by finding the sum of the SAPPOP22 entries and comparing it to the total population in the Census 2022 ED dataset. In testing there was a difference of 1 in a total of 5,123,536.

> **Note:** The above process was undertaken by the EPA for national coverage datasets which can be provided to NMB in the file 'OSI_Small_Areas_Ungen_ITM_population_2016-2022_prelim_v2.shp'.

Guidance Note 88:

1. Download Census 2016 SAPS and Census 2022 ED population from CSO;
2. Download 'Small Areas Ungeneralised OSi National Statistical Boundaries – 2015' from the OSi Open Data Portal;
3. Join the Census 2016 SAPS data to the SAPS boundaries;
4. Edit the SAPS data: create CSOED2 attribute, copy from CSOED and edit the value for the 39 composite EDs;
5. Edit the Census 2022 ED data: create the EDno2 attribute, copy from EDnumber and edit the value for the 39 composite EDs;
6. Join the Census 2022 ED data to the SAPS boundaries;
7. Edit the SAPS data: create SAPPOP22, TPPH22 and TPCE22 and calculate the estimated 2022 population from the 2016 SAPS T1_1AGETT, T5_2_TP and T7_1_NP and the 2022 ED POPCCHG;
8. Check that sum of SAPPOP22 matches sum of Census 2022 ED POP_2022.

With the estimated Census 2022 total number of people assigned to each SAPS area, it is now necessary to establish which buildings contain dwellings, and the total number of people living within those dwellings.

11.6.2 GeoDirectory

The GeoDirectory data products are developed by OSi and An Post to provide a single point location object for each building in Ireland. The complete dataset is available with the "GeoAddress Locator" product, and each point location has a number of attributes which may be useful in identifying both vacant and occupied dwellings.

GeoDirectory is updated quarterly, for the purpose of the R3 strategic noise mapping it is recommended to use the Q4 2021.

As GeoDirectory provides a location point for each building, it is necessary to undertake a filter procedure in order to identify the two location datasets required for the assessment, namely:

- Point locations for buildings containing dwellings, and
- Point locations for buildings containing occupied dwellings.

The highest level of resolution within GeoDirectory is within the ADDRESS_POINTS table, which has a many-to-one link to the BUILDINGS table i.e. there can be many address points within one building, and one building may contain one or many address delivery points.

The number of linked address points is provided:

- RESIDENTIAL_DELIVERY_POINTS
    - Having a null entry in the ORGANISATION attribute within the ADDRESS_POINTS table

- COMMERCIAL_DELIVERY_POINTS attributes.
    - Having a valid entry in the ORGANISATION attribute within the ADDRESS_POINTS table.

The BUILDING_USE attribute has three possible entries:

- R for Residential
    - There should be zero COMMERCIAL_DELIVERY_POINTs
- C for Commercial
    - There should be zero RESIDENTIAL_DELIVERY_POINTs
- B for Both.

The ADDRESS_POINTS table also has attributes for VACANT, INVALID, UNOCCUPIED and UNDER_CONSTRUCTION for each of the entries, whether they are commercial, residential or both.

1. In order to produce a location dataset of "RESIDENTIAL_ADDRESS_POINT", the following filters should be applied to the GeoDirectory ADDRESS_POINTS table:

    - DERELICT – filter out all Y (yes);
    - INVALID – filter out all Y (yes);
    - UNDER_CONSTRUCTION – filter out all Y (yes) entries; and
    - RESIDENTIAL_DELIVERY_POINTS – filter out all 0 (zero) entries, as they do not have any residential delivery points.

The resultant dataset contains the location points for all residential address point, whilst the RESIDENTIAL_DELIVERY_POINTS attribute provides the total number of residential dwellings within each building.

In order to create a location dataset for occupied buildings, the following steps should be undertaken:

2. Add Field in the attribute table for VACANT_ADD_PNT, use the Field Calculator to assign VACANT_ADD_PNT = 1 if VACANT = "Y".

3. To produce a building level dataset from the address point data, the GeoDirectory data should be dissolved to result in one entry per BUILDING_ID, keeping the following fields:

    - BUILDING_ID - first
    - ADDR_LINE_1 - first
    - ADDR_LINE_2 - first
    - ADDR_LINE_3 - first
    - ADDR_LINE_4 - first

- ADDR_LINE_5 - first
- ADDR_LINE_6 - first
- RESIDENTIAL_DELIVERY_POINTS - mean
- COMMERCIAL_DELIVERY_POINTS - mean
- BUILDING_USE - first
- SMALL_AREA_ID - first
- EAST - first
- NORTH - first
- VACANT_ADD_PNT - sum

4. Open the attribute table of the new building level dataset and Add Field OCCUPIED_ADD_PNT and use Field Calculator to populate it with MEAN_RESIDENTIAL_ADDRESS_POINTS – SUM_VACANT_ADD_PNT.

   Note: In some cases, there are more entries for a building point in the address point dataset than there are residential address points, typically for blocks of flats where the building name has an entry alongside an entry per flat. As a result, this can create negative vales for OCCUPIED_ADD_PNT therefore it is recommended to add an if statement to ensure any negative values of OCCUPIED_ADD_PNT are set to zero.

The building level Geodirectory data now contains the two values required for the exposure assessment per building address point:

- Number of dwelling = MEAN_RESIDENTIAL_ADDRESS_POINTS
- Number of occupied dwellings = OCCUPIED_ADD_PNT

As a final step, if necessary, the GeoDirectory point data should be clipped to the dissolved boundaries of the SAPS area covering the project extent.

Guidance Note 89:

1. Filter out GeoDirectory points for derelict, invalid, under construction, and without residential delivery points;
2. Create and populate VACANT_ADD_PNT attribute;
3. Dissolve address points by BUILDING_ID to create one point per building;
4. Create and populate OCCUPIED_ADD_PNT;
5. Clip points to boundary of assessment based on dissolved SAPS areas.

11.7 Developing the Population Distribution Datasets

Ideally the GEO_ID could be used to join the GeoDirectory building data to the building polygons, however it does not form a robust method at present for the following reasons:

- GeoDirectory points for which there is no PRIME2 building polygon, possibly due to recent construction; and
- Multiple GeoDirectory points within a single PRIME2 building polygon.

In order to address these two issues, and prepare the final population distribution datasets required for the exposure assessment the following workflow is recommended.

11.7.1 Stage 1: Clip the GeoDirectory points inside building polygons

The noise mapping software will use the PRIME2 building polygons as part of the noise calculation model. The building polygons will have a height assigned which will be used as part of the propagation model, and the basis for the façade receiver points. Therefore, the buildings within the PRIME2 theme will be used in the calculation model, and the façade receivers used for the basis of the dwellings and people in dwellings exposure assessment will be placed around these building objects. For this reason, only GeoDirectory points inside building polygons will be considered for the exposure assessment, and the SAPS population data will be assigned to these buildings.

1. **Clip** dissolved GeoDirectory points with the PRIME2 BUILDING_Poly theme

11.7.2 Stage 2: Spatial join GeoDirectory Points to SAPS Area Data

Next the number of occupied dwellings is to be joined to the SAPS area data.

2. **Spatial Join** SAPS areas to the clipped dissolved GeoDirectory points from Stage 1.

   Join Operation: JOIN_ONE_TO_ONE
   Keep All Target Features - Ticked
   Merge Rules:
      BUILDING_ID = Count
      RESDIENTAIL_DELIVERY_POINTS = Sum
      COMMERCIAL_DELIVERY_POINTS = Sum
      VACANT_ADD_PNT = Sum
      OCCUPIED_ADD_PNT = Sum
   Match Option: CONTAINS

11.7.3 Stage 3: Assign "Persons in Private Households per Occupied Address Point" to each SAPS Area

Using the SAPS Area output from Stage 2:

3. **Open Attribute Table - Add Field…**

   PPH_OcAP

4. Select the new **PPH_OcAP** attribute and **Field Calculator…**

   PPH_OcAP = [**TPPH22**] / [OCCUPIED_ADD_PNT]

(Persons in Private Households 2022 per Occupied Address Point)

11.7.4 Stage 4: Assign "Population per Residential Delivery Point" to each GeoDirectory delivery point

Using the SAPS Area output from Stage 3:

5. **Spatial Join** SAPS area from the end of Stage 3, to the clipped dissolved GeoDirectory points.

   Join Operation: JOIN_ONE_TO_ONE
   Keep All Target Features - Ticked
   Merge Rules:
   PPH_OcAP = First
   Match Option: WITHIN

11.7.5 Stage 5: Assign Total Residents Per Building to Residential Delivery Points

Using the GeoDirectory data output from Stage 4:

6. **Open Attribute Table - Add Field…**

   RESIDENTS

7. Select the new **RESIDENTS** attribute and **Field Calculator…**

   RESIDENTS = [PPH_OcAP] * [OCCUPIED_ADD_PNT]

11.7.6 Stage 6: Assign Building Use and Residents and Dwellings per Building to Building Polygons

Using the GeoDirectory data output from Stage 5:

8. **Spatial Join** PRIME2 BUILDING_POLY to the GeoDirectory points form the end of Stage 5.

   Join Operation: JOIN_ONE_TO_ONE
   Keep All Target Features – Ticked
   Merge Rules:
   RESIDENTIAL_DELIVERY_POINTS = Sum
   BUILING_USE = First
   VACANT_ADD_PNT = Sum
   OCCUPIED_ADDR_PNT = Sum
   PPH_OaAP = Mean
   RESIDENTS = Sum

Match Option: CONTAINS

This joins the Geodirectory and population data to each building polygon, and sums the attributes where there are multiple GeoDirectory points within a building polygon.

It is then possible to confirm the success of the process by finding the total number of dwellings and people assigned to all buildings within the assessment area, and checking that it aligns with the original source data from Census and GeoDirectory data.

11.7.7 Stage 7: Finalise building usage

The building use will be derived from the GeoDirectory BUILDING_USE and the BUILD_USE assigned to OSi PRIME2 buildings, this classification will be used for the creation of façade noise receivers and the assessment of exposure to noise.

Using the buildings polygon datasets:

9. **Open Attribute Table - Add Field…**

   BUILD_USAGE (Text)

10. Assign values to DESIGN_USE using the following approach:
    a. Where Geo_Directory BUILDING_USE = R or B, then BUILD_USAGE = RESIDENTIAL
    b. Where BUILDING_CLASS = SCHOOL, and BUILD_USAGE is null, then BUILD_USAGE = SCHOOL
    c. Where BUILDING_CLASS = HOSPITAL, and BUILD_USAGE is null, then BUILD_USAGE = HOSPITAL
    d. Where Geo_Directory BUILDING_USE = C, and BUILD_USAGE is null, then BUILD_USAGE = COMMERCIAL
    e. Where BUILD_USAGE is null, then DESIGN_USE = OTHER

11.7.8 Stage 8: Assign building type

The three different methods for the exposure assessment of dwellings and people in dwellings are to be used, see section 9.5.1 above, with the following types of buildings:

- Method 1: “single dwellings”
- Method 2: "multi-dwellings - single exposed facade"
- Method 3: “multi-dwellings - >1 facade, or not known”

The building type is used to set which approach will be used for assigning noise levels to buildings. It will be derived from the number of GeoDirectory residential delivery points and the area of the building.

Using the buildings polygon datasets:

1. **Open Attribute Table - Add Field…**

   BLD_TYPE (Text)

2. Assign values to DESIGN_USE using the following approach:
   a. Where RESIDENTIAL_DELIVERY_POINTS = 1, then BLD_TYPE = "single dwellings"
   b. Where RESIDENTIAL_DELIVERY_POINTS = >1 and AREA_M2 < 150, then BLD_TYPE = "single dwellings"
   c. Where RESIDENTIAL_DELIVERY_POINTS = >1 and AREA_M2 => 150, then BLD_TYPE = "multi-dwellings - >1 facade, or not known"
   d. Where RESIDENTIAL_DELIVERY_POINTS = 0 then BLD_TYPE = "no dwellings"
   e. Where BUILD_USAGE = SCHOOL, then BLD_TYPE = "single dwellings"
   f. Where BUILD_USAGE = HOSPITAL, then BLD_TYPE = "single dwellings"

   Note: Section 9.5.1 indicates that Method 2 "multi-dwellings - single exposed facade" can be assigned for buildings with a minor wing > 16m (Figure 18), but this is not implemented in the above list at present. Buildings may be assigned this value in line with the guidance, or manually when the building design is known, at the discretion of the noise mapping body.

11.7.9 Stage 9: Create Address Points from building Polygons

Using the building polygon data output from Stage 6:

3. **Feature to Point**

   Inside – ticked

This process creates the address point dataset with each point being inside the corresponding building polygon, having the same ID as the building polygon, and having the number of dwellings and persons in dwelling as attributes.

Guidance Note 90:

1. Clip GeoDirectory points inside buildings;
2. Spatial join GeoDirectory Points to SAPS Area Data;
3. Assign "Persons in Private Households per Occupied Address Point" to each SAPS Area;
4. Assign "Population per Residential Delivery Point" to each GeoDirectory delivery point;
5. Assign Total Residents Per Building to Residential Delivery Points;
6. Assign Building Use and Residents and Dwellings per Building to Building Polygons;
7. Finalise building usage;
8. Assign building type;
9. Create Address Points from building Polygons.

