Provision of Consultancy Services for Round 4 Reporting Obligations Including the Strategic Noise Mapping in Malta Under the Directive 2002/49/EC - ERA

Reference number: SPD8/2022/011

Final Project Report

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EXECUTIVE SUMMARY

The Environmental Noise Directive (END), officially known as EC Directive 2002/49/EC[1], was established to achieve the community objective of safeguarding against the impacts of environmental noise. Its fundamental principles include:

- Monitoring the environmental noise situation,
- Informing and involving the public,
- Addressing local noise concerns,
- Developing a long-term strategy at the EU level.

To accomplish these goals, the Directive outlines three key stages:

- Conducting strategic noise mapping to assess exposure to environmental noise. This involves the observation and collection of data to monitor the environmental issue.
- Providing accessible information on environmental noise and its effects to the public, aligning with the principles of the Aarhus Convention[2],
- Formulating action plans, based on the results of noise mapping, to prevent and mitigate environmental noise where necessary, especially when exposure levels present risks to human health, and to uphold high environmental noise quality.

Strategic noise mapping is required to be performed every five years. The initial round of mapping was reported by the end of 2007, followed by subsequent rounds in June 2012, 2017 and 2022 in respect of 2021 assessment year. The resulting information, such as population exposure, coverage statistics and quality information, must be submitted to the European Commission (EC) within six months of the reporting dates, utilizing recommended reporting templates provided by the European Environment Agency (EEA) through the EIONET Reportnet Reporting Obligations Database (ROD) and from Round 4 onwards through the new EIONET portal Reportnet 3.0. The END mandates Member States to conduct strategic noise mapping for major sources of environmental noise, including major roads, railways, airports and agglomerations with over 100,000 inhabitants.

For the first round (R1) of the Directive, Malta's designated competent authority, which back then was referred to as Malta Environment and Planning Authority (MEPA), conducted strategic noise mapping in 2006, focusing on major roads with a traffic flow exceeding 6 million vehicles per year.

Subsequent rounds of mapping and action planning under the END saw adjustments to population and traffic flow thresholds. Agglomerations for assessment were lowered to

[1] Environmental Noise Directive 2002/49/EC. Available from https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32002L0049 [Accessed May 2024]

[2] Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters. Available from: https://unece.org/environment-policy/public-participation/aarhus-convention/text [Accessed Aug 2024]

populations exceeding 100,000, while traffic flow thresholds for major roads and railways decreased to 3 million and 30,000 vehicle passages per year respectively. The threshold for major airports remained at 50,000 movements per year.

Similarly to the third round, in the fourth round (R4) of the Directive, which was undertaken in 2021, the Environment and Resources Authority (ERA) assumed responsibility as Malta's competent authority. ERA assessed noise levels from major roads with over 3 million vehicles per year and evaluated noise exposure from roads, industry and aircraft within Malta's noise agglomeration.

Approach

In September 2022, ERA awarded a contract titled "Provision of Consultancy Services for Round 4 Reporting Obligations Including the Strategic Noise Mapping in Malta Under the Directive 2002/49/EC" (Ref: SPD8/2022/011) hereinafter referred to as the "Contract," to LEMITOR Ochrona Środowiska Sp. z o.o.

The primary objective of the contract was to conduct Round 4 strategic noise mapping for Malta in accordance with the Environmental Noise Directive 2002/49/EC. This goal was achieved through several key stages:

- Review of Round 3 Strategic Noise Mapping,
- Data Collection,
- Measurement of noise from IPPC sites affecting the agglomeration
- Interim Project Report and Noise Maps,
- Final Project Reporting of Strategic Noise Maps and Model Data input GIS files,
- Update of noise reporting data flows.

This report presents a review of the project, including an assessment of the Round 3 mapping, the scope of Round 4 mapping, a review of the strategic noise mapping work for Round 4 to develop the final model data input (FMDI) GIS files, the noise calculation results, and a summary of the noise exposure statistics reported to the EC.

The report encompasses major roads, agglomeration roads, agglomeration industry, and agglomeration aircraft noise. It should be examined alongside other reports delivered within the project, specifically reports relating to industrial noise monitoring and aviation modelling:

- Amino_Report_A-2023-09_231,
- Metalco_Report_A-2023-09_232,
- Sant_Report_A-2023-09_233,
- WSTOL_Report_A-2023-09_234,
- WSTRV_Report_A-2023-09_235

Conclusions

A thorough review of the Round 3 strategic noise mapping datasets was conducted, leading to the determination that revisions and extensions were necessary to align with the updates available in the mapping datasets and to meet the requirements of Round 4. Each noise mapping dataset developed during the Round 3 mapping process was revised and updated as needed. Additionally, new height datasets obtained from new basemap for 2018 (Basemap Hardcoded - SintegraM 2018) and Digital Terrain Model (DTM) dataset, along with a fresh dataset for 2021 traffic flows and updated population dataset from 2021 National Census and dwelling locations datasets, were incorporated.

This project involved a comprehensive overview of the work undertaken, accompanied by a summary of the results achieved through strategic noise mapping for major roads, agglomeration roads, agglomeration industry, and agglomeration aircraft. These efforts were carried out in strict adherence to EC Directive 2002/49/EC and relevant regulations.

1. INTRODUCTION

This report was prepared by LEMITOR Ochrona Środowiska Sp. z o.o. as a deliverable of the contract "Provision of Consultancy Services for Round 4 Reporting Obligations Including the Strategic Noise Mapping in Malta Under the Directive 2002/49/EC" (Ref: SPD8/2022/011) (herein and after referred to as the "Contract").

The objective of the study was to fulfil the Round 4 Reporting obligations including Strategic Noise Mapping in Malta under the Environmental Noise Directive (END) 2002/49/EC (later referred to in this document as the Directive).

The Directive mandates Member States to gather data on long-term exposure to road, rail, aircraft, and industrial noise. This is achieved through strategic noise mapping, utilizing 3D assessment models and mapping software. The Directive establishes a common approach for monitoring and managing environmental noise, aiming to prevent or reduce harmful effects, such as annoyance and sleep disturbance. Member States must assess noise exposure, inform the public, and adopt action plans based on mapping results. The Directive also serves as a basis for community measures to reduce noise from major sources. It addresses environmental noise affecting humans in built-up areas, public parks, quiet zones, rural areas, and near noise-sensitive buildings like schools and hospitals, as well as noise from major roads, railways, and aircraft.

It does not cover noise caused by individuals, domestic activities, neighbours, entertainment, workplaces, noise inside means of transport, or military activities.

1.1. Legislative Background

Directive 2002/49/EC, commonly referred to as the Environmental Noise Directive (END), requires Member States to undertake strategic noise mapping within agglomerations, in the vicinity of major road and rail transport corridors and around major airports. The aim is to define a common approach to prevent or reduce harmful effects due to environmental noise. The Directive sets out principles including monitoring the problem, informing the public, addressing local noise issues, and developing a long-term EU strategy. It mandates three stages: strategic noise mapping, public information, and action plan adoption based on mapping results. The Directive does not prescribe limit values or measures for action plans, leaving it to Member States' discretion. Mapping is conducted every five years with results reported to the European Commission to support long-term EU strategy development. The END mandates Member States to monitor and manage environmental noise strategically, focusing on major sources like roads, railways, airports, and agglomeration. . In Malta, the END was transposed into national legislation S.L. 549.37, "Assessment and Management of Environmental Noise Regulations, 2004", L.N. 193 of 2004 (Regulations) and subsequently amended in 2007, 2018 and 2022. Under the Environmental Noise Regulations, the Environment and Resources Authority (ERA) is stated as the designated competent authority for the making of strategic noise maps, the publication of information on environmental noise, and the drawing up of action plans. The responsibility of the environment now resides within the Ministry for the Environment, Energy and Regeneration of the Grand Harbour (MEER). , The first round of noise maps in 2007 covered major roads with a threshold of over 6 million vehicles annually. For the second and subsequent rounds in 2012, 2017 and the fourth round in 2022, the population threshold for assessment within the agglomeration was reduced from 250,000 to 100,000 inhabitants and traffic flow thresholds were reduced to 3 million vehicle passages per year. The threshold for major airports remained at 50,000 movements per year.

Under R4 of the END, ERA conducted strategic noise mapping for major roads with over 3 million vehicles annually, as well as for roads, industry, and aircraft affecting the Maltese agglomeration.

The project adhered to Directives and Regulations including:

- EU Directive 2002/49/EC on the assessment and management of environmental noise (Environmental Noise Directive);
- EU Directive 2015/996 establishing common noise assessment methods;
- Delegated Directive (EU) 2021/1226 amending for the purpose of adapting scientific and technical progress the common noise assessment methods;
- EU Directive 2007/2/EC establishing an Infrastructure for Spatial Information in the European Community (INSPIRE); and
- Assessment and Management of Environment Noise Regulation (S.L. 549.37).

1.2. Aims

The main aim of the contract was to provide the Round 4 strategic noise mapping for Malta under the Environmental Noise Directive (END) 2002/49/EC.

1.3. Objectives

The main objective was to support ERA in fulfilling the requirements of the Environmental Noise Directive (END) through the following actions:

- Reviewing Round 3 strategic noise mapping;
- Preparing and executing Round 4 strategic noise mapping; and
- Conducting noise measurements from IPPC sites affecting the agglomeration.

These objectives were to be realised through the delivery of:

1. Review of Round 3 Strategic Noise Maps;
2. The collection of all baseline input data for assessment year 2021;
3. Measurement of noise from sites of industrial activity and compilation of noise measurement reports;
4. Interim Project Report;
5. Development of the R4 Strategic Noise Maps, for L_{den} and L_{night} for:
    - Major roads,
    - Agglomeration industry,

- Agglomeration roads,
- Agglomeration aircraft;

6. Final Model Data input (FMDI) GIS files; and
7. Final Project Report, including:
   a. Review of Round 3 Strategic Noise Maps,
   b. Development of the R4 Strategic Noise Maps and Model Data input GIS files,
   c. Compilation of strategic noise maps by means of noise modelling software suite using the CNOSSOS-EU computation method in accordance with CNOSSOS Delegated Directive (EU) 2021/1226[3]
   d. The post processing and analysis of the noise level calculations in line with the requirements of the END, including statistical results of exposure assessment of area, dwellings and people in dwellings exposed to noise, school and hospital buildings exposed to noise.
8. Develop and finalise END-INSPIRE data models for R4 major roads and R4 agglomeration (roads, industry, airport) under noise dataflows DF1_5 and DF4_8 to be submitted to the EIONET Reportnet 3.0 portal in accordance with the EEA Data model documentation 2021, aligning the END and INSPIRE reporting mechanisms.

1.4. Scope

This report presents a comprehensive review of the project, including an assessment of R3 mapping, the scope of R4 mapping, a review of R4 strategic noise mapping for developing the Final Model Data Input (FMDI) GIS files, noise calculation results, and a summary of noise exposure statistics reported to the European Commission.

The report focuses on major roads, agglomeration roads, agglomeration industry, and agglomeration aircraft noise. It should be examined in conjunction with other project reports, specifically reports relating to industrial noise monitoring and aviation modelling:

- Amino_Report_A-2023-09_231,
- Metalco_Report_A-2023-09_232,
- Sant_Report_A-2023-09_233,
- WSTOL_Report_A-2023-09_234,
- WSTRV_Report_A-2023-09_235, and

1.5. Report Outline

This report is set out as follows:

- Chapter 1: Introduction
- Chapter 2: Overview of Mapping Process

[3] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32021L1226

- Chapter 3: Review of Round 3 Mapping
- Chapter 4: Defining Round 4 Noise Mapping
- Chapter 5: Developing Round-4 Noise Models
- Chapter 6: Noise Level Calculations
- Chapter 7: Results of Round 4 Strategic Noise Mapping
- Chapter 8: Conclusions

Further information is set out in the Appendices at the end of the document

2. Overview of Mapping Process

The main aim of the project was to conduct strategic noise mapping of Malta in accordance with the fourth round of EC Directive 2002/49/EC.

The approach ensured meeting specific requirements:

- Fulfilling the objectives of Article 1(a) of the Directive,
- Ensure compliance with Annex IV of the Directive by meeting the minimum requirements, including strategic noise mapping for data submission to the Commission (Article 10(2) and Annex VI), citizen information (Article 9), and action plan development (Article 8), each necessitating a distinct type of strategic noise map,
- Creating strategic noise maps for local or national use at an assessment height of 4m and using the 5dB ranges of L_{den} and L_{night},
- Developing strategic noise maps for major roads and for road, rail, aircraft, and industrial noise in agglomerations,
- Depicting the situation in the previous calendar year,
- Completing maps for L_{den} and L_{night} indicators, covering all relevant roads, airports, and industrial sites affecting agglomerations and all areas covering designated major roads.

The proposed approach was based on a proven seven-stage process, as outlined in

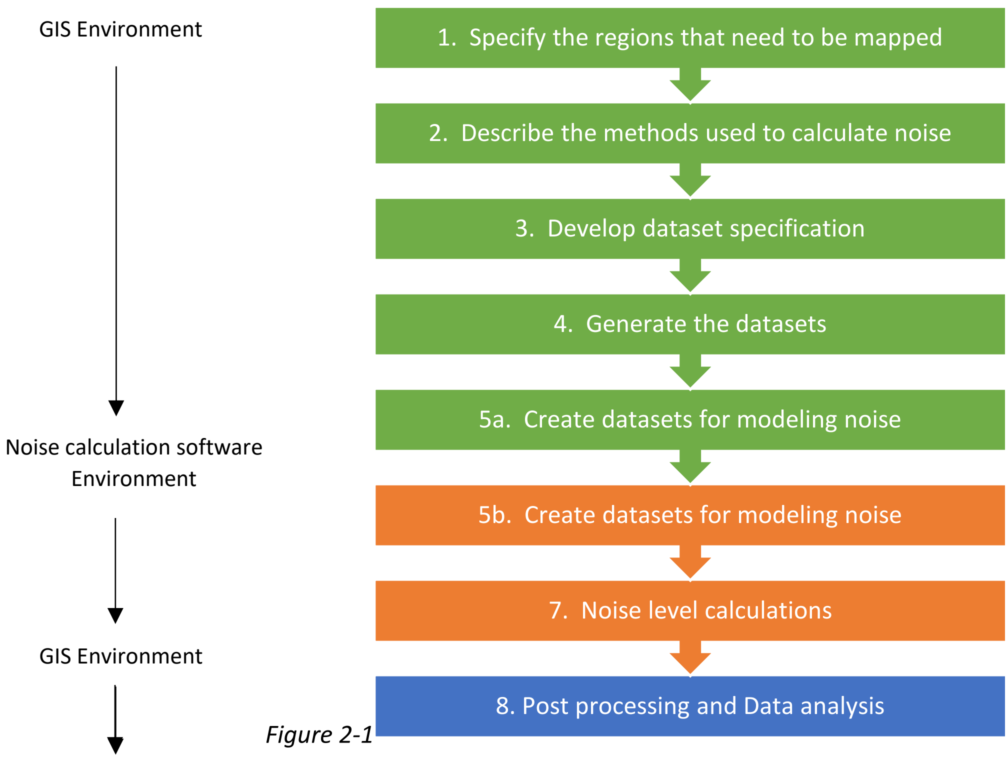

Figure 2-1. Overview of noise mapping process

3. REVIEW OF ROUND 3 MAPPING

In the context of Round 4 Strategic Noise Mapping, the first deliverable required by the Contract was the revision of Round 3 Strategic Noise Mapping.

3.1. Round 3 Strategic Noise Maps

To meet the requirements of the END for Round 3, ERA developed strategic noise maps for major roads (roads with traffic flow above 3 million vehicles per annum) and for road, industry and aircraft noise affecting the agglomeration.

The extent of the L_{den} noise level contour results for major roads are shown in Figure 3-1. The noise contours for agglomeration roads, Figure 3-2, agglomeration industry, Figure 3-3 and agglomeration aircraft, Figure 3-4, are also shown below.

