



Project: **EPBC Act 2010/5747 Review of F-35A aircraft noise management and reporting**

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Report No.: **Rp 003 R02 20200162**

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Document Control

Status:	Ver:	Comments	Date:	Author:	Reviewer:
Complete	-	Issued for Defence review	26 February 2021	L. Deen/ A. Morabito	J. Adcock
Complete	R01	Issued for Defence review	6 May 2021	L. Deen/ A. Morabito	J. Adcock
Complete	R02	Issued for Defence/DAWE	17 May 2021	L. Deen/ A. Morabito	J. Adcock

EXECUTIVE SUMMARY

The first two (2) F-35A Lightning II aircraft arrived in Australia on 10 December 2019. Royal Australian Air Force (RAAF) commenced F-35A aircraft flying operations at RAAF Base Williamtown in mid-January 2020. Operations over Salt Ash Air Weapons Range occurred in May 2020.

This report addresses specific subclauses of Condition 3 of the approval decision (EPBC Act 2010/5747) for the flying operations of the F-35A aircraft in Australia.

The conditions define a range of ongoing management and reporting requirements relating to environmental noise from the operation of the aircraft, including a review of existing noise management programs, flight activity monitoring systems, and the communication of information on F-35A aircraft noise to the public.

The condition also requires a comparison of measured flying activity and noise levels with the assessment documented in the Environmental Impact Statement. This is addressed separately in the first biennial report (Marshall Day Acoustics, 2021) for the period December 2018 to December 2020. Defence's existing aircraft noise management programmes and the methods of reporting aircraft noise levels and flying operations to the public have been reviewed to address elements of Condition 3.b., Condition 3.c., 3.e.i. and 3.f.

The ongoing management of aircraft noise requires a careful balance between safety, operational requirements, and environmental noise levels. Importantly, the procedures used to minimise noise must not compromise the safe operation of the F-35A aircraft, having regard to the safety of the public and RAAF pilots, and must allow for training and operational requirements to be fulfilled.

The suitability of noise management programmes for addressing community impacts due to noise associated with F-35A aircraft operations have been evaluated and considered appropriate for the following reasons:

- Defence's policies and systems are comprehensive and contain the necessary elements to effectively manage F-35A aircraft operational noise;
- Each element of Defence's policies and systems is appropriately documented, integrated and communicated at different organisational levels to support the management of F-35A aircraft noise levels;
- There are mechanisms that aim to limit the occurrence of noise events, minimise noise levels when they do occur where practical, and register and investigate complaints to identify further opportunities to reduce aircraft noise;
- The systems in place are dynamic (i.e. reviewed and updated regularly) and effective at resulting in changes to reduce community noise impacts. This is evidenced through improvements that have been implemented, or are in the process of being implemented, including the recommendations identified by the Aircraft Noise Ombudsman's audit in 2016. Much of the improvements have been tailored to address the requirements of military fast jet operations and the introduction of F-35A aircraft operations;
- F-35A aircraft noise mitigation measures are consistent with those nominated by other international air forces that operate the aircraft;
- The noise management programmes are proportionate to the requirements to manage F-35A aircraft noise levels, and include review processes to enable management measures to be adjusted; and
- The number of complaints for RAAF Base Williamtown and SAAWR have been relatively consistent over the past eight (8) years, and less than half compared to 10 years ago, providing further support that existing noise management programmes, including the review and update processes are appropriate. Although the number of complaints in 2020 were higher than the number of complaints for the years immediately prior to the delivery of the F-35A aircraft, this may be attributed to changes arising from the COVID-19 pandemic, the increased publicity of the retirement of the F/A-18A/B Hornet and delivery of F-35A aircraft and the ongoing trials of differing flying operations as part of the transition period.

A review of how information on aircraft noise is monitored, reported and communicated was undertaken to address elements of Condition 3.c. and 3.e. The review compared information made available by Defence regarding F-35A aircraft noise and operations with the following:

- Publications regarding the presentation of aircraft noise information;
- Information prepared by other air forces that operate the F-35 aircraft; and
- Information prepared by major Australian civil airports and key features of the public interface of other proprietary aircraft noise measurement and flight tracking systems of large international airports.

The review determined that:

- The level of information provided by Defence is comparable to that of major civilian airports in Australia, and well beyond that of other international air forces; and
- There were areas where information could be refined or improved when benchmarked against relevant aircraft noise information guidelines and other systems. These items have been noted to inform Defence's internal review processes and identify how the reporting of F-35A aircraft noise and flying operations could be adapted in future if and where required.

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1.0 INTRODUCTION

The Royal Australian Air Force (RAAF) has commenced operation of the F-35A Lighting II (F-35A) aircraft. Noise from the proposed flying operations of the F-35A aircraft was previously assessed under the requirements of the Commonwealth Legislation, specifically the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Full details of the noise assessment were documented in the Environmental Impact Statement (EIS), Volume 10, Appendix F (Marshall Day Acoustics, 2014).

In July 2015, the Department of the Environment (now Department of Agriculture, Water and the Environment (DAWE)) published the approval decision (EPBC 2010/5747, 2015) (DAWE, 2015) for the flying operations of the F-35A aircraft in Australia. The approval decision outlines a suite of conditions including requirements for the management of environmental noise. Condition 3 of the approval decision defines a range of ongoing management and reporting requirements relating to environmental noise from the operation of the aircraft, including review of existing noise management programs, flight activity monitoring systems, and the communication of information on F-35A aircraft noise to the public.

The Department of Defence (Defence) subsequently engaged Marshall Day Acoustics Pty Ltd (MDA) to provide input to the environmental noise reporting requirements outlined in the approval decision.

This report has been prepared to address specific subclauses of Condition 3 of the approval decision and includes an appraisal of existing aircraft noise management programs, and a review of how information on aircraft noise information is monitored, reported and communicated.

The report has been prepared with reference to the Technical Method Document (Marshall Day Acoustics, 2020) which was prepared to clarify a method to address the conditions and inform the preparation of this report.

Section 3.0 presents a review of existing aircraft noise management programmes, including community consultation to address elements of Condition 3.b., Condition 3.c., 3.e.i and 3.f.

Section 4.0 reviews the aircraft noise information and flight activity reported by Defence to address elements of Condition 3.c. and 3.e. The information is benchmarked with best practice in Australia for the provision of aircraft noise information.

The review of F-35A aircraft noise and flying activity required as part of Condition 1 and Condition 3, is documented in the separate Marshall Day Acoustics report (2021), which is cross-referenced where appropriate in this report.

A glossary of terminology and abbreviations used throughout this report is provided in Appendix A.

A list of the documents referenced in this report is provided in Appendix B.

2.0 APPROVAL DECISION

The approval decision (DAWE, 2015) for the flying operations of the F-35A aircraft in Australia, EPBC Act project Approval 2010/5747, outlines conditions relating to the management of F-35A aircraft noise. These include requirements to review existing noise management programs, flight activity monitoring systems, and the communication of F-35A aircraft noise information to the public.

This report addresses the following clauses of Condition 3 from the approval decision:

3. Prepare and implement Aircraft Noise Management Plan(s), as described in the Aircraft Noise Management Strategy, at RAAF Base(s) to minimise noise disturbance at sensitive receptors from the flying operations of the F-35A Lightning II aircraft. The plan(s) must include, but not be limited to, the following measures:

...

b) A review of existing noise management programmes;

c) Monitoring, to validate predicted noise impacts to sensitive receptors at RAAF Base Williamtown (including Salt Ash Air Weapons Range), RAAF Base Tindal and RAAF Base Townsville. This must include, but not be limited to:

- i. An investigation of alternative noise measurement and analysis methods;*
- ii. utilisation of Noise and Flight Path Monitoring Systems (where installed), to provide ongoing noise information, and the development of a noise measuring system at RAAF Base Tindal;*
- iii. comparison of actual measured F-35A Lightning II aircraft noise levels with those predicted in the Environmental Impact Statement; and*
- iv. biennial review of noise monitoring locations, unless agreed with the Minister.*

...

e) Reporting, to ensure clear and timely public access to noise levels and flight activity monitoring data. This must include, but not be limited to:

- i. conducting a biennial evaluation of the effectiveness of flight activity monitoring and programmes at RAAF Base(s) until agreed in writing by the Minister;*

...

f) Consultation activities, to ensure adequate communication with stakeholders, including local residents and relevant authorities. Consultation activities must include, but not be limited to:

...

- iv. development of a concise location specific package of key information related to noise levels and flight activity monitoring data that addresses community concerns in an easily understandable manner for the lay person.*

In relation to Condition 3, the overarching requirement to prepare an Aircraft Noise Management Plan for RAAF Base Williamtown was addressed by Defence's publication in 2018, which was subsequently endorsed by a DAWE delegate on 3 December 2018. The review presented herein is therefore primarily concerned with the information requirements set in the subclauses listed above. Comparisons of actual measured F-35A aircraft noise levels with those predicted in the EIS to address condition 3.c.iii. are presented in the separate Marshall Day Acoustics report (2021).