12 Noise Model Preparation

Following preparation of the noise model input datasets within GIS, the next step is to prepare the noise model within the calculation system.

Strategic noise mapping projects in Ireland have generally been undertaken using the Predictor-LimA[76] noise calculation software, for this reason the overview set out below will include some examples from Predictor-LimA, however the same steps may be completed within any of the available noise modelling software systems via similar tools.

12.1 Import Data

The first step is to import the GIS datasets into the noise calculation software. This is typically achieved by saving the GIS data to ESRI Shapefile format, one per dataset, and then using the import function within the noise mapping software. Other data formats are now supported for transfer between GIS and noise mapping systems, such as GeoPackage, GML and MapInfo.

Ideally the GIS datasets and attributes use a naming convention based on the format used within the noise mapping software, as this helps to reduce errors during import by making matching of GIS to noise mapping attributes much easier.

Based on the guidance in the previous sections, the following datasets would each be imported to the noise model software one layer at a time:

- Road traffic source model
- Railway traffic source model
- Industry source model
- Height points
- Equal height contours
- 3D breaklines
- Bridges
- Ground cover regions
- Barriers
- Buildings
- Address points
- Calculation area

During the import process, some datasets need special attention to ensure that the data prepared in GIS is used to correctly setup the noise model.
For example, Buildings, Roads, and Railways should be imported using the Group option in Predictor-LimA to ensure the objects are assigned to the correct groups in Predictor, for example:

[76] https://softnoise.com/ [Accessed September 2024]

- Buildings
  - Residential
  - Schools
  - Hospitals
  - Commercial
  - Other
- Road
  - Major Roads
  - Non-Major Roads
- Railways
  - Major Railways
  - Non-Major Railways

As an example, the importing of buildings

12.1.1 Import Buildings

As an example, importing of buildings will be overviewed:

- Import to Predictor-LimA
  - Group is selected, and BUILD_USE field used to assign imported building polygons to groups
  - Predictor-LimA attributes are aligned with attributes in the imported SHP file

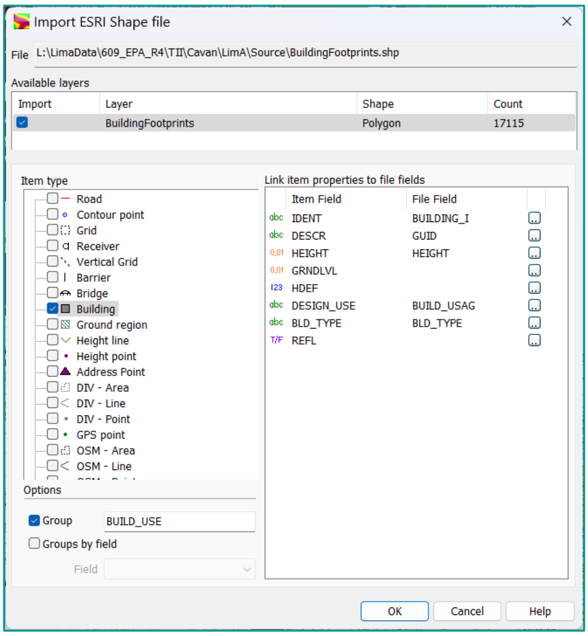


Figure 12.1: Example of Building import to Predictor-LimA

These settings will import the BUILDING_POLYGONS to Predictor-LimA as Buildings and Grouped according to the Building Use classes:

- RESIDENTIAL

- SCHOOL
- HOSPITAL
- COMMERCIAL
- OTHER

This will help Predictor-LimA to setup façade receiver points around residential, school and hospital buildings in the next steps of the model setup.

Guidance Note 91: All buildings with BUILD_USE of RESIDENTIAL, SCHOOL or HOSPITAL should all be reviewed to ensure they have a valid "Name" value derived from the BUILDING_ID during import to Predictor, as this value is used to link buildings to address points and façade receiver locations.

The BUILD_USE and BLD_TYPE attributes were assigned in GIS to support the assessment of noise exposure. When the buildings were imported to Predictor-LimA, these values should align with the entries in the Building Use and Building Type catalogues. Figure 12.2 shows an example of the **Building Use** Catalogue.

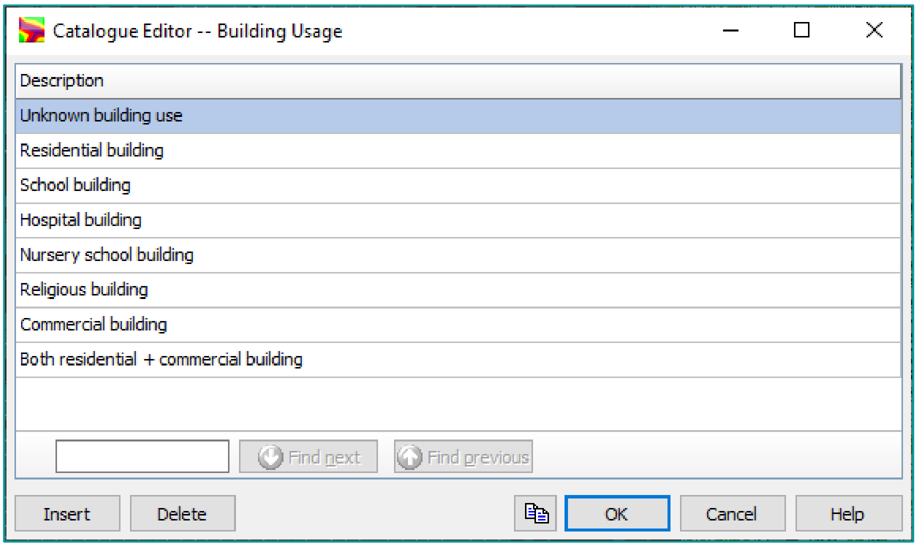


Figure 12.2: Example of the Building Use catalogue in Predictor-LimA

The **Building Type** is specifically to be assigned to residential buildings, to be processed in line with one of the three methods set out within the Delegated Directive. Figure 12.3 shows an example of the **Building Type** Catalogue.

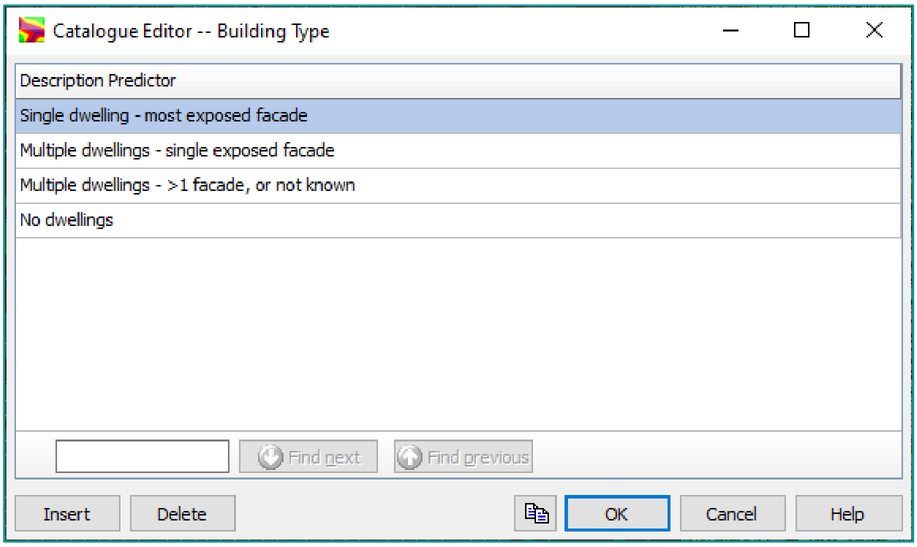


Figure 12.3: Example of the Building Type catalogue in Predictor-LimA

12.1.2 Confirm Imported Datasets

Following data import into the noise software, the imported data should be confirmed.

Guidance Note 92:
Following the import of each dataset into the noise calculation software, the imported dataset should be reviewed to ensure that:

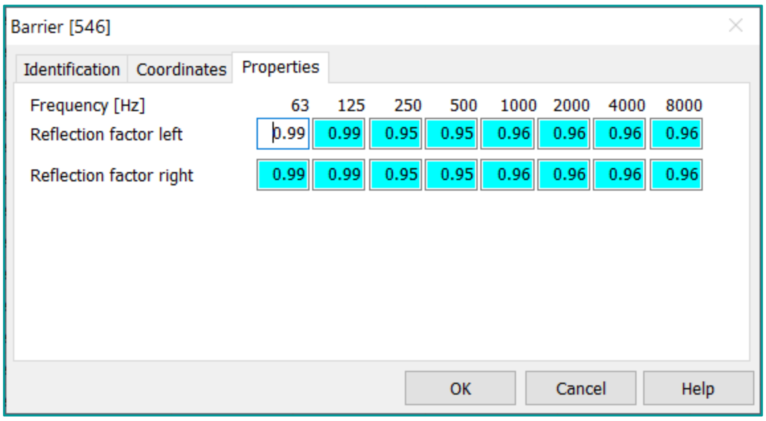
1) The number of objects within the noise software is the same as within GIS, i.e. all objects were successfully imported; and
2) All attributes of the imported dataset have been assigned correctly within the noise software, and the values are appropriate.

12.2 Prepare Barriers

Both sides of each barrier should be assigned a reflection factor spectrum. Table 12.1 contains example absorption coefficients which may be suitable for facades of noise barriers.

- Example of assigning reflection factors to barriers in Predictor-LimA:
  - Model, List of Items….
  - Select Barrier
  - Select all Barriers (click in rectangle top left between “1” and “Name”)
  - Select “Edit Mode”
  - Select “Edit”
  - In dialogue, select “Properties” tab

- Edit "Reflection factor" octave band values as shown for 50mm wood[77]
  - NOTE: Examples of other possible values for alternative material for barriers are shown in Table 12.1



- Select "OK" to save
- All the reflection factors in the table should be updated to these values:

	Name	Desc.	ISO H	ISO Terr.	HDef.	Refl.L 63	Refl.L 125	Refl.L 250	Refl.L 500	Refl.L 1k	Refl.L 2k	Refl.L 4k	Refl.L 8k	Refl.R 63	Refl.R 125	Refl.R 250	Refl.R 500	Refl.R 1k	Refl.R 2k	Refl.R 4k
1	1449172	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
2	1449088	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
3	1448878	Divider	3.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
4	1448805	Divider	1.50	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
5	1449880	Divider	3.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
6	1448793	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
7	1449052	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
8	1449604	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
9	1449141	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
10	1449155	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
11	1449348	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
12	1448921	Divider	3.50	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
13	1449419	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
14	1449274	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
15	1449891	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
16	1449842	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
17	1449919	Divider	3.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
18	1449907	Divider	3.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
19	1449150	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96
20	1449908	Divider	2.00	--	Relative	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96	0.99	0.99	0.95	0.95	0.96	0.96	0.96

Table 12.1: Reflection coefficients for some typical noise barrier constructions

Material	Frequency (Hz)							
	63	125	250	500	1K	2K	4K	8K
Noise Barrier - Absorbent - 4 dB loss	1.00	0.95	0.75	0.45	0.35	0.35	0.45	0.45
Noise Barrier - Class A0 - reflecting	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Noise Barrier - Class A1 typical spectrum - 1 to 4 dB loss	0.98	0.96	0.93	0.88	0.82	0.72	0.60	0.60
Noise Barrier - Class A2 typical spectrum - 4 to 7 dB loss	0.88	0.82	0.68	0.53	0.38	0.27	0.18	0.18
Noise Barrier - Class A3 typical spectrum - 8 to 11 dB loss	0.74	0.57	0.36	0.18	0.12	0.09	0.08	0.08
Noise Barrier - Class A4 typical spectrum - >11 dB loss	0.56	0.33	0.08	0.00	0.03	0.05	0.07	0.07
Noise Barrier - Highly absorbent - 8 dB loss	0.80	0.70	0.50	0.20	0.10	0.10	0.20	0.20
Noise Barrier - Transparent - reflecting	0.90	0.88	0.92	0.95	0.96	0.97	0.98	0.98
Wood - 50mm thick	0.99	0.99	0.95	0.95	0.96	0.96	0.96	0.96

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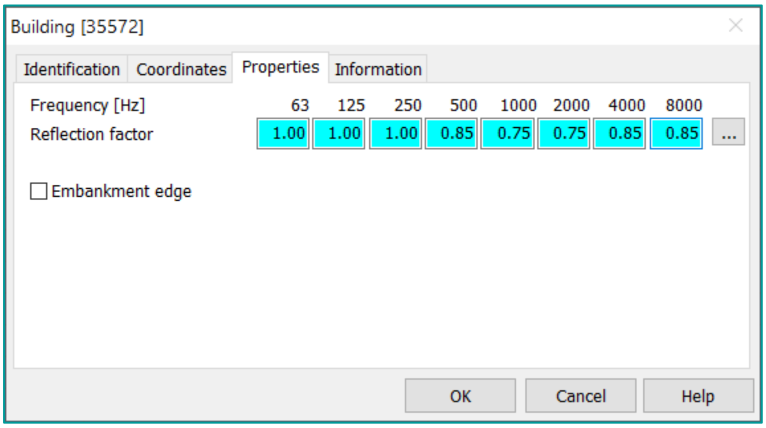
77 Cox T. & D'Antonio, P. Acoustic Absorbers and Diffusers. New York: Taylor & Francis; 2004. Available at: https://danylastchild07.files.wordpress.com/2016/05/trevor_j-_cox_acoustic_absorbers_and_diffusers.pdf [Accessed June 2022]

12.3 Prepare Buildings

Folling the import of the buildings, they should be assigned a reflection coefficient spectrum. Table 12.2 contains example reflection factors which may be suitable for buildings facades within the noise calculation model.