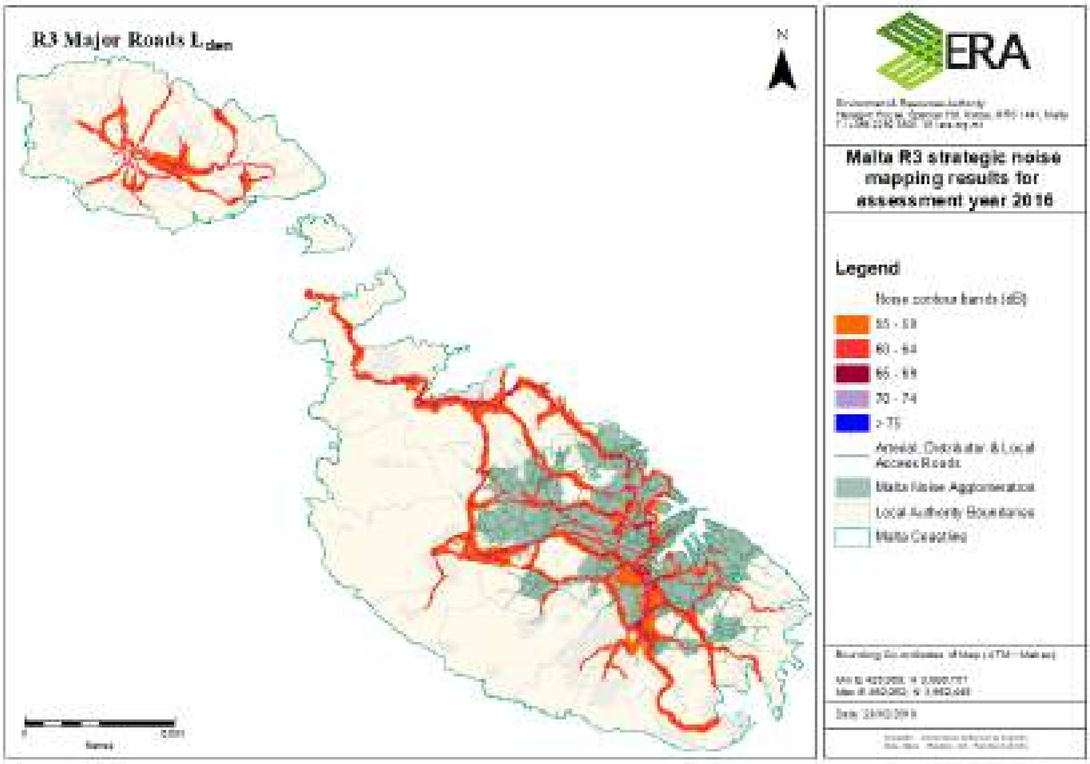

Figure 3-1. R3 major roads noise map – L_{den}

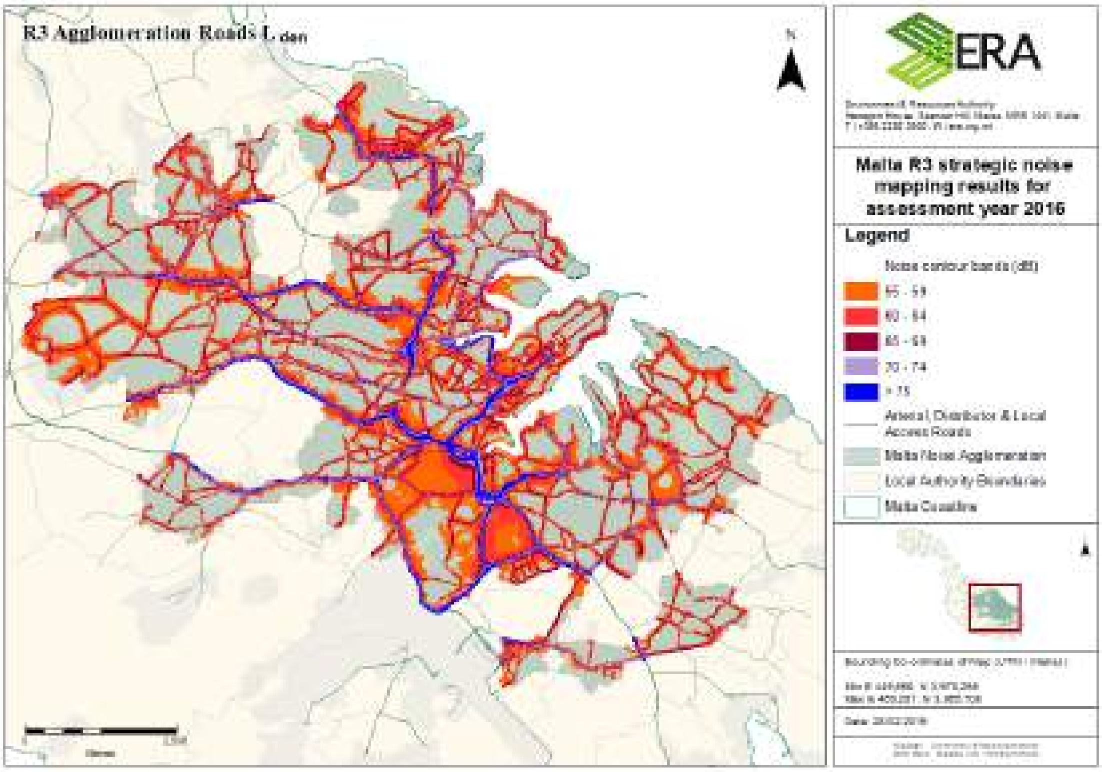

Figure 3-2. R3 agglomeration roads noise map – L_{den}

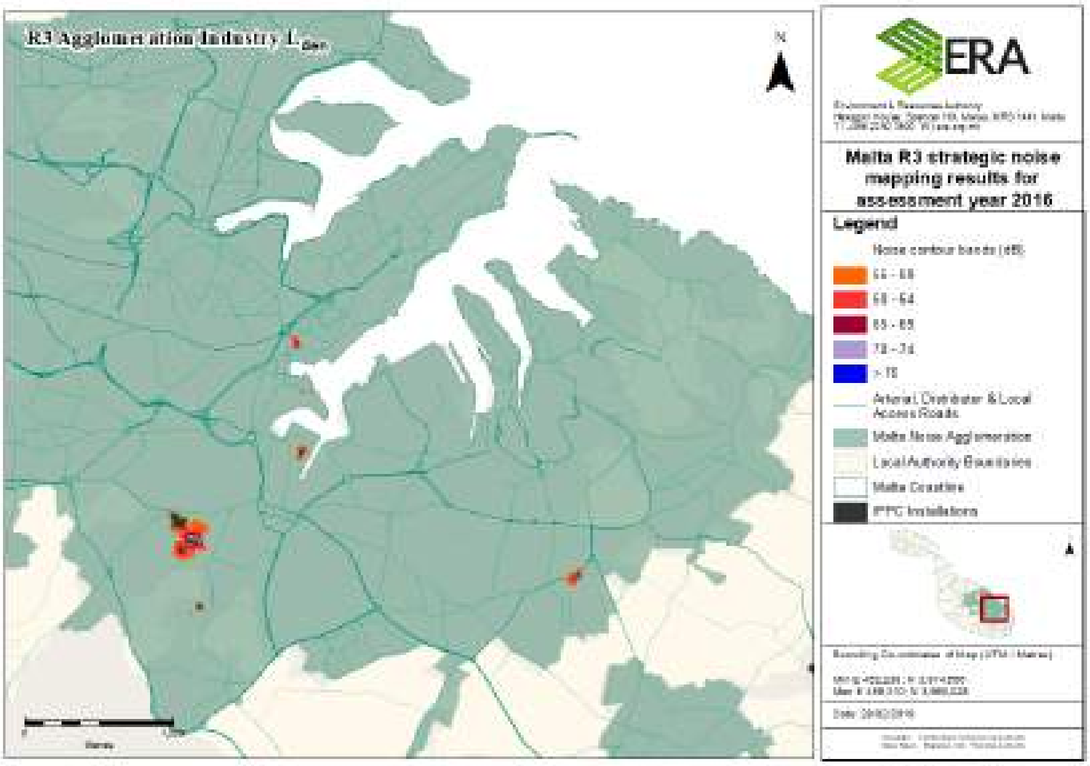

Figure 3-3. R3 agglomeration industry noise map – L_{den}

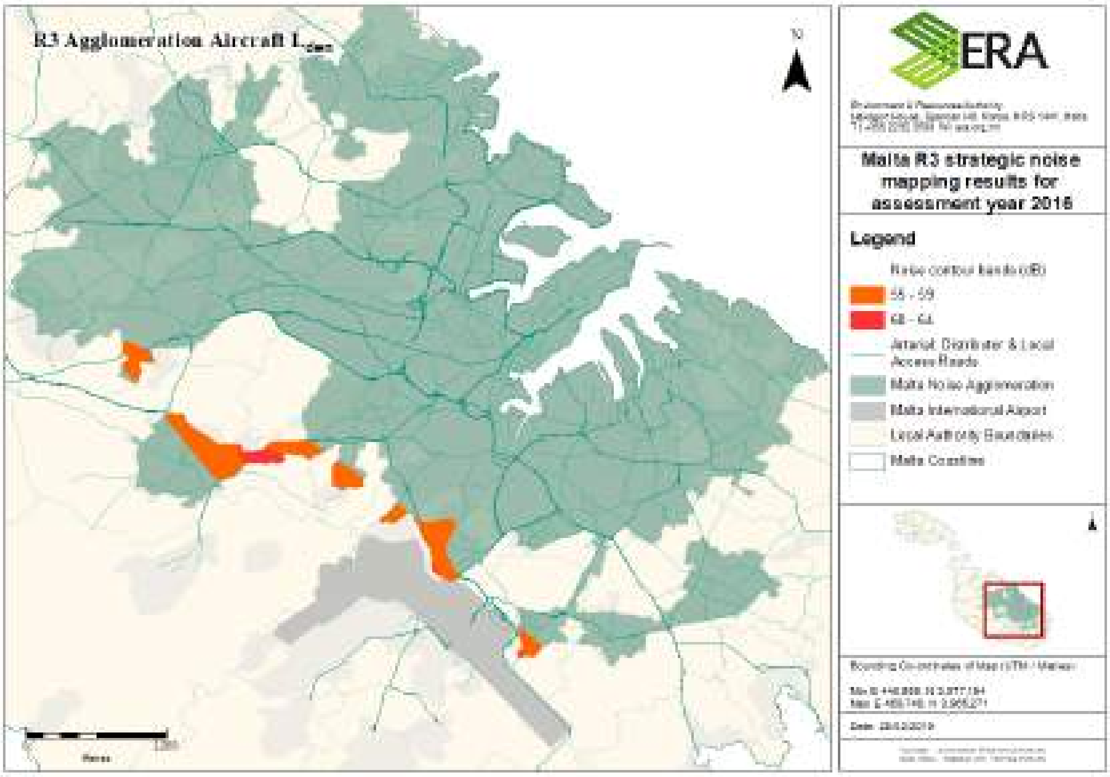

Figure 3-4. R3 agglomeration aircraft noise map – L_{den}

The noise maps were based on a series of datasets supplied by ERA, the Planning Authority (PA), Transport Malta (TM), National Statistics Office (NSO), Malta International Airport (MIA) and Malta Air Traffic Services (MATS), and Water Services Corporation (WSC).

The process of developing the strategic noise maps in Round 3 is set out in the following documents:

- "593-15-2/2 Provision of Consultancy Services for Round 3 Reporting Obligations Including the Strategic Noise Mapping in Malta Under the Directive 2002/49/EC, Contract Ref. No.: ERA_T06/2017, Final Project Report"[4], March 2019;
- "593-14-2/3 Provision of Consultancy Services for Round 3 Reporting Obligations Including the Strategic Noise Mapping in Malta Under the Directive 2002/49/EC, Contract Ref. No.: ERA_T06/2017, Malta International Airport Noise Modelling, Final Report"5, March 2019.

[4] https://era.org.mt/wp-content/uploads/2019/10/593-15-2v2-1_Compile-R3-Noise-Maps-for-Malta-Final-Report.pdf

[5] https://era.org.mt/wp-content/uploads/2019/10/593-14-2v3-1_Malta-International-Airport-R3-Final-Report.pdf

3.2. Requirements for Review of R3 Strategic Noise Mapping

The Regulations introduce an obligation on ERA to review, and revise if necessary, Strategic Noise Maps at least every five years after the date of their preparation[6].

In the subchapters below, the process of creating R3 Strategic Noise Maps is reviewed and summarized.

In the R3 Strategic Noise Map a set of terms and conditions were developed in order to define the areas for which the result of the R2 noise levels could have been published as the R3 noise level results, and the areas for which the noise levels had to be updated in R3.

In Round 4 Strategic Noise Mapping, the calculation methods for each noise source differs from the calculation methods used in Round 3. The new calculations follow the CNOSSOS-EU (Common Noise Assessment Methods in Europe) methodology, which was introduced to standardize noise modelling across all EU member states. This methodology provides a more precise and consistent approach to assessing noise from various sources, including road traffic, railways, aircraft, and industrial activities. By incorporating updated parameters and noise propagation models, CNOSSOS ensures that the results better reflect real-world conditions. Consequently, a revision of the strategic noise maps was necessary for the entire area covered by Round 4 Mapping.

3.3. Definition dataset in R3

Agglomeration Boundary

The Agglomeration Boundary used for R3 Strategic Noise Mapping was the same as in R1 and R2. The R1 Strategic Noise Mapping developed a detailed specification for the agglomeration in Malta, derived from NSO census data, land use and building extents datasets. The agglomeration was designated and reported to the EC under DF5 in 2011, see Figure 3-5.

The total area of R3 agglomeration was 54.1 km^2 and the total R3 population within the agglomeration was 277 600.

Following discussion with the Contracting Authority, it was agreed to revise the agglomeration for round 4 in view of the extent of urban development and changes were implemented in the agglomeration boundary that were used for R4 strategic noise mapping.

The methodology of updating the agglomeration boundary is presented in "*Review of agglomeration boundary*".

The total area of R4 agglomeration is 54.3 km^2 and the total R4 population within the agglomeration is 339 361.

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[6] Directive 2002/49/EC, Article 7 (5)

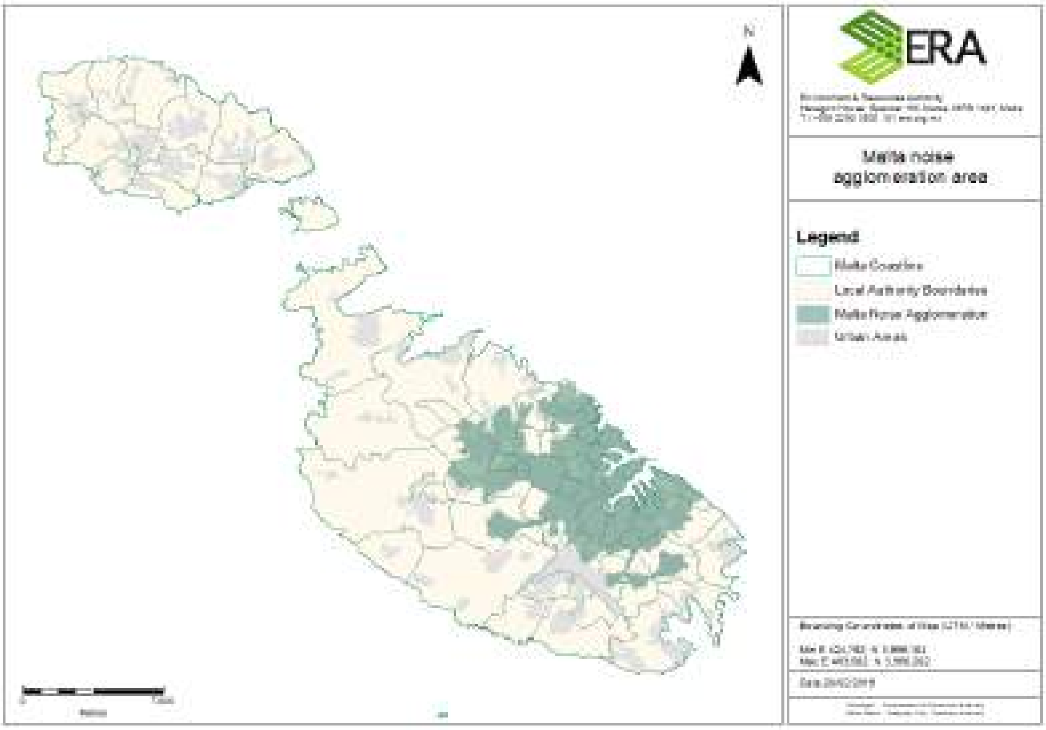


Figure 3-5. R3 agglomeration area

Model Area Boundary

For R3 Strategic Noise Mapping the model area boundary was prepared by:

- buffering by 1 km the agglomeration boundary – for calculation of noise levels in the agglomeration,
- buffering by 1 km the centrelines of major roads inside and outside of the agglomeration – for calculation of noise levels in the vicinity of major roads.

The model area boundary used for R3 Strategic Noise Mapping is presented below.

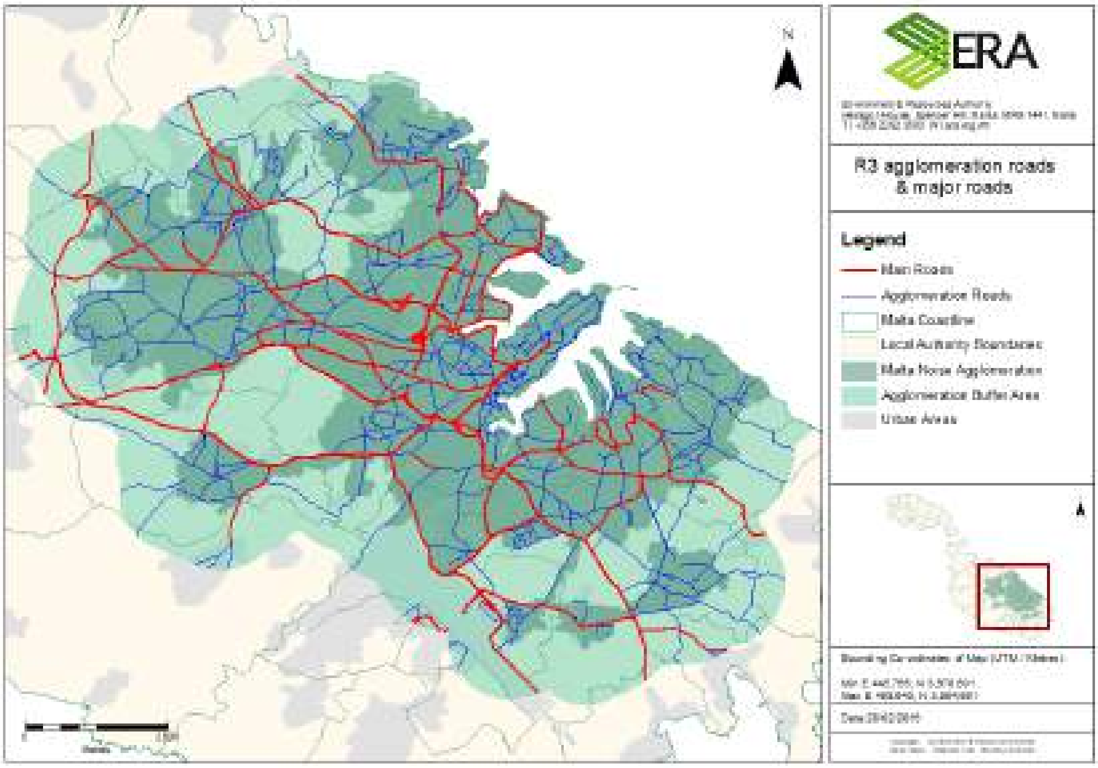


Figure 3-6. Agglomeration buffered by 1km to define model extent

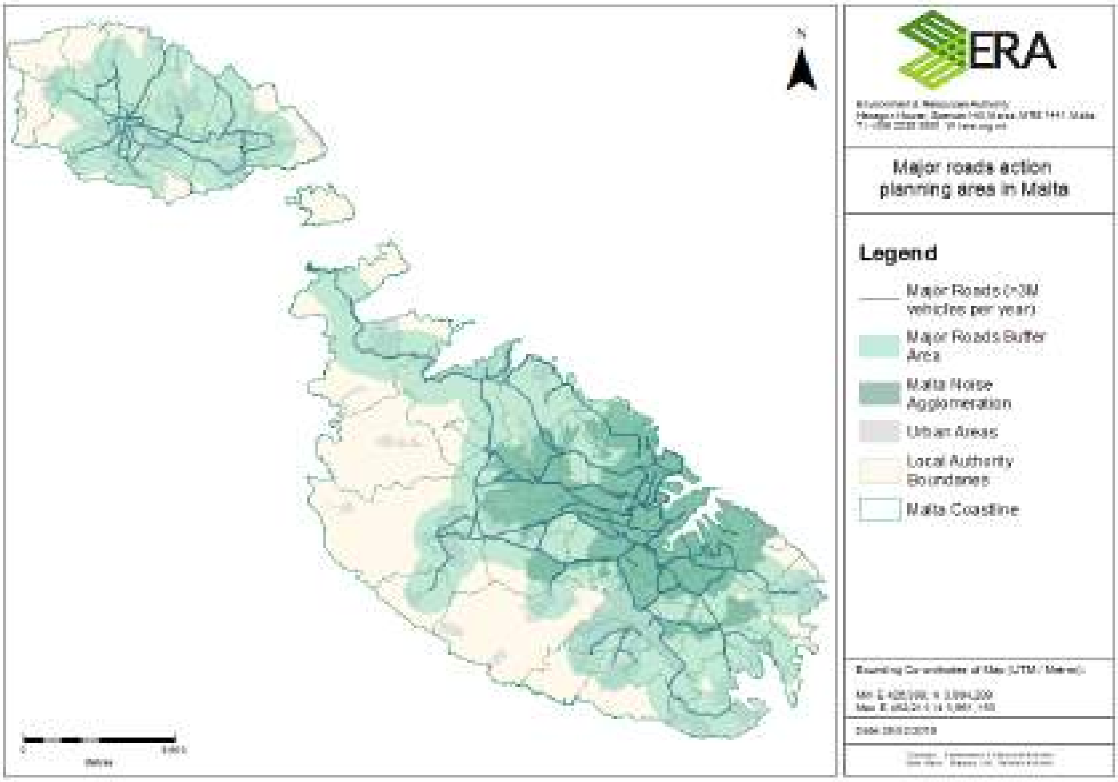


Figure 3-7. Main roads model extent

3.4. Pathway Data

Digital ground model

Digital ground model for R3 Strategic Noise Mapping was prepared based on LiDAR survey data, Basemap datasets and 1 m contours.

The LiDAR survey data contained a digital surface model (DSM) and a digital terrain model (DTM). Figure 3-8 displays a sample of the DTM illustrating ground surface heights, while Figure 3-9 showcases a sample of the DSM highlighting the tops of objects. To generate a raster depicting the relative heights of objects, the DTM raster was subtracted from the DSM raster. Figure 3-10 presents a sample of the resulting relative height raster.

Figure 3-8. Sample of the digital terrain model (DTM)

Figure 3-9. Sample of the digital surface (DSM)

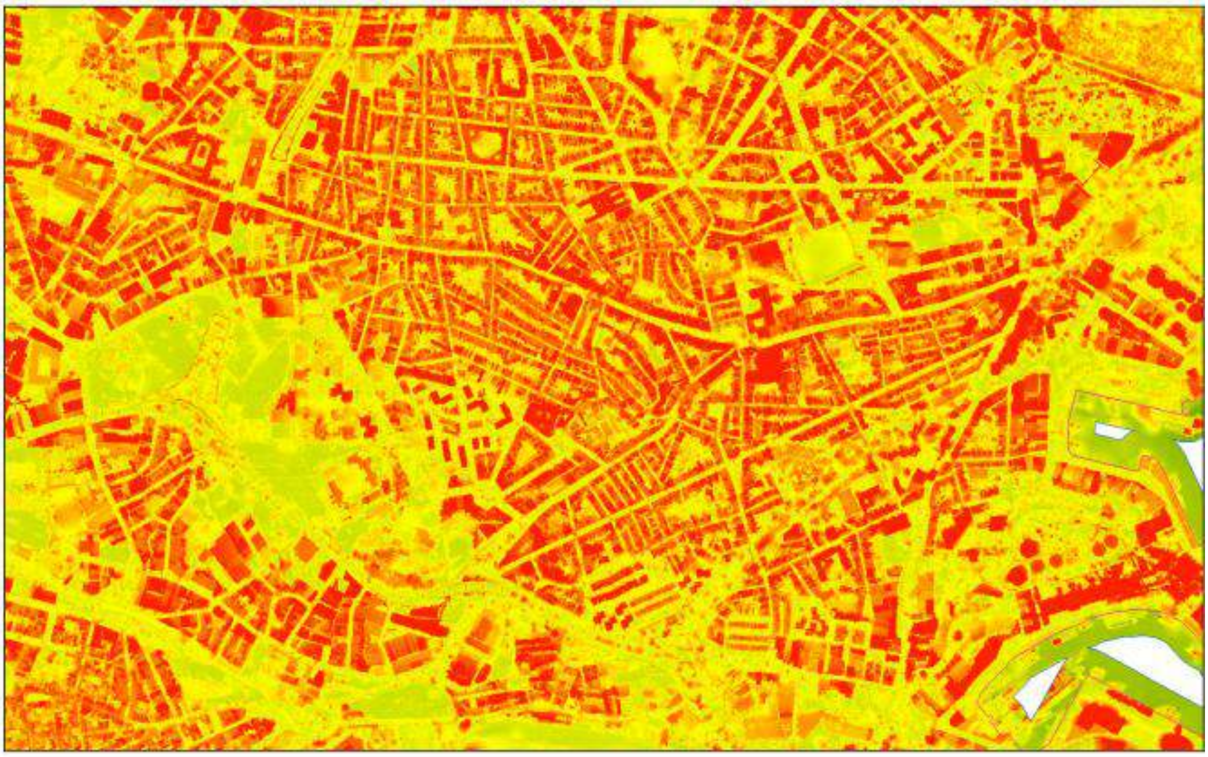


Figure 3-10. Sample of the relative height raster derived from DSM – DTM.

The Basemap datasets contained data on various elements of the landscape and urban furniture. Following elements were extracted from the datasets: normal embankment, foot of embankment, double sided normal embankment, quarry, runway outline, road outline, pavement, tunnel, traffic island, traffic island line, concrete quay, cliffs, cut and 3D height data was assigned to them (based on the DTM).

For some parts of digital terrain model the 1 m contours were used to complete the terrain model.

For the R4 strategic noise mapping, the Contracting Authority supplied a digital terrain model conducted in 2018 along with Basemap Hardcoded - SintegraM 2018 datasets as provided by the Planning Authority (PA). The digital ground model for R4 was updated using this data as outlined in the subsection 5.1 Terrain.

Buildings Dataset

The building dataset for R3 Strategic Noise Mapping was created using BaseMap datasets. The polygons including the following feature codes were extracted:

- B01 hard buildings,
- B02 light buildings,
- B03 public buildings,
- B05 buildings under construction,
- B06 ruins,
- B30 church,

- B91 industrial buildings,
- B92 light industrial structure,
- G03 tank/silo.

The extracted polygons often represented more than one building. In order to split polygons in separate polygons, each representing one building, the polylines layers B07 PROPERTY DIVISIONS and B10 THICK WALL from BaseMap datasets were used. Later, the absolute height based upon the DSM raster and relative height above the ground (based on the DSM – DTM raster) were assigned to each building.

Checks were undertaken to ensure that all residential buildings were more than 4.5 m high. These checks were performed to ensure that the façade receivers would be calculated correctly.

For the R4 strategic noise mapping the Consulting Authority provided Basemap datasets from 2018. Buildings dataset for R4 were prepared using previously mentioned data as described in the subsection 0 Buildings. After the buildings were prepared, 299 831 polygons were identified. Data presenting the population, number of dwellings and heights have been assigned to the buildings. Based on NSRs data and WSC population data from 2021, the following functions were assigned to the buildings:

- Residential buildings,
- School buildings,
- Childcare centres,
- Hospital buildings,
- Elderly care homes,
- Unprotected buildings.

Topography Dataset

Dataset for R3 was prepared based on CORINE 2012 datasets, obtained from EEA EIONET Central Data Respository. For the R4 noise mapping, the most recent datasets available for Malta were utilized. Dataset for R4 was prepared based on the following data:

- CORINE 2018,
- Urban Atlas 2018 (only for the island of Malta),
- OpenStreetMap,
- Sentinel 2 satellite images.

All datasets were downloaded from the EEA EIONET Central Data Repository.

Aerial Imagery

For the R3 noise mapping the following were the basis for checking the R3 model datasets:

- 2012 aerial imagery,
- Google Maps,

- Google Earth,
- Google Street View,
- MS Bing maps.

For the R4 noise mapping the same datasets were used to verify R4 model datasets. In addition, data available from ERA was used, i.e. orthophoto map images from 2018 and the latest satellite images available in Google Earth dated 2021.

Meteorological Dataset

The meteorological dataset used for R3 Strategic Noise Mapping was the same as in R1 and R2.

Dataset was provided by Malta International Airport (MIA). It contained information on long term average data, 30 years from 1961 to 1990, on the average temperature, humidity and wind speed for each month of the year. More data was provided by the back then MEPA relating to the source of information on long-term wind direction.

For the R4 mapping, recent data provided by Met Office for long-term average monthly meteorological conditions for years 1991-2020 were used to prepare meteorological dataset. Required meteorological data was calculated based on the data from 2010 to 2020.