Appendix C provides a cross reference table of sections of this report that address these conditions.

3.0 NOISE MANAGEMENT PROGRAMMES

The review of existing aircraft noise management programmes presented in this section addresses subclauses of Condition 3.b., Condition 3.c.i. 3.e.i and 3.f of the approval decision. The method for addressing compliance with these conditions comprises:

- Reviewing whether Defence's policies and systems contain the necessary elements to effectively manage F-35A aircraft operational noise; and
- Evaluating the suitability of each element to support the management of F-35A aircraft noise levels.

To address the specific requirements of individual subclauses of Condition 3 in the context of application to F-35A operations, this section of the report provides:

- A summary of RAAF policies concerning aircraft noise;
- An overview of community consultation activities and communications;
- An overview of the aircraft noise complaint system and how the Noise and Flight Path Monitoring System (NFPMS) is utilised in regard to aircraft noise complaint management;
- A high level review of the noise management practices adopted by overseas air forces operating F-35 aircraft to provide a benchmark for evaluating the scope and effectiveness of Defence's policies and systems; and
- An evaluation of the suitability of the above to provide effective aircraft noise management that is proportionate to the significance of aircraft noise impacts near RAAF bases and ranges.

A key point of context to the appraisal presented herein is that RAAF Base Williamtown has been a permanent fighter aircraft base since its construction in 1941. Military aircraft noise has therefore been a long term feature of the environment around RAAF Base Williamtown and SAAWR. Historic and future aircraft operations have previously and will continue to result in periodic high noise levels at surrounding sensitive receptors.

The ongoing management of aircraft noise requires a careful balance between safety, operational requirements, and environmental noise levels. Importantly, the procedures used to minimise noise must not compromise the safe operation of the F-35A aircraft, having regard to the safety of the public and RAAF pilots, and must allow for training and operational requirements to be fulfilled.

3.1 RAAF noise policies and systems

RAAF Base Williamtown is the headquarters of Air Combat Group (ACG), who are responsible for F-35A aircraft operations. However, aircraft noise management requires coordinated efforts at multiple levels within Defence. The objective of RAAF policies is to clarify and communicate noise management objectives throughout the organisation and define how aircraft noise is to be managed.

This section provides a summary of the Defence aircraft noise management strategy, framework, policies, and publications.

3.1.1 Air Force Aircraft Noise Management Strategy 2018

The Air Force Aircraft Noise Management Strategy sets out the high level objectives and responsibilities for managing aircraft noise in and around RAAF bases and training areas. The strategy sets out the following six (6) objectives for managing aircraft noise, as well as the goals and commitments to achieve them:

1. Minimise the impact of aircraft noise on local communities;
2. Continue proactive community engagement and consultation;
3. Manage noise complaints effectively;
4. Minimise urban encroachment on Air Force airfields and training areas;
5. Conduct responsible environmental planning; and
6. Integrate a comprehensive noise management system into Air Force activities.

The strategy is designed for both internal (Defence) use, public release, and provides the overarching framework for how the RAAF will balance operational and training requirements with their obligation to meet environmental legislative requirements and the minimisation of noise impacts on local communities.

Defence reviews the Air Force Aircraft Noise Management Strategy every five (5) years.

3.1.2 Aircraft Noise Management System

The Aircraft Noise Management System (AC SI(OPS) 03-11) (ANMS) is an internal RAAF document.

The purpose of the ANMS is to guide the implementation of aircraft noise management at a local level (base by base), referring to higher level policies, including the Air Force Aircraft Noise Management Strategy. It provides guidance on the preparation of operational plans and procedures, encourages open communication and consultation with the public for managing noise from aircraft operations.

The key elements of the ANMS include:

- Defining responsibilities
- Aircraft noise mitigation procedures;
- Aircraft noise complaint management;
- Communication and collaboration; and
- Monitoring and review.

The ANMS applies to all flying and ground operations involving Air Force aircraft, civil-registered aircraft leased by the Air Force, Defence contracted aircraft operated by external service providers, and foreign military aircraft operating in Australia.

Defence reviews the ANMS every two years.

3.1.3 Fly Neighbourly Policy

The Fly Neighbourly Policy (FNP) (Air Combat Group, 2012) is a publicly available document that summarises procedures to minimise noise.

The FNP guides and promotes the undertaking of Defence flying operations in a manner which is considerate of local communities, while still maintaining safe operation of aircraft and achieving the required level of capability.

The following items in the FNP apply to all flying operations conducted by RAAF pilots at all bases where RAAF aircraft operate:

- Comply with published airfield noise abatement procedures (procedures specific to RAAF Base Williamtown and SAAWR are discussed further below);
- Use appropriate runway length for departures to maximise height over local communities;
- Minimise the use of afterburner on fast jets during take-off and minimise noise during climb out;
- Limit the speed of aircraft when flying over populated areas;
- Minimise flight over residential areas and other noise sensitive buildings such as hospitals and schools;
- Avoid low flying over known noise sensitive areas such as livestock yards;
- Minimise flying late at night or early in the morning;
- Include aircraft noise awareness in pilot training and familiarisation; and
- Notify local communities of major exercises or other non-routine training and flying activities such as flying displays.

In addition to the general items above, RAAF implements base-specific procedures where necessary. The following procedures were developed by ACG and are specific to fast jet operations at RAAF Base Williamtown and SAAWR:

- Comply with fast jet visual departure procedures outlined in *Flight Information Handbook Australia* (FIHA) AD2 Supplement (SUPP) Williamtown (YWLM):
 - Departures on runway 30 to eastern airspace are to be conducted over Grahamstown Dam and turn to nominated departure gates north of Medowie to minimise overflight of populated areas. If required to overfly Medowie, aircraft are to fly at an altitude of at least 3,500 ft above mean sea level (AMSL),
 - Departures on runway 30 turn left to minimise overflight of Raymond Terrace,
 - Departures on runway 12 are to continue straight on the extended runway centreline, and not turn until over the ocean or once at an altitude of at least 2,500 ft AMSL;
- Arrivals are to primarily be visual using the 'Initial and Pitch' method, which are the quickest and most efficient way for aircraft in formation to land at the base. The intent is to minimise the number of instrument arrival procedures which generally result in aircraft flying at lower altitudes for longer durations over Raymond Terrace, and therefore result in higher community noise levels, when compared to Initial and Pitch arrivals;
- Minimising flying operations at SAAWR to a level that meets Defence's training needs; and
- Flying formations at SAAWR minimised to two (2) aircraft in lieu of four (4), where possible.

These military fast jet noise mitigation measures were developed by ACG in 2012 and are regularly reviewed. The measures are reviewed and updated such they can be adhered to by all local and visiting fast jets operating at RAAF Base Williamtown and SAAWR, including the F-35A aircraft.

3.1.4 Base Aircraft Noise Management Plans

The ANMS requires Base Aircraft Noise Management Plans (BANMP) to be implemented at RAAF Bases to minimise noise disturbance at sensitive receptors arising from F-35A aircraft operations, consistent with Condition 3 of the approval decision.

The RAAF Base Williamtown BANMP was prepared by Defence in 2018 and endorsed by a DAWE delegate (document ID G1082525/G14263835), and applies to all aircraft operations at the base and SAAWR. It is reviewed and updated annually.

The RAAF Base Williamtown BANMP includes:

- Descriptions of standard aircraft operations and variations to standard aircraft operations;
- Specific aircraft noise management procedures that apply to operations at the base. Items of note include:
 - Noise management is to be a briefing item for all flying. ACG aircrew are to conduct operations with due cognisance of the impact of noise on communities,
 - Specific requirements of low altitude flying and flight paths are in place to avoid overflying communities,
 - Minimising afterburner use by the F-35A aircraft where practicable and to minimise thrust settings at times during departures and arrivals once safe altitudes and airspeeds are achieved,
 - Management of noise from aircraft engine maintenance ground operations,
 - Relocation of the F-35A Engine Test Facility (for live engine testing);
- A summary of community consultation practices, the NFPMS for the base, and how noise complaints are lodged by the community; and
- Details of how Defence is complying with the requirements of Condition 3 (Enclosure 1 to the BANMP).

BANMPs have been developed for RAAF Bases Tindal, Townsville and Darwin have been submitted to DAWE, with the RAAF Base Darwin NMP approved 12 May 2021.

3.1.5 Other

There are several other publications and Standing Instructions (SI) that are used internally by Defence to maintain consistency in flying operations and manage aircraft noise at all airbases in Australia. Some examples include:

- Air Activities Environmental Management Plan, which provides guidance for flight planners and aircrew to identify sensitive receptors and consider potential aircraft noise;
- Flight Information Handbook Australia;
- General Planning Australia;
- En Route Supplement Australia;
- AC SI (OPS) 03-04: Supersonic Flight (i.e. flying speeds greater than the speed of sound), which limits supersonic flight over populated areas in order to minimise any impact to the public from sonic disturbances

In addition to RAAF publications, Condition 2 of the approval decision specifies the following requirement for F-35A operations in Australia:

Implement the management and mitigation measures outlined at M01 to M36 of Appendix M of the Environmental Impact Statement and at S01 to S08 of Annex A.