- Example of assigning reflection factors to barriers in Predictor-LimA:
  - Model, List of Items…
  - Select Building
  - Select all Buildings (click in rectangle top left between “1” and “Name”)
  - Select “Edit Mode”
  - Select “Edit”
  - In dialogue, select “Properties” tab
  - Edit “Reflection factor” octave band values as shown[78]:



  - Select “OK” to save
  - All the reflection factors in the table should be updated to these values:

	Name	Desc.	Height	Terrain L	HDef.	Function	Bld.type	Embankment	Refl. 63	Refl. 125	Refl. 250	Refl. 500	Refl. 1k	Refl. 2k	Refl. 4k	Refl. 8k
1	0		8.00	44.00	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
2	0		8.00	44.00	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
3	0		12.00	70.01	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
4	27022733		12.00	91.00	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
5	0		8.00	48.80	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
6	0		8.00	46.43	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
7	0		8.00	65.56	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
8	0		12.00	65.95	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
9	0		8.00	90.30	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
10	0		8.00	44.97	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
11	0		12.00	47.04	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
12	0		8.00	46.82	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
13	27110548		12.00	46.00	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
14	50467453		12.00	45.00	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
15	0		8.00	55.53	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
16	0		12.00	64.89	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
17	0		8.00	62.00	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
18	0		8.00	64.00	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
19	0		8.00	48.23	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
20	0		8.00	47.44	Relative	Unknown building use	No dwellings	No	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85

[78] LAI-Hinweise zur Lärmkartierung - Dritte Aktualisierung - 27 Jan 2022, Available at: https://www.umwelt.sachsen.de/download/laerm_licht_mobilfunk/LAI-Hinweise_Laermkartierung_2022_Fassung_20220127_PhysE.pdf [Accessed June 2022]

Table 12.2: Reflection coefficients for some typical building facade constructions

Material	Frequency (Hz)							
	63	125	250	500	1K	2K	4K	8K
100% absorbing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
absorbing	0.20	0.20	0.20	0.20	0.20	0.20	0.20	0.20
reflecting	0.80	0.80	0.80	0.80	0.80	0.80	0.80	0.80
100% reflecting	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Breeze Block	0.80	0.80	0.70	0.40	0.40	0.50	0.50	0.50
Brickwork - plain painted	0.95	0.95	0.96	0.98	0.96	0.95	0.95	0.95
Brickwork - smooth painted	0.99	0.99	0.99	0.98	0.98	0.98	0.98	0.98
Brickwork - smooth with deep pointing	0.92	0.92	0.91	0.88	0.84	0.78	0.76	0.76
Brickwork - smooth with flush pointing	0.98	0.98	0.97	0.97	0.96	0.95	0.93	0.93
Building facades - plain, smooth, reflecting - 1 dB loss	1.00	1.00	1.00	0.85	0.75	0.75	0.85	0.85
Building facades - structured/divided - 2 dB loss	1.00	1.00	0.98	0.68	0.58	0.58	0.68	0.68
Concrete - clinker without surface finish	0.90	0.90	0.80	0.60	0.40	0.50	0.40	0.40
Concrete - rough	0.98	0.98	0.97	0.97	0.97	0.96	0.93	0.93
Concrete - smooth unpainted	0.99	0.99	0.99	0.98	0.98	0.98	0.95	0.95
Concrete - smooth painted or glazed	0.99	0.99	0.99	0.99	0.98	0.98	0.98	0.98
Concrete block - coarse	0.64	0.64	0.56	0.69	0.71	0.61	0.75	0.75
Concrete block - painted	0.90	0.90	0.95	0.94	0.93	0.91	0.92	0.92
Concrete block - porous without surface finish	0.95	0.95	0.95	0.95	0.92	0.86	0.80	0.80
Glass - double glazing	0.90	0.90	0.93	0.95	0.97	0.98	0.98	0.98

12.4 Create Façade Receivers

Following import of the building polygons into Predictor-LimA, if they have not already been prepared in GIS, the receivers around the building facades may be created for all buildings with a residential use. Figure 12.4 shows the settings within Predictor-LimA to automatically generate receivers in line with Case 2a of the Delegated Directive.

- Example of assigning reflection factors to barriers in Predictor-LimA:
    - Edit, Search and Select
    - Group = RESIDENTIAL
    - Edit, Batch Create Items, Receivers at Façade

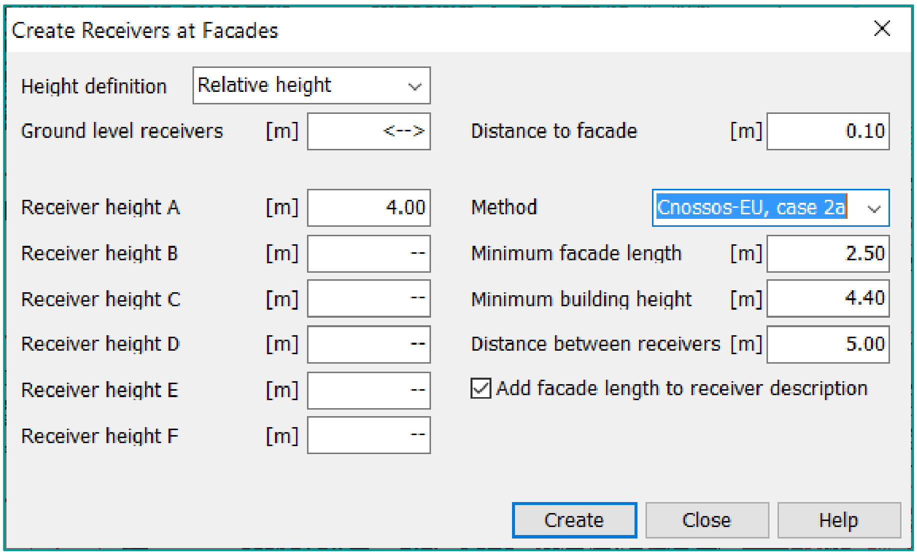


Figure 12.4: Predictor tool to create receivers around building facades

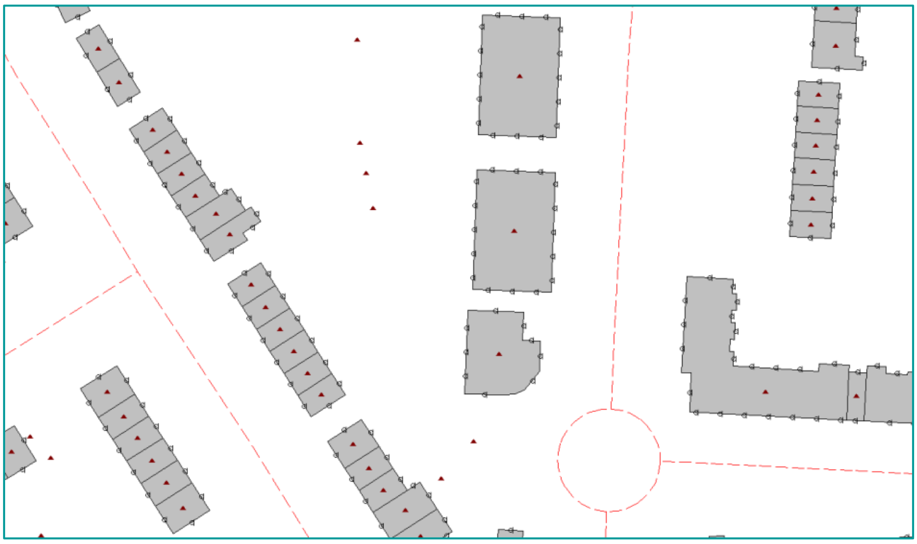


Figure 12.5: Illustration of façade receivers created around Residential buildings

Then repeat the process for school and hospital buildings.

- Example of assigning reflection factors to barriers in Predictor-LimA:
    - Edit, Search and Select
    - Group = SCHOOL
    - Edit, Batch Create Items, Receivers at Façade
    -
    - Edit, Search and Select
    - Group = HOSPITAL
    - Edit, Batch Create Items, Receivers at Façade

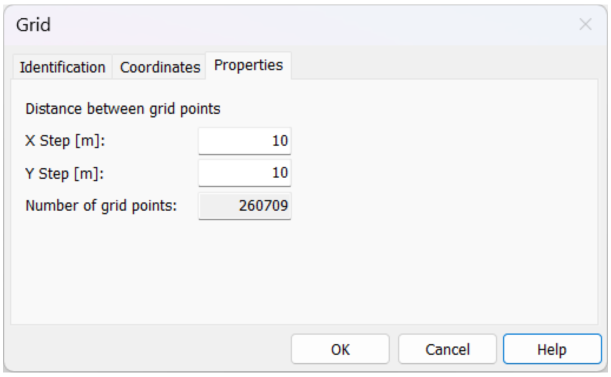
12.5 Create Grid Receivers

Following import of the polygon describing the calculation area it will describe the boundary of the grid of receiver points to be calculated.

In some noise calculation software, the grid spacing is one of the calculation settings, while in Predictor-LimA it is a setting on the Grid object in the model. The grid receiver calculations are undertaken in order to produce graphical noise contour maps, and may also be used to calculate the area exposed to noise.

Guidance Note 93:
It is recommended that the grid of calculation receivers is set to a regular 10 x 10m grid spacing.

- Example of assigning reflection factors to barriers in Predictor-LimA:
  - Model, List of Items…
  - Select Grid
  - Double click the grid to open the dialogue
  - In dialogue, select “Properties” tab
  - Enter 10 into X Step (m), and 10 into Y Step (m), the number of grid points will then be estimated.



Note: There is a limit of 1 million receiver points per grid. If this value is exceeded it will be necessary to split the grid into smaller areas, and set each as a 10 x 10 m calculation grid.

12.6 Finalise Calculation Model

The final steps before running the noise calculations are to ensure that the model is fully configured and prepared for the noise calculations.

Noise mapping software systems often include tools for checking model data, and visualising the models. The 3D model viewer within the software can be very useful to check alignment of bridges with terrain, and road and rail centrelines.

- Example of model checks within Predictor-LimA:
    - Model, Check Model, Terrain…
    - Model, Check Model, Items….
    - View, 3D View…
    - View, Cross Section….

Guidance Note 94:
It is recommended that any model checking tools and 3D model viewers within the noise mapping software are used to review model data prior to commencement of noise calculations. Any issues identified should be resolved prior to calculations commencing.

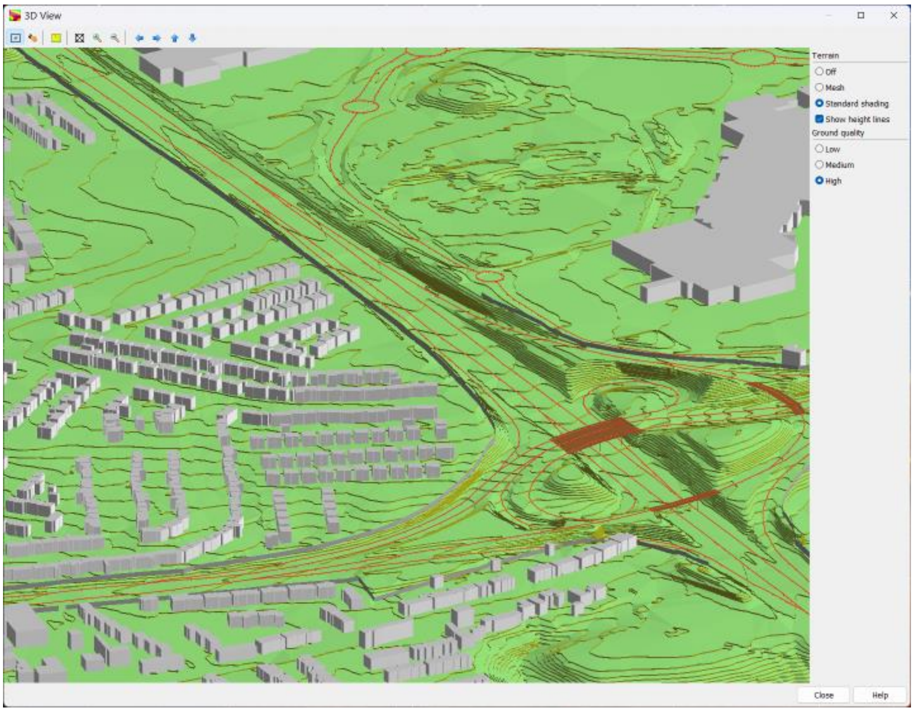


Figure 12.6: Example of use of 3D view to check model objects

13 Noise Level Calculations

While the main focus of initial considerations regarding the assessment of noise levels for strategic noise mapping under the Regulations may well centre on the calculations to be undertaken at this stage of the process. Experience of large area city and regional noise mapping projects suggests that the data capture, and data processing stages are the most time consuming, costly and labour intensive. The noise calculations at this stage may be more specialised in nature, but when operating a good commercial software solution rely more on machine time for processing, rather than staff time.