3.5. Aircraft Source Data

In R3 Malta International Airport was not designated as a major airport under the Directive 2002/49/EC as there were fewer than 50 000 movements during 2016 calendar year.

MIA is not located inside the boundary of agglomeration, but it is located within the 1 km buffer, and the flight paths taken by arriving and departing aircraft pass over parts of agglomeration. Because of that, MIA was included within the R3 noise mapping.

For R3 noise mapping R2 model was reused, as the airport infrastructure had not changed. Aircraft movement data for 2016 was used to update the R2 model.

ERA Project report 593-14-2/3 “Malta International Airport Noise Modelling, Final Report” sets out details of the approach to mapping the airport, data acquisition, noise calculations and analysis of results for R3 Strategic Noise Mapping of aircraft noise.

For R4 mapping, a new dataset on aircraft movement was provided by MIA. The provided data covers the timeframe from 1st of January 2021 to 31st of December 2021. This dataset was utilized to revise the Aircraft Source model. The detailed description of proposed approach is outlined in the subsection 0 Aircraft.

3.6. Industry Source Data

The R3 Strategic Noise Mapping of the IPPC licensed sites affecting the agglomeration included 8 industrial facilities. For some of them the noise measurements performed for R2 Strategic Noise Mapping were used, and for others new measurements were undertaken. The industrial facilities included in the R3 mapping exercise together with information on the approach to noise measurements, area and perimeter is presented in the table below.

Table 3-1. IPPC licensed industrial facilities included within R3 mapping.

ID	Name	Round 3 Approach	Area [m^2]	Perimeter [m]
1.	Amino Chemicals Ltd.	New R3 measurements	6985	595
2.	Marsa Power Station	New R3 measurements	74676	1290
3.	Waste Oils Co. Ltd.	Re-use R2 measurements	3635	280
4.	Edible Oil Refining Co. Ltd	Re-use R2 measurements	13210	471
5.	Metalco Ltd	New R3 measurements	7783	593
6.	Sant Antnin Waste Treatment Plant	New R3 measurements	47540	1069
7.	Crystal Pharma Ltd (Solea Pharma)	Re-use R2 measurements	2720	215
8.	Thermal Treatment Facility	Re-use R2 measurements	1545	191

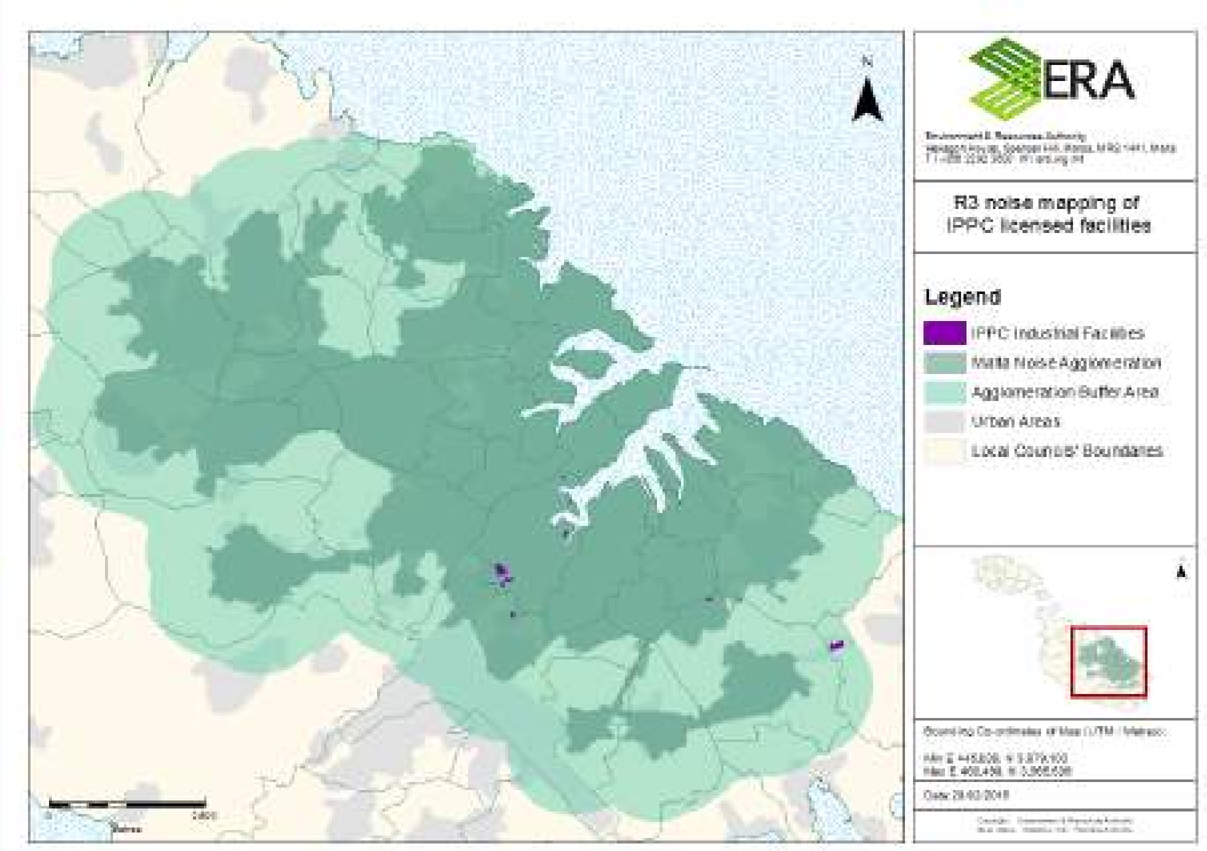


Figure 3-11 IPPC licensed industrial facilities included within R3 mapping.

The approach to on-site noise level measurements for R3 was consistent with approach for R2 measurements. The measurements surveys and analysis were undertaken in line with ISO 8297, which resulted in an equivalent octave band sound power emission level for each IPPC licensed process area.

In preparation for the R4 noise mapping, the data on the IPPC licensed industrial facilities supplied by the Contracting Authority underwent analysis to determine which facilities should be included in R4 strategic noise mapping. Additionally for sites where modifications in operations or new significant noise sources were identified since Round 3 noise mapping, new noise measurements were recommended.

Following the analysis of the data provided, a meeting with Contracting Authority was held in order to confirm the proposed approach.

The final approach to the R4 strategic noise mapping of IPPC licensed industrial facilities is outlined in Table 3-2.

Table 3-2. IPPC licensed industrial facilities included within R4 mapping

ID	Name	Round 4 Approach	Area [m^2]	Perimeter [m]
1.	Waste Oils Company LTD	New R4 measurements	3897	273
2.	Marsa Power Station	Re-use R3 measurements	74933	1288
3.	Wasteserv Thermal Treatment Facility	New R4 measurements	10416	737
4.	Amino Chemicals	New R4 measurements	8667	678
5.	DDE Attard Limited	New R4 measurements	9064	455
6.	Metalco	New R4 measurements	7586	599
7.	Sant' Antnin Waste treatment Plant	New R4 measurements	47336	1089

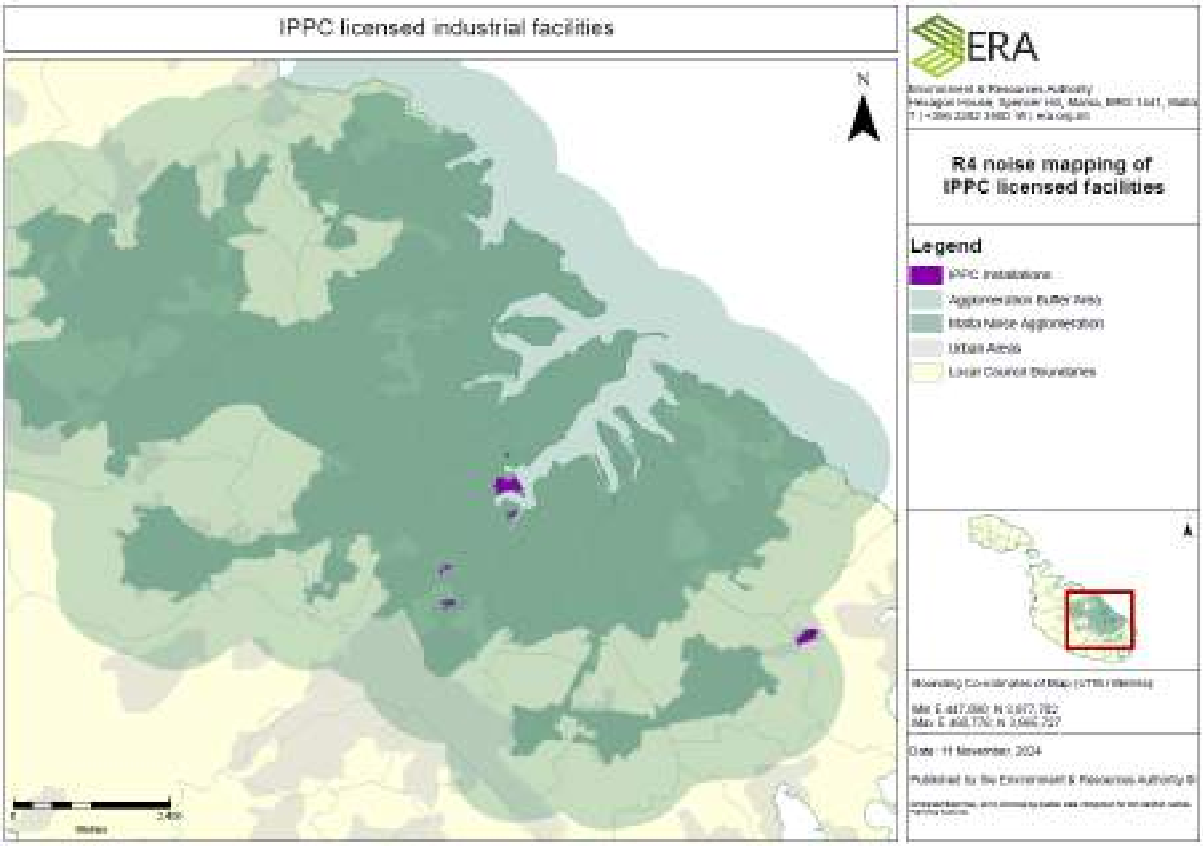


Figure 3-12 IPPC licensed industrial facilities included within R4 mapping.

Consistent with the R3 approach, on-site noise level measurements were proposed to be undertaken for 6 sites, in line with ISO 8297, in order to determine the noise level emission from the sites ahead of the R4 noise mapping calculations.

3.7. Road Traffic Source Data

Road traffic source datasets used for R1 and R2 Strategic Noise Mapping, were developed by the Consultants based on the data provided by Transport Malta and MEPA.

A new transport model for Malta was developed by Transport Malta and this was used as a new R3 road traffic source dataset.

Transport model dataset was also supplemented by road traffic count data, that was collected by the Consultants developing R3 Strategic Noise Mapping, while working on other projects. For areas in which new roads were constructed the transport model dataset was updated and the traffic flow assigned to the dataset was revised too.

The following approach was used to identify major roads sections:

1. From transport model dataset the following classes sections were selected:

- International road - TEN-T classified Arterial Roads
- National roads, - Arterial Roads which have not been classified as TEN-T roads; and
- Regional roads - Distributor Roads (including rural and urban roads with linking function from Local Access Roads)

2. The road section within those classes with annual traffic flow of greater than 3 million vehicles were designated as “major roads”.

The following approach was used to identify agglomeration roads sections:

3. From transport model dataset the following road sections were selected inside the agglomeration boundary and 1 km buffer around it:
    - TEN-T classified Arterial Roads,
    - Arterial Roads which have not been classified as TEN-T roads,
    - Distributor Roads,
    - Local Access Roads with linking functions.
4. All road sections in these classes within the agglomeration model area were included within the mapping of agglomeration roads.

For R4 mapping, data was updated using the revised National Transport Model provided by Transport Malta and was used as road traffic source dataset. The National Transport Model is modelled on the National Household Travel Survey (NHTS) which was carried out in 2021.

Road centrelines

For R3 noise modelling the road centrelines dataset were based on the Transport Malta GIS road centrelines.

For R4 noise modelling road centrelines dataset were based on the road centrelines provided by Transport Malta.

Road and traffic flow data

For R3 noise mapping road traffic flow dataset was developed by Consultants in consultation with TM.

Road traffic flow dataset for R4 noise mapping was developed by Consultants in collaboration with TM and the Contracting Authority. The preparation of the noise modeling dataset included various key attributes and methodologies. The road layer incorporated geometry information, such as road width, which was assigned based on road category and lane count. The road surface type was verified using orthophoto maps to identify significant changes, particularly from an acoustic perspective. Traffic data were collected, including traffic flow and mean speed for different time periods (day, evening, night), calculated according to the CNOSSOS-EU methodology. Vehicle classification followed the new categories established by the EU Directive 2015/996, allowing for accurate noise emission estimates from different vehicle types. Additionally, separate layers for roundabouts and traffic light junctions were created and processed to include the required attributes for noise calculation, ensuring a comprehensive approach to modelling noise in the agglomeration area and along Major Roads. More information can be found in subchapter 5.1.

3.8. Dwellings and People in Dwellings Data

For R3 the water meter dataset provided by Water Services Corporation (WSC) was used for dwelling and people in dwelling exposure assessment. Dataset contains information on location of inhabited dwellings and the number of people in dwellings (one point per one water meter).

The points within building polygons were spatially linked to the buildings, resulting in each building being allocated a number of dwellings and residents based on the WSC data. This process also facilitated the categorization of buildings as either residential or non-residential, a capability that was unavailable during the R1 and R2 noise mapping exercises.

For the R4 noise mapping round, data from the WSC and 2021 Census data provided by NSO were used. Building layers were subsequently generated and classified into residential, unprotected buildings such as non-residential, and special buildings based on NSR data provided by ERA. Population figures align with the census data, totalling 519,562 inhabitants overall, with 339,361 inhabitants residing within the agglomeration. The population distribution was carried out using both the WSC layer and NSO data. The number of people within the NSO grids was identified by maintaining the WSC data distribution while applying the NSO numbers. The allocation of number of dwellings per buildings was determined using the WSC point layer.

3.9. Summary of Review

The review of Round 3 Strategic Noise Maps including the possible revision of the delineation of the agglomeration boundary is a deliverable of the contract "Provision of Consultancy Services for Round 4 Reporting Obligations Including the Strategic Noise Mapping in Malta Under the Directive 2022/49/EC" (Ref: SPD8/2022/011).

In this document the approach used in R3 Strategic Noise Mapping relating to the preparation of datasets was analysed and summarized.

Based on the review of datasets developed within the framework of the R3 strategic noise mapping process, it was concluded that the following datasets require revision to be utilized in the R4 strategic noise mapping:

- Agglomeration boundary,
- Model areas,
- Digital ground model,
- Digital terrain model,
- Buildings datasets,
- Meteorological dataset,
- Population data
- Road dataset (road traffic network, traffic flow data, road surfaces and classification of vehicle types in accordance with CNOSSOS),
- Industry source noise emission (industrial sites monitoring),
- Airport and aircraft movement data.

In Round 4 Strategic Noise Mapping, the calculation methods for each noise source differ from those used in Round 3. Consequently, a revision of the strategic noise maps was necessary for the entire area covered by Round 4 Mapping. The datasets containing input data for noise modelling were developed in accordance with the CNOSSOS-EU methodology.

4. DEFINING ROUND 4 NOISE MAPPING

Following the seven-stage process depicted in

Figure 2-1, the strategic noise mapping for R4 is presented below.

4.1. Step 1 – Define areas to be mapped

Agglomeration

The strategic noise mapping for R1 involved creating a comprehensive specification for the Malta agglomeration. This specification was derived NSO census data, datasets outlining land use, and building extents. The decision was made to retain the same agglomeration definition for both R2 and R3, facilitating a meaningful level of comparison.

In this round (R4), in order to revise and update the definition of the agglomeration area, the following data was taken into consideration:

- Urban Atlas dataset (provided by the Copernicus Land Monitoring Service), includes layers depicting various urban cover types, such as continuous urban fabric, discontinuous dense urban fabric, discontinuous medium density urban fabric, discontinuous low density urban fabric, discontinuous very low density urban fabric, construction sites, industrial, commercial, public, military, and private units, other roads and associated land, port areas, green urban areas, and sports and leisure facilities;
- Population density, a heat map was generated based on a point layer from the Water Services Corporation serving as an indicator representing population concentration;
- Building Layer, including the aforementioned data, highlighting areas where new buildings have been constructed and indicating the expansion of urban agglomerations.

The total area of the R4 agglomeration is 54.33 km^2 whilst the total R4 population within agglomeration is 339,361 compared with 54.1 km^2 and population of 277,600 during R3.

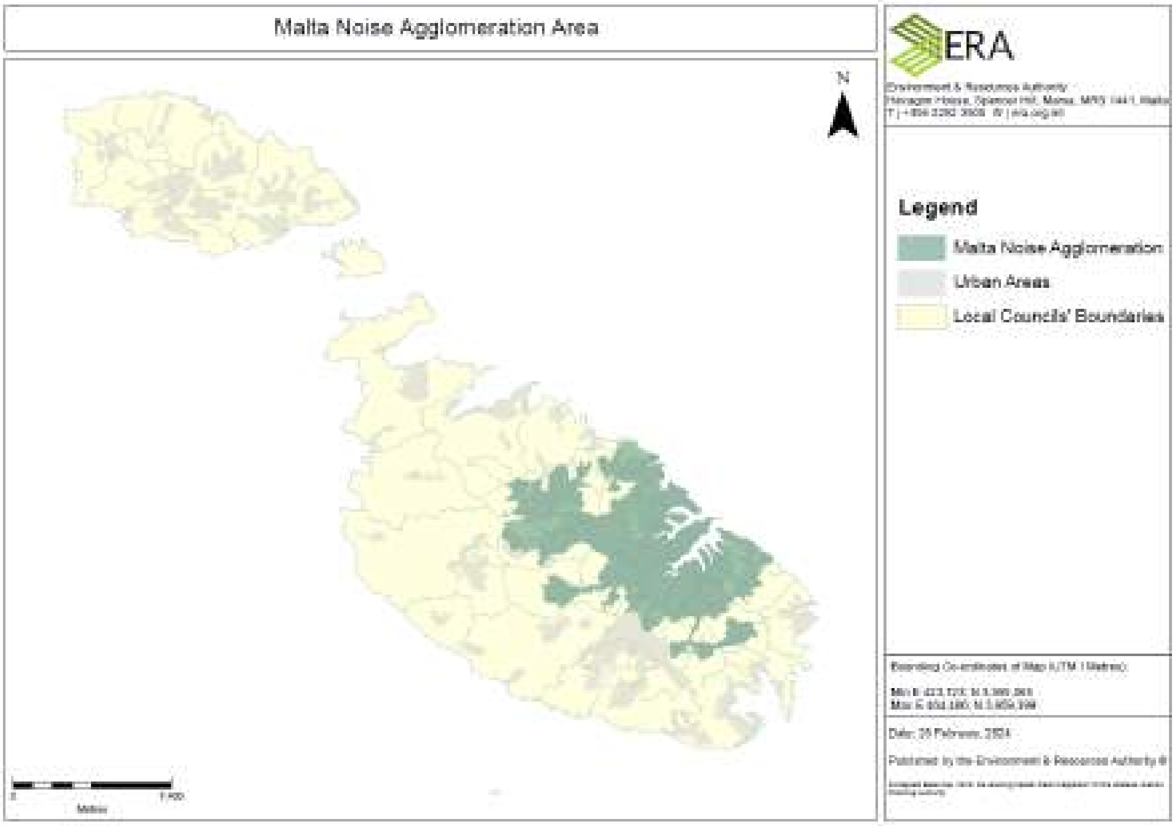


Figure 4-1 The boundaries of the agglomeration covered by the scope of the 4th round of noise mapping

Strategic noise mapping within the agglomeration considered the impact of specific sources, including:

- aircraft in flight arriving and departing from MIA, traversing the agglomeration,
- industrial sites under IPPC and selected Environmental Permit Licenses influencing the agglomeration,
- relevant roads within the agglomeration and major roads with over 3 million vehicles annually affecting the agglomeration.

To ensure accuracy in calculating noise levels at the periphery of the agglomeration, noise sources and barriers from outside the area were considered. As a result, a 1 km buffer was applied to define the modelling area for agglomeration mapping.

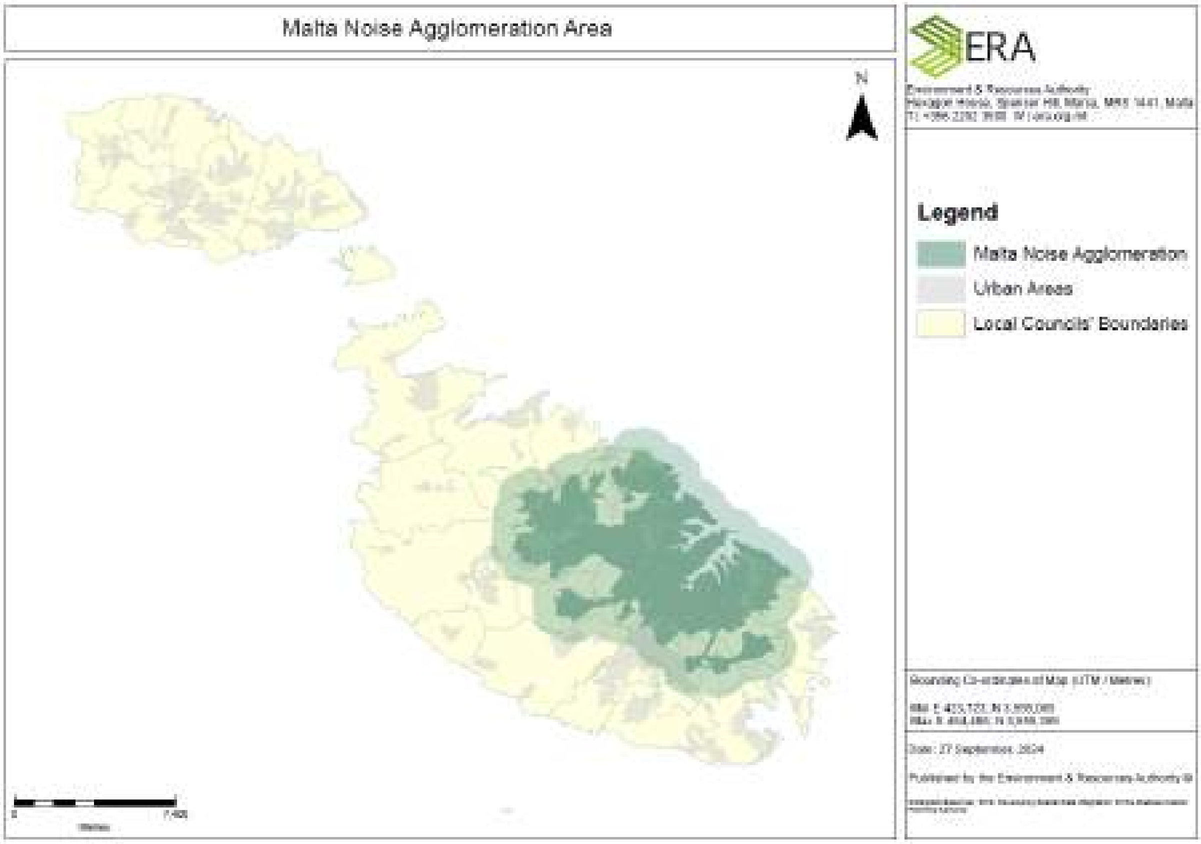


Figure 4-2 Agglomeration area with a 1 km buffer

Major roads

The detailed inventory of the national road traffic network and traffic flow served as the initial reference for identifying roads requiring noise level calculations. Sections with a traffic volume exceeding 3,000,000 vehicles per year were prioritized, as mandated by legislation. Additionally, to maintain the continuity of the main road network, certain roads falling below the 3,000,000 threshold (such as connecting roads like roundabouts or links between main roads) were also included. This approach aligns with the methodology employed in previous mapping rounds.