Defence published an annual compliance report (2020) which described the implementation of these measures. The relevant F-35A aircraft noise management and mitigation measures referred to in the condition are reproduced in Table 1.

Table 1: F-35A aircraft noise management measures reproduced from Appendix M of the EIS

No.	Item
M01	Schedule operations on weekdays, where possible (training flights on weekends and public holiday will not generally occur).
M02	Schedule the majority of aircraft movements generally between 7 am and 10 pm (11 pm during daylight savings). (Applicable to RAAF Base Williamtown)
M03	Comply with flight path requirements as specified in the Defence policies.
M04	Follow the Air Combat Group Fly Neighbourly Policy guidelines where training and operational requirements and flight safety circumstances allow.
M05	Limit night flying at SAAWR to the minimum required to achieve operational and training targets.
M06	Comply with noise complaint handling procedures as specified in Defence instructions.
M07	Adopt a 60% thrust setting during climb, as a standard procedure where training and operational requirements and flight safety circumstances allow
M08	Limit afterburner takeoffs to only those that are required for training, operational and safety reasons.
M30	Abide by the nofly zone over Cabbage Tree Island and Boondelbah Island during Gould's petrel breeding season. Under the no fly zone, F-35A aircraft will have altered flight paths to avoid flying close to, or above the islands.
M35	Liaise with relevant land use planning agencies and authorities in the areas in which the F-35A aircraft operates.
M36	Consult with key stakeholders regarding flying operations, compliance with approved flight paths and operational controls, and future plans.
S01	Implement an Aircraft Noise Management System that will require each RAAF Base or Force Element Group to develop an aircraft noise management plan
S02	Maintain a Memorandum of Understanding with the Aircraft Noise Ombudsman to independently review F-35A aircraft noise management and complaint handling
S03	Introduce new noise abatement procedures for RAAF Base Williamtown in October 2014.
S04	Conduct additional noise assessments at child care centres on RAAF Base Williamtown, RAAF Base Darwin, and RAAF Base Amberley.
S05	Investigate engineering options that would provide practical solutions to reduce the exposure of children on RAAF bases to aircraft noise.
S06	Provide updated noise information for the F-35A aircraft as it becomes available, particularly information on the noise from cannons.
S07	Continue publication of noise and flight path monitoring data for RAAF Base Williamtown, RAAF Base Darwin, and RAAF Base Townsville on the Defence Aircraft Noise website.
S08	Maintain and continue to participate in forums for community consultation such as the Williamtown Advisory Group and the Darwin International Airport Community Consultation Group

The report on F-35A aircraft noise and flying activity for the period December 2018 to December 2020 (Marshall Day Acoustics, 2021) also summarises the implementation of these measures.

3.2 Community consultation activities and communication

This section provides an overview of Defence communications and public consultation activities for managing aircraft noise to address Condition 3.f. of the approval decision.

Environmental noise is a significant and unavoidable consequence of aircraft operations. Public communication and consultation are therefore essential elements in aircraft noise management for the following reasons:

- To identify and understand any significant community concerns to be addressed as part of any noise mitigation strategies;
- To provide communities with realistic expectations about how noise can be managed;
- To circulate information about any planned operations that may differ from regular activity and may cause high noise levels or more frequent noise events; and
- To provide confidence to communities that their concerns are being continually recognised and considered and that reasonable and practical measures to reduce the noise are continually being reviewed.

In addition to online reporting about aircraft noise levels and flying activity (refer to Section 4.0), public communication and consultation are addressed by Defence in several ways that are tailored to meet the relevant circumstances of communities around each base.

A RAAF Base Williamtown Community Engagement and Information Provision Plan (CEIP) was developed in November 2018, and outlines the key mechanisms and forums to communicate with residents. The CEIP is reviewed and updated annually. Similar plans are to be developed for the other Main Operating Base (MOB), RAAF Base Tindal, and the Forward Operating Bases, as F-35A aircraft operations commence at those locations. Part of the CEIP is scheduling ongoing planned and structured engagement with key stakeholders. The CEIP aims to update stakeholders through established forums in an efficient manner.

The forums provide an opportunity for direct engagement between community, Defence and a range of stakeholders, including all levels of government. The forums encourage community engagement and provide a greater understanding of military flying activities and base operations.

An example communication forum is the Williamtown Advisory Group (WAG), that primarily functions to engage and inform the community regarding RAAF Base Williamtown military and Newcastle Airport civilian operations. The WAG is a scheduled forum that meets every six (6) months and comprises representatives from Defence, Newcastle Airport, local government, state government and the local community.

Defence continually review ways to improve their community engagement. Examples of previous improvements to the dissemination of aircraft noise information include:

- Increased media releases around non-routine activities, such as training exercises (Dawn Strike, diversions to other airfields), low altitude flying, flypasts for base commemorations and ceremonial events (e.g. ANZAC Day, Remembrance Day);
- Increased social media program and planning;
- RAAF Base Williamtown website and flying program notifications via several general and local community media channels. This is now part of standard operations to inform the public (i.e. Operations Near Me website discussed in Section 4.2); and
- Direct email notifications to specific base and weapons' range neighbours of non-routine activities.

Other community consultation and engagement activities undertaken by Defence include:

- Community-specific meetings, such as SAAWR Community meetings;
- Community open days, for example:
 - An open day for the F-35A precinct in July 2019 for 200 invited guests comprising local, state and federal Members of Parliament, key stakeholders and WAG members,
 - WAG members flown to RAAF Base Amberley to view the F-35A aircraft that was transported to Australia specifically for the 2017 Australian International Air Show Avalon;
- Operation of a free-call 1800 phone number to enable the community to access further information about base operations, and to facilitate the aircraft noise complaints management system (refer Section 3.3).

3.3 RAAF aircraft noise complaint register and response process

3.3.1 Overview

This section provides an overview of the aircraft noise complaint register and response process.

An objective of the ANMS is to *manage noise complaints effectively*.

This is addressed by:

- Providing an appropriate and timely response to noise complaints;
- Providing adequate training and instruction to staff who manage aircraft noise complaints;
- Sharing information about exercises and non-routine flying activities with the Airservices Australia National Complaint and Information Service;
- Continuing participation in the Government Aviation Complaint Handling Forum; and
- Working closely with the Aircraft Noise Ombudsman (ANO).

Complaints are managed at a local level (base by base). The overall process is summarised below.

1. Complaints are received by the following means:

- Direct via a base specific 1800 phone number or via the Defence Switchboard; or
- Lodged via the Defence Aircraft Noise website on-line complaint form, letter or email; or
- Received via the ANO or Airservices Australia.

All complaints are directed to the Air Base Command Post (ABCP) of the relevant base. If the base receives a complaint that is outside of their responsibility to investigate, they pass it onto the relevant ABCP and inform Air Force Headquarters (AFHQ) Aircraft Noise.

2. The complaint is recorded:

- Details relating to the event are entered using a standardised form and at minimum includes details of the complainant's name, date and time of contact and a summary of the event.

3. The complaint is investigated:

- The investigating officer follows a process formally documented by Defence.
- Information is sought from the main operating squadron, Air Traffic Control, Public Affairs, relevant Wing and/or Squadrons where applicable, and responses are provided to the investigator for their review.
- Data including feedback from the above sources is to be used by the investigator to provide a response to a complainant.

4. Completing an investigation:

- The investigation into a complaint is to be completed as soon as practicable, however in all cases, a response is to be provided to the complainant within 28 days of the incident.
- The ABCP or investigating officer attempts to contact the complainant verbally three times or provide a written response within 28 days before considering the closure of the complaint.
- A complaint or enquiry is considered 'completed' where one of the following applies:
 - The complainant or person seeking information is satisfied,
 - All reasonable steps have been taken to investigate the complaint and an appropriate remedy and/or a full explanation for the situation has been offered to the complainant or person seeking information, or
 - The complaint or issues of concern are being managed through a separate process.

5. Review:

- Each complaint is reviewed by Headquarters Air Command (HQAC) to ensure that the ANMS process have been followed appropriately, if any noise management opportunities have been identified and if those identified opportunities have been implemented.

6. Complaint Closure:

- Each complaint is registered in a central database held by AFHQ.
- If the complaint is not lodged with the Aircraft Noise Ombudsman (ANO), it is closed by AFHQ. If the complaint is lodged with the ANO, it remains open until the ANO has concluded their independent investigation and any follow-on recommendations have been implemented.

As identified above, if a complainant is not satisfied with how Defence have responded to a complaint, they may elevate their complaint to the ANO. The ANO conducts independent reviews of Airservices Australia's and Defence's management of aircraft noise-related activities, including complaint handling, community engagement and the distribution of aircraft noise information.