Set out below is guidance on some aspects for consideration when considering the selection of a noise mapping software solution, as well as some issues to be tested and documented whilst using the software for strategic noise mapping.

13.1 Noise Mapping System Requirement Criteria

Whilst it is desirable to allow complete freedom of choice over the noise mapping tool to be used by the noise mapping bodies, it is logical that certain desired functionality and a wish for consistency of quality will result in a restriction over the selection of some software tools. The following is a list of criteria that any selected tool should satisfy in order to be acceptable within the strategic noise mapping process under the Regulations:

- Commercial availability and supported within Ireland;
- Is generally available with an installed user base;
- Documented compliance with the latest versions of CNOSSOS-EU and ECAC Doc 29, as appropriate, including self-certification to ISO/TR 17534-3 for CNOSSOS-EU;
- Proven record of use in city sized projects and larger;
- Means of calculating large areas in a seamless coherent manner which avoids discontinuity of results;
- Compatibility with 3D datasets without compromising integrity of height data;
- Utilisation or acceptance of conventional GIS datasets, therefore import/export, batch process proprietary GIS formats and export results data for use in GIS or publish images;
- Scalable, therefore server or GIS based systems to be included; and
- Suitable software should have some or all of these features:
    - Ability to use or interface with personal or server based geodatabase systems;
    - Multi-processor or multi-machine capabilities for parallel processing of calculations;
    - Previous experience with handling geodatasets of over 50 km^2 with more than 1,000,000 points or objects; and
    - Ability to enable multi-user working on a project.

13.2 Model Uncertainty

Noise calculation software brings together the noise model and the noise calculation methodology within a 3D calculation environment. Noise calculations are then performed within the 3D environment with tolerances, accuracy and resolution determined by a number of factors.

The Defra funded NANR 93[79] research project for WG-AEN sets out the first treatment of uncertainty within strategic noise mapping[80]. The model uncertainty is used to describe the uncertainties introduced into the calculated results due to the method of assessment being used, and the specific details of how this method is transposed into a software tool and configured by the developer and the user.

The main characterisation of model uncertainty is considered to be the responsibility of the owners and developers of the noise models being used, as they are in a position to effect change to the model if uncertainty is identified and quantified.

Within the current noise mapping situation there are probably two main sub-elements to noise mapping uncertainty:

1. The issue of how accurate the prescribed calculation standard is at representing the real world situation, and what uncertainties it introduces due to the (necessary) simplifications made in order to present a solution which is relatively simple to implement, and;
2. The secondary issue of how the documented standard is transposed from a paper document into a 3D noise calculation tool, and how the tool's additional simplifications, efficiency techniques and assumptions introduce further uncertainties into an uncertain methodology in order to create usable real world calculation times.

Figure 13.1 below shows how model uncertainty is introduced into the noise mapping.

The accuracy of the calculation standard is outside the control of the end user, and under the Regulations the CNOSSOS-EU methodology must be used for the calculations, so this source of uncertainty should be the same for all users.

The consistent implementation of the methodology within noise calculation software is the objective of the ISO 17534 series of standards, with ISO/TR 17534-4 specifically relating to CNOSSOS-EU, and including 30 propagation test cases which software developers may use to self-certify that they have a consistent implementation of the methodology.

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[79] NANR93 - WG-AEN Good Practice Guide and the implications for acoustic accuracy - NO01050, Hepworth Acoustics, 2004. Available at: https://randd.defra.gov.uk/ProjectDetails?ProjectId=13248 [Accessed September 2024]
[80] NANR93 – Sensitivity Analysis for Noise Mapping, Hepworth Acoustics, 2004. Available at: file:///D:/Downloads/14593_SENSITIVITY-ANALYSIS.PDF [Accessed September 2024]

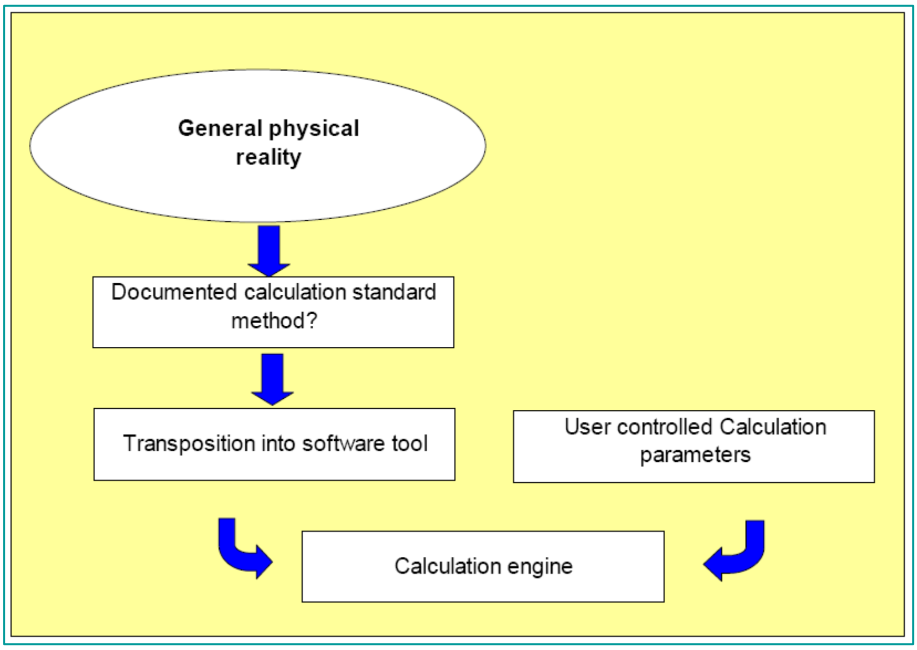


Figure 13.1: Model Uncertainty Flow Chart

13.3 User Defined Calculation Settings

There are many aspects of the noise calculations which may be controlled by use of the user defined settings. These can range from specifying grid resolution (i.e. grid cell spacing at which noise was calculated), to determining how many reflections should be considered. Other calculation settings can be defined as 'efficiency settings' which aim to simplify aspects of the assessment in order to reduce processing time, these generally aim to provide improvements in processing efficiency, or scalability.

The use of these user controlled calculation parameters may have a significant effect upon the uncertainty associated with the calculated results, and due care and process checks should be included in order to ensure that the settings in use do not introduce unacceptable levels of uncertainty.

Efficiency settings are designed to reduce calculation time by employing different techniques which either reduce the number of calculations required, or reduce the complexity and detail of the calculations. Despite the benefit in reducing calculation time, efficiency settings can introduce uncertainties into the calculated noise levels.

In general efficiency settings are designed to simplify, or ignore, aspects of the source to receiver propagation path assessment based upon criteria set by the user and the software developer. This introduces a compromise between uncertainty and calculation time. In general, a fast calculation will introduce more uncertainty into the noise levels than a slower calculation.

Some efficiency settings perform better than others both in isolation and in parallel. As a result, it is recommended that investigations are carried out using test areas by the project team to identify the appropriate calculation settings which should be used for the final calculations. These aim to strike a balance between time saving and uncertainty introduced into the noise level results.

13.3.1 Use of Test Calculations

It is recommended that prior to final calculation runs being commenced, that a test area (or areas) of the model are used to investigate the optimal calculation settings to be used. A suitable model area could be 5 x 5 km in area, with a calculation area defined as the central 1 x 1 km area. The test model should be representative of the model as a whole, and provide a range of propagation situations.

It is recommended that the settings associated with the standard are reviewed and set, these include aspects such as search radius for reflections, minimum source to receiver distance, number of reflections etc. These should remain the same throughout the tests.

The settings which the developer suggests may provide efficiency benefits should then be set to their most accurate value, which will normally result in the highest quality calculation taking the longest time. These settings should then be varied one at a time, and the results grids statistically compared with the base case to assess the uncertainty in calculated results.

By running multiple tests, for multiple parameters in a number of settings, it is possible to compare the costs (uncertainty in results) with the benefits (time saving) and select a preferred set of calculation parameters. It is recommended where possible that the 95% confidence interval of the results is kept within 1.0 dB of the base case results.

As an alternative, uncertainty may be estimated by following the approach set out within Annex C of ISO 17534-1:2015 using tools within the noise mapping software, where available.

Guidance Note 95:
It is recommended that prior to final calculation runs being commenced, that a test area (or areas) of the model are used to investigate the optimal calculation settings to be used. It is recommended that the settings are varied one at a time, and the results statistically compared with the base case to assess the uncertainty in calculated results, alongside the change in calculation time.
It is recommended where possible that the 95% confidence interval of the results is kept within 1.0 dB of the base case results.

13.4 Calculation Hardware Environment

In addition to defining the appropriate settings for the calculation parameters, the calculation process can be further optimised using a combination of:

- Calculation Tiling;
- Multiple Calculation Servers; and

- Hardware Environment.

All three of these optimisation techniques may be utilised during the calculation of noise levels.

13.4.1 Calculation Tiling

Calculation tiling is a technique which allows one large calculation area and model to be split into smaller areas, which can then be calculated simultaneously on several computers or one by one. Generally, it has been found that the smaller the tile size, the faster the calculations will run due to the smaller dataset in process, however this could lead to many hundreds of model tiles.

The tiles would generally be configured with a central calculation area, say 1 x 1 km, plus a buffer of data, say 2 km all around to make a 5 x 5 km model area, to ensure that the tiled results combine in a seamless manner.

Advanced noise mapping software handles this distribution of processing in an automated manner. There are significant advantages of tiling calculations over a single model calculation. These are:

- **Reduced Calculation Times:** By splitting the calculation up into tiles, this allows a noise model to be distributed across multiple calculation servers. Smaller models also process more quickly per grid point than larger models.
- **Calculation Redundancy:** Tiling increases calculation redundancy significantly with respect to a single calculation. In the event of hardware failure only one tile will fail rather than a single large calculation

13.4.2 Multiple Calculation Servers

The use of multiple calculation computers also improves calculation time by allowing automation of calculations, and parallel processing of multiple model tiles. Advanced noise mapping software systems contain tools which can be licensed which will automatically distribute multiple parallel processing jobs across multiple processors, across multiple computers if available.

Over recent years this has developed further with a number of noise mapping software suppliers offering services to run calculations within their own datacentre, or within the public cloud.

13.4.3 Hardware Environment

If the computer hardware in use is only expected to be undertaking noise mapping calculations, then the hardware environment may also be optimised for calculations based on the requirements of the noise mapping software. This may be achieved by turning off all the unnecessary system services to improve the available physical memory and CPU to the calculation core. Testing across multiple CPU manufacturers and architecture designs may also lead to dramatic differences in processing time not solely related to CPU clock speeds.

Historically this approach has lead to banks of computers running noise calculations for very large projects, however more recently the use of computers with multiple CPUs and multiple cores has reduced the number of machines required, while virtual machines, highly tuned for the purpose of noise calculations, may be deployed either in-house on physical hardware, or in the public cloud.

13.5 Pre-flight Checks

Prior to the final calculations being commenced, it can be very useful to run a series of pre-flight checks to confirm that the model will be processed without problems.

Final datasets should be loaded into the noise mapping software tool, and a number of single receptor calculations undertaken to confirm that the relevant files load and process without issues.

It can also be useful to undertake a 100m x 100m grid calculation across the model, as this will test any model tiling or automatic distribution of processing across multiple machines, but will also assess 1% of the grid points from the final run, which will help to provide a good indication of likely processing times.

Using current computer hardware, an initial estimate of processing time may be gained by using processing times of around 0.25 seconds per grid point for assessments of road traffic noise in agglomerations, railways, industry and major sources often process more rapidly.

Guidance Note 96:
It is recommended to run a series of pre-flight checks to confirm error free calculations can be generated from the model. A number of single receptor calculations, and ideally a 100m x 100m grid calculation, can be used to test the calculation software and hardware prior to the final calculation run.

13.6 Review Calculation Settings

The final steps before running the noise calculations are to ensure that the model is fully configured and prepared for the noise calculations.

13.6.1 Percentage Favourable Propagation

The meteorological conditions should be set to reflect the location of the model. In support of the Round 4 strategic noise mapping, TII let a research project[81] to develop Irish specific meteorological correction factors required to implement CNOSSOS-EU:2020 based on data available from Met Éireann.