To ensure comprehensive coverage of areas exposed to noise from major roads, the centrelines of these roads were buffered by 1 km to delineate the extent of the model. The total length of R4 major roads is approx. 355 km, compared with approx. 293 km mapped as R3 major roads.

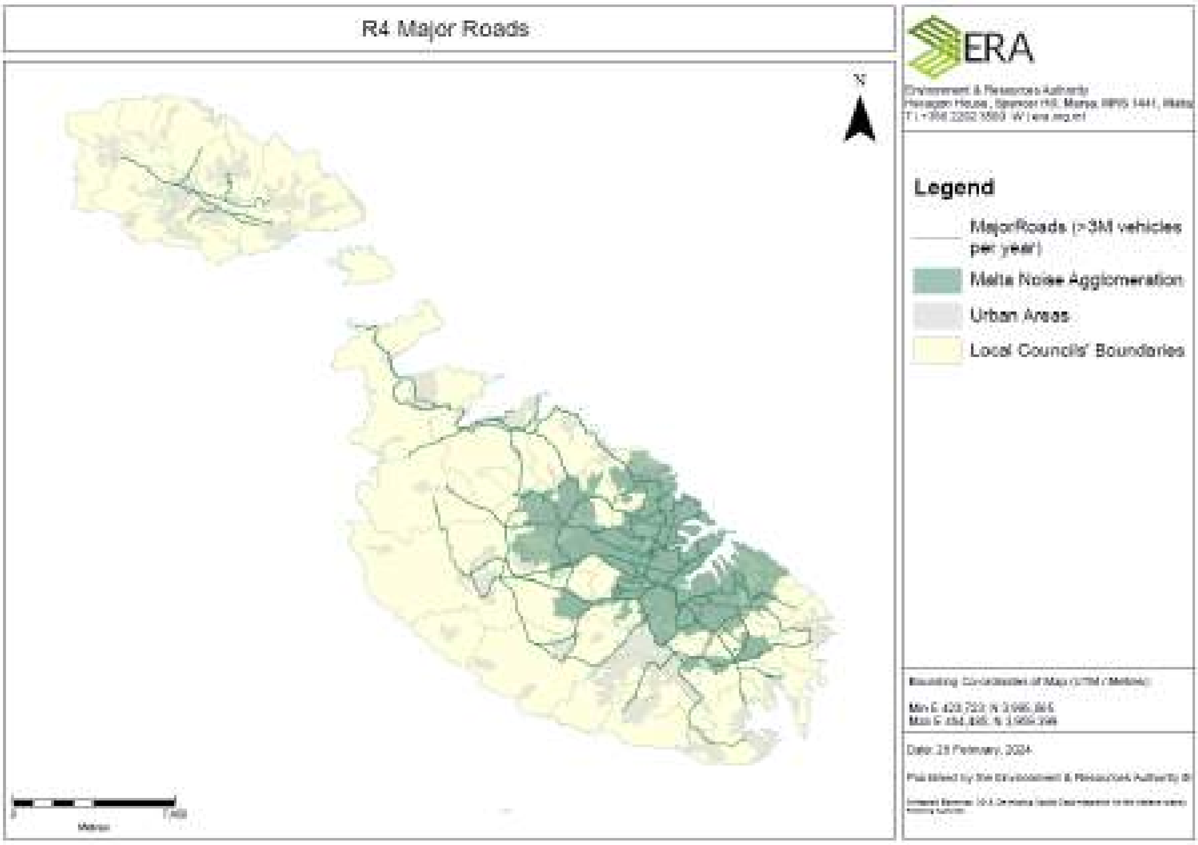


Figure 4-3 The network of major roads covered by the 4th round of noise mapping

4.2. Step 2 – Define noise calculation methods

The calculations were performed using SoundPLAN 8.2 noise modelling software in accordance with the Regulations described in EU 2015/996 Directive and Delegated Directive 2021/1226. The values of L_{den} and L_{night} were determined by computation, according to the CNOSSOS-EU method. The Contracting Authority uses LimA noise modelling software, therefore the Contractor will provide the Contracting Authority with data which is compatible with the reproduction of models in LimA, and will provide assistance in this regard.

More detailed information about the calculations is presented in Chapter 6 .

4.3. Step 3 – Develop dataset specification

During the R1 strategic noise mapping project, a data schema specification was developed for the model layers pertaining to the strategic mapping of major roads. The existing data schema specification underwent review, and where necessary, model elements were revised or added to encompass all relevant components of the R4 mapping.

5. DEVELOPING ROUND 4 NOISE MODELS

In continuation of the definitions outlined in Chapter 4, the subsequent steps, Steps 4 and 5, were initiated to generate the datasets and formulate the noise model datasets. Referring back to Chapter 3, the R4 model datasets were derived from the initial datasets utilized for the R3 mapping. These original R3 datasets underwent revisions and updates, as elaborated in Chapter 3, to yield the final R4 model datasets. The following section delves into the details of any distinct new datasets or substantially modified datasets pertinent to the R4 mapping procedure.

5.1. Step 4 – Produce datasets

Terrain

The Contracting Authority provided the following data:

- Digital terrain model (raster layers),
- Digital surface model (raster layers),
- Contour lines, interval 2.5 m (vector layer),
- Contour lines, interval 10 m (vector layer).

Part of the dataset provided by the Contracting Authority – digital terrain model (DTM) – was used as input for 3D terrain model preparation. The DTM, completed in 2018 (with no more recent data available), comprises 421 tiles saved in geotiff format. Covering the entire territory of Malta, the DTM is highly accurate, with a spatial resolution of 0.15 meters. As a result, contour layers were omitted from the preparation of the 3D model, as the precision of the DTM was deemed sufficient and contour lines did not contribute to improving the 3D model.

Due to the large size of the DTM data, some filters were applied during data import to noise calculation software (maximum distance between points, maximum difference between height of points). It was helpful to clean the digital terrain model of redundant information, without losing quality.

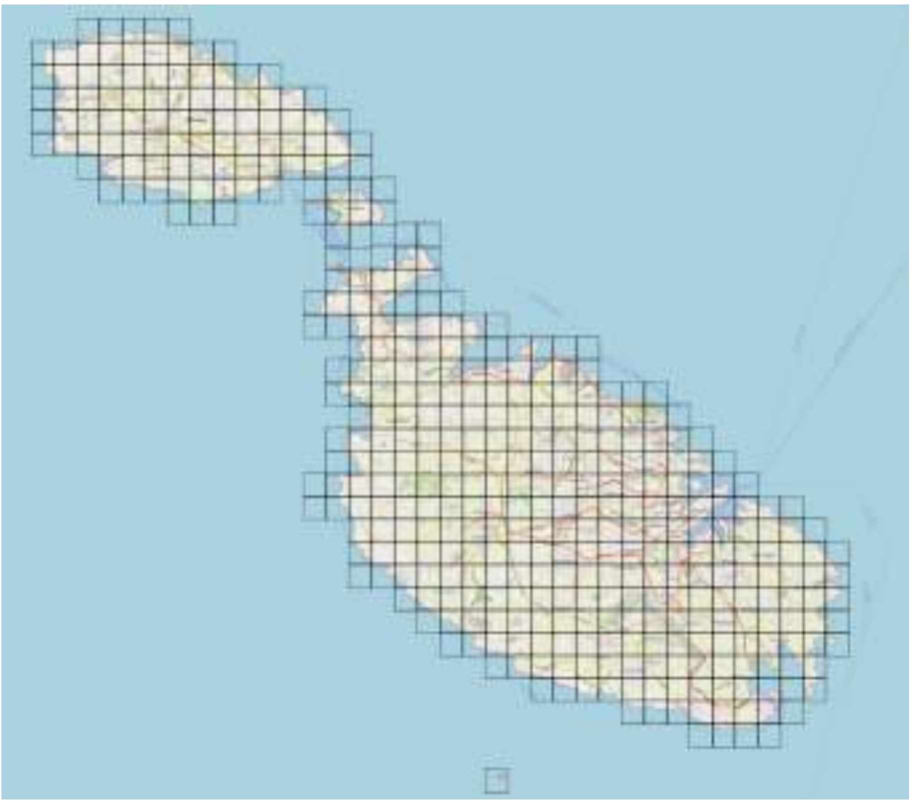


Figure 5-1. Overview of the Digital Terrain tiles

Barriers and walls

Besides the DTM, the 3D model was prepared using lines and objects from the Base Map (the barrier objects) and data provided by the Contracting Authority. The relevant Base Map layers were clipped within 15 m of the road centrelines, and this only applied to those roads that were considered for calculations. The BaseMap themes that served as the foundation for the walls dataset were:

- FEATCO B09 THICK_RUBBLE_WALL
- FEATCO B10 THICK_WALL
- FEATCO B11 THIN__BOUNDARY_WALL
- FEATCO B12 RUBBLE_WALL
- FEATCO B13 RETAINING_WALL
- FEATCO B41 LOW WALL

Similarly, a 50 m buffer zone was determined for industrial sites. This step helped to narrow down the number of items that had a real impact on the results of the calculations.

The barrier objects needed to be converted to three-dimensional before being imported into the noise software. To develop relative object heights, original object attributes were used, and StreetView was utilized to verify these heights for greater accuracy. The process of assigning height values was carefully checked to prevent any mismatches.

Flyovers, bridges, and other engineering structures

It is important that engineering structures that affect noise propagation, are included in the 3D model. The database of roads, provided by the Contracting Authority, was used as the input layer. Additionally, the Contractor inspected and verified data of newly constructed roads (not yet added into the Base Map), as provided by Infrastructure Malta (IM) and included them in the road network. The updated road network was associated with new data from the traffic dataset received from TM for R4 noise mapping of agglomeration roads and major roads.

The final roads layer was filtered to select objects that were located above the ground level and were within a buffer of 15 m from the analyzed road sections. An attribute was added to the selected sections of bridges/obstacles to determine their width, so that the 3D modelling of the structure in the acoustic model could be done. The *'Z'* information was extracted from the land cover model.

Buildings

The buildings layer was created based on Base Map dataset.

To develop a comprehensive layer to import into the calculation program, several steps were planned, including:

- Verification for 2021:
  - Using freely available data (Google Earth), a check was made to identify any new constructions or demolitions. New buildings were manually digitized by the Contractor, while demolished buildings were removed from the layer.
- Geometry:
  - Initially, buildings were aggregated groups of objects with uniform height. To isolate individual buildings, a subdivision was performed using the Base Map linear layer.
- Number of occupants and dwellings:
  - Information on the population of buildings was necessary for the Strategic noise map. This was accomplished using GIS tools based on a point layer provided by the Water Services Corporation. Each point represented one unit, with the number of points within the building's contour indicating the number of dwelling units. The total number of occupants was derived from the sum of points within the building outline. Verification of the population assignment was conducted to ensure consistency with data from the 2021 Population and Housing Census provided by the National Statistics Office (NSO). Any discrepancies were resolved through consultation with the Contracting Authority to determine the final information on the number of occupants and dwellings.
- Attributes:
  - Buildings were categorized based on function, including residential, schools, hospitals, nursing homes, and other sensitive receptor buildings. Data on the

location of schools, hospitals, and nursing homes were assigned based on information provided by the Contracting Authority. Buildings with assigned inhabitants were classified as residential, while others were categorized as unprotected.

Other attributes that were added to the building layer: height (Base Map), number of floors (height divided by the statistical value of floors).

Ground cover

Ground cover information was taken from the Base Map – Ground Surface Cover layer. Types of cover were converted into an acoustic absorption coefficient attribute ranging between 0 and 1.

Where necessary, publicly available data from the Copernicus Land Monitoring Service was used as additional information.

Roads

5.1.1.1. Spatial data

The database of roads (National Transport Model), provided by Transport Malta, was used as the input layer. Additionally, the Contractor inspected and verified data of newly constructed roads (not yet added into the Base Map), and included them in the road network. The updated road network was associated with new data from the traffic dataset received from TM for R4 noise mapping of agglomeration roads and major roads.

Before being imported into the calculation software, the roads layer was edited. As a significant source of noise emissions, the roads layer needed to be accurately mapped to represent the actual location on the ground. The spatial projection of the road was positioned in the axis of the road or its individual lane (in the case of roads with two or more carriageways). Therefore, the mapped road sections were checked for their position in the field (roadway axis on the orthophotos).

An important attribute, related to the geometry of the road/roadway, was the width. It was added according to the road category and the number of lanes. This process was verified for significant errors.

Information about the location of the road was added to the road layer: whether it was on the ground surface, above the ground (overpasses, bridges, flyovers), or below the ground surface (tunnel). Objects that were not on the ground were selected for a special modelling process to ensure that the noise propagation at these locations was correctly mapped.

5.1.1.2. Traffic data

The necessary attributes for input datasets for road noise calculation, in accordance with the CNOSSOS-EU calculation method, are described in following subheadings.

- **Traffic flow and mean traffic speed for day, evening, and night periods**

EU 2015/996 Directive introduced new classification of vehicles. Vehicles are grouped into five separate categories. Groups were determined based on the characteristic of noise emission of vehicles. The road traffic noise source is determined by combining the noise emissions of each individual vehicle forming traffic flow. In the Table 5-1 the vehicle classes with additional descriptions are presented.

Table 5-1. Vehicle classes[7]

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

The road network data was provided by TM. To ensure compliance with the CNOSSOS methodology, appropriate calculations were performed. In the first step, annual average values for light vehicles, heavy vehicles, and school buses were determined based on the received data. The process of determining annual average daily traffic required the use of the AM peak hour layer and applying coefficients provided in the "Base Year Model & Forecasting Report" by TM. In the next step, the annual average traffic intensity values for vehicles categorized as light, heavy, and school buses were used to calculate traffic flow divided into CNOSSOS vehicle categories, following the methodology outlined in the "TM to ERA Model Reconciliation Methodology" prepared by TM.

[7] Source: EU Directive 2015/996 establishing common noise assessment methods according to Directive 2002/49/EC of the European Parliament and of the Council

- **Road surface type**

This attribute was assigned to the input dataset using the following approach. Firstly, a default assignment of the CNOSSOS-EU reference road surface was conducted for all road sections included in the R4 maps. The choice of the reference road surface was determined by its good accuracy in representing most real-world road situations. Secondly, verification of the road surface was performed using orthophoto maps to identify significant changes in the surface, particularly from an acoustic standpoint. As a result of this verification, road sections with cobblestone surfaces were identified, and the surface type was updated accordingly.

- **Roundabouts and junctions with traffic lights**

The Contractor prepared two additional layers that were imported to calculation software:

- Roundabouts layer,
- Junction with traffic lights layer.

The traffic lights layer as provided by TM was delivered to the Contractor by the Contracting Authority. This layer was processed in GIS software in order to:

- Eliminate the traffic lights located outside of areas defined for mapping,
- Eliminate the traffic lights located at the roads in agglomeration that were not included in calculations,
- Assign the attributes required by calculation software as input data for junction object type.

The roundabouts layer was not available, so the Contractor created this layer based on available open-source data (i.e. Open Street Map). Attributes required by the calculation software as input data for the roundabout object type were assigned to each object.

Industrial sites

The Contracting Authority provided the following data:

- IPPC permit sites layer,
- Environmental permit sites layer,
- IPPC noise survey reports,
- R2 and R3 noise measurement layers.

Preparation of input dataset for Industrial noise sources was divided into the following stages:

- Identification of IPPC sites within the agglomeration boundary and buffer.
- Review of the list of IPPC sites included in R3.
- Determination of Industrial Sites to be included in R4 Strategic Noise Mapping as highlighted in table 3-2.
- Determination of the Industrial Sites for which the noise measurements had to be undertaken.
- Measurements of noise from sites of industrial activity affecting the agglomeration.

In the subchapters below (5.1.1.3 and 5.1.1.4) information on the Industrial Input Dataset Specification is given.

Measurement of noise from sites of industrial activity affecting the agglomeration was Deliverable 3 of the Contract. The following steps were considered in the process of developing the Deliverable 3:

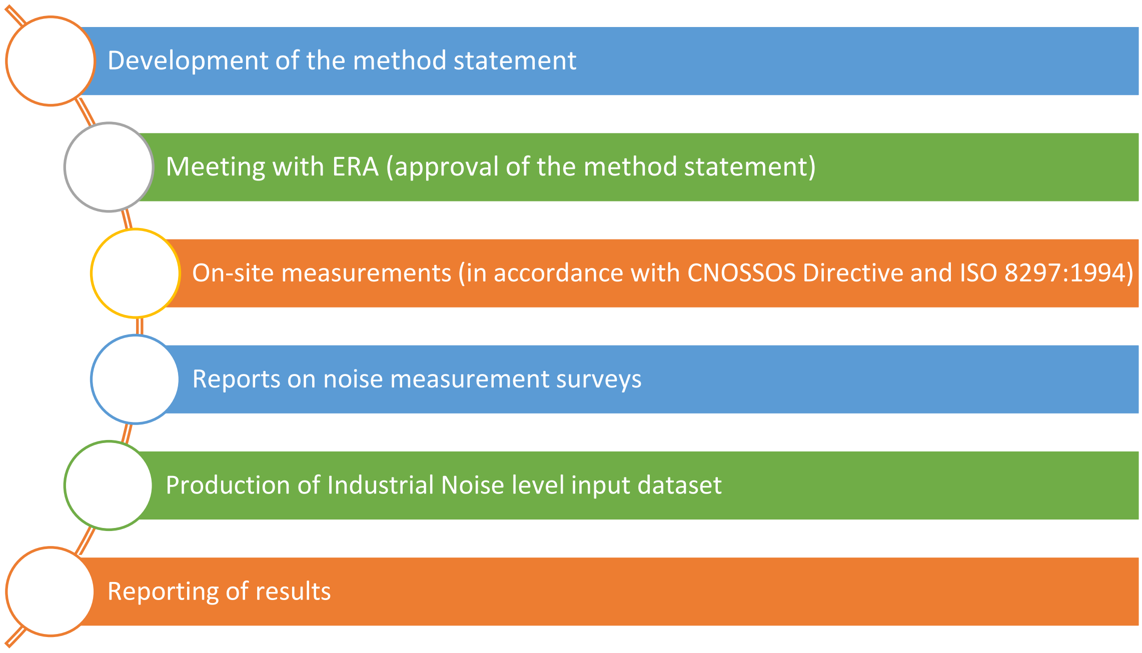


Figure 5-2. Process of developing the Deliverable 3

5.1.1.3. Spatial data

The following spatial data was prepared for Industrial Sites that were included in R4 Strategic Noise Mapping:

- Perimeter of the Industrial Site,
- Noise source groups for the Industrial Sites in which the noise sources were grouped in specific areas,
- Measurement areas for the Industrial Sites for which the noise measurements were required.

5.1.1.4. Sound power data

To each polygon representing an Industrial Site or the group of noise sources at the Industrial Sites the octave band sound power level emissions per m^2 were assigned. Also, the attribute describing the operation time of each Industrial Site was included in the Industrial Input Dataset.

Aircraft

Malta International Airport (MIA) is not designated as a major airport under the Directive as there were fewer than 50,000 movements during 2021. The airport is located outside the boundary of the agglomeration, within the 1 km buffer, and the flight paths taken by arriving and departing aircraft pass over parts of the agglomeration. For this reason, the airport was included within the R4 noise mapping, in order to determine whether the aircraft movements produced noise exposure inside the agglomeration.

The calculation model was prepared based on the data provided by the Contracting Authority. The model was based on airport infrastructure and aircraft movement data, as in previous rounds.

The total number of movements to and from MIA during 2021 was 49,214.

5.1.1.5. Aircraft noise model

Within the CNOSSOS-EU methodology the ECAC CEAC Doc 29 4th edition aircraft noise model is used. General scheme of the aircraft noise model is shown below in Figure 5-3.

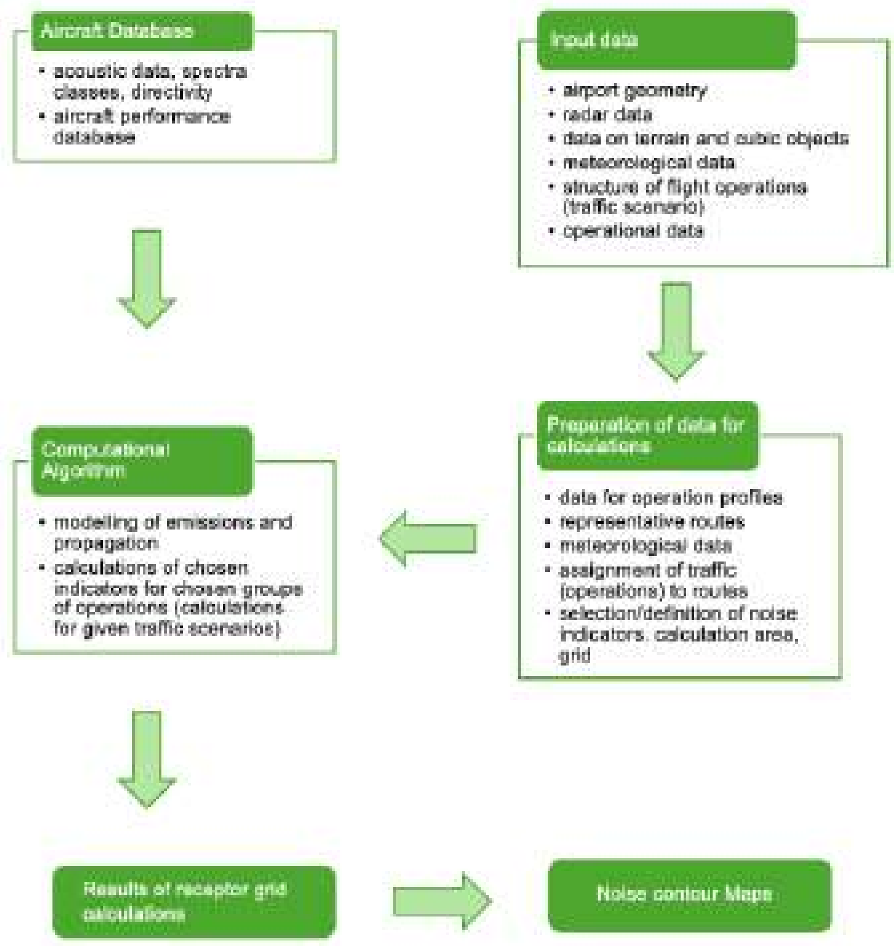


Figure 5-3. General scheme of the aircraft noise model

5.1.1.6. Airfield definitions

In this subchapter the input data used for defining airfield, is given.