3.3.2 ANO Review of Defence's Aircraft Noise Complaints Management System

Following agreement with the Department of Defence in 2015, the ANO now also serves as an independent noise complaint and review mechanism for Australian Defence Force flight operations in Australia. The ANO's work with Defence has focused on the need for a high level of community engagement and improved administrative practices, including the provision of noise related information.

The ANO annual reports (Aircraft Noise Ombudsman, 2019, 2020) indicate a total of nine (9) complaints relating to Defence aircraft operations for the 2018-2019 financial year, and 13 complaints in the 2019-2020 financial year. A review of the aircraft noise complaints at RAAF Base Williamtown and SAAWR for 2019 and 2020 are provided in Section 3.3.3.

The ANO (2016) published the *Review of Defence's Aircraft Noise Complaints Management System*. The review assessed the effectiveness of Defence's handling of complaints relating to aircraft noise and provided recommendations for improvements where appropriate. The report adopted Australian/New Zealand Standard AS/NZS 10002:2014 *Guidelines for complaint management in organizations* (AS/NZS 10002) as a benchmark for the review.

A summary of the seven (7) ANO recommendations from the review are reproduced in Table 2.

Table 2: ANO recommendations for Defence's Aircraft Noise Complaints Management System

No.	ANO recommendations from the 2016 review
1	Defence should expand the focus of complaint investigation beyond compliance checking to also identify and pursue opportunities for noise improvements, improved community engagement and better public information.
2	To help in managing complainant expectations, Defence should improve the public information about the complaints process to address the information requirements outlined in AS/NZS 10002 and as identified within the report.
3	Defence should review the Defence Aircraft Noise web information and, taking account of comments in this report, make improvements to information provision, presentation and functionality.
4	To support the timely release of written responses, Defence should: a) Document the procedures to be followed in the event of written complaints (whether received through post, email or an online form), ensuring such procedures incorporate a timely acknowledgement of the complaint b) Streamline any necessary review and approval processes for written responses to complaints c) Consider the provision of training and support material for staff that will be responding to complaints, in particular via email following the introduction of electronic complaint submission.
5	Defence should adhere to its existing requirements for complaint recording and tracking.
6	Defence should update its localised recording systems and the OA39 form as appropriate to incorporate: a) Closing date b) A place to record consideration of noise improvement opportunities, community engagement improvements and public information improvements c) Undertakings or follow up action required (including who is accountable for delivery) d) A mechanism for tracking any undertakings or follow up actions through to completion.
7	a) Ensure that complaints not readily ascribed to a base are managed as effectively as other complaints b) Share data, experience and learnings across bases to maximise noise improvement opportunities and enhance complaint management across Defence.

Section 5.17 of the *ANO 20109-2020 Annual Report* confirms that the ANO closed out all recommendations in November 2019, with recommendation 2 to update the Defence Aircraft Noise website the last item to be addressed and was being actively undertaken by Defence.

This outcome indicates that the ANO considers Defence's Aircraft Noise Complaints Management System to be either satisfactory or is in the process of being upgraded to satisfy recommended standards.

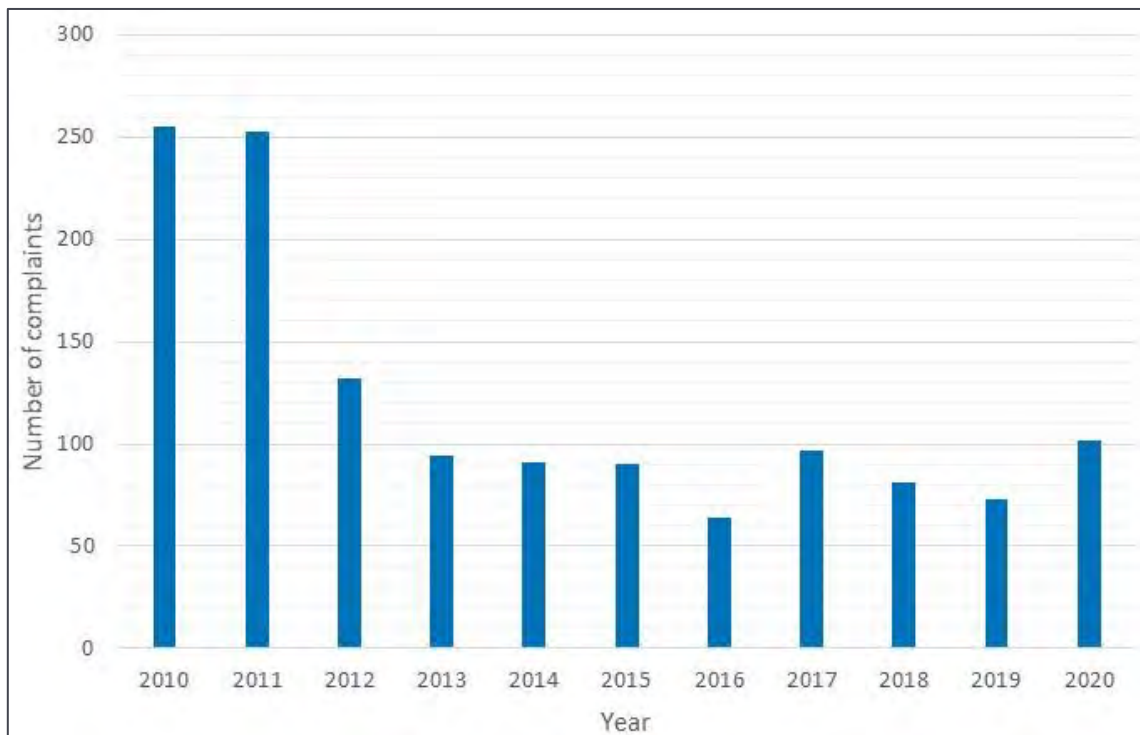
3.3.3 Complaints management

Aircraft noise complaints are managed at a local level (base by base). All complaints are registered and then addressed following a structured resolution process. Complaint investigations are to be completed as soon as practicable. In all cases, a response is to be provided to the complainant within 28 days of the lodgement of a complaint.

The aircraft noise complaint management system has undergone review by the ANO, and in November 2019 the ANO was satisfied that all recommendations either were implemented or are in the process of implementation.

ACG has provided counts of the number of annual aircraft noise complaints relating to operations at RAAF Base Williamtown and SAAWR received since 2010. These are summarised in Figure 1.

Figure 1: Summary of annual aircraft noise complaints at RAAF Base Williamtown and SAAWR 2010 – 2020



The annual number of complaints have been relatively consistent over the past eight (8) years, and are less than half of the number of complaints in 2010 and 2011.

A summary of the aircraft noise complaints by aircraft type is provided in Table 3 for 2019 and 2020 respectively, covering the time since the F-35A aircraft commenced operations at RAAF Base Williamtown.

Table 3: RAAF Base Williamtown and SAAWR aircraft noise complaints attributed to aircraft type – 2019-2020

Aircraft type	Number of complaints	
	2019	2020
F-35A	4	22
F/A-18A/B Hornet	50 complaints	19
Hawk 127	concerning military fast jets other than F-35A	28
Military fast jets (type unknown)	aircraft	28
Other Defence aircraft	7	5
Non Defence aircraft	12	-
Total	73	102

The investigation process for the 2019 complaints identified the following:

- One (1) F-35A aircraft complaint was identified to be a F/A-18A/B Hornet four-aircraft formation operation, not an F-35A aircraft as initially reported by the complainant;
- One (1) F-35A aircraft complaint was reported to be due to operations at SAAWR aircraft, although there were no F-35A aircraft operating on SAAWR at the time of complaint (October 2019); and
- Three (3) complaints related to SAAWR military fast jet operations.

The increase in complaints for the year 2020 relative to 2019 may be associated with the increased number of F-35A aircraft operations, however, may also be attributed to:

- Farewell flying operations associated with the retirement of the F/A-18A/B Hornet that were promoted through traditional and social media, including significant radio and television coverage. Of the 102 complaints for 2020, 19 were related to F/A-18A/B Hornet operations conducting farewell activities during the last week of flying (7 - 10 December 2020)
- F-35A aircraft conducting trial departures as part of ongoing evaluation of departure noise mitigation measures;
- An increase in people working from home during weekdays due to COVID-19, rather than at workplaces that may experience fewer aircraft noise events or that are less sensitive to noise than a home office environment;
- Minimal civilian aircraft flying activity as a result of COVID-19, causing Defence operations to seem more prominent; and

ACG has advised that the results of investigations into complaints for 2020 identified Air Force aircrew had conducted their flying operations in accordance with flying instructions, RAAF Base Williamtown BANMP and FNP subject to safety and operational considerations.

3.4 Noise and flight track monitoring information

Defence currently engages external contractors (Envirosuite) to install, maintain and operate the NFPMS at RAAF Bases Williamtown, Amberley, and Townsville. The system has been in use at RAAF Base Williamtown and SAAWR since 2005, at RAAF Base Amberley since 2010, and at RAAF Base Townsville since 2013.