Long term annual average temperature, relative humidity and mean seal level pressure data was determined. The percentage of favourable propagation in 20-degree increments for the

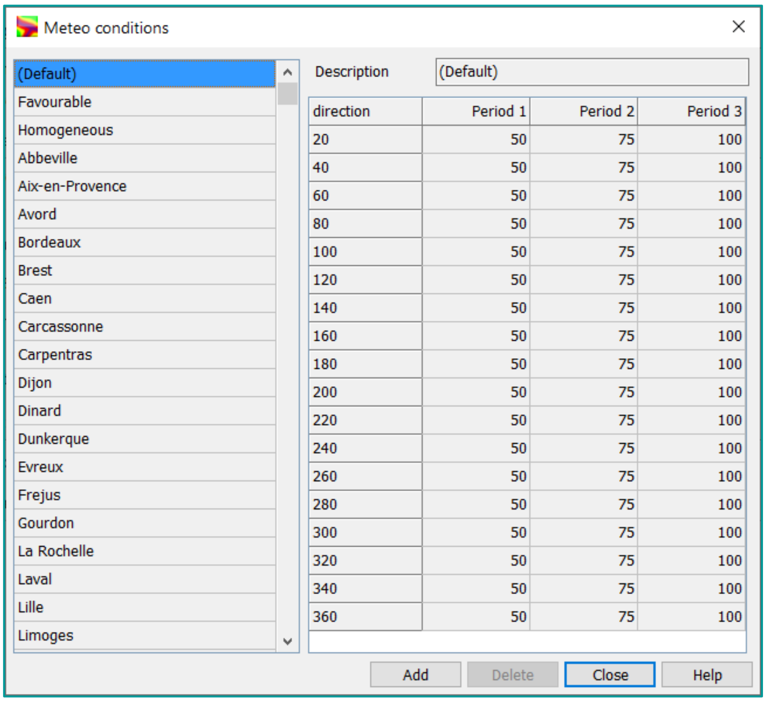
[81] Common Noise Assessment Methods in Europe (CNOSSOS-EU): Meteorological Correction Factors for Ireland, RE-ENV-07007, TII, October 2022. Available at: https://www.tiipublications.ie/advanced-search/results/document/?id=3214 [Accessed September 2024]

day, evening and night periods were also determined from the long-term meteorological data using the Nord2000 methodology.

The results were produced for each County in Ireland and are set out in Appendix C, Tables C-1 and C-2.

The percentage favourable propagation (%FP) values in 20 degree increments for the day, evening and night periods for the relevant County should be selected, or entered, into the relevant table within the noise calculation software.

- Example of percentage favourable propagation data within Predictor-LimA:
    - Meteorological correction, Location
        - The day, evening, night %FP values from Appendix C should be entered for Period 1, 2 and 3 within the dialogue



direction	Period 1	Period 2	Period 3
20	50	75	100
40	50	75	100
60	50	75	100
80	50	75	100
100	50	75	100
120	50	75	100
140	50	75	100
160	50	75	100
180	50	75	100
200	50	75	100
220	50	75	100
240	50	75	100
260	50	75	100
280	50	75	100
300	50	75	100
320	50	75	100
340	50	75	100
360	50	75	100

Figure 13.2: Example of meteo conditions dialogue for entering %FP data for day, evening and night periods

13.6.2 Calculation Settings

Noise calculation software systems include a wide range of different calculation settings, which can affect both the time taken to run the calculations, and the quality of the results. Ideally, a series of test calculations can be run, using different settings, to investigate how cost and benefit of the various settings.

Based upon previous experience, and example of calculation settings which may be used for CNOSSOS-EU within the Predictor-LimA software are shown in Figure 13.3.

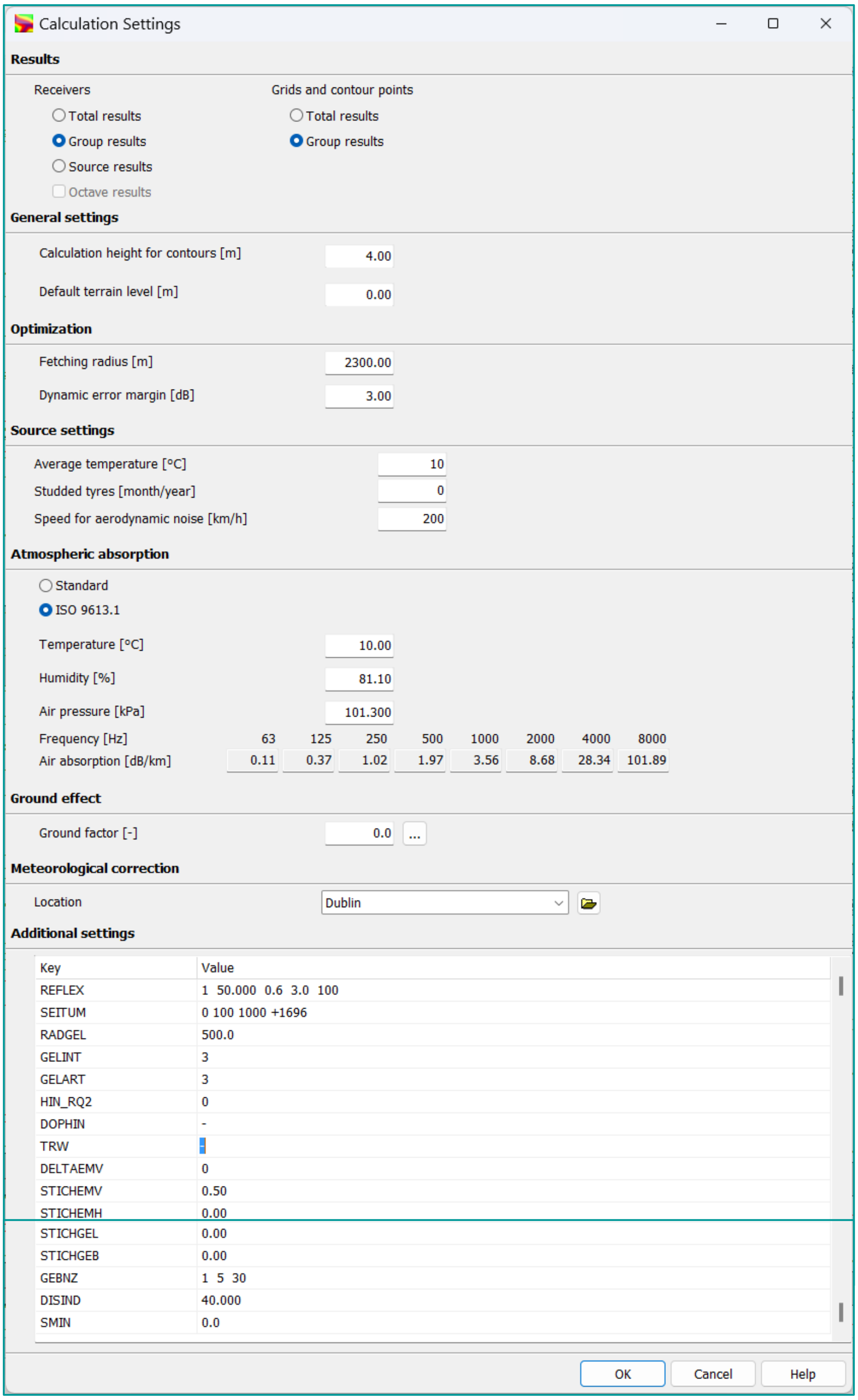


Figure 13.3: Example of calculation settings for strategic noise mapping under CNOSSOS-EU in Predictor-LimA

Guidance Note 97:

1. Recommended calculation settings:
    a. Fetching radius = 2,300m for roads, 1,500m for railways and 1,000 for industry
    b. Dynamic error margin 3.0 dB
    c. Average Temperature, Humidity and Pressure from TII Research Report per County
    d. Location defined for the relevant County, with % FP values from the TII Research Report

Large models may be split into tiles to enable each tile to be calculated on a separate processor or computer in parallel.

Guidance Note 98:

1. It is recommended that the model is split into tiles ahead of the calculation processing. These could be 2 x 2 km, 1 x 1 km or 500m x 500m.

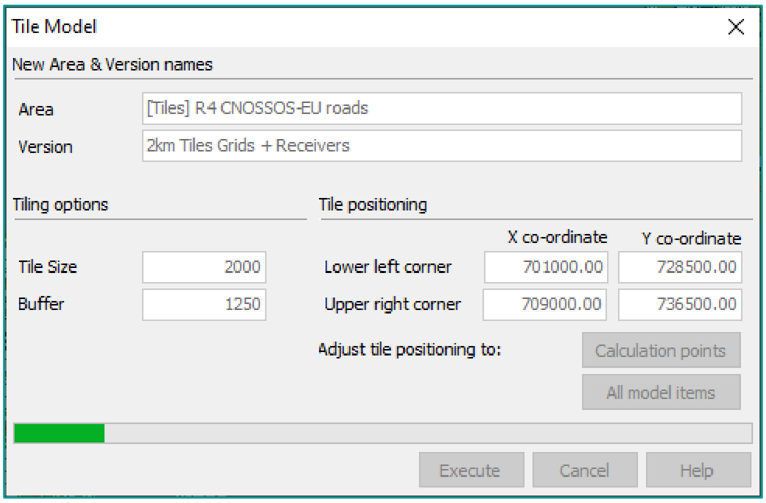


Figure 13.4: Tile the model into parts

Under the CNOSSOS-EU calculation methodology, noise levels are to be calculated for both regular grid receivers, and building façade receivers.

In some noise calculation systems this requires the calculations to be run twice, once for each type of receiver, while in other software both types of receivers can be calculated during the same process.

Guidance Note 99:
1. If using Predictor-LimA it is recommended to calculate the grid and façade receivers together in one calculation run by selecting “All calculation points”.

When all the tile calculations are 100% completed, all the results may be downloaded as one batch and the results integrated back into the tiled models. These tiled results are then merged back into the complete model which was used to generate the tiles, in order to support analyse of the results across the whole model area.

13.7 Post Calculation Checks

Following the completion of the calculation run it is important that checks are carried out to verify that the noise levels produced are in line with expectations.

Some noise mapping systems also provide output log files which may be reviewed to ensure that all the necessary input datasets were loaded, and that the calculations were processed without errors.

Before running the exposure analysis, ensure that the Contours and Results Labels are setup for 5 dB bands from 40 dB to >75 dB, as shown in Figure 13.5.

Guidance Note 100:
It is recommended that the noise mapping software is used to produce graphical representations of the noise levels, as noise contour maps, in order for any gaps, errors or anomalies to be identified.

The reference values[82] for the recommended colour bands are shown in Table 13.1.

Table 13.1: Recommended colour bands for presentation of noise contour results

Band	Colour	R	G	B	C	M	Y	K	Hex
>30-35	dark blue-green	130	166	173	53	23	28	4	#82A6AD
>35-40	Blue-green	160	186	191	42	18	21	2	#A0BABF
>40-45	light blue-green	184	214	209	33	6	19	0	#B8D6D1
>45-50	light green	206	228	204	24	1	25	0	#CEE4CC
>50-55	yellowish green	226	242	191	16	0	33	0	#E2F2BF
>55-60	light orange	243	198	131	5	26	54	0	#F3C683
>60-65	orange	232	126	77	3	61	71	0	#E87E4D
>65-70	dark orange	205	70	62	15	84	74	3	#CD463E
>70-75	magenta	161	26	77	32	98	47	14	#A11A4D
>75-80	purple	117	8	92	58	100	26	17	#75085C
>80	dark purple	67	10	74	79	100	37	39	#430A4A

[82] Coloring Noise, Dr. Beate Tomio, 2016. Available at: https://www.coloringnoise.com/theoretical_background/new-color-scheme/ [Accessed June 2022]

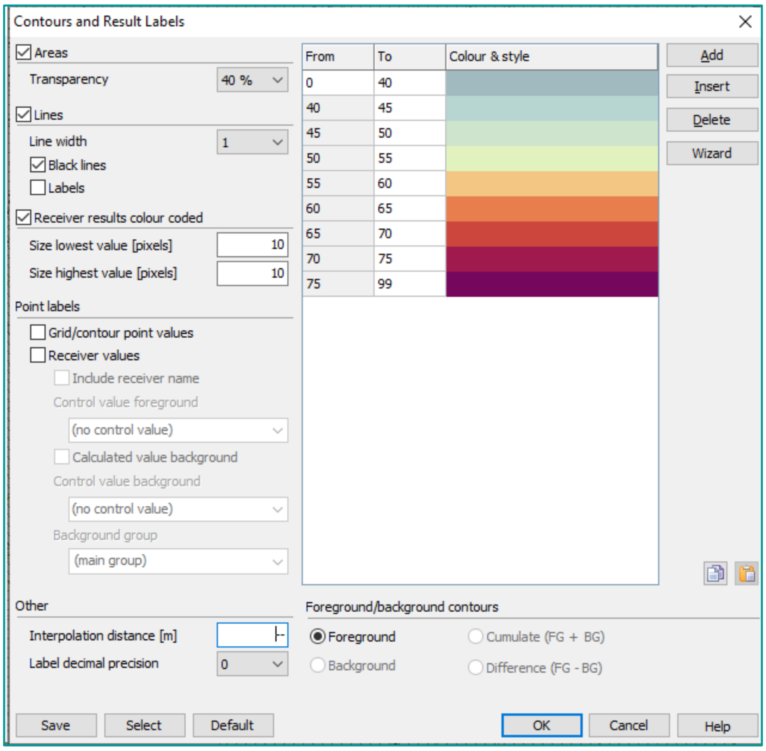


Figure 13.5: Noise exposure bands for results analysis

Detailed guidance on the assessment of exposure and harmful effects, based on the results of the strategic noise mapping, may be found in Part 3 of the guidance, Assessment of Noise Exposure and Harmful Effects.