- **Airport Reference Point**

In order to enable the correct assessment of corrections due to meteorological conditions, the centre point for the study area was selected, as the official Airport Reference Point (APR) provided by MIA.

Table 5-2. Airport reference point

Latitude	Longitude	Elevation [m]
35°51’27.15’’N	14°28’38.78’’E	90.5

- **Runways at MIA**

There are two runways at MIA:

- runway 13/31 – runs from south-east to north-west,
- runway 05/23 – runs from south-west to north-east.

In the table below the runway end points are given.

Table 5-3. Runway end points

RWY Designator	Dimensions of RWY (length x width) [m]	Latitude	Longitude	Elevation [m]
05	2373 x 40	35°51’35.64’’N	14°28’53.41’’E	90
23	2373 x 40	35°50’50.97’’N	14°27’36.40’’E	75
13	3350 x 58	35°50’06.55’’N	14°30’18.66’’E	78
31	3350 x 58	35°51’23.07’’N	14°28’43.84’’E	70

- **Runway thresholds**

Runways might have a displaced thresholds to indicate a part of the runway which cannot be used for landings, but might be used for taxiing, take-off and landing rollouts. At MIA no runway has a displaced thresholds.

In the Table 5-4 the threshold cross height is presented.

Table 5-4. Thresholds data

Location	Departures	Arrivals		
	Displaced Threshold (m)	Displaced Threshold (m)	Glide Slope (degrees)	Threshold Cross height (m)
RWY 05	0	0	3	20.5
RWY 23	0	0	3	20.5
RWY 13	0	0	3	17.6
RWY 31	0	0	3	17.6

- **Location of start-of-roll**

The locations on the runway where the aircraft begins the take-off run is called start-of-the roll. The distance of start-of-roll from the centre point for each RWY is given in the table below.

Table 5-5. Start of roll distance referenced to centre point

Start of roll distance referenced to centre point	
RWY end	Distance [m]
13	1,772
31	1,677
05	1,188
23	1,188

In the picture below the runways at MIA are presented.

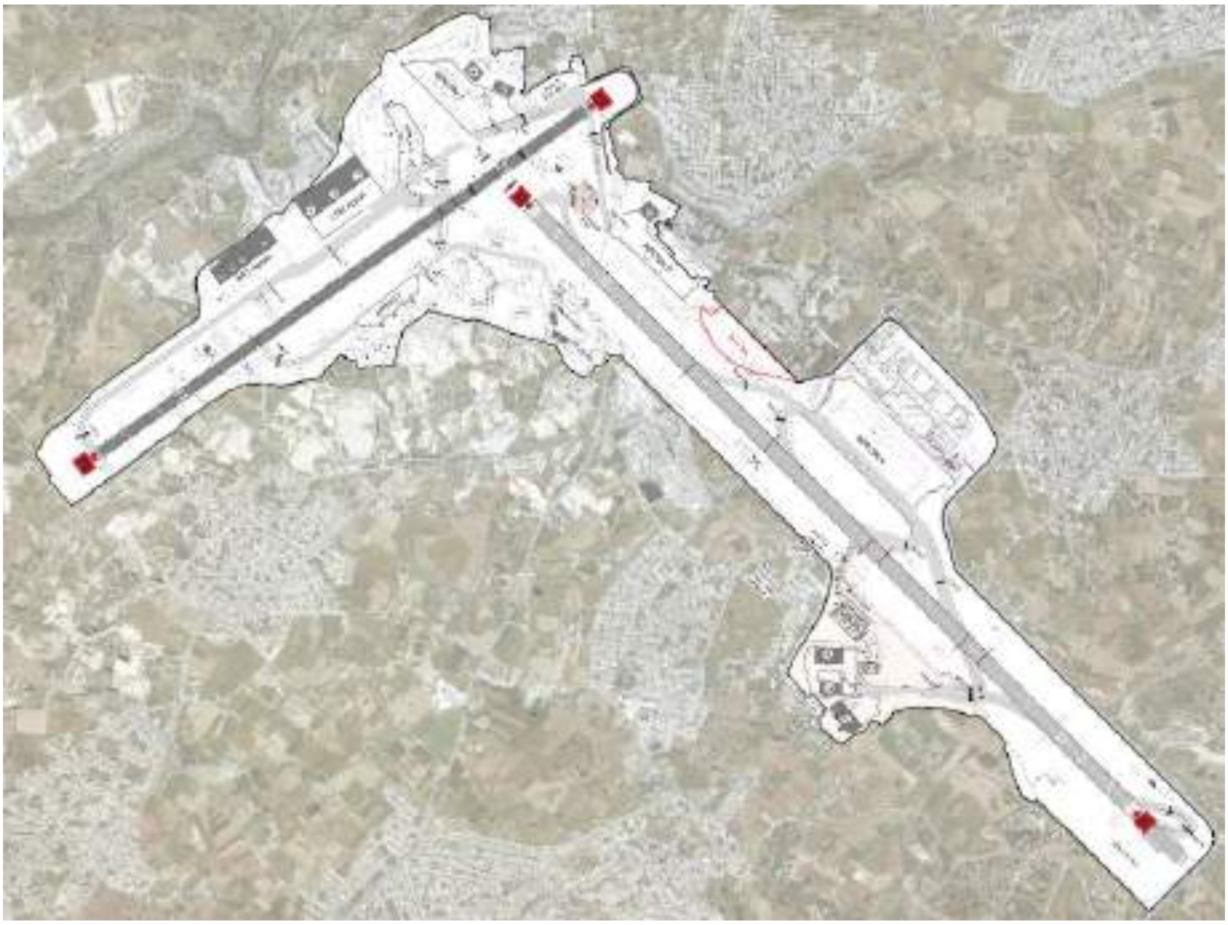


Figure 5-4. Runways at MIA[8]

[8] Source: “Chart – Intersection take-off points.pdf” provided by Malta International Airport and ortophoto map provided by the Contracting Authority as Web Map Service (WMS).

5.1.1.7. Aircraft movement data

The data on the aircraft movement was provided by MIA. Provided data refers to the time period from 1st January 2021 to 31st December 2021. The total numbers of movements (arrivals and departures) at MIA during 2021 was 49,214. The table below presents a summary of movements from 2021.

Table 5-6 Summary of 2021 movements on MIA

Assessment period	Type of movement	Number of movements	Total sum	Percentage of total number of movements	
Day	**Arrival**	19 352	39 454	39.32	80.17
	Departure	20 102		40.85	
Evening	**Arrival**	3 843	6 779	7.81	13.77
	Departure	2 936		5.97	
Night	**Arrival**	1 410	2 981	2.87	6.06
	Departure	1 571		3.19	
24h	**Arrival**	24 605	49 214	50.00	100
	Departure	24 609		50.00	

Following information for flights was provided by MIA:

- Type of operation (arrival or departure),
- Origin (for arrivals) and destination (for departure),
- Aircraft Registration,
- Flight Type,
- Aircraft Type (ICAO),
- Date (ATA),
- Actual time of arrival/departure (hours and minutes).

First stage of data processing was a preliminary check. The main aim of this check was to identify flight operations for which some data might have been missing. Based on the analysis conducted, it was determined that the provided data is complete.

Following the preliminary check the following steps were taken:

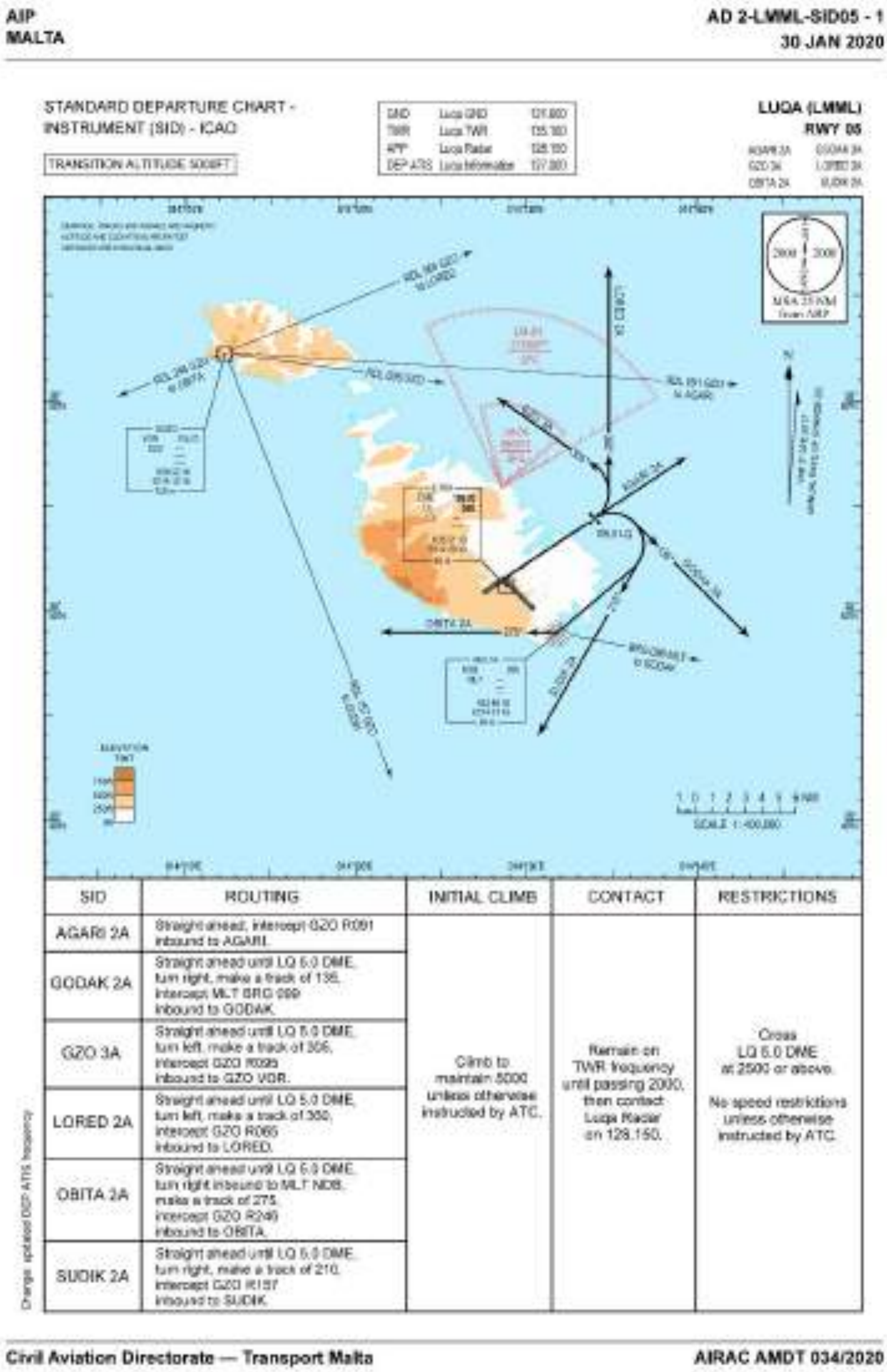
- Processing of movement data – extraction of civil aircraft only,
- Analysis of civil aircraft types,
- Identification of the most appropriate matches between the aircraft type and the available acoustic data in calculation software,
- Determination of number of movements for each aircraft type.

5.1.1.8. Routes

In order to perform aircraft noise calculation it is crucial to implement the routes followed by the aircraft arriving and departing MIA. Malta Air Traffic Service (MATS) provided Standard Instrument Departure Routes. In this file the routes for departing aircraft from each of the four runways are indicated. The diagrams are shown in Figure 5-5, Figure 5-6, Figure 5-7, Figure 5-8.

- **Runway 05**

In Figure 5-5 a standard departure chart for runway 05 is shown.


AIP MALTA

AD 2-LMML-SID05 - 1
30 JAN 2020

STANDARD DEPARTURE CHART - INSTRUMENT (SID) - ICAO

TRANSITION ALTITUDE 5000FT

LUQA (LMML) RWY 05

SID	ROUTING	INITIAL CLIMB	CONTACT	RESTRICTIONS
AGARI 2A	Straight ahead, intercept GZO R091 inbound to AGARI.	Climb to maintain 5000 unless otherwise instructed by ATC.	Remain on TWR frequency until passing 2000, then contact Luqa Radar on 128.150.	Cross LQ 5.0 DME at 2500 or above. No speed restrictions unless otherwise instructed by ATC.
GODAK 2A	Straight ahead until LQ 5.0 DME, turn right, make a track of 135, intercept MLT BRG 099 inbound to GODAK.			
GZO 3A	Straight ahead until LQ 5.0 DME, turn left, make a track of 305, intercept GZO R095 inbound to GZO VOR.			
LORED 2A	Straight ahead until LQ 5.0 DME, turn left, make a track of 360, intercept GZO R065 inbound to LORED.			
OBITA 2A	Straight ahead until LQ 5.0 DME, turn right inbound to MLT NDB, make a track of 275, intercept GZO R246 inbound to OBITA.			
SUDIK 2A	Straight ahead until LQ 5.0 DME, turn right, make a track of 210, intercept GZO R157 inbound to SUDIK.			

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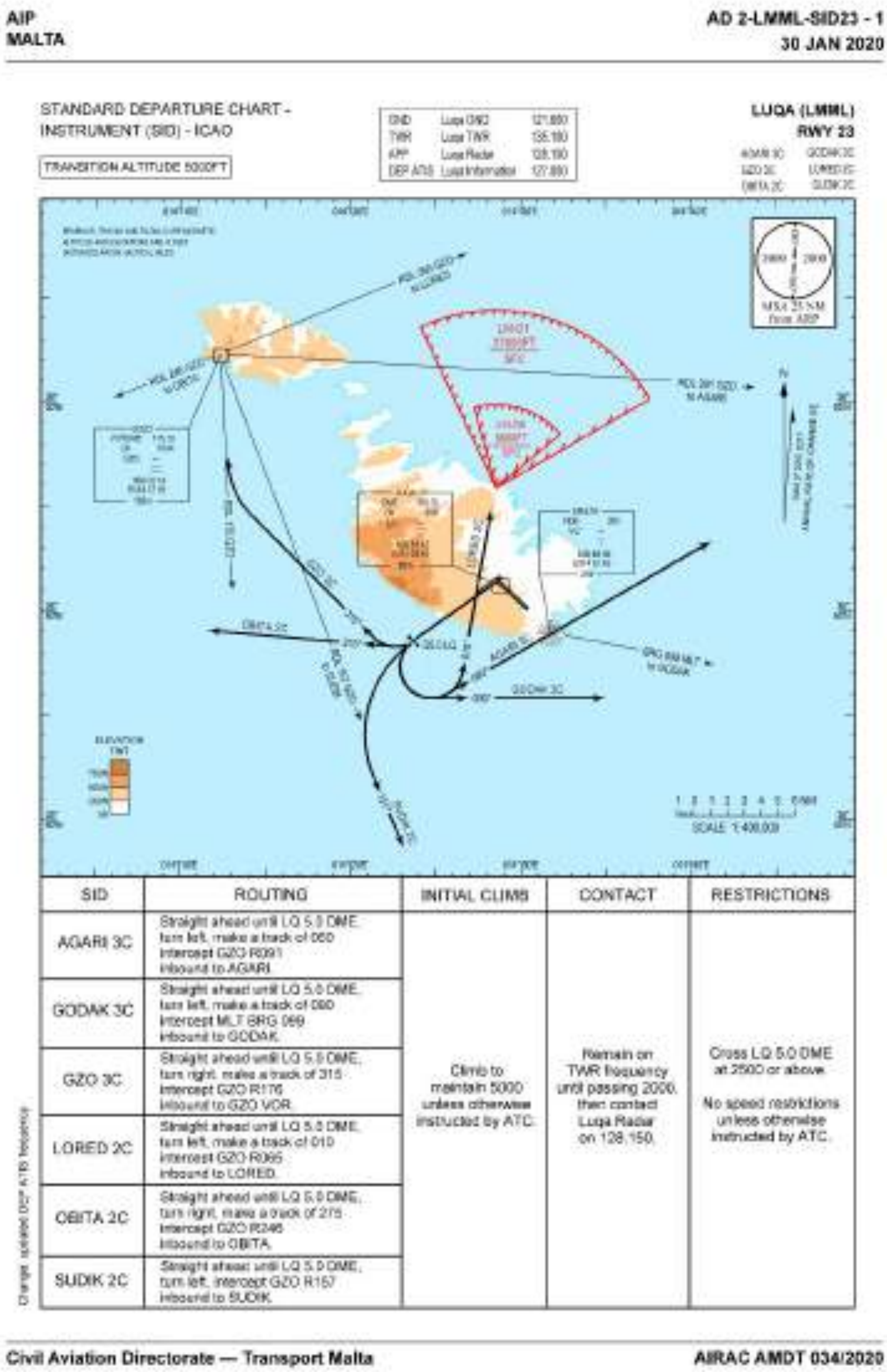
Figure 5-5. Standard departure chart for RWY 05

- **Runway 23**

In Figure 5-6 a standard departure chart for runway 23 is shown.

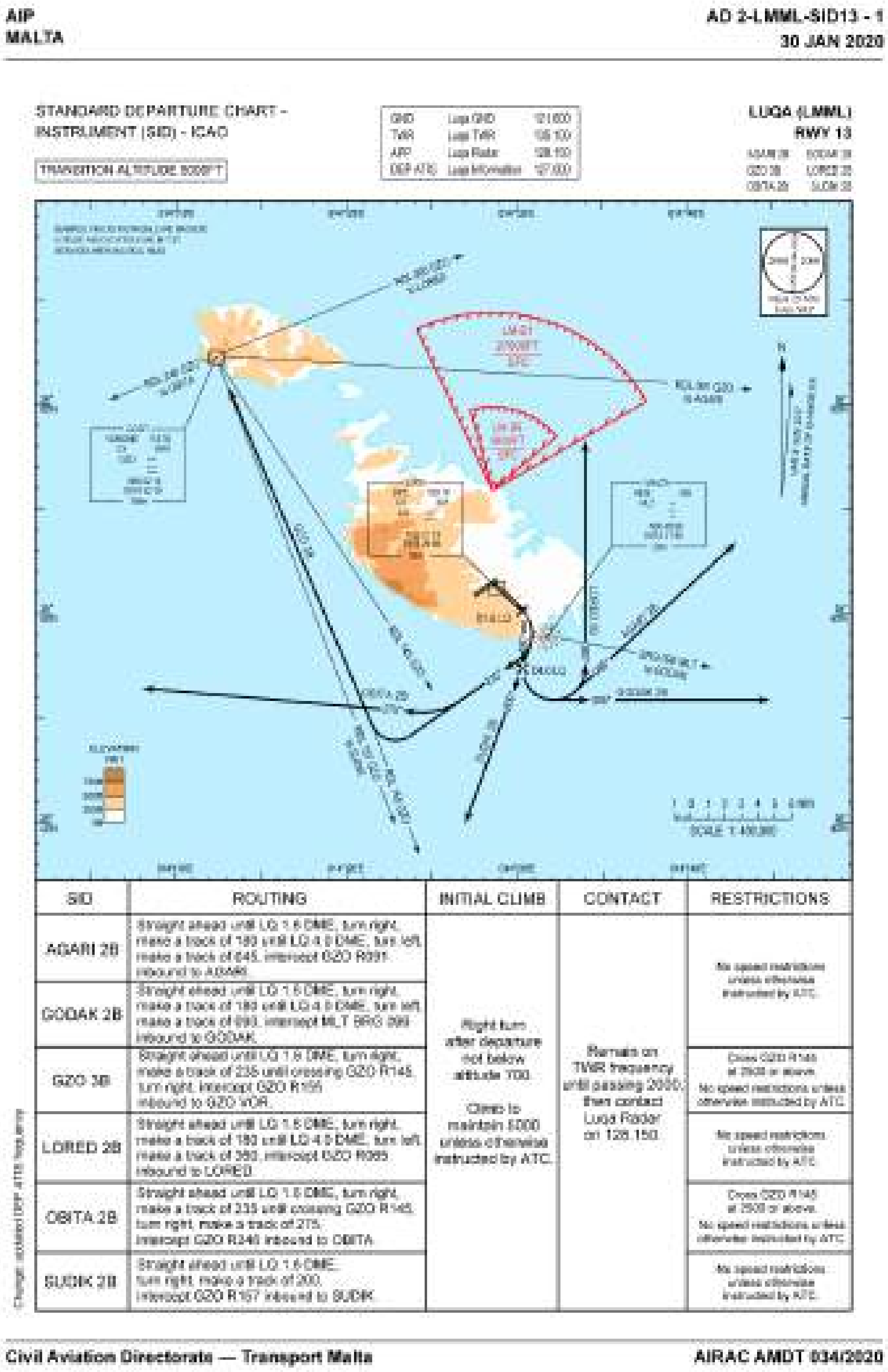


SID	ROUTING	INITIAL CLIMB	CONTACT	RESTRICTIONS
AGARI 3C	Straight ahead until LQ 5.0 DME, turn left, make a track of 060 intercept GZO R091 inbound to AGARI.	Climb to maintain 5000 unless otherwise instructed by ATC.	Remain on TWR frequency until passing 2000, then contact Luqa Radar on 128.150.	Cross LQ 5.0 DME at 2500 or above. No speed restrictions unless otherwise instructed by ATC.
GODAK 3C	Straight ahead until LQ 5.0 DME, turn left, make a track of 090 intercept MLT BRG 099 inbound to GODAK.			
GZO 3C	Straight ahead until LQ 5.0 DME, turn right, make a track of 315 intercept GZO R176 inbound to GZO VOR.			
LORED 2C	Straight ahead until LQ 5.0 DME, turn left, make a track of 010 intercept GZO R065 inbound to LORED.			
OBITA 2C	Straight ahead until LQ 5.0 DME, turn right, make a track of 275 intercept GZO R246 inbound to OBITA.			
SUDIK 2C	Straight ahead until LQ 5.0 DME, turn left, intercept GZO R157 inbound to SUDIK.			