The NFPMS data is collated, screened for sensitive operational information, and processed monthly by Envirosuite prior to being uploaded to the public website.

The system is used in the management of aircraft noise in several ways:

- Monitoring of specific conditions of the F/A-18F Super Hornet at RAAF Base Amberley, with the noise data reviewed with data contained within the Public Environmental Report and subsequent Noise Management Plans. The experienced gained from this process can be used as a point of reference for F-35A aircraft noise management;
- Ongoing monthly reporting of trends in flying operations and noise level measurements. For example, Envirosuite are currently using the data to assist ACG in the evaluation of alternative F-35A aircraft departure procedures, and resultant levels at noise monitoring terminal locations, as part of the RAAF Base Williamtown BANMP's Verification and Validation Program;
- Ongoing review by Defence on how the data can be used to evaluate the effectiveness of other noise management measures; and
- Providing input information for noise studies of Defence activities, such as the EIS, and noise modelling for the development of forecasts (e.g. Australian Noise Exposure Forecast, ANEF) that are used to inform land use planning around RAAF Base Williamtown and SAAWR.

Envirosuite and Defence are currently exploring ways to make NFPMS data more readily accessible to Defence in a timely manner for a range of uses concerning noise management, including complaint resolution.

Further details on the NFPMS are provided in Section 4.3.

3.5 Noise management practices by overseas Air Forces operating F-35 aircraft

A high-level review has been undertaken of military fast jet noise management practices implemented by the United Kingdom and United States and Air Forces operating the F-35 aircraft that may influence their F-35 aircraft operations. The review predominantly identified noise management practices that apply generally to military fast jet operations, including F-35 aircraft operations.

3.5.1 United Kingdom Royal Air Force (RAF)

The review of United Kingdom Royal Air Force (RAF) military fast jet noise management practices is summarised in Table 4.

Table 4: RAF military fast jet noise management practices

RAF noise management practices	Comments
Military low altitude flying at altitudes down to 100-250 ft occurs in three Tactical Training Areas in mid Wales, northern Scotland and near the border of Scotland and England. A timetable of days and times of low altitude flying in the three areas is made publicly available to inform the public of when flying could be expected to occur, however some aspects of the activity are planned on the day or can change without notice. There are no set flight paths and routes are varied as much as possible to minimise occurrences of noise disturbances in these areas, but there are some locations where this is not practical.	Low altitude flying and minimising noise are managed through RAAF's FNP and base specific BANMP that apply to military fast jet operations near noise sensitive receptors (refer Section 3.1.4). The <i>Defence Aircraft Noise</i> website includes a monthly calendar of general times of flying activity in designated flying airspace to provide information to the public on upcoming days and times of likely aircraft operations (Section 4.2.1).
The <i>Noise Amelioration Scheme (Military)</i> is a non-statutory assistance scheme for residents who live within the eligibility areas of military airfields and ranges, including RAF Marham where F-35 aircraft will be based. The scheme is part of a noise mitigation programme, which aims to reduce the effect of noise disturbance from military activities to those who live close to a military airfield or range. The scheme is based on 16-hour average noise level contours ($L_{Aeq,16hr}$) as follows: • Owners of properties within the 72 dB $L_{Aeq,16hr}$ contour may receive a purchase offer from MOD, or may opt for a grant for an acoustic glazing package if they do not wish to sell; • Owners of dwellings within the 66 dB $L_{Aeq,16hr}$ contour may receive a grant for acoustic double glazing package to habitable rooms and acoustic ventilation systems such that windows can remain closed for extended periods; and • Noise sensitive developments (e.g. schools, hospitals, aged care facilities) built prior to 2003 within the 63 dB $L_{Aeq,16hr}$ contour may receive a grant for an acoustic insulation package.	The Defence website refers homeowners who wish to reduce the impact of aircraft noise to the <i>Noise Control</i> page of the Department of Industry, Science, Energy and Resources <i>Your Home</i> website. Furthermore, Defence does not generally purchase noise-affected properties or fund noise attenuation measures (like ceiling insulation or double-glazing). It is noted that the UK scheme uses a different noise exposure metric (16-hour equivalent noise level, $L_{Aeq,16hr}$) to the metric used in Australia (ANEF).

The UK RAF documents reviewed did not include specific details of aircraft noise management practices to minimise aircraft noise, such as strategic runway and flight corridor use, setting minimum distances or altitudes for operations around key locations, avoiding scheduling flying operations for weekends and holidays or at night, limiting the use of afterburner.

3.5.2 United States Air Force (USAF)

The review of United States Air Force (USAF) F-35A aircraft noise management practices described in F-35A Beddown EIS is summarised in Table 5.

Table 5: USAF noise management practices applicable to F-35A aircraft

USAF noise management practices	Comments
The USAF Air Force Reserve Command (AFRC) published (2020) an EIS which assessed noise impacts at four alternative bases for F-35A Operational Beddown operations replacing the existing F-16 Fighting Falcon and A-10 Thunderbolt II aircraft. The EIS included discussion on the following noise mitigation measures for future F-35A aircraft operations at the four bases: • Reduce the number of practice approaches, particularly for visiting F-35A aircraft • Use of flight simulators for training purposes	RAAF have already broadly considered and implemented most of the noise mitigation measures for F-35A aircraft operations discussed in the AFRC EIS.
• Where possible, adjust runway usage patterns so that loud overflights occur less frequently over areas of greater noise sensitivity, particularly at night and on weekends and public holidays • Avoiding direct overflight of identified noise-sensitive receivers and neighbourhood areas around bases	There are minimum training requirements for RAAF F-35A aircraft pilots that must be met that in turn result in a minimum number of annual operations that must occur at RAAF bases. Importantly, the RAAF EIS was based on the number F-35A aircraft operations being comparable to F/A-18A/B Hornet operations. The EIS was also based on an increased utilisation of flight simulators, which is expected to result in a significant reduction in the use of SAAWR by F-35A aircraft compared to the F/A-18A/B Hornet. Flight track use to avoid overflight of noise sensitive areas is managed through RAAF's FNP and base-specific BANMP that apply to F-35A aircraft operations near noise sensitive receptors (refer Section 3.1.4).
• Regular review of opportunities to increase distance between aircraft and noise-sensitive locations by increasing altitudes or adjusting routing where possible to reduce aircraft noise levels at the ground. This includes 'expeditious' climbs to assigned altitudes during take-off • Only 5 % of departures are expected to utilise afterburner. Deactivation of afterburner at the base boundary (for select bases). It was not clear whether afterburner would be used only for the take-off segments of departures, or also for the climb segment.	RAAF are currently trialling and reviewing alternative departure procedures from RAAF Base Williamtown for noise mitigation as part of the Verification and Validation Program. The EIS forecast 20 % of F-35A aircraft departure operations at RAAF Base Williamtown would utilise afterburner, and afterburner would only be used during take-off and not during the climb.

USAF noise management practices	Comments
Limiting late night flying between 10 pm and 7 am to only 4 % of total AFRC operations. Further reductions would compromise pilot training requirements	The EIS forecast 20 % of F-35A aircraft operations during the evening and night (7 pm – 7 am), though the summary of actual flying records for the first two years indicate that evening and night flying has only comprised approximately 5 % of F-35A operations, and only 1 % of late night operations between 10 pm and 7 am. It is however expected that night flying will increase once F-35A operations reach Full Operating Capability, consistent with forecast in the EIS.
Limiting airspeeds within 30 nautical miles and below 10,000 ft altitude at select bases. Though not explicitly stated in the EIS, this is assumed to be intended to limit supersonic flight and sonic booms near noise sensitive areas	Restrictions on supersonic flight are already in place for RAAF aircraft, through AC SI (OPS) 03-04.
Continue to work closely with local communities to minimise noise impacts	There are existing community engagement activities undertaken by Defence as discussed in Section 3.2.
Validation studies for noise impacts identified in the EIS will be undertaken after the Beddown period is complete.	The approval decision includes conditions that require a comparison of measured flying activity and noise levels against the RAAF EIS. This is addressed as part of the first biennial report of F-35A aircraft noise and flying activity for the period December 2018 to December 2020 (Marshall Day Acoustics, 2021).
The USAF Air Combat Command (ACC) published an EIS on 19 November 2020 which included noise impact assessments at Tyndall Air Force Base (AFB) due to future F-35A operations. The EIS included discussion on noise mitigation measures for future F-35A aircraft operations that were comparable to those discussed in the AFRC as summarised above.	See comments above
The USAF Air National Guard (ANG) published a Draft EIS in August 2019 for the Beddown of F-35A aircraft operations at two of five alternative ANG bases. The F-35A aircraft would replace the existing F-15 Eagle, F-16 Fighting Falcon and/or A-10 Thunderbolt II fighter attack aircraft at the two selected bases. The EIS included discussion on the noise mitigation measures for future F-35A aircraft operations that were comparable to those discussed in the AFRC as summarised above.	Defence has already broadly considered and implemented these noise mitigation measures for F-35A aircraft operations as below.