Appendix A: Glossary of Acoustic and Technical Terms

Term	Definition
%FP	Percentage Favourable Propagation
AEDT	Federal Aviation Authority, Aviation Environmental Design Tool
Agglomeration	Major Continuous Urban Area as set out within the Regulations
ANP	Aircraft Noise Performance database hosted by Eurocontrol
Attribute Data	A trait, quality, or property describing a geographical feature, e.g. vehicle flow or building height
Attributing (Data)	The linking of attribute data to spatial geometric data
CAA	Civil Aviation Authority
CNOSSOS-EU	Common Noise Assessment Methods for Europe, Directive 996/2015 (as amended)
CPX	Close Proximity Measurements
CSO	Central Statistics Office
Data	Data comprises information required to generate the outputs specified, and the results specified
dB	Decibel
DEM	Digital Elevation Model
DG JRC	European Commission Directorate General Joint Research Centre
DSM	Digital Surface Model
DTM	Digital Terrain Model
EC	European Commission
ECAC	European Civil Aviation Conference
ECAC Doc 29	ECAC Report on Standard Method of Computing Noise Contours Around Civil Airports
END	Environmental Noise Directive (2002/49/EC)
EPA	Environmental Protection Agency
EU	European Union
FAA	Federal Aviation Authority
GIS	Geographic Information System
ICAO	International Civil Aviation Organization
IED	Industrial Emissions Directive 2010/75/EU
Irish National Grid (ING)	Superseded spatial referencing system of Ireland
Irish Transverse Mercator (ITM)	The official spatial referencing system of Ireland
ISO	International Standards Organisation
Metadata	Descriptive information summarising data
NA	Not Applicable
NMB	Noise Mapping Body
Noise Bands	Areas lying between contours of the following levels (dB): L_{den} <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, ≥75 L_d <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, ≥75

Term	Definition
	L_e <55, 55 – 59, 60 – 64, 65 – 69, 70 – 74, ≥75 L_n <45, 45-49, 50 – 54, 55 – 59, 60 – 64, 65 – 69, ≥70 Notes: It is recommended that class boundaries be at .00, e.g. 55 to 59 is actually 55.00 to 59.99 The assessment and reporting of the 45 – 49dB band for Lnight is optional under the Regulations
Noise Levels	Free-field values of L_{den}, L_d, L_e, L_n, and $L_{Aeq,16h}$ at a height of 4m above local ground level
Noise Level - L_d - Daytime	L_d (or L_{day}) = $L_{Aeq,12h}$ (07:00 to 19:00)
Noise Level - L_e - Evening	L_e (or $L_{evening}$) = $L_{Aeq,4h}$ (19:00 to 23:00)
Noise Level - L_n - Night	L_n (or L_{night}) = $L_{Aeq,8h}$ (23:00 to 07:00)
Noise Level - L_{den} – Day/Evening/Night	A combination of L_d. L_e and L_n as follows: L_{den} = 10 * log 1/24 {12 * 10^((L_{day})/10) + 4 * 10^(($L_{evening}$+5)/10) + 8 * 10^((L_{night}+10)/10)}
Noise Mapping (Input) Data	Two broad categories: (1) Spatial (e.g. road centre lines, building outlines). (2) Attribute (e.g. vehicle flow, building height – assigned to specific spatial data)
Noise Mapping Software	Computer program that calculates required noise levels based on relevant input data
Noise Model	All the input data collated and held within a computer program to enable noise levels to be calculated.
Noise Model File	The (proprietary software specific) project file(s) comprising the noise model
NPD	Noise-Power-Distance
Output Data	The noise outputs generated by the noise model
OSI	Ordnance Survey for Ireland
Processing Data	Any form of manipulation, correction, adjustment factoring, correcting, or other adjustment of data to make it fit for purpose. (Includes operations sometimes referred to as 'cleaning' of data)
QA	Quality Assurance
SAPS	Small Area Population Statistics
Spatial (Input) Data	Information about the location, shape, and relationships among geographic features, for example road centre lines and buildings.
SPB	Statistical Pass-By measurements
SWL	Sound Power Level
TII	Transport Infrastructure Ireland
WG - AEN	Working Group – Assessment of Exposure to Noise

Appendix B: Bibliography and References

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Appendix C: Long term mean values for relevant meteorological variables in Ireland, by county

In support of the Round 4 strategic noise mapping, TII let a research project[83] to develop Irish specific meteorological correction factors required to implement CNOSSOS-EU:2020 based on data available from Met Éireann. Long term annual average temperature, relative humidity and mean seal level pressure data was determined. The percentage of favourable propagation in 20-degree increments for the day, evening and night periods were also determined from the long-term meteorological data using the Nord2000 methodology.

The results were produced for each County in Ireland and are set out in Tables C-1 and C-2.

Long term means for relevant meteorological variables in Ireland, by county

Table C-1: Temperature, relative humidity and pressure across Ireland, long-term averages, by County

County	Temperature (°C)	Temperature (K)	Relative humidity (%)	Mean Sea Level Pressure (kPa)
Carlow	9.9	283.0	83.0	101.4
Cavan	9.3	282.5	83.2	101.2
Clare	10.6	283.8	82.7	101.3
Cork	9.8	283.0	84.6	101.4
Donegal	9.7	282.8	81.8	101.2
Dublin	10.0	283.2	81.1	101.3
Galway	10.0	283.2	84.3	101.3
Kerry	10.9	284.0	81.8	101.4
Kildare	9.9	283.0	83.0	101.3
Kilkenny	9.9	283.0	82.9	101.4
Laois	9.7	282.8	83.7	101.2
Leitrim	9.8	283.0	81.9	101.2
Limerick	10.2	283.3	83.0	101.3
Longford	9.6	282.8	83.6	101.3
Louth	9.7	282.8	82.5	101.2
Mayo	9.6	282.8	85.4	101.3
Meath	9.7	282.8	82.6	101.3
Monaghan	9.3	282.5	83.5	101.2
Offaly	9.8	283.0	83.7	101.3
Roscommon	9.3	282.5	85.1	101.2

[83] Common Noise Assessment Methods in Europe (CNOSSOS-EU): Meteorological Correction Factors for Ireland, RE-ENV-07007, TII, October 2022. Available at: https://www.tiipublications.ie/advanced-search/results/document/?id=3214 [Accessed September 2024]

County	Temperature (°C)	Temperature (K)	Relative humidity (%)	Mean Sea Level Pressure (kPa)
Sligo	9.6	282.8	83.6	101.2
Tipperary	10.1	283.3	82.5	101.3
Waterford	10.6	283.8	82.7	101.4
Westmeath	9.5	282.7	84.2	101.3
Wexford	10.5	283.7	83.2	101.4
Wicklow	9.8	283.0	82.5	101.3

%Pf for day, evening and night-time periods for all Irish counties

Table C-2: %Pf factors across Ireland for day, evening and night periods, long-term averages, by County

County	Period	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340
CARLOW	D	36%	30%	24%	21%	20%	25%	33%	39%	44%	49%	53%	55%	55%	53%	50%	48%	46%	42%
	E	48%	45%	42%	40%	40%	45%	51%	56%	61%	66%	71%	74%	75%	71%	66%	61%	57%	53%
	N	51%	48%	45%	44%	45%	50%	56%	60%	65%	68%	72%	74%	75%	71%	67%	63%	59%	55%
CAVAN	D	23%	22%	21%	22%	24%	28%	32%	36%	41%	48%	53%	55%	54%	52%	48%	40%	32%	26%
	E	50%	49%	48%	48%	50%	54%	59%	64%	70%	75%	77%	77%	75%	72%	68%	63%	58%	53%
	N	49%	48%	47%	47%	50%	55%	60%	66%	72%	77%	80%	80%	77%	73%	69%	63%	56%	51%
CLARE	D	26%	23%	22%	25%	31%	34%	37%	40%	46%	52%	54%	55%	52%	50%	49%	46%	40%	32%
	E	40%	36%	36%	37%	41%	43%	46%	49%	54%	61%	65%	66%	63%	61%	60%	56%	52%	45%
	N	39%	39%	41%	44%	49%	52%	54%	57%	62%	66%	66%	65%	61%	58%	56%	52%	48%	42%
CORK	D	32%	27%	24%	23%	24%	27%	32%	36%	42%	44%	46%	50%	53%	54%	52%	48%	43%	38%
	E	48%	44%	40%	37%	37%	38%	43%	47%	53%	57%	61%	65%	68%	67%	64%	59%	55%	52%
	N	50%	46%	43%	40%	39%	40%	42%	46%	51%	55%	59%	64%	67%	67%	65%	61%	57%	54%
DONEGAL	D	30%	26%	26%	26%	28%	31%	36%	41%	46%	51%	55%	58%	58%	57%	54%	49%	43%	36%
	E	41%	38%	37%	37%	38%	40%	44%	49%	54%	59%	63%	65%	64%	63%	61%	57%	52%	46%
	N	36%	34%	34%	34%	37%	41%	48%	54%	59%	64%	66%	68%	66%	64%	58%	53%	46%	41%
DUBLIN	D	19%	18%	19%	21%	24%	27%	30%	36%	42%	51%	58%	62%	63%	61%	57%	48%	37%	26%
	E	32%	30%	30%	30%	33%	38%	44%	53%	63%	71%	76%	77%	75%	71%	66%	57%	48%	38%
	N	30%	28%	26%	27%	30%	35%	41%	51%	63%	73%	79%	80%	78%	75%	71%	62%	50%	38%
GALWAY	D	28%	26%	25%	24%	24%	26%	30%	35%	42%	50%	55%	58%	59%	58%	55%	50%	41%	33%
	E	44%	41%	38%	37%	37%	38%	42%	48%	55%	62%	66%	68%	69%	69%	68%	64%	56%	49%
	N	42%	40%	39%	39%	40%	43%	48%	53%	59%	64%	67%	68%	68%	67%	64%	59%	52%	46%

County	Period	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340
KERRY	D	31%	26%	23%	22%	23%	27%	34%	39%	44%	47%	51%	55%	55%	54%	51%	47%	42%	37%
	E	45%	41%	40%	40%	42%	46%	53%	58%	61%	64%	68%	69%	67%	64%	60%	55%	51%	48%
	N	46%	44%	44%	45%	47%	52%	59%	62%	65%	67%	68%	69%	66%	63%	58%	55%	51%	49%
KILDARE	D	27%	25%	24%	22%	21%	23%	28%	34%	41%	47%	52%	56%	55%	48%	41%	37%	33%	30%
	E	50%	48%	47%	47%	49%	53%	60%	66%	71%	75%	78%	79%	78%	72%	65%	61%	57%	53%
	N	48%	47%	46%	47%	49%	54%	62%	69%	75%	79%	81%	82%	79%	73%	65%	59%	54%	51%
KILKENNY	D	30%	26%	22%	21%	22%	26%	33%	39%	44%	50%	54%	55%	54%	51%	48%	44%	40%	35%
	E	49%	46%	44%	45%	46%	51%	56%	61%	66%	70%	74%	75%	75%	71%	67%	62%	57%	53%
	N	56%	54%	52%	52%	53%	57%	61%	66%	70%	73%	76%	78%	78%	76%	72%	68%	63%	59%
LAOIS	D	26%	24%	22%	20%	19%	21%	25%	30%	36%	44%	51%	57%	58%	56%	51%	42%	35%	30%
	E	56%	53%	51%	51%	51%	55%	60%	66%	74%	80%	84%	85%	86%	84%	78%	71%	65%	60%
	N	55%	53%	52%	52%	53%	56%	61%	67%	74%	81%	85%	87%	87%	85%	80%	71%	64%	59%
LEITRIM	D	28%	22%	22%	23%	26%	30%	34%	38%	41%	45%	49%	53%	53%	53%	50%	45%	40%	35%
	E	49%	46%	46%	47%	49%	52%	56%	60%	66%	70%	74%	74%	72%	70%	66%	61%	55%	52%
	N	45%	43%	43%	46%	50%	54%	60%	63%	69%	72%	74%	74%	71%	68%	63%	57%	51%	48%
LIMERICK	D	31%	26%	23%	22%	23%	24%	26%	30%	35%	39%	41%	44%	46%	47%	46%	45%	41%	37%
	E	66%	64%	62%	62%	62%	63%	65%	70%	75%	79%	82%	84%	85%	84%	81%	77%	73%	70%
	N	66%	64%	63%	63%	64%	66%	69%	73%	78%	81%	83%	84%	85%	84%	81%	76%	73%	69%
LONGFORD	D	26%	26%	26%	27%	30%	33%	38%	44%	50%	54%	56%	57%	54%	46%	39%	34%	31%	27%
	E	61%	60%	60%	61%	65%	69%	74%	81%	85%	86%	87%	86%	83%	77%	70%	67%	64%	62%
	N	61%	60%	61%	62%	66%	70%	76%	82%	86%	87%	88%	87%	84%	76%	70%	66%	64%	62%
LOUTH	D	25%	22%	22%	22%	25%	29%	32%	35%	39%	42%	46%	50%	50%	50%	48%	44%	38%	30%
	E	54%	51%	50%	49%	50%	53%	57%	62%	67%	71%	74%	75%	75%	72%	69%	66%	62%	57%
	N	53%	49%	46%	45%	46%	49%	52%	58%	64%	70%	74%	76%	76%	74%	72%	68%	62%	56%
MAYO	D	29%	25%	24%	25%	27%	29%	34%	42%	48%	53%	58%	59%	59%	58%	55%	48%	41%	34%