Figure 5-6. Standard departure chart for RWY 23

- **Runway 13**

In Figure 5-7 a standard departure chart for runway 13 is shown.

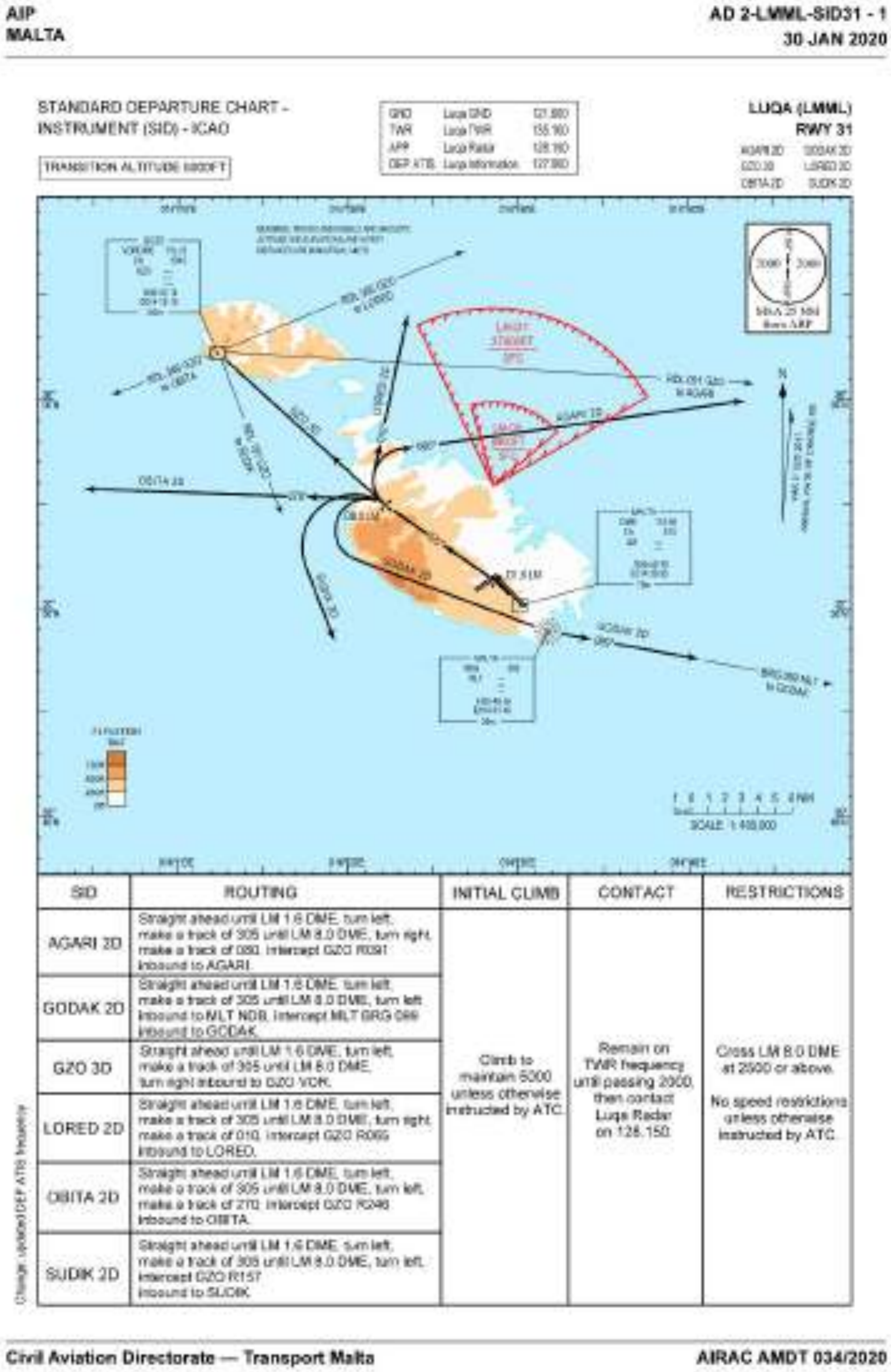


SID	ROUTING	INITIAL CLIMB	CONTACT	RESTRICTIONS
AGARI 2B	Straight ahead until LQ 1.6 DME, turn right, make a track of 180 until LQ 4.0 DME, turn left, make a track of 045, intercept GZO R091 inbound to AGARI.	Right turn after departure not below altitude 700. Climb to maintain 5000 unless otherwise instructed by ATC.	Remain on TWR frequency until passing 2000, then contact Luqa Radar on 128.150.	No speed restrictions unless otherwise instructed by ATC.
GODAK 2B	Straight ahead until LQ 1.6 DME, turn right, make a track of 180 until LQ 4.0 DME, turn left, make a track of 093, intercept MLT BRG 099 inbound to GODAK.			
GZO 3B	Straight ahead until LQ 1.8 DME, turn right, make a track of 235 until crossing GZO R145, turn right, intercept GZO R155 inbound to GZO VOR.			Cross GZO R145 at 2500 or above. No speed restrictions unless otherwise instructed by ATC.
LORED 2B	Straight ahead until LQ 1.6 DME, turn right, make a track of 180 until LQ 4.0 DME, turn left, make a track of 360, intercept GZO R085 inbound to LORED.			No speed restrictions unless otherwise instructed by ATC.
OBITA 2B	Straight ahead until LQ 1.6 DME, turn right, make a track of 235 until crossing GZO R145, turn right, make a track of 275, intercept GZO R240 inbound to OBITA.			Cross GZO R145 at 2500 or above. No speed restrictions unless otherwise instructed by ATC.
SUDIK 2B	Straight ahead until LQ 1.6 DME, turn right, make a track of 200, intercept GZO R157 inbound to SUDIK.			No speed restrictions unless otherwise instructed by ATC.

Figure 5-7. Standard departure chart for RWY 13

- **Runway 31**

In Figure 5-8 a standard departure chart for runway 31 is shown.



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30 JAN 2020

STANDARD DEPARTURE CHART - INSTRUMENT (SID) - ICAO

TRANSITION ALTITUDE 5000FT

LUQA (LMML)
RWY 31

SID	ROUTING	INITIAL CLIMB	CONTACT	RESTRICTIONS
AGARI 2D	Straight ahead until LM 1.6 DME, turn left, make a track of 305 until LM 8.0 DME, turn right, make a track of 080. Intercept GZO R091 inbound to AGARI.	Climb to maintain 5000 unless otherwise instructed by ATC.	Remain on TWR frequency until passing 2000, then contact Luqa Radar on 128.150.	Cross LM 8.0 DME at 2500 or above. No speed restrictions unless otherwise instructed by ATC.
GODAK 2D	Straight ahead until LM 1.6 DME, turn left, make a track of 305 until LM 8.0 DME, turn left inbound to MLT NDB. Intercept MLT BRG 099 inbound to GODAK.			
GZO 3D	Straight ahead until LM 1.6 DME, turn left, make a track of 305 until LM 8.0 DME, turn right inbound to GZO VOR.			
LORED 2D	Straight ahead until LM 1.6 DME, turn left, make a track of 305 until LM 8.0 DME, turn right, make a track of 010. Intercept GZO R065 inbound to LORED.			
OBITA 2D	Straight ahead until LM 1.6 DME, turn left, make a track of 305 until LM 8.0 DME, turn left, make a track of 270. Intercept GZO R246 inbound to OBITA.			
SUDIK 2D	Straight ahead until LM 1.6 DME, turn left, make a track of 305 until LM 8.0 DME, turn left, intercept GZO R157 inbound to SUDIK.			

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Figure 5-8. Standard departure chart for RWY 31

5.1.1.9. Route dispersions

Aircraft departing from MIA follow one of the departure routes outlined in the standard departure charts in subchapter 5.1.1.8 but they do not necessarily align precisely with the centre of the departure route. There may be some variation in the departure route for each individual flight. Unfortunately, the actual tracks for aircraft departing MIA are not accessible, making it impossible to consider the actual tracks flown.

In Round 3 Mapping, data on actual tracks for aircraft departing MIA was also unavailable. Therefore, an assumed dispersion on all departure routes was prepared. The Contractor reviewed the approach to modelling dispersion from R3 Mapping and decided to maintain this approach in R4 Mapping.

- **Distribution of the aircraft across routes.**

Following methodology from R3 Mapping the aircraft were distributed onto five flight tracks in the following way:

- 39.0% of departures were allocated to the main departure route,
- 24.0% of departures were allocated equally to the two inner dispersion routes and offset by a distance of 1 standard deviation,
- 6.5% of departures were allocated equally to the two outer dispersion routes and offset by a distance of 2 standard deviations.

- **Assumed dispersions**

The widths of the dispersed tracks were assigned in accordance with the approach proposed in R3 Mapping. The Table 5-7 presents assumed dispersions that were used on all departure routes.

Table 5-7. Assumed Dispersions on all departure routes

Distance From Start of Roll [km]	Half Width [m]	2 Standard Deviations Outer Track Displacement [m]	2 Standard Deviations Outer Track Displacement [nmi]
0.0	0	0	0.0
1.0	0	0	0.0
2.0	0	0	0.0
3.0	20	40	0.022
3.5	39	77	0.042
4.0	78	156	0.084
4.5	119	238	0.128
5.0	160	320	0.173
5.5	205	410	0.221
6.0	250	500	0.270
6.5	292	585	0.315
7.0	334	668	0.360

Distance From Start of Roll [km]	Half Width [m]	2 Standard Deviations Outer Track Displacement [m]	2 Standard Deviations Outer Track Displacement [nmi]
7.5	372	743	0.401
8.0	409	818	0.441
8.5	437	874	0.471
9.0	465	930	0.501
9.5	489	977	0.527
10.0	512	1024	0.552
10.5	533	1066	0.574
11.0 and above	554	1107	0.597

5.1.1.10. Runway use

Runway use was estimated based on following data:

- Movements 2021 – provided by MIA,
- MIA Threshold use – provided by MIA,
- RIU Stats monthly – provided by MATS.

Initially, data for each flight from the "*Movements 2021*" file was matched with the corresponding data from "*RIU Stats monthly*". Based on data prepared in this manner, it was possible to analyse the operations at MIA and obtain the data as presented in the scheme in Figure 5-9.

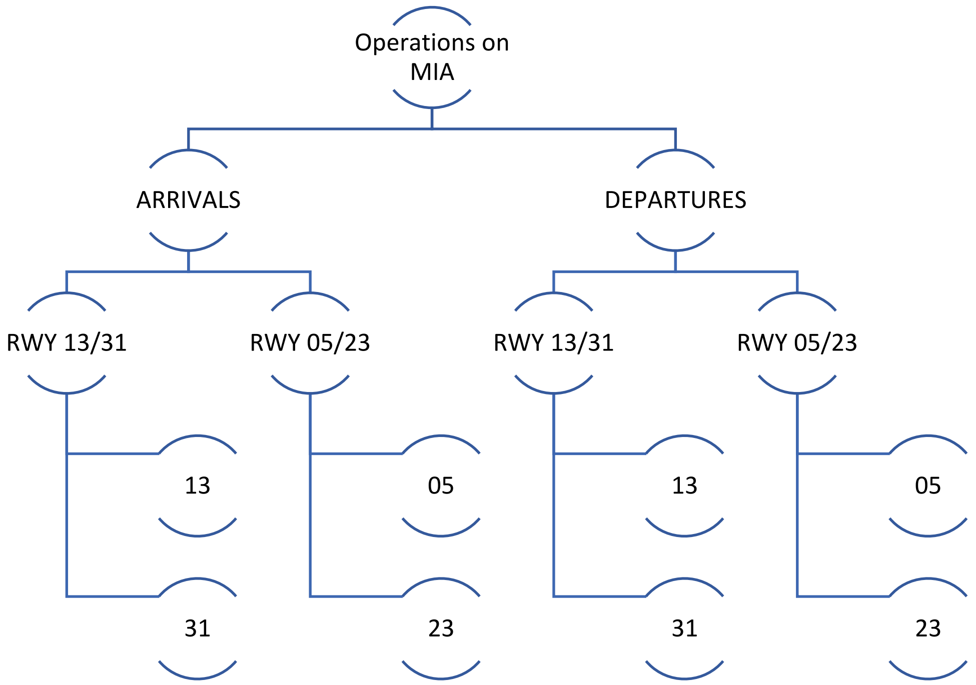

Figure 5-9. Analysis of the operations on MIA per runway - scheme

The “*MIA Threshold use*” file includes information on the departure routes. Based on the data included in this file, the number of aircraft assigned to each departure route was calculated.

The tables below include detailed data on monthly and total annual movements per runway, categorized by arrivals and departures (Table 5-8) and the percentages of departure routes used in the model (

Table 5-9).

Table 5-8 Analysis of the operations on MIA per runway

Month	**Arrivals**				**Deartures**			
	RWY 13/31		**RWY 05/23**		**RWY 13/31**		**RWY 05/23**	
	13	**31**	**5**	**23**	**13**	**31**	**5**	**23**
January	72	74	0	13	78	64	2	48
February	198	317	4	12	164	290	1	23
March	237	189	2	5	231	177	4	4
April	324	213	5	7	283	217	4	16
May	139	75	17	17	117	70	13	37
June	774	369	3	20	662	341	5	90
July	522	801	20	24	420	794	8	69
August	738	1457	62	75	572	1478	19	198
September	773	974	161	141	769	1052	48	129
October	888	1121	57	17	756	1153	17	104
November	834	796	12	54	719	805	3	127
December	311	1229	34	73	228	1300	2	117
Total	**5810**	**7615**	**377**	**458**	**4999**	**7741**	**126**	**962**

Table 5-9 Analysis of the use of the departure routes

RWY05		**RWY23**		**RWY13**		**RWY31**	
SID Description	**Flights (%)**	**SID Description**	**Flights (%)**	**SID Description**	**Flights (%)**	**SID Description**	**Flights (%)**
AGARI 2A	3	AGARI 3C	3	AGARI (2B)	3	AGARI 2D	3
GOZO (GZO) 3A	90	GOZO (GZO) 3C	90	GOZO (GZO) 3B	90	GOZO (GZO) 3D	90
OBITA 2A	1	OBITA 2C	1	OBITA (2B)	1	OBITA 2D	1
GODAK 2A	1	GODAK 3C	1	GODAK (2B)	1	GODAK 2D	1
LORED 2A	3	LORED 2C	2	LORED (2B)	3	LORED 2D	3
SUDIK 2A	2	SUDIK 2C	2	Sudik (2b)	2	SUDIK 2D	2

5.2. Step 5 – Compilation of strategic noise maps by means of noise modelling software

The datasets described in Chapter 5.1 were imported into the noise calculation software. The order of importing data and additional information is presented in Table 5-1.

Table 5-10. Completion of 3D noise model.

Order	Input dataset	Object type	Additional information
1.	Terrain	Points	Before any other dataset was imported the Digital Ground Model was calculated.
2.	Areas mapped	Polygons	These areas were used as calculation area
3.	Buildings	Polygons	-
4.	Barriers	Lines	-
5.	Ground cover	Polygons	-
6.	Industrial sites	Polygons	-
7.	Roads	Lines	-
8.	Roundabouts	Points	-
9.	Traffic lights	Points	-

Once all data sets were imported into the noise calculation software, the detailed model review was undertaken, including test calculations. The review included examining the entire model inside calculation areas using 3D visualization. Additionally, a thorough review of any warnings appearing in software logbook was conducted.

6. NOISE LEVEL CALCULATIONS

6.1. Step 6 – Noise level calculations

Two types of calculations were undertaken, with each type serving a distinct purpose:

- Grid calculations – the results were presented in graphical form,
- Façade receptor calculations – the results formed the basis for assessing dwelling and population exposure.

Calculation method and settings

At the stage of creating a calculational record a number of parameters needed to be set. As it was previously mentioned in subchapter 4.2 for all noise sources the CNOSSOS-EU calculation method was used. More detailed information on calculation settings is presented in Table 6-1 below.

Table 6-1. Main settings for calculational records

Calculation setting	**Mapped noise source**			
	Main roads (outside of agglomeration)	**Agglomeration (road)**	**Agglomeration (industry)**	**Agglomeration (Aircraft)**
Calculation method	CNOSSOS-EU	CNOSSOS-EU	CNOSSOS-EU	CNOSSOS-EU
Grid space [m]	10 x 10	10 x 10	10 x 10	10 x 10
Grid height above ground [m]	4,0	4,0	4,0	4,0
Location of receivers (Façade noise map calculations)	CASE 1A described in EU Directive 2015/996	CASE 1A described in EU Directive 2015/996	CASE 1A described in EU Directive 2015/996	CASE 1A described in EU Directive 2015/996
Reflection order	1	1	3	1
Maximum search radius [m]	800	800	2000	800

Meteorological dataset

The following meteorological data was taken into account in the CNOSSOSS-EU calculation methodology:

- Humidity [%],
- Air pressure [mbar],
- Temperature [°C],
- Percent of favourable sound propagation conditions (pfav [%]).

Humidity, air pressure and temperature were determined based on meteorological data provided by the Contracting Authority. The mean values were calculated based on data from 2010 to 2020.

The impact of meteorological conditions on noise propagations increases with the increase of the distance from the source. In terms of average annual noise assessment indicators, the impact is significant at distances well over 100 m. In the CNOSSOS-EU method, meteorological conditions are taken into account when calculating the impact of:

- The attenuation due to atmospheric absorption, A_{atm},
- Refraction, included in the $A_{boundary}$ function through calculations for neutral and favourable noise propagation conditions. The amount of refraction during different times of the day throughout the year is decided by a percentage, denoted as *p*,
- Air temperature on rolling noise (road traffic noise), $\Delta LW_{,}$ function.

Good Practice Guide for Strategic Noise Mapping and the production of Associated Data on Noise Exposure (2007)[9] introduces values proposed in the absence of the possibility of more accurate calculations available, and taking into account the precautionary principle, standard values of meteorological conditions (percentage of favourable sound propagation conditions, *p*, equal to 50, 75 and 100 percent, for the time of day, evening and night, respectively). However, Conclusions of the CEDR Project Group Road Noise[10] report recommending standardized values for conditions of meteorological conditions, while pointing out that the values proposed in GPG WG-AEN 2007[11], lead to an overestimation of noise levels.

There is no standardized way to calculate the percentage of favourable sound propagation conditions. The actual vertical profiles of temperature and wind speed (necessary to determine the influence of refraction) depend on many local factors related to topography, soil type, vegetation cover, presence of cubic obstructions, etc., which makes the correlation between regional meteorological data (even from a dense measurement network) and the local meteorological characteristics of a specific site very questionable.

The CNOSSOS-EU methodology has low sensitivity to *p* value, defined in the range of actual values between 40% and 100%, which is within the acceptable accuracy of the input data (±2 dB).

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[9] Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure, European Commission Working Group Assessment of Exposure to Noise (GPG WG-AEN), version 2, 2007

[10] CEDR (Conference of European Directors of Roads) Project Group Road Noise 2: subgroup END noise mapping, Best practice in strategic noise mapping, 2013

[11] Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exposure, European Commission Working Group Assessment of Exposure to Noise (GPG WG-AEN), version 2, 2007

Recommendation

The Contractor recommends the following favourable sound propagation conditions:

- day – **p_d = 55%,**
- evening – **p_e = 60%,**
- night – **p_n = 85%.**

Calculations

This stage was in fact divided into three steps presented in the Figure 6-1.

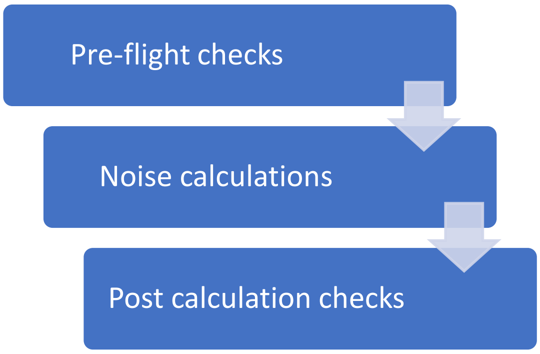


Figure 6-1. Three steps of calculation stage

6.1.1.1. Pre-flights checks

Prior to the final calculations being commenced, a series of pre-flight checks were undertaken to confirm that the prepared model was processed without errors and that data required for the noise propagation calculations was imported correctly.

6.1.1.2. Noise calculation

As it was stated at the beginning of this chapter grid and Façade receptor calculations were performed for following noise source:

- Major roads outside of the agglomeration,
- Major roads inside of the agglomeration,
- Road network inside of the agglomeration,
- Industrial noise (agglomeration),
- Aircraft noise (agglomeration).

6.1.1.3. Post calculation checks

Following the completion of the calculations run, the post calculations checks were performed including:

- verification of comments appearing in software logbook after calculations,

- verification of graphical representation of grid noise calculations in order to identify gaps and anomalies,
- verification of the results of Façade receptor calculation (identification of the receptors where the results differ significantly from those in nearby receptors).

6.2. Step 7 - Export of the results of calculation

The results of the noise calculations were exported from noise calculation software.

6.2.1.1. Grid noise map

The results of Grid noise map calculation were exported as bands in shape files.

For L_{den} indicator the bands in following ranges were exported: 55-59, 60-64, 65-69, 70-74 and >75. For L_{night} indicator the bands in following ranges were exported: 50-54, 55-59, 60-64, 65-69 and >70. This data was used to create maps and was processed to deliver the statistics on the area exposed in km^2 within noise level bands.

6.2.1.2. Façade receptor calculations

The results of Façade receptor calculations were exported as points in shape files. This file was later processed in order to deliver the required statistics on the number of people living in dwellings exposed to the noise, number of dwellings, as well as other noise-sensitive buildings (such as hospitals, schools, etc.) exposed to the noise. Aforementioned statistics are presented in chapter 7.

7. RESULTS OF ROUND 4 STRATEGIC NOISE MAPPING

The results of the strategic noise mapping assessment are shown as noise contour maps in Appendix B

Following the assessment of noise levels, it was possible to undertake secondary analysis utilizing the results from the noise calculation process. In this chapter numerical data is presented in areas at risk of noise expressed by L_{den} and L_{night} indicators for the following :

- Area (in km^2),
- Number of dwellings, schools and hospitals,
- Number of people living in dwellings (rounded to hundreds)

The data is presented for:

- Major roads outside of the agglomeration,
- Major roads inside of the agglomeration,
- Major roads including agglomeration,
- Road network (agglomeration),
- Industrial noise (agglomeration),
- aircraft noise (agglomeration).