USAF noise management practices	Comments
Additional items discussed in the ANG EIS included:	-
Avoid where practicable identified seasonally sensitive Indigenous American ceremonies or other activity	
Avoid overflight of ranches and recreational activity and on holidays below 5,000 ft	The FNP and BANMP discuss noise abatement for flying activity at or below altitudes of 5,000 ft. The base specific procedures identify sensitive areas and activities which are to be avoided or not flown over at a minimum altitude.
Flying between 10 pm and 7 am will be minimised to <1 % of F-35A aircraft movements	The summary of actual flying records for the first two years indicate that night flying (10 pm – 7 am) has only comprised approximately 1 % of F-35A aircraft movements.
A mitigation plan is to be developed following the final publication of the EIS. A final version of the EIS is not yet publicly available.	The DAWE approval decision included conditions that require the development of base-specific Aircraft Noise Management Plans. See Section 3.1.4 for further details.

The operational noise mitigation measures considered by the USAF are summarised as follows:

- Minimise the number of operations while still achieving operational and training requirements, including the use of flight simulators, and undertaking training at bases and training areas away from populated areas;
- Avoid flying at sensitive times, including at night and on weekends and public holidays;
- Reduce noise levels by maximising the distance between aircraft and noise sensitive receptors on the ground by using specific runways and flight paths, and by climbing at a steep angle during departures;
- Avoid overflight of noise sensitive areas or specific locations;
- Minimise the use of afterburner; and
- Undertake supersonic flying activities away from noise sensitive locations.

All the above types of mitigation measures have been adopted by RAAF for Australian F-35A aircraft operations. The measures are implemented via the existing RAAF policies and systems described in Section 3.1.

3.6 Evaluation

Environmental noise is an inherent aspect of military aircraft operations. However, Defence has committed to undertaking flying operations in a manner which is considerate of the local communities through the implementation of a comprehensive aircraft noise management system. The object of this system is to minimise aircraft noise while maintaining safe operation of aircraft and achieving the required levels of capability.

Aircraft noise is a local issue at Air Force bases and training areas. It is therefore managed and implemented at local (base specific) level, but guided by policies and strategies developed at AFHQ and HQAC levels which influence how F-35A aircraft are operated by the RAAF.

This review has identified there are strategies in place to support Defence's noise management programs through the development of policies and systems.

These policies and systems are considered appropriate for the following reasons:

- Each element of Defence's policies and systems are appropriately documented, integrated and communicated at different organisational levels;
- They include mechanisms that aim to:
 - Limit the occurrence of F-35A aircraft noise events,
 - When events do occur, minimise aircraft noise levels at key sensitive receptors and residential areas where practical,
 - Register and respond to complaints from the community regarding noise events, and
 - Investigate how noise events that result in complaint occur and identify opportunities to reduce aircraft noise;
- Mitigation measures specific to F-35A aircraft noise are consistent with those identified by other international air forces;
- They are dynamic (i.e. reviewed and updated regularly); and
- They are effective at resulting in changes to reduce community noise impacts.

Importantly, the programs include processes for the ongoing review and evaluation, consistent with the requirements of the approval decision. This is a key element to ensure the programmes remain appropriate as F-35A aircraft numbers and hence operations increase, particularly until a mature operating state has been reached. A prime example is the ongoing evaluation of F-35A aircraft departure profiles that differ to those envisaged in the EIS, but which aim to minimise noise at communities as far as practical.

Since 2015, RAAF has improved managing aircraft noise through undertaking detailed environmental impact statements, establishing fly neighbourly policies where they did not previously exist, updating ANEF maps and establishing community forums.

This includes updates to the following, which have been developed and refined in recognition of noise considerations relating to the introduction of F-35A aircraft operations:

- RAAF Base Williamtown and SAAWR specific noise mitigation measures;
- Aircraft Noise Management Strategy;
- nationwide Fly Neighbourly Policy; and
- Base Aircraft Noise Management Plans.

Systems are in place to effectively manage aircraft noise complaints. The ANO has reviewed these systems and considered them satisfactorily meet, or are undergoing improvement to satisfy recommended standards.

When investigating complaints, there are limitations when attributing an aircraft type and operation to an event that resulted in a complaint:

- The complainant is often unable to successfully identify an aircraft type visually, or does not provide enough information to sufficiently inform an investigation;
- The primary tool for the ABCP or investigating officer to correlate a specific aircraft operation with a complaint is to liaise directly with the flying squadron to establish what aircraft may have been operating near the complainant at the time of the noise event;
- The NFPMS collates flight track and aircraft noise level data that would be of benefit when investigating complaints. In most cases, the investigating officer can review the flying program and, if needed, obtain data to determine which aircraft type is involved. However, there may be instances where the data cannot be accessed from the system or monthly summary reports in a timely manner to identify the event and aircraft details without specifically engaging the NFPMS contractors for assistance; and
- There are times when the noise and flight track monitoring system has limitations in the identification of an aircraft as described in Section 4.3.3.

As the NFPMS correlates flight track and aircraft noise level data that is of benefit when investigating complaints, it can be an effective tool for assisting with investigations into complaints, particularly to provide additional information whether a particular aircraft operation was atypical or deviated from noise management policies.

Defence and the contractors responsible for the management of the NFPMS are currently exploring ways to make NFPMS data more readily accessible to Defence in a timely manner, which could be of benefit when providing responses to complainants within 28 days of receiving a complaint. All of this data is subject to strict security protocols.

4.0 REPORTING OF F-35A AIRCRAFT NOISE LEVELS AND FLIGHT ACTIVITY

This section provides a review of the aircraft noise and flight activity reporting and information provided to the public by Defence, and how this compares with best practice in Australia for the provision of aircraft noise information. The public information and website is available at <https://www.defence.gov.au/AircraftNoise/NFPMS/Default.asp>.

This section is prepared to address elements of Condition 3.c and 3.e of the approval decision. The method for addressing compliance with these conditions comprises:

- Undertaking a literature review for reporting of aircraft noise information;
- Review of Defence's current reporting of aircraft noise information; and
- Evaluation and recommended information reported by Defence on F-35A aircraft operations.

4.1 Literature review

A limited literature review has been undertaken to identify recent publications, new or updated policies, technologies and websites from other Air Force bases or major civilian airports for reporting of aircraft noise information.

The review has considered information in the context of reporting on military fast jet operations, including the F-35A aircraft.

4.1.1 Aircraft noise information

Aircraft noise information sources that have been reviewed include:

- Standards and guidelines;
- Recent environmental aircraft noise assessments in Australia;
- F-35A operations in Australia – EIS and other technical studies;
- Impact Assessments of F-35 aircraft operations outside of Australia; and
- Information provided on Australian civilian airport noise websites.

The detailed literature review findings are contained in Appendix D, with the key findings as follows:

- Standards Australia Handbook HB 149:2016 *Acoustics—Guidance on producing information on aircraft noise* (SA HB 149) (Standards Australia, 2016), released in 2016 after the publication of the F-35A EIS, presents a comprehensive guide to providing information to the public on aircraft flying activity and noise in the vicinity of an airport. A direct comparison between the recommendations of SA HB 149 and the information presented on the *Defence Aircraft Noise* website is presented in Section 4.4;
- The ANEF is the key publication for guidance on land use planning around Australian airports. The ANEF metric is specifically used in Australia in lieu of the day-night average sound level (DNL or L_{dn}) used overseas and referenced in some of the reviewed publications. ANEF maps endorsed by Defence, Airservices Australia or both are required to provide additional information on noise modelling assumptions;
- The F-35A Fauna Management Plan (Coffey Environments, 2016) and Western Sydney Airport EIS (Wilkinson Murray, 2016) both considered 90th percentile values for some noise metrics to represent typical upper aircraft noise level events or operational scenarios;
- Many publications present or recommend illustrations of aircraft flight corridors, and information on the frequency of aircraft movements in those corridors. Military fast jet flight tracks are prone to higher degrees of variation than those of civilian and commercial aircraft for a variety of

reasons, and result in flight tracks spread over large areas away from a RAAF base. Flight track density plots are a suitable tool for describing where military fast jets commonly fly;

- The F-35 EIS assessments prepared by the USAF present maps showing military airspace utilised around a base, but do not provide typical flight tracks between the base and the airspaces;
- The Onset Rate-Adjusted Day-Night Average Sound Level (L_{dnmr}) is an additional noise metric in the USAF assessments to describe annoyance associated with startle effects from military aircraft operations. This analysis is based on the L_{dn} metric, to assess the percentage of people highly annoyed by aircraft noise, whereas the ANEF metric is used in Australia;
- The Time Above metric is also referenced in USAF assessments to provide information on the occurrence of the interruption of speech-based activities;
- Several of the publications considered the average noise level (L_{Aeq}) during school hours when reviewing impacts at educational facilities. A limitation of this metric is that a scenario of few occurrences of very high noise level events can give the same $L_{Aeq,8hr}$ value as a scenario of many occurrences of lower noise level events. However, the period of time that learning activities may be impacted could be very different for the two scenarios with the same $L_{Aeq,8hr}$ rating. A number above analysis or a time above analysis to accompany an L_{Aeq} analysis like that presented in the USAF assessment could be considered as an alternative method to address the potential impacts of aircraft noise at educational facilities;
- The Airservices Australia website *Aircraft Noise in your Neighbourhood* sets a high standard for the provision of aircraft flying activity and noise to the public. The website integrates educational and explanatory material with flight path use statistics and noise level measurements on concise pages that are linked to flow in a logical manner; and
- Interactive maps with searchable addresses and switchable layers provided as part of online content are an effective way for people to quickly identify their location relative to the airport, and review flight paths, noise contours and noise monitoring terminals relevant to their location.