County	Period	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340
	E	38%	35%	34%	34%	35%	35%	39%	46%	52%	56%	61%	63%	63%	62%	61%	55%	49%	44%
	N	36%	34%	33%	35%	37%	41%	45%	51%	56%	60%	63%	63%	62%	60%	56%	51%	45%	40%
MEATH	D	23%	21%	22%	23%	23%	25%	29%	33%	38%	44%	52%	57%	58%	57%	52%	46%	38%	29%
	E	51%	49%	48%	47%	47%	50%	56%	63%	69%	76%	79%	79%	78%	75%	70%	65%	61%	56%
	N	50%	48%	47%	47%	48%	51%	57%	64%	71%	77%	80%	81%	81%	78%	73%	67%	61%	55%
MONAGHAN	D	28%	24%	21%	21%	23%	27%	31%	35%	41%	47%	50%	51%	52%	51%	47%	41%	34%	31%
	E	56%	53%	52%	52%	52%	55%	60%	63%	69%	73%	76%	77%	78%	76%	72%	67%	61%	58%
	N	56%	53%	52%	52%	54%	58%	63%	67%	73%	77%	79%	80%	79%	77%	74%	68%	62%	59%
OFFALY	D	23%	21%	20%	20%	24%	29%	34%	38%	43%	51%	56%	57%	54%	51%	47%	41%	33%	27%
	E	51%	48%	48%	48%	52%	57%	62%	67%	73%	78%	81%	81%	78%	74%	69%	64%	59%	54%
	N	50%	47%	48%	50%	55%	61%	68%	73%	79%	84%	85%	84%	81%	76%	71%	64%	58%	53%
ROSCOMMON	D	29%	26%	25%	24%	24%	26%	30%	35%	41%	46%	51%	54%	55%	53%	48%	43%	39%	33%
	E	47%	45%	43%	42%	42%	46%	49%	54%	61%	65%	69%	71%	71%	69%	65%	61%	56%	52%
	N	45%	43%	43%	43%	44%	48%	53%	58%	63%	67%	71%	72%	71%	68%	64%	59%	55%	50%
SLIGO	D	31%	29%	26%	24%	25%	28%	33%	36%	42%	47%	48%	47%	44%	43%	42%	41%	38%	34%
	E	57%	56%	55%	56%	58%	61%	64%	65%	69%	74%	76%	75%	74%	72%	70%	67%	64%	59%
	N	56%	55%	55%	56%	59%	63%	67%	70%	73%	78%	79%	77%	74%	71%	68%	65%	62%	58%
TIPPERARY	D	23%	21%	21%	21%	21%	22%	25%	30%	39%	49%	56%	60%	60%	57%	50%	40%	32%	26%
	E	51%	46%	43%	42%	43%	47%	53%	61%	70%	77%	80%	82%	82%	79%	75%	68%	61%	56%
	N	48%	44%	44%	44%	45%	49%	56%	63%	71%	79%	82%	83%	83%	81%	76%	67%	59%	54%
WATERFORD	D	32%	28%	26%	26%	26%	27%	28%	31%	36%	41%	44%	48%	52%	55%	55%	50%	43%	36%
	E	59%	55%	52%	49%	47%	46%	48%	52%	59%	66%	71%	75%	76%	76%	76%	72%	68%	63%
	N	62%	58%	53%	49%	47%	44%	45%	49%	56%	62%	69%	73%	75%	77%	77%	74%	70%	65%
WESTMEATH	D	25%	23%	21%	21%	23%	27%	32%	36%	40%	47%	52%	55%	56%	53%	49%	43%	36%	30%
	E	49%	46%	45%	44%	45%	50%	55%	61%	66%	71%	75%	76%	74%	70%	66%	61%	57%	52%

County	Period	0	20	40	60	80	100	120	140	160	180	200	220	240	260	280	300	320	340
	N	48%	46%	45%	46%	48%	53%	58%	64%	70%	74%	77%	78%	76%	72%	68%	62%	57%	52%
WEXFORD	D	29%	27%	26%	25%	25%	28%	31%	37%	46%	52%	55%	56%	57%	55%	51%	41%	32%	30%
	E	44%	41%	38%	36%	37%	41%	46%	53%	62%	68%	71%	73%	74%	73%	70%	62%	54%	49%
	N	47%	44%	41%	38%	36%	38%	42%	49%	58%	65%	69%	72%	74%	74%	71%	63%	57%	52%
WICKLOW	D	33%	29%	24%	21%	19%	20%	29%	38%	42%	45%	47%	48%	45%	38%	34%	35%	35%	34%
	E	65%	63%	61%	60%	61%	63%	70%	74%	76%	78%	80%	82%	83%	78%	74%	73%	69%	67%
	N	64%	62%	60%	59%	60%	62%	70%	76%	78%	79%	81%	83%	83%	76%	71%	71%	68%	66%

Appendix D: Buildings

FORM_ ID	FORM_ VALUE	FUNC _ID	FUNC_VALUE	FORM_ FUNC_ID	MINIMUM _HEIGHT	BUILDING_USE	INCLUDE_IN _EXPOSURE
9	Airport Terminal	632	Not Applicable	9_632	12	NON-RESIDENTIAL	No
16	Apartment Building	376	Residence	16_376	8	RESIDENTIAL	Yes
16	Apartment Building	672	Commercial/Residential	16_672	8	RESIDENTIAL	Yes
21	Aquatic Centre	632	Not Applicable	21_632	8	NON-RESIDENTIAL	No
31	Barrack	18	Air Corps Barracks	31_18	5	NON-RESIDENTIAL	No
31	Barrack	38	Army Barracks	31_38	5	NON-RESIDENTIAL	No
31	Barrack	198	Garda Headquarter	31_198	5	NON-RESIDENTIAL	No
31	Barrack	199	Garda Training College	31_199	5	NON-RESIDENTIAL	No
31	Barrack	308	Navy Barracks	31_308	5	NON-RESIDENTIAL	No
41	Belfry	632	Not Applicable	41_632	12	NON-RESIDENTIAL	No
55	Building General	14	Abattoir	55_14	8	NON-RESIDENTIAL	No
55	Building General	15	Abbey	55_15	8	NON-RESIDENTIAL	No
55	Building General	16	Adventure Centre	55_16	8	NON-RESIDENTIAL	No
55	Building General	19	Airport Building	55_19	8	NON-RESIDENTIAL	No
55	Building General	22	Ambulance Station	55_22	8	NON-RESIDENTIAL	No
55	Building General	23	Amusement Arcade	55_23	5	NON-RESIDENTIAL	No
55	Building General	26	Animal Pound	55_26	5	NON-RESIDENTIAL	No
55	Building General	33	Aquarium	55_33	5	NON-RESIDENTIAL	No
55	Building General	39	Art Gallery	55_39	8	NON-RESIDENTIAL	No
55	Building General	40	Auction House	55_40	8	NON-RESIDENTIAL	No
55	Building General	41	Bakery	55_41	5	NON-RESIDENTIAL	No
55	Building General	42	Bank	55_42	5	NON-RESIDENTIAL	No
55	Building General	45	Basketball Arena	55_45	8	NON-RESIDENTIAL	No
55	Building General	58	Bowling Alley	55_58	8	NON-RESIDENTIAL	No
55	Building General	59	Brewery	55_59	8	NON-RESIDENTIAL	No
55	Building General	63	Building Society	55_63	5	NON-RESIDENTIAL	No
55	Building General	69	Bus Depot	55_69	12	NON-RESIDENTIAL	No
55	Building General	70	Bus Station	55_70	8	NON-RESIDENTIAL	No
55	Building General	86	Childrens Home	55_86	5	RESIDENTIAL	Yes
55	Building General	94	Cinema	55_94	8	NON-RESIDENTIAL	No
55	Building General	96	Civil Defence	55_96	8	NON-RESIDENTIAL	No
55	Building General	99	Clinic	55_99	5	NON-RESIDENTIAL	No
55	Building General	106	Coastguard Station	55_106	5	NON-RESIDENTIAL	No
55	Building General	107	Cold Store	55_107	5	NON-RESIDENTIAL	No
55	Building General	108	Community Centre	55_108	5	NON-RESIDENTIAL	No
55	Building General	109	Concert Hall	55_109	12	NON-RESIDENTIAL	No
55	Building General	110	Conference Centre	55_110	8	NON-RESIDENTIAL	No
55	Building General	111	Consulate	55_111	8	NON-RESIDENTIAL	No
55	Building General	112	Convent	55_112	5	RESIDENTIAL	Yes
55	Building General	114	Coroner's Court	55_114	8	NON-RESIDENTIAL	No
55	Building General	115	Courthouse	55_115	8	NON-RESIDENTIAL	No
55	Building General	118	Creamery	55_118	8	NON-RESIDENTIAL	No
55	Building General	119	Credit Union	55_119	5	NON-RESIDENTIAL	No
55	Building General	120	Crematorium	55_120	8	NON-RESIDENTIAL	No
55	Building General	131	Day Centre	55_131	5	NON-RESIDENTIAL	No
55	Building General	137	Distillery	55_137	8	NON-RESIDENTIAL	No
55	Building General	155	Electricity Station	55_155	5	NON-RESIDENTIAL	No
55	Building General	159	Embassy	55_159	8	NON-RESIDENTIAL	No
55	Building General	171	Equestrian Centre	55_171	5	NON-RESIDENTIAL	No
55	Building General	174	Factory	55_174	8	NON-RESIDENTIAL	No
55	Building General	181	Fitness Centre	55_181	8	NON-RESIDENTIAL	No
55	Building General	192	Friary	55_192	8	NON-RESIDENTIAL	No
55	Building General	194	Funeral Home	55_194	8	NON-RESIDENTIAL	No
55	Building General	197	Garage	55_197	8	NON-RESIDENTIAL	No
55	Building General	202	Gas Station	55_202	8	NON-RESIDENTIAL	No
55	Building General	218	Hall	55_218	8	NON-RESIDENTIAL	No
55	Building General	219	Hangar	55_219	12	NON-RESIDENTIAL	No
55	Building General	222	Health Centre	55_222	5	NON-RESIDENTIAL	No
55	Building General	231	Hostel	55_231	5	NON-RESIDENTIAL	No
55	Building General	234	Hut	55_234	3	NON-RESIDENTIAL	No
55	Building General	237	Icehouse	55_237	3	NON-RESIDENTIAL	No
55	Building General	238	Incinerator	55_238	5	NON-RESIDENTIAL	No
55	Building General	246	Interpretive Centre	55_246	5	NON-RESIDENTIAL	No
55	Building General	252	Laboratory	55_252	5	NON-RESIDENTIAL	No