The statistics are presented in the 5dB bands depending on the noise indicator:

L_{den}:	55 - 59	60 - 64	65 - 69	70 - 74	≥75
L_{night}:	50 - 54	55 - 59	60 - 64	65 - 69	≥70

7.1. Area analysis

The results of the analysis of areas exposed to noise from major roads (Table 7-2) and from various sources in the agglomeration (Table 7-3) are presented in the tables below, along with a comparison of the obtained values with the results from the previous round (R3) of mapping (Table 7-1).

Table 7-1 Area exposed to noise from R3 and R4 major roads

Noise Scenario	Noise Category	R3 Area (including agglomeration) [km^2]	R4 Area (including agglomeration) [km^2]
L_{den}	>55	45.3	63.52
	>65	13.1	19.01
	>75	2.9	3.70

Table 7-2 Area exposed to noise from major roads (R4 of mapping)

Noise Scenario	Noise Category	R4 area exposed to noise from major roads outside agglomerations [km²]	R4 area exposed to noise from major roads inside agglomerations [km²]	R4 area exposed to noise from major roads including agglomerations [km²]
L_{den}	55-59	22.27	6.26	28.53
	60-64	11.18	4.80	15.98
	65-69	5.89	3.72	9.61
	70–74	3.15	2.55	5.70
	≥75	1.60	2.10	3.70
	Total	**44.09**	**19.43**	**63.52**
L_{night}	50-54	13.66	5.23	18.89
	55-59	6.78	4.04	10.82
	60-64	3.50	2.73	6.23
	65-69	1.94	1.80	3.74
	≥70	0.13	0.69	0.82
	Total	**26.01**	**14.49**	**40.50**

Note: Due to rounding of underlying results to the nearest km, the values in the tables may not always add up as expected.

Table 7-3 Area exposed to noise from different noise sources within agglomeration (R4 of mapping)

Noise Scenario	Noise Category	R4 area exposed to noise from agglomeration roads [km²]	R4 area exposed to noise from agglomeration industrial sites [km²]	R4 area exposed to noise from agglomeration aircraft [km²]
L_{den}	55-59	5.816	0.131	1.271
	60-64	4.880	0.073	0.024
	65-69	3.421	0.031	0.000
	70–74	1.753	0.032	0.000
	≥75	1.411	0.027	0.000
	Total	**17.282**	**0.295**	**1.295**
L_{night}	50-54	5.173	0.080	0.067
	55-59	3.820	0.039	0.000
	60-64	1.917	0.021	0.000
	65-69	1.213	0.021	0.000
	≥70	0.466	0.018	0.000
	Total	**12.589**	**0.180**	**0.067**

Note: Due of rounding of underlying results to nearest km, the values in the table may not always add up as expected.

7.2. Analysis of dwellings, school and hospital buildings

The results of the analysis of dwellings, schools and hospitals exposed to noise from major roads (

Table 7-5,

Table 7-6, Table 7-7) and from various sources in the agglomeration (Table 7-8, Table 7-9, Table 7-10) are presented in the tables below, along with a comparison of the obtained values with the results from the previous round (R3) of mapping (Table 7-4).

Table 7-4 Number of dwellings exposed to noise from R3 and R4 major roads

Noise Scenario	Noise Category	R3 number of dwellings exposed to noise from major roads including agglomerations	R4 number of dwellings exposed to noise from major roads including agglomerations
L_{den}	>55	24 200	12 600
	>65	10 100	4 200
	>75	1 100	200

Table 7-5 Number of dwellings exposed to noise from major roads (R4 of mapping)

Noise Scenario	Noise Category	R4 number of dwellings exposed to noise from major roads outside agglomerations	R4 number of dwellings exposed to noise from major roads inside agglomerations	R4 number of dwellings exposed to noise from major roads including agglomerations
L_{den}	55-59	1 100	3 600	4 700
	60-64	900	2 900	3 700
	65-69	700	2 100	2 900
	70–74	200	1 000	1 100
	≥75	0	200	200
	Total	**2 900**	**9 800**	**12 600**
L_{night}	50-54	900	2 900	3 800
	55-59	800	2 300	3 200
	60-64	200	1 200	1 400
	65-69	0	200	300
	≥70	0	0	0
	Total	**1 900**	**6 600**	**8 700**

Note: Due to rounding of underlying results to nearest 100, the values in the table may not always add up as expected.

Table 7-6 Number of school buildings exposed to noise from major roads (R4 of mapping)

Noise Scenario	Noise Category	R4 number of schools exposed to noise from major roads outside agglomerations	R4 number of schools exposed to noise from major roads inside agglomerations	R4 number of schools exposed to noise from major roads including agglomerations
L_{den}	55-59	11	96	107
	60-64	8	55	63
	65-69	3	63	66
	70–74	1	20	21
	≥75	0	7	7
	Total	**23**	**241**	**264**
L_{night}	50-54	6	69	75
	55-59	1	28	29
	60-64	0	8	8
	65-69	0	1	1
	≥70	0	0	0
	Total	**7**	**106**	**113**

Note: Individual schools or hospitals may contain several buildings, the values in the tables do not represent the number of schools or hospitals exposed to noise, rather the number of buildings within school and hospitals grounds exposed to noise.

Table 7-7 Number of hospital buildings exposed to noise from major roads (R4 of mapping)

Noise Scenario	Noise Category	R4 number of hospitals exposed to noise from major roads outside agglomerations	R4 number of hospitals exposed to noise from major roads inside agglomerations	R4 number of hospitals exposed to noise from major roads including agglomerations
L_{den}	55-59	2	27	29
	60-64	0	13	13
	65-69	0	6	6
	70–74	0	2	2
	≥75	0	0	0
	Total	**2**	**48**	**50**
L_{night}	50-54	0	9	9
	55-59	0	2	2
	60-64	0	0	0
	65-69	0	0	0
	≥70	0	0	0
	Total	**0**	**11**	**11**

Note: Individual schools or hospitals may contain several buildings, the values in the tables do not represent the number of schools or hospitals exposed to noise, rather the number of buildings within school and hospitals grounds exposed to noise.

Table 7-8 Number of dwellings exposed to noise from different noise sources within agglomeration (R4 of mapping)

Noise Scenario	Noise Category	R4 number of dwellings exposed to noise from agglomeration roads	R4 number of dwellings exposed to noise from agglomeration industrial sites	R4 number of dwellings exposed to noise from agglomeration aircraft
L_{den}	55-59	5 900	0	3 700
	60-64	6 100	0	0
	65-69	3 000	0	0
	70–74	1 000	0	0
	≥75	200	0	0
	Total	**16 200**	**0**	**3 700**
L_{Night}	50-54	6 100	0	100
	55-59	3 600	0	0
	60-64	1 200	0	0
	65-69	300	0	0
	≥70	0	0	0
	Total	**11 200**	**0**	**100**

Note: Due to rounding of underlying results to nearest 100, the values in the table may not always add up as expected.

Table 7-9 Number of school buildings exposed to noise from different noise sources within agglomeration (R4 of mapping)

Noise Scenario	Noise Category	R4 number of schools exposed to noise from agglomeration roads	R4 number of schools exposed to noise from agglomeration industrial sites	R4 number of schools exposed to noise from agglomeration aircraft
L_{den}	55-59	127	0	23
	60-64	112	0	0
	65-69	72	0	0
	70–74	22	0	0
	≥75	8	0	0
	Total	**341**	**0**	**23**
L_{night}	50-54	81	0	0
	55-59	31	0	0
	60-64	8	0	0
	65-69	1	0	0
	≥70	0	0	0
	Total	**121**	**0**	**0**

Note: Individual schools or hospitals may contain several buildings, the values in the tables do not represent the number of schools or hospitals exposed to noise, rather the number of buildings within school and hospitals grounds exposed to noise.

Table 7-10 Number of hospital buildings exposed to noise from different noise sources within agglomeration (R4 of mapping)

Noise Scenario	Noise Category	R4 number of hospitals exposed to noise from agglomerations roads	R4 number of hospitals exposed to noise from agglomeration industrial sites	R4 number of hospitals exposed to noise from agglomeration aircraft
L_{den}	55-59	29	0	0
	60-64	25	0	0
	65-69	7	0	0
	70–74	2	0	0
	≥75	0	0	0
	Total	**63**	**0**	**0**
L_{night}	50-54	12	0	0
	55-59	2	0	0
	60-64	0	0	0
	65-69	0	0	0
	≥70	0	0	0
	Total	**14**	**0**	**0**

Note: Individual schools or hospitals may contain several buildings, the values in the tables do not represent the number of schools or hospitals exposed to noise, rather the number of buildings within school and hospitals grounds exposed to noise.

7.3. Population analysis

The results of the analysis of population exposed to noise from major roads (Table 7-13) and from various sources in the agglomeration (Table 7-15) are presented in the tables below for round 4 (R4) of mapping. Additionally, the results of the analysis of population exposed to noise from major roads (

Table 7-12) and from various sources in the agglomeration (

Table 7-14) are presented in the tables below for round 3 (R3) mapping, along with a comparison of the obtained values with the results from both rounds (Table 7-11).

Table 7-11 Number of people living within dwellings exposed to noise from R3 and R4 major roads.

Noise Scenario	Noise Category	R3 Population (including agglomeration)	R4 Population (including agglomeration)
L_{den}	>55	39 900	35 900
	>65	15 700	12 000
	>75	1 600	600

Table 7-12 Number of people living within dwellings exposed to noise from major roads (R3 of mapping)

Noise Scenario	Noise Category	R3 number of people exposed to noise from major roads outside agglomerations	R3 number of people exposed to noise from major roads inside agglomerations	R3 number of people exposed to noise from major roads including agglomerations
L_{den}	55-59	3 500	12 000	15 500
	60-64	2 300	6 500	8 800
	65-69	2 000	4 800	6 900
	70–74	1 900	5 200	7 200
	≥75	400	1 100	1 600
	Total	**10 200**	**29 700**	**39 900**
L_{night}	50-54	2 500	7 000	9 400
	55-59	2 000	4 800	6 700
	60-64	2 000	5 500	7 400
	65-69	600	1 600	2 200
	≥70	0	0	0
	Total	**7 100**	**18 800**	**25 800**

Note: Due to rounding of underlying results to nearest 100, the values in the table may not always add up as expected.

Table 7-13 Number of people living within dwellings exposed to noise from major roads (R4 of mapping)

Noise Scenario	Noise Category	R4 number of people exposed to noise from major roads outside agglomerations	R4 number of people exposed to noise from major roads inside agglomerations	R4 number of people exposed to noise from major roads including agglomerations
L_{den}	55-59	3 100	10 300	13 400
	60-64	2 400	8 100	10 500
	65-69	2 000	6 100	8 100
	70–74	500	2 800	3 300
	≥75	100	500	600
	Total	**8 100**	**27 800**	**35 900**
L_{night}	50-54	2 500	8 200	10 700
	55-59	2 200	6 700	9 000
	60-64	700	3 400	4 000
	65-69	100	700	800
	≥70	0	0	0
	Total	**5 500**	**19 000**	**24 500**

Note: Due to rounding of underlying results to nearest 100, the values in the table may not always add up as expected.

Table 7-14 Number of people living within dwellings exposed to noise from different noise sources within agglomeration (R3 of mapping)

Noise Scenario	Noise Category	R3 number of people exposed to noise from agglomeration roads	R3 number of people exposed to noise from agglomeration industrial sites	R3 number of people exposed to noise from agglomeration aircraft
L_{den}	55-59	23 200	0	7 600
	60-64	14 600	0	500
	65-69	21 600	0	0
	70–74	6 700	0	0
	≥75	1 100	0	0
	Total	**67 200**	**0**	**8 100**
L_{night}	50-54	15 200	0	800
	55-59	21 900	0	0
	60-64	7 900	0	0
	65-69	1 600	0	0
	≥70	0	0	0
	Total	**46 500**	**0**	**800**

Note: Due to rounding of underlying results to nearest 100, the values in the table may not always add up as expected.

Table 7-15 Number of people living within dwellings exposed to noise from different noise sources in agglomeration (R4 of mapping)

Noise Scenario	Noise Category	R4 number of people exposed to noise from agglomeration roads	R4 number of people exposed to noise from agglomeration industrial sites	R4 number of people exposed to noise from agglomeration aircraft
L_{den}	55-59	17 000	0	11 000
	60-64	17 100	0	100
	65-69	8 500	0	0
	70–74	2 800	0	0
	≥75	500	0	0
	Total	**45 900**	**0**	**11 100**
L_{night}	50-54	17 200	0	400
	55-59	10 200	0	0
	60-64	3 400	0	0
	65-69	700	0	0
	≥70	0	0	0
	Total	**31 500**	**0**	**400**

Note: Due to rounding of underlying results to nearest 100, the values in the table may not always add up as expected.

8. CONCLUSION

The Environmental Noise Directive (END) mandates Member States to gather data on prolonged noise exposure from road, rail, aircraft, and industrial sources via strategic noise mapping.

The primary goal of the contract was to conduct Round 4 strategic noise mapping for Malta under the Environmental Noise Directive 2002/49/EC. The key objectives of the contract were as follows:

1. Review the R3 strategic noise mapping.
2. Prepare the R4 strategic noise mapping.
3. Implement the R4 strategic noise mapping.
4. Measuring noise from IPPC sites affecting the agglomeration.

A review of the Round 3 strategic noise mapping datasets was undertaken, leading to the conclusion that the Round 3 maps needed to be revised and extended to account for updates available in the mapping datasets and to be in line with the requirements of Round 4. Each of the noise mapping datasets developed during the R3 mapping process were revised and updated as described. These were supplemented by new height datasets obtained from new basemap for 2018 (Basemap Hardcoded - SintegraM 2018) and Digital Terrain Model (DTM) dataset, along with a fresh dataset for 2021 traffic flows and updated population dataset from 2021 National Census and dwelling locations datasets.

An overview of the work undertaken during the project is provided and a summary of the results for the strategic noise mapping is provided for the major roads, agglomeration roads, agglomeration industry and agglomeration aircraft undertaken in compliance with EC Directive 2002/49/EC and the Regulations.

APPENDIX A: GLOSSARY OF ACOUSTIC AND TECHNICAL TERMS

Term	Definition
Aarhus Convention	Convention on access to information, public participation in decision-making and access to justice in environmental matters.
CEDR	The Conference of European Directors of Roads
CNOSSOS-EU	Common Noise Assessment Methods in Europe
dB	Decibel
DSM	Digital Surface Model
DTM	Digital Terrain Model
EC	European Comission
EEA	European Environment Agency
EIONET	European Environment Information and Observation Network
END	Environmental Noise Directive (2002/49/EC)
ERA	Environmental and Resource Authority
EU	European Union
FMDI	Final model data input
Geotiff format	Public domain metadata standard that enables georeferencing information to be embedded within an image file.
GIS	Geographic Information System
GPG WG-AEN	Good Practice Guide for Strategic Noise Mapping and the Production of Associated Data on Noise Exinsposure, European Commission Working Group Assessment of Exposure to Noise
HA	High Annoyance
HSD	High sleep disturbance
ICAO	International Civil Aviation Organisation
IHD	Ischemic Heart Disease
IM	Infrastructure Malta
INSPIRE	Infrastructure for Spatial Information in Europe
IPPC	Integrated Pollution Prevention and Control Directive
ISO	International Standards Organisation
LiDAR	Light Detection and Ranging — is a remote sensing method used to examine the surface of the Earth.
LimA	Environmental Noise Calculation and Mapping Software
MATS	Malta Air Traffic Services
MEER	The Ministry for the Environment, Energy and Regeneration of the Grand Harbour
MEPA	Malta Environment and Resource Authority
MIA	Malta International Airport
NA	Not Applicable
NHTS	National Household Travel Survey
Noise Level L_d – Daytime	L_d = LAeq,12h (07:00 to 19:00)
Noise Level L_{den} – Day/ Evening/ Night	L_{den} = 10*log1/24{12*10^(L_d/10)+4*10^((Le+5)/10)+8*10^((Ln+10)/10)}
Noise Level L_e – Evening	L_e = LAeq,4h (19:00 to 23:00)
Noise level L_n - Night	L_n = LAeq, 8h (23:00 to 07:00)
NSO	National Statistics office

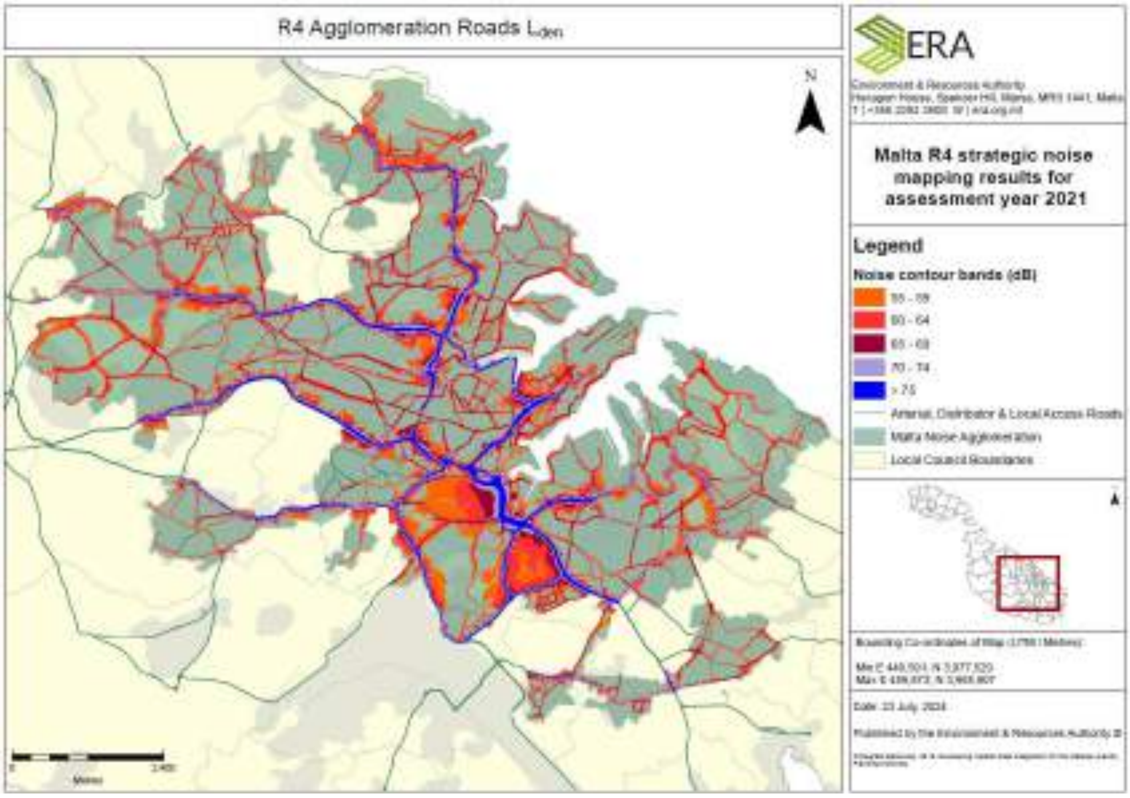
PA	Planning Authority
RWY	Runway
SoundPlan	Modelling Software
TEN-T	Trans-European Transport Network (TEN-T)
TM	Transport Malta
Urban Atlas	Copernicus Land Monitoring Service
WSC	Water Services Corporation

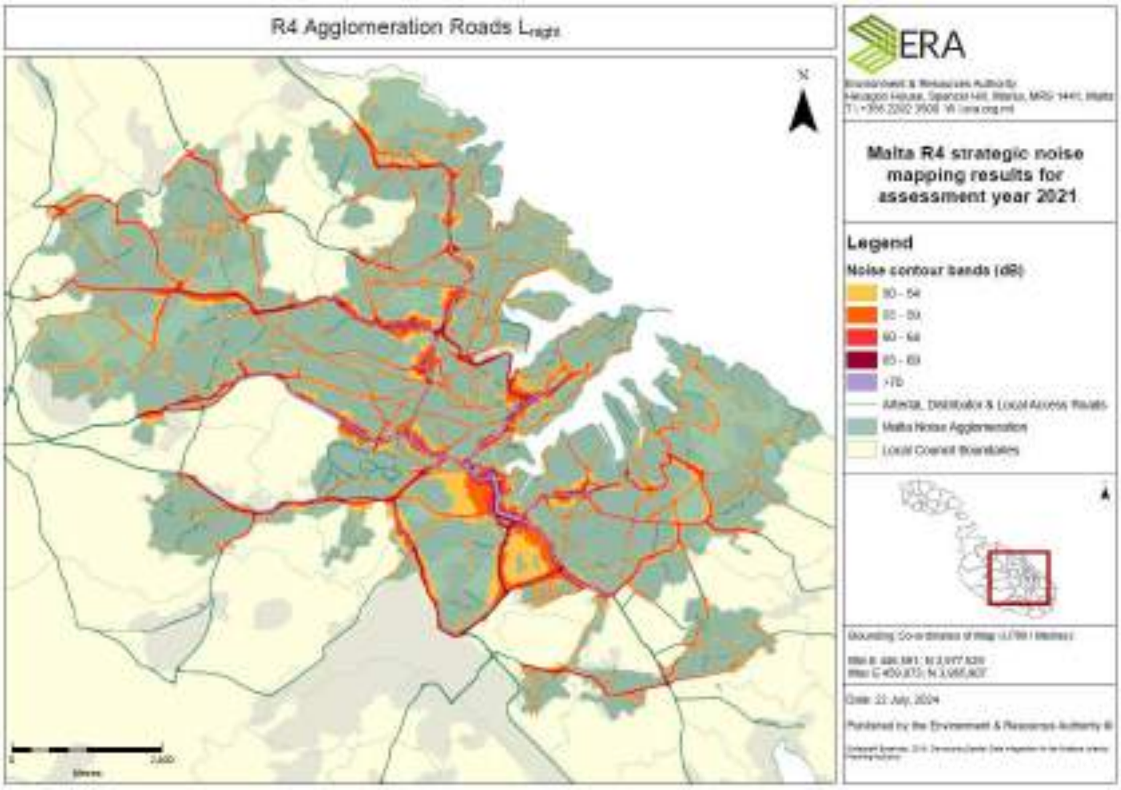
APPENDIX B: ACQUIRED DATASET OVERVIEW

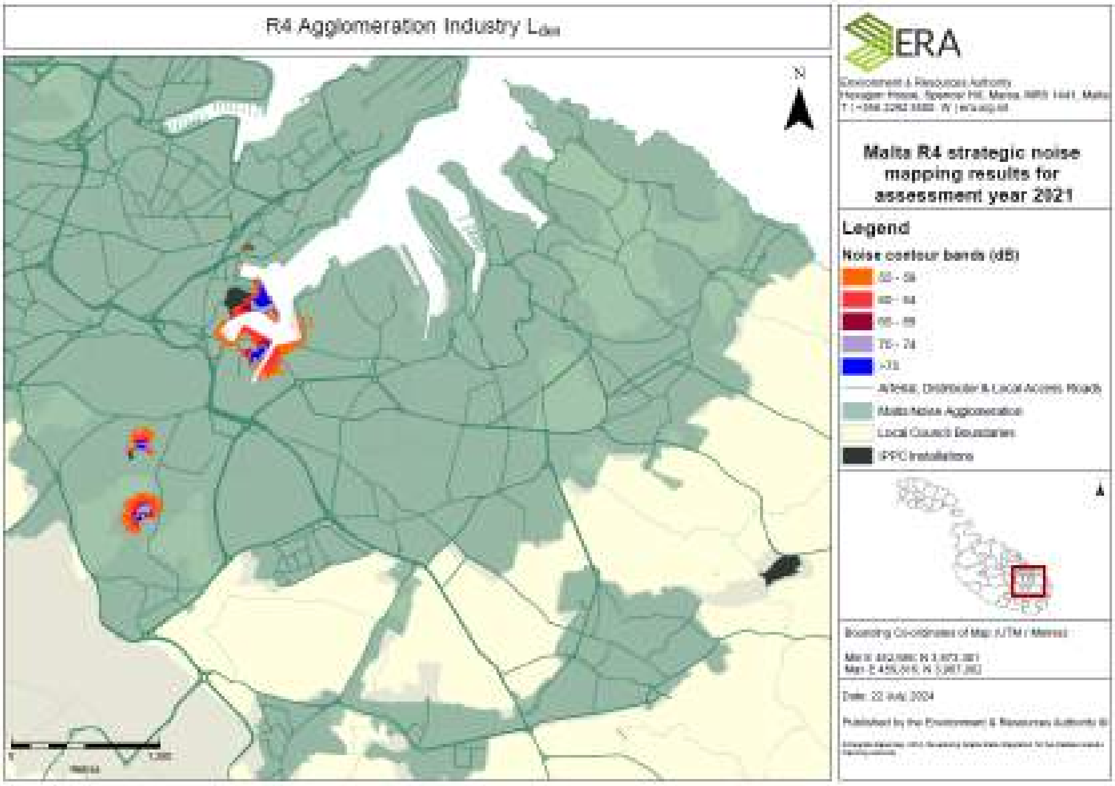
No.	Layer	Source
1.	SPED 2015 and Land Categories datasets	© Planning Authority
2.	Hard coded base map (Basemap2018.gdb layer - land, terrain, buildings, roads, surface waters)	© SIntegraM Basemap Hardcoding dataset, 2018, Developing Spatial Data Integration for the Maltese Islands, Planning Authority
3.	Agglomeration boundary from the previous mapping round	© Environment and Resources Authority
4.	Land Use, Land-Use Change and Forestry (LULUCF) dataset	© Planning Authority, 2021, produced for the European Environmental Agency as part of an Implementing Framework service contract
5.	Population count for Malta and Gozo per 1 square kilometer compiled for the 2021 Population and Housing Census	© Census of Population and Housing 2021, National Statistics Office, Malta
6.	Digital Terrain Model 2018 (raster files)	© SIntegraM Digital Terrain Model, 2018, Developing Spatial Data Integration for the Maltese Islands, Planning Authority
7.	Digital Surface Model 2018 (raster files)	© SIntegraM Digital Surface Model, 2018, Developing Spatial Data Integration for the Maltese Islands, Planning Authority
8.	Orthophoto 2018 (WMS)	© SIntegraM Orthophoto, 2018, Developing Spatial Data Integration for the Maltese Islands, Planning Authority
9.	Population and housing information: ERA_DATA_NOP (shapefile number of inhabitants + non res and res dwellings)	© Water Services Corporation
10.	Roads and traffic lights shapefile layers (Traffic lights layer, AAPT_Network_AM17_link, AADT_Network_AM2020DS_link, CNOSSOS correction document)	© Transport Malta
11.	1991 - 2020 long-term meteorological data	© Met Office
12.	Location of industrial plants (shapefile) with reports from the previous mapping round and other information on industrial areas (IPPC Sites layer, Environmental Sites layer, Round 3 noise measurement reports, IPPC Permits noise survey reports)	© Environment and Resources Authority
13.	Data on projects, extensions and investments in roads (Cycle lanes, IM drawings - Central link, IM drawings - Marsa Junction, IM drawings - Tal Balal, IM drawings - Via Santa Lucia, IM drawings to shapefiles, shapefile for the site areas of major projects carried out, List of road works where SMA was used, and pdf site plans as available)	© Infrastructure Malta

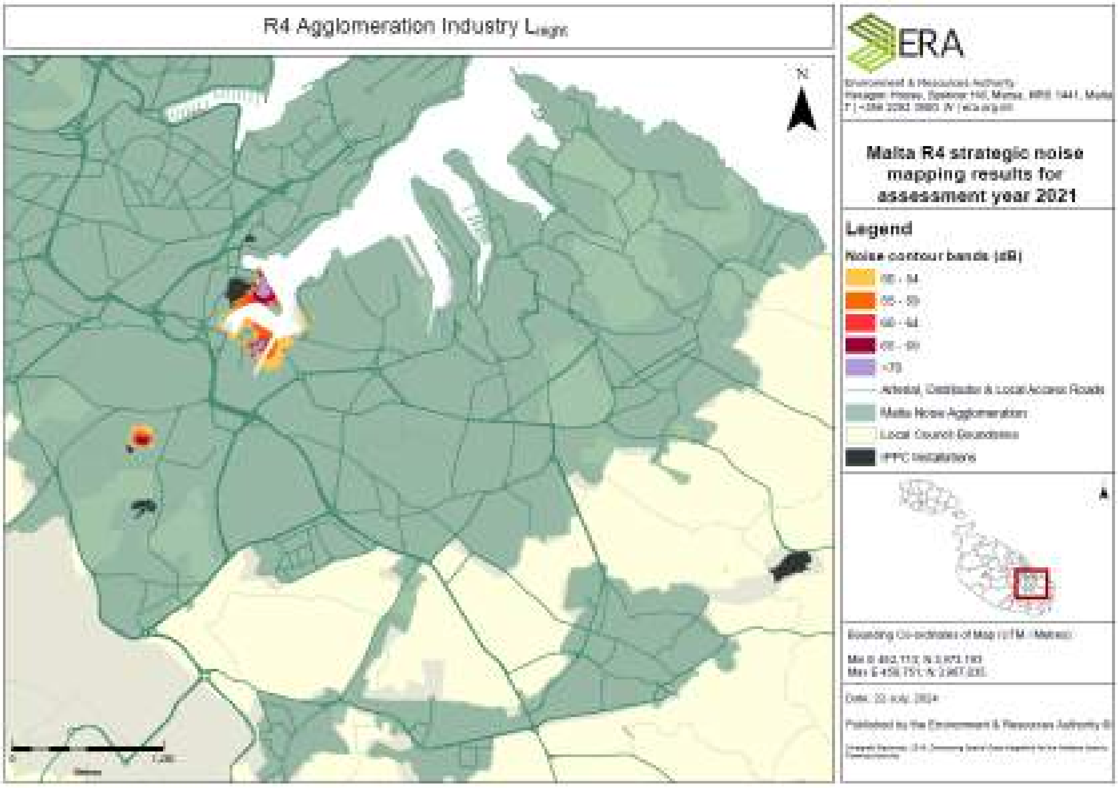
No.	Layer	Source
14.	Information and data about: runway direction, arrival route per aircraft, departure route per aircraft, data per aircraft movement	© Malta Air Traffic Services
15.	Information and data about: runway data, airport movements, airport map	© Malta International Airport
16.	UrbanAtlas 2018 data (land use on the island of Malta)	© Copernicus, European Environment Agency (EEA)
17.	Shapefile data on noise sensitive receptors (NSR's)	© Environment and Resources Authority
18.	Reports from previous mapping rounds	© Environment and Resources Authority

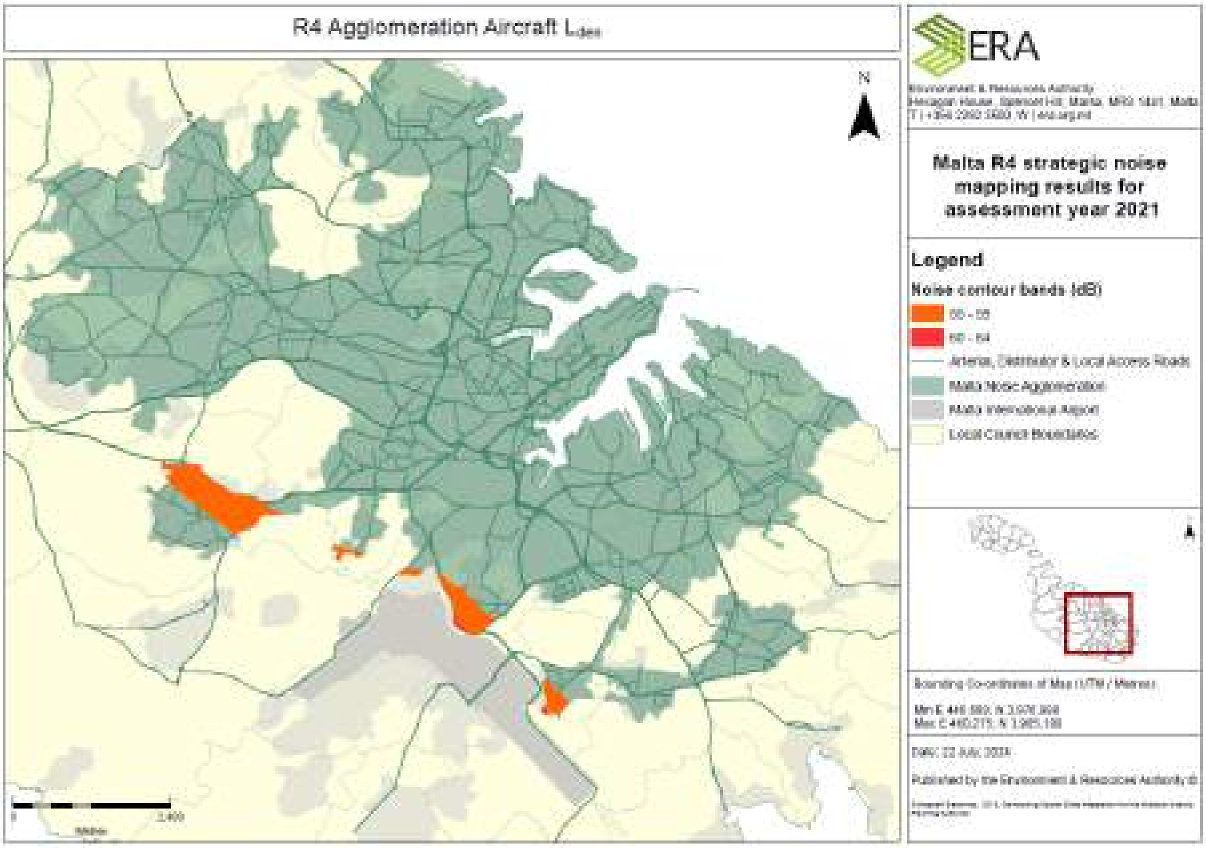
APPENDIX C: NOISE LEVEL CONTOUR MAPS

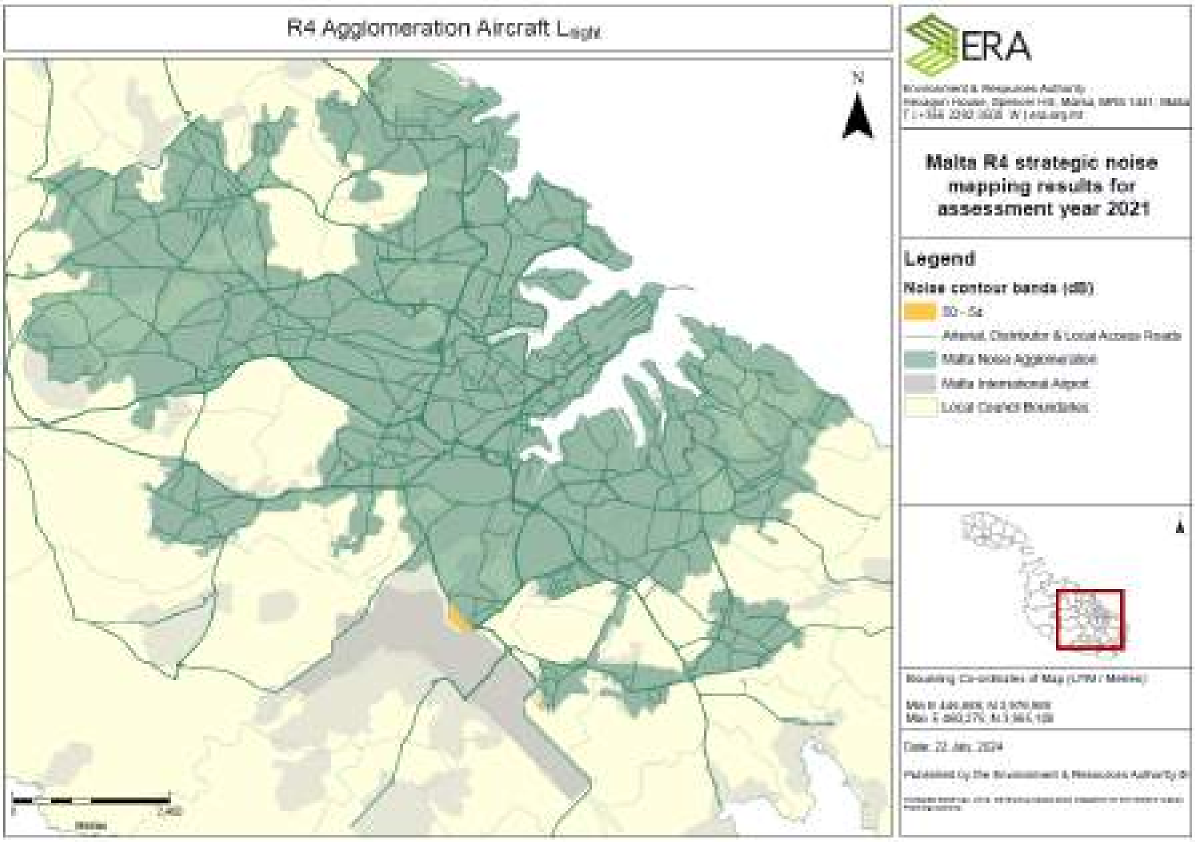


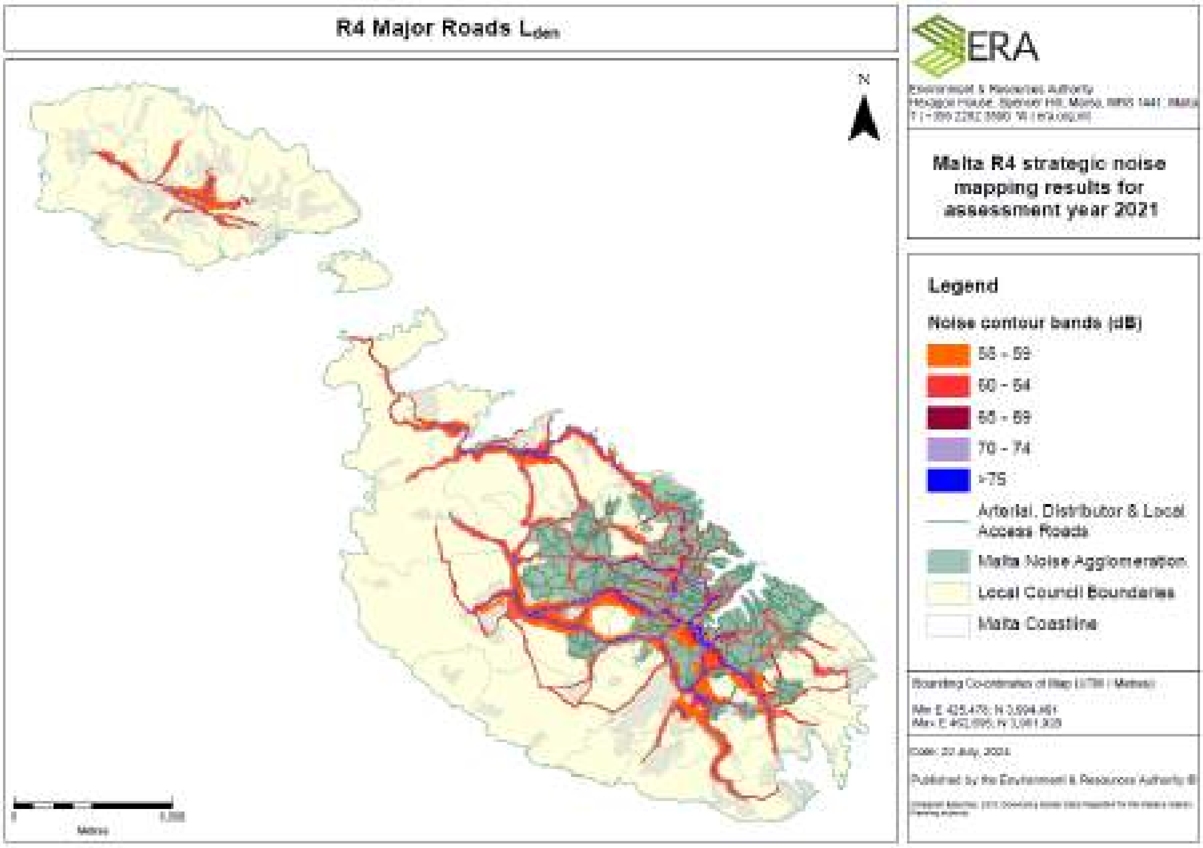


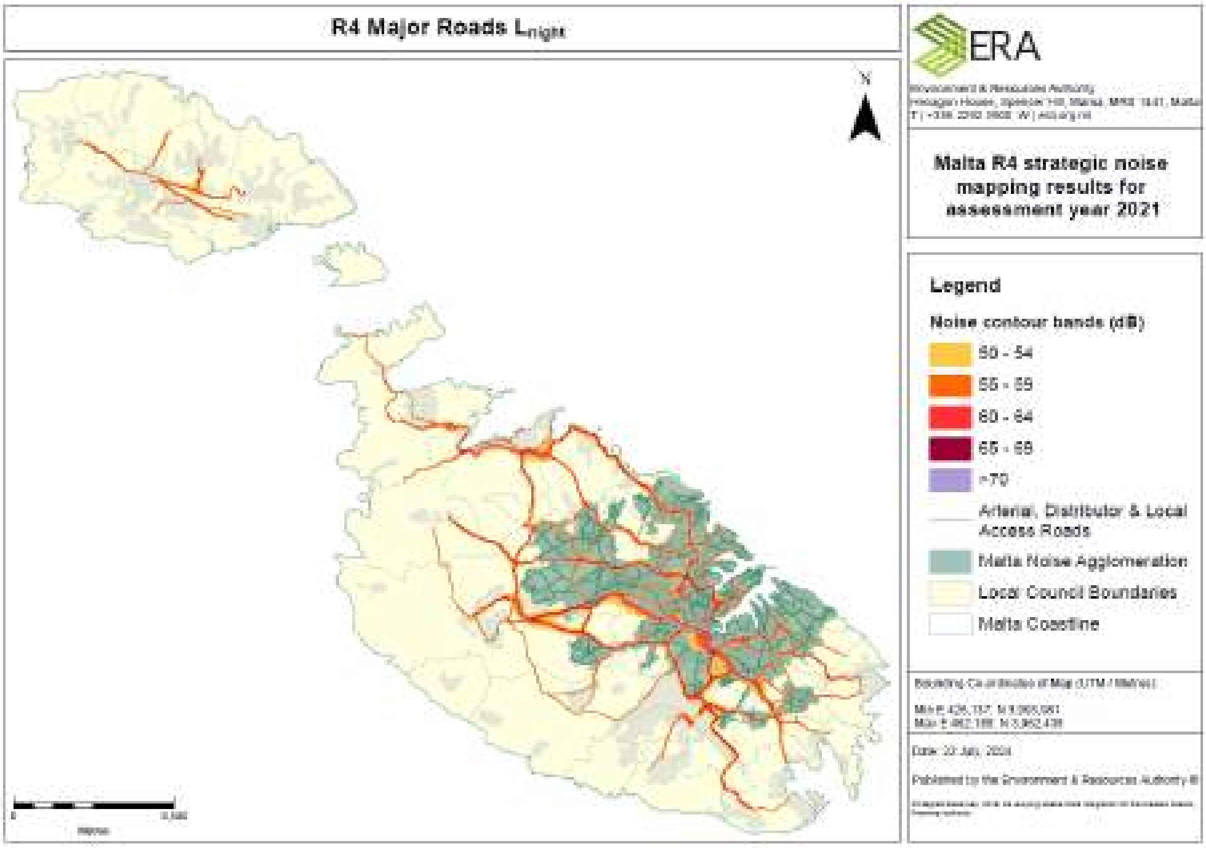

R4 Agglomeration Industry Lden
N
ERA
Malta R4 strategic noise mapping results for assessment year 2021
Legend
Noise contour bands (dB)
55 - 59
60 - 64
65 - 69
70 - 74
>75
Arterial, Distributor & Local Access Roads
Malta Noise Agglomeration
Local Council Boundaries
IPPC Installations


R4 Agglomeration Industry Lnight
N
ERA
Malta R4 strategic noise mapping results for assessment year 2021
Legend
Noise contour bands (dB)
50 - 54
55 - 59
60 - 64
65 - 69
>70
Arterial, Distributor & Local Access Roads
Malta Noise Agglomeration
Local Council Boundaries
IPPC Installations


R4 Agglomeration Aircraft Lden
N
ERA
Malta R4 strategic noise mapping results for assessment year 2021
Legend
Noise contour bands (dB)
55 - 59
60 - 64
Arterial, Distributor & Local Access Roads
Malta Noise Agglomeration
Malta International Airport
Local Council Boundaries


R4 Agglomeration Aircraft Lnight
N
ERA
Malta R4 strategic noise mapping results for assessment year 2021
Legend
Noise contour bands (dB)
50 - 54
Arterial, Distributor & Local Access Roads
Malta Noise Agglomeration
Malta International Airport
Local Council Boundaries


R4 Major Roads Lden
N
ERA
Malta R4 strategic noise mapping results for assessment year 2021
Legend
Noise contour bands (dB)
55 - 59
60 - 64
65 - 69
70 - 74
>75
Arterial, Distributor & Local Access Roads
Malta Noise Agglomeration
Local Council Boundaries
Malta Coastline


R4 Major Roads Lnight
N
ERA
Malta R4 strategic noise mapping results for assessment year 2021
Legend
Noise contour bands (dB)
50 - 54
55 - 59
60 - 64
65 - 69
>70
Arterial, Distributor & Local Access Roads
Malta Noise Agglomeration
Local Council Boundaries
Malta Coastline