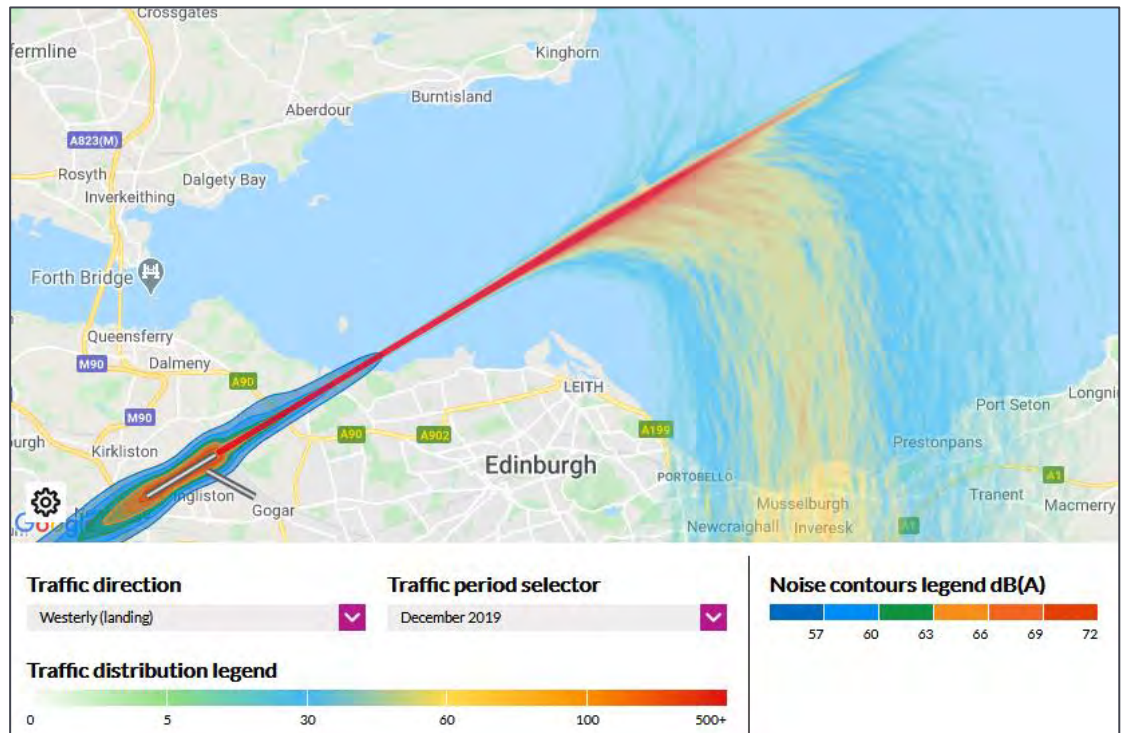
4.1.2 Features of aircraft noise measurement and analysis systems

The public interfaces for a selection of proprietary aircraft noise measurement and flight tracking systems have been reviewed, with details provided in Appendix D6.

The key findings from the review of these systems are as follows:

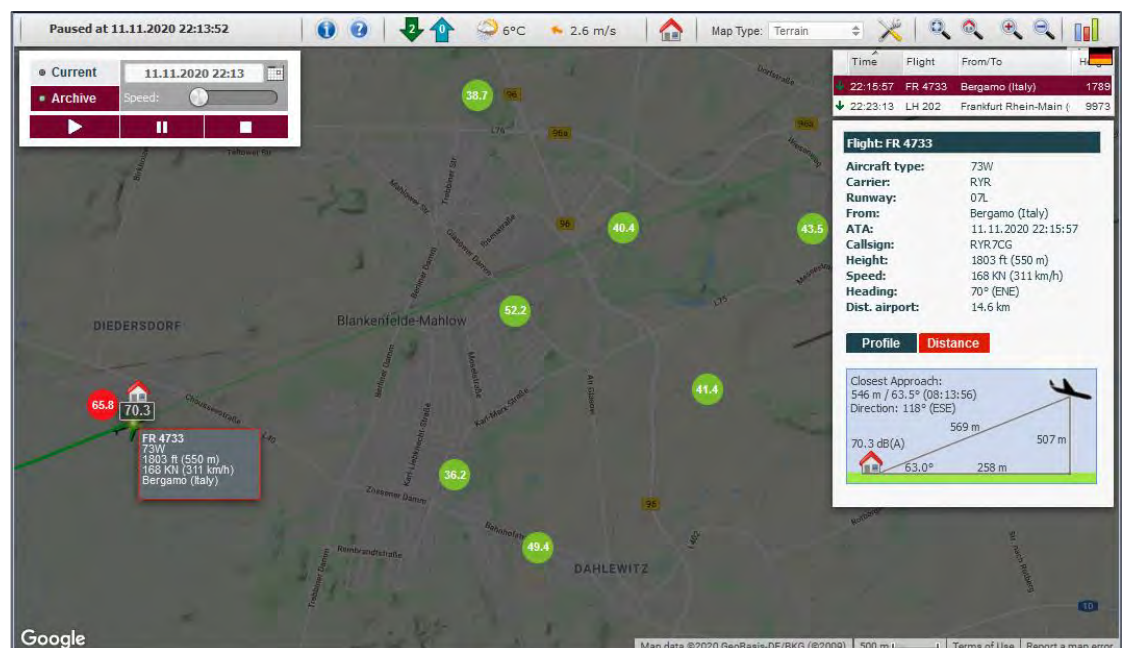
- All can present a comparable suite of fundamental aircraft noise and flight information to the public;
- The NFPMS used by Defence measures and computes much more information than what is currently provided on the Defence Aircraft Noise website (refer Section 4.3). Defence has nominated information they consider relevant and unclassified to be presented on the website to communities surrounding bases that is sufficiently informative based on feedback from consultation activities, but avoids confusion due to complexity or excessive quantity and satisfies defence operational security requirements;
- The Casper system provides airport specific information and other educational material on aircraft noise which is presented alongside interactive maps. The system can also be configured to show monthly density plots for arrivals and departure tracks from different runways, as shown in Figure 2. This example includes noise contours, which were noted to not change when different air traffic directions and months were selected. While not explicitly stated, these contours appear to be long-term average noise contours commonly referenced for UK land use planning and therefore based on the airport operating at full capacity in a future year. Based on current industry-standard technology, noise contours cannot be generated by these systems directly and can only be practically generated by aircraft noise modelling software packages.

Figure 2: Casper flight track density (source: <https://noiselab.casper.aero/edi/>)



- The Topsonic system shows distances and estimated (calculated) aircraft noise levels from a tracked event at any location on the map, as shown in Figure 3. However, uncertainties in the order of up to 5 dB were observed between instantaneous measurements at NMTs and estimated noise levels at the same location. Further, there are likely to be many limitations with the calculations and large uncertainties when estimating noise from military fast jets due to complex factors including highly variable thrust usage, formation flying, significantly variable sound directivity, spectral content and meteorological factors. The additional uncertainty in predicting noise levels from an actual military fast jet movement mean that it may not be appropriate to present predicted noise levels from a historic single movement.

Figure 3: Topsonic estimated noise levels at a user defined location on the map (source: <https://travisber.topsonic.aero/travis.php?lang=en>)



4.1.3 Information presented by other Air Forces operating F-35 aircraft

Other defence forces provide little information on military aircraft flying activity and aircraft noise, compared with many civilian airports, government authorities, community groups and other organisations that provide websites with much more detail.

A limited review of the United States Air Force (USAF), UK Royal Air Force (RAF) and Canadian Royal Air Force (RCAF) websites indicates public information on military aircraft noise is not easily accessible, compared with RAAF's *Defence Aircraft Noise* website (refer Section 4.2). Readily available online information on aircraft noise provided by these Air Forces is as follows:

- Several USAF Bases have published their own factsheets on military aircraft flying activity and noise. The fact sheets are approximately five pages and include discussion of the following:
 - Why jet noise can be heard from the base;
 - Training territories where the military aircraft fly;
 - The influence of weather on noise and flying operations;
 - How is aircraft noise minimised and lodging complaints;
 - Afterburner use;
 - Night flying;
 - Low altitude flying;
 - Noise from weapons ranges or supersonic flight; and
 - The DNL noise metric.

The website and factsheets provide phone numbers or online forms for the community to lodge enquiries or complaints on aircraft noise.

- The RAF webpages (<https://www.gov.uk/low-flying-in-your-area>) provide limited information on low flying military aircraft, weekly low flying timetables and information on lodging complaints or requests to avoid low level training during a key period. The website for RAF Marham, home of the RAF F-35B aircraft, also provides limited information on low flying and night flying, lodging complaints, enquiries and how to receive updates on flying operations (<https://www.raf.mod.uk/our-organisation/stations/raf-marham/flying-info/>)
- For select RCAF air base websites, instructions on information to provide when lodging a complaint on aircraft noise are provided in the bases' *Contact Us* webpages.

4.2 Defence Aircraft Noise website

4.2.1 Overview

The *Defence Aircraft Noise* website (<https://defence.gov.au/aircraftnoise>) can be accessed through Defence's primary website (www1.defence.gov.au), using the search function for 'noise' or other key words.

The RAAF website (<https://www.airforce.gov.au>) has a page on *Aircraft noise enquiries*, which provides a link to the Defence Aircraft Noise website.

A link to the *Defence Aircraft Noise* website is also provided on the Airservices Australia website and through the ANO website for lodging noise complaints.

Table 6 summarises the aircraft noise and flying activity information available through the *Defence Aircraft Noise* website. The information is relevant to all RAAF flying operations and will therefore include F-35A aircraft noise and flying activity. The summary includes review observations where opportunities to enhance the effectiveness of the system were identified. It is however important that the review observations are considered in the context of the broader finding of this review that RAAF aircraft noise reporting is significantly more comprehensive than that of other overseas air forces.

Table 6: Defence Aircraft Noise content summary

Website section	Summary	Review comments
Home	Introductory text on the need to meet operational and training requirements and the types of aircraft noise mitigation strategies used. Links to <i>the Aircraft Noise Management Strategy</i> and the <i>Fly Neighbourly Policy</i> documents.	-
Ops Near Me	Links to separate pages for each Royal Australian Air Force and Royal Australian Navy base with base-specific information, including: • The based squadrons and operating aircraft; • An interactive map through ‘Flying Operations’ page showing: - information on key flying areas, training airspaces and weapon ranges as well as announcements on upcoming flying events and a link to subscribe to an RSS (Really Simple Syndication) feed for alerts on atypical flying activity, flying demonstrations or ceremonial flying near populated areas around Australia; and - Each airspace has a calendar for upcoming events that depicts days of frequent or infrequent flying, helicopter flying and whether flying will occur in the morning, afternoon or evening. • Noise management, including: - A summary of the measures of the Fly Neighbourly Policy; - Descriptions of common military aircraft activity such as initial and pitch arrivals, circuit training and low flying activity; and - Links to key Air Force aircraft noise abatement publications, relevant EIS publications and any NFPMS sites if installed around the base; • Collaboration between Airservices Australia and Defence when designing flight paths; • Links to the ANEF maps for the base; and • Links to local community consultation group webpages or other base-specific contacts and where applicable, discussion on consultation regarding updates to ANEF maps. Provides links to Air Force, Army and Navy websites that list upcoming and historic training exercises. The Air Force website lists dates and times of specific military exercises, low flying, night flying or flying activity by uncommon aircraft types at locations all around Australia.	This review has focussed on RAAF Bases Williamtown, Tindal, Darwin and Townsville as these are the F-35A aircraft Main and Forward Operating Bases. The flying operations page separate out ‘fixed wing’ and ‘rotor wing’ (helicopter) flying activity, however, does not detail particular aircraft types. The intent of these pages is to provide general notification of flying activity and noise-related activities. The Air Force <i>Flying Operations</i> webpage identifies flying activity by specific aircraft. The ability for the public to subscribe and add calendar alerts regarding operations near them is a novel service provided by Defence. There are several locations on Defence and Air Force websites where notifications are posted. Notifications are also issued via social media platforms. Consolidating these notification services or implementing systems for maintaining consistency would improve the effectiveness of this system.

Website section	Summary	Review comments
<i>Environment</i>	Links to Environmental Impact Statements, Public Environmental Reports, consent conditions and related publications for the introduction of operations by F-35A aircraft, F/A-18F Super Hornet and Hawk 127 aircraft at key bases in Australia. The publications include detailed information on aircraft operations and noise level predictions. A review of the contents of the EIS reports has not been considered as part of this report.	The webpage does not explicitly state that detailed information on forecast F-35A aircraft flying activity and aircraft noise levels are included in EIS reports. Notwithstanding, the F-35A aircraft biennial reporting of actual noise and flying activity, as required by the approval decision would provide the latest information and compare with that in the EIS.
<i>Understanding Noise</i>	Includes informative subsections for the following: • Links to ANEF maps and the FNP through the 'Reducing Noise Impacts' page; • Discussion on the development of civil and military flight paths; • Military aircraft engines; • Low level flying; • Night flying; • Arrival types; • The types of aircraft weapons and weapon ranges; and • Condensation trails.	-

Website section	Summary	Review comments
<i>Forecasts</i>	Provides the endorsed ANEF map for each base. For RAAF Base Williamtown and SAAWR, the Main Operating Base for the F-35A page, additional information to support the development of the ANEF is also provided, including: • Summary report of model input data; • Noise model flight tracks; • Tabulated annual aircraft movements by aircraft type; • Comparison with previous endorsed ANEFs; and • Factsheets, including discussion of the EIS process. Supporting information on the ANEF system is also provided, as well as discussion on aircraft noise at existing and future residential properties.	As discussed in Section 4.1.1, AS 2021 requires endorsed ANEF maps prepared after 2015 to incorporate the noise modelling assumptions, including the annual aircraft movements for each runway. This information is only provided for the RAAF Base Williamtown and SAAWR ANEF, beyond that provided by other international defence force. The RAAF Base Tindal 2025 Australian Noise Exposure Concept (ANEC), included in the Forecasts page, was prepared in 2013 as part of the EIS, however is not an endorsed ANEF. Major Australian civilian airports include information on aircraft movements numbers, runway operating modes and flight track use in their Master Plan. There are potential differences in sensitivity of information and therefore, while additional information is provided for civilian airports, it is not necessarily appropriate for comparable information to be provided for a military airfield (security considerations, etc.).
<i>Monitoring</i>	Provides a summary of the NFPMS installed at RAAF Bases Williamtown, Amberley, and Townsville. Historic noise monitoring reports and a factsheet on the measurement of aircraft noise is also available. The factsheet discusses aircraft noise measurement metrics, studies of community annoyance due to aircraft noise and factors that influence aircraft noise propagation.	The features of the NFPMS are detailed in Section 4.3.
<i>Contact Us</i>	Provides an online form, a phone number, postal address and background information for the submission of enquiries and complaints. A link has also been provided to the Aircraft Noise Ombudsman should a complainant be dissatisfied with the investigation of the query. Further details of aircraft noise complaint handling are presented in Section 3.3.	-

4.2.2 Discussion

The RAAF is the only English-speaking Air Force to have a dedicated website with consolidated information on aircraft noise level and flying information, as well as maintaining a permanent system at three (3) bases for monitoring military, commercial and passenger aircraft flight tracks and noise levels at locations around each base. While some European joint user (military/civilian) airfields have similar noise and flight tracking systems, it was not clear whether military aircraft (including fast jets) are identified and 'live' or historic information presented on the public website, or if this information is obtained but not provided to the public.

It is therefore important to recognise that the quality and quantity of military fast jet information presented on the Defence Aircraft Noise website and made available to the public is above that provided by other Air Forces. The reported aircraft noise measurement information on the Defence NFPMS site is comparable to that provided by operators of Australian civilian airports.

The key points of the above reviews are as follows:

- The *Defence Aircraft Noise* website is readily accessible by search engines using key words, though it is difficult to quickly locate when navigating the primary Defence or Air Force websites;
- The website provides links to base specific pages, consistent with existing RAAF policies to implement aircraft noise management at a local level (base by base);
- The level of information is tailored to the specifics of the base, e.g. additional F-35A aircraft noise information is provided for RAAF Base Williamtown and SAAWR, the F-35A aircraft Main Operating Base;
- F-35A aircraft flight track information showing where aircraft fly is provided in two (2) ways:
 - Historic flight tracks that have been flown, which are measured by the NFPMS at RAAF Bases Williamtown, Amberley, and Townsville. Flight track measurements are only available at bases where the NFPMS hardware is installed.
 - EIS reports for RAAF Bases Williamtown and SAAWR, Tindal, Townsville and Darwin, which show simplified