55	Building General	260	Laundry	55_260	5	NON-RESIDENTIAL	No
55	Building General	263	Library	55_263	5	NON-RESIDENTIAL	No
55	Building General	265	Local Government Building	55_265	8	NON-RESIDENTIAL	No
55	Building General	276	Mausoleum	55_276	5	NON-RESIDENTIAL	No
55	Building General	281	Mercantile Bank	55_281	5	NON-RESIDENTIAL	No
55	Building General	295	Mortuary	55_295	5	NON-RESIDENTIAL	No
55	Building General	299	Multiple Use	55_299	8	NON-RESIDENTIAL	No
55	Building General	301	Museum	55_301	8	NON-RESIDENTIAL	No
55	Building General	313	Nursing Home	55_313	5	RESIDENTIAL	Yes
55	Building General	316	Oil Depot	55_316	5	NON-RESIDENTIAL	No
55	Building General	322	Oratory	55_322	5	NON-RESIDENTIAL	No
55	Building General	325	Outbuilding	55_325	3	NON-RESIDENTIAL	No
55	Building General	330	Parochial House	55_330	5	RESIDENTIAL	Yes
55	Building General	332	Pavilion	55_332	3	NON-RESIDENTIAL	No
55	Building General	336	Photographic Gallery	55_336	5	NON-RESIDENTIAL	No
55	Building General	338	Piggery	55_338	3	NON-RESIDENTIAL	No
55	Building General	342	Post Office	55_342	5	NON-RESIDENTIAL	No
55	Building General	343	Pottery	55_343	5	NON-RESIDENTIAL	No
55	Building General	344	Power Station	55_344	12	NON-RESIDENTIAL	No
55	Building General	345	Prayer/Mission Hall	55_345	8	NON-RESIDENTIAL	No
55	Building General	347	Presbytery	55_347	5	RESIDENTIAL	Yes
55	Building General	349	Priory	55_349	5	RESIDENTIAL	Yes
55	Building General	354	Public House	55_354	8	NON-RESIDENTIAL	No
55	Building General	355	Pump House	55_355	3	NON-RESIDENTIAL	No
55	Building General	358	Radio Station	55_358	8	NON-RESIDENTIAL	No
55	Building General	366	Recreational Complex	55_366	8	NON-RESIDENTIAL	No
55	Building General	367	Rectory	55_367	5	RESIDENTIAL	Yes
55	Building General	368	Recycling Centre/Depot	55_368	8	NON-RESIDENTIAL	No
55	Building General	369	Recycling Plant	55_369	12	NON-RESIDENTIAL	No
55	Building General	370	Relay Station	55_370	3	NON-RESIDENTIAL	No
55	Building General	371	Research Centre	55_371	8	NON-RESIDENTIAL	No
55	Building General	372	Research Institute	55_372	8	NON-RESIDENTIAL	No
55	Building General	373	Research Laboratory	55_373	8	NON-RESIDENTIAL	No
55	Building General	374	Research Station	55_374	8	NON-RESIDENTIAL	No
55	Building General	376	Residence	55_376	5	RESIDENTIAL	Yes
55	Building General	377	Restaurant	55_377	5	NON-RESIDENTIAL	No
55	Building General	379	Retirement Home	55_379	5	RESIDENTIAL	Yes
55	Building General	416	Sheltered Accommodation	55_416	5	RESIDENTIAL	Yes
55	Building General	460	Sweat House	55_460	5	NON-RESIDENTIAL	No
55	Building General	461	Swimming Pool	55_461	8	NON-RESIDENTIAL	No
55	Building General	463	Synagogue	55_463	8	NON-RESIDENTIAL	No
55	Building General	468	Telecommunication	55_468	5	NON-RESIDENTIAL	No
55	Building General	469	Telephone Exchange	55_469	5	NON-RESIDENTIAL	No
55	Building General	471	Television Station	55_471	8	NON-RESIDENTIAL	No
55	Building General	474	Theatre	55_474	12	NON-RESIDENTIAL	No
55	Building General	482	Tourist Office	55_482	5	NON-RESIDENTIAL	No
55	Building General	486	Town Hall	55_486	12	NON-RESIDENTIAL	No
55	Building General	496	Unknown	55_496	5	NON-RESIDENTIAL	No
55	Building General	499	Vehicle Pound	55_499	5	NON-RESIDENTIAL	No
55	Building General	500	Veterinary Clinic	55_500	5	NON-RESIDENTIAL	No
55	Building General	502	Vicarage	55_502	5	RESIDENTIAL	Yes
55	Building General	506	Warehouse	55_506	12	NON-RESIDENTIAL	No
55	Building General	587	Bus Terminus	55_587	8	NON-RESIDENTIAL	No
55	Building General	636	Office	55_636	8	NON-RESIDENTIAL	No
55	Building General	637	Commercial/Retail	55_637	8	NON-RESIDENTIAL	No
55	Building General	638	Industrial facility	55_638	8	NON-RESIDENTIAL	No
55	Building General	672	Commercial/Residential	55_672	5	RESIDENTIAL	Yes
55	Building General	673	Delivery Service Unit	55_673	8	NON-RESIDENTIAL	No
55	Building General	677	Childcare	55_677	5	NON-RESIDENTIAL	No
55	Building General	679	Adult Learning Centre	55_679	5	SCHOOL	Yes
55	Building General	686	Supported Living Residence	55_686	5	RESIDENTIAL	Yes
55	Building General	687	Intellectual Disability Services	55_687	5	NON-RESIDENTIAL	No
75	Castle	632	Not Applicable	75_632	8	NON-RESIDENTIAL	No
77	Cell	632	Not Applicable	77_632	5	NON-RESIDENTIAL	No
82	Chapel	632	Not Applicable	82_632	8	NON-RESIDENTIAL	No
84	Church	24	Anglican Cathedral	84_24	12	NON-RESIDENTIAL	No
84	Church	25	Anglican Church	84_25	12	NON-RESIDENTIAL	No
84	Church	80	Catholic Cathedral	84_80	12	NON-RESIDENTIAL	No
84	Church	81	Catholic Church	84_81	12	NON-RESIDENTIAL	No
84	Church	89	Church of Ireland Church	84_89	12	NON-RESIDENTIAL	No

84	Church	90	Church of Ireland Cathedral	84_90	12	NON-RESIDENTIAL	No
84	Church	249	Jehovah Witness Church	84_249	12	NON-RESIDENTIAL	No
84	Church	259	Latter Day Saints Church	84_259	12	NON-RESIDENTIAL	No
84	Church	282	Methodist Church	84_282	12	NON-RESIDENTIAL	No
84	Church	346	Presbyterian Church	84_346	12	NON-RESIDENTIAL	No
84	Church	496	Unknown	84_496	12	NON-RESIDENTIAL	No
89	Clochan	292	Monk's Cell	89_292	5	NON-RESIDENTIAL	No
90	Clubhouse	632	Not Applicable	90_632	5	NON-RESIDENTIAL	No
92	College	17	Agricultural College	92_17	5	SCHOOL	Yes
92	College	242	Institute of Technology	92_242	5	SCHOOL	Yes
92	College	350	Private College	92_350	5	SCHOOL	Yes
92	College	467	Teacher Training College	92_467	5	SCHOOL	Yes
92	College	476	Third Level	92_476	5	SCHOOL	Yes
92	College	495	University	92_495	5	SCHOOL	Yes
92	College	649	Further Education	92_649	5	SCHOOL	Yes
97	Tower Control	632	Not Applicable	97_632	12	NON-RESIDENTIAL	No
112	Detached Building	376	Residence	112_376	5	RESIDENTIAL	Yes
129	End of Terrace	376	Residence	129_376	5	RESIDENTIAL	Yes
139	Ferry Terminal	632	Not Applicable	139_632	12	NON-RESIDENTIAL	No
141	Filling Station	632	Not Applicable	141_632	5	NON-RESIDENTIAL	No
142	Fire Station	632	Not Applicable	142_632	8	NON-RESIDENTIAL	No
149	Fort	632	Not Applicable	149_632	12	NON-RESIDENTIAL	No
157	Garda Station	632	Not Applicable	157_632	8	NON-RESIDENTIAL	No
163	Glasshouse	632	Not Applicable	163_632	3	NON-RESIDENTIAL	No
168	Grandstand	632	Not Applicable	168_632	12	NON-RESIDENTIAL	No
190	Hospital	87	Childrens Hospital	190_87	5	HOSPITAL	Yes
190	Hospital	133	Dental Hospital	190_133	5	HOSPITAL	Yes
190	Hospital	173	Eye and Ear Hospital	190_173	5	HOSPITAL	Yes
190	Hospital	206	General Hospital	190_206	5	HOSPITAL	Yes
190	Hospital	230	Hospice	190_230	5	RESIDENTIAL	Yes
190	Hospital	275	Maternity Hospital	190_275	5	HOSPITAL	Yes
190	Hospital	352	Psychiatric Hospital	190_352	5	HOSPITAL	Yes
190	Hospital	682	Specialised Hospital	190_682	5	HOSPITAL	Yes
190	Hospital	683	Community Hospital	190_683	5	HOSPITAL	Yes
190	Hospital	684	District Hospital	190_684	5	HOSPITAL	Yes
190	Hospital	685	Private Hospital	190_685	5	HOSPITAL	Yes
192	Hotel	632	Not Applicable	192_632	8	NON-RESIDENTIAL	No
217	Lifeboat Station	632	Not Applicable	217_632	5	NON-RESIDENTIAL	No
218	Lighthouse	632	Not Applicable	218_632	12	NON-RESIDENTIAL	No
222	Mansion	632	Not Applicable	222_632	8	RESIDENTIAL	Yes
227	Tower Martello	27	Antiquity	227_27	12	NON-RESIDENTIAL	No
227	Tower Martello	301	Museum	227_301	12	NON-RESIDENTIAL	No
227	Tower Martello	376	Residence	227_376	12	RESIDENTIAL	Yes
227	Tower Martello	377	Restaurant	227_377	12	NON-RESIDENTIAL	No
231	Meteorological Office	632	Not Applicable	231_632	8	NON-RESIDENTIAL	No
235	Mill	632	Not Applicable	235_632	8	NON-RESIDENTIAL	No
240	Monastery	632	Not Applicable	240_632	8	RESIDENTIAL	Yes
243	Mosque	632	Not Applicable	243_632	12	NON-RESIDENTIAL	No
253	Multi-Storey Car Park	632	Not Applicable	253_632	12	NON-RESIDENTIAL	No
263	Observatory	632	Not Applicable	263_632	8	NON-RESIDENTIAL	No
293	Prison	176	Female Detention Centre	293_176	8	RESIDENTIAL	Yes
293	Prison	250	Juvenile Detention Centre	293_250	8	RESIDENTIAL	Yes
293	Prison	267	Male Detention Centre	293_267	8	RESIDENTIAL	Yes
311	Railway Service Shed	632	Not Applicable	311_632	5	NON-RESIDENTIAL	No
312	Railway Signal Box	632	Not Applicable	312_632	5	NON-RESIDENTIAL	No
313	Railway Station	364	Railway Terminus	313_364	5	NON-RESIDENTIAL	No
313	Railway Station	632	Not Applicable	313_632	5	NON-RESIDENTIAL	No
329	Tower Round	632	Not Applicable	329_632	12	NON-RESIDENTIAL	No
338	School	223	Hearing Impaired School	338_223	5	SCHOOL	Yes
338	School	258	Language School	338_258	5	SCHOOL	Yes
338	School	293	Montessori School	338_293	5	SCHOOL	Yes
338	School	348	Primary School	338_348	5	SCHOOL	Yes
338	School	410	Secondary School	338_410	5	SCHOOL	Yes
338	School	437	Special Needs School	338_437	5	SCHOOL	Yes
338	School	496	Unknown	338_496	5	SCHOOL	Yes
338	School	504	Visually Impaired School	338_504	5	SCHOOL	Yes
338	School	655	Primary and Secondary School	338_655	5	SCHOOL	Yes
343	Semi-Detached Building	376	Residence	343_376	5	RESIDENTIAL	Yes

351	Shop	632	Not Applicable	351_632	5	NON-RESIDENTIAL	No
353	Shopping Centre	632	Not Applicable	353_632	12	NON-RESIDENTIAL	No
360	Tower Signal	632	Not Applicable	360_632	12	NON-RESIDENTIAL	No
381	Stable	632	Not Applicable	381_632	3	NON-RESIDENTIAL	No
382	Stadium	632	Not Applicable	382_632	12	NON-RESIDENTIAL	No
385	State Government Building	632	Not Applicable	385_632	12	NON-RESIDENTIAL	No
403	Terraced Building	376	Residence	403_376	5	RESIDENTIAL	Yes
409	Toilet	632	Not Applicable	409_632	3	NON-RESIDENTIAL	No
410	Toll Booth	632	Not Applicable	410_632	3	NON-RESIDENTIAL	No
413	Tower General	52	Bell Tower	413_52	12	NON-RESIDENTIAL	No
413	Tower General	101	Clock Tower	413_101	12	NON-RESIDENTIAL	No
413	Tower General	182	Flag Tower	413_182	12	NON-RESIDENTIAL	No
413	Tower General	496	Unknown	413_496	12	NON-RESIDENTIAL	No
413	Tower General	507	Watch Tower	413_507	12	NON-RESIDENTIAL	No
413	Tower General	629	Gate Tower	413_629	12	NON-RESIDENTIAL	No
413	Tower General	630	Church Tower	413_630	12	NON-RESIDENTIAL	No
439	Watermill	632	Not Applicable	439_632	8	NON-RESIDENTIAL	No
446	Windmill	632	Not Applicable	446_632	12	NON-RESIDENTIAL	No
448	Workhouse	27	Antiquity	448_27	8	NON-RESIDENTIAL	No
501	Market	648	Commercial/Livestock/Fruit/Vegetable/Fish	501_648	5	NON-RESIDENTIAL	No
508	Gate House	376	Residence	508_376	5	RESIDENTIAL	Yes
508	Gate House	632	Not Applicable	508_632	5	NON-RESIDENTIAL	No
509	Gate Lodge	376	Residence	509_376	5	RESIDENTIAL	Yes
509	Gate Lodge	632	Not Applicable	509_632	3	NON-RESIDENTIAL	No
513	Duplex	376	Residence	513_376	8	RESIDENTIAL	Yes
657	Data Centre	632	Not Applicable	657_632	8	NON-RESIDENTIAL	No
658	Multi-Storey Public Car Park	632	Not Applicable	658_632	12	NON-RESIDENTIAL	No
659	Primary Care Centre	632	Not Applicable	659_632	8	NON-RESIDENTIAL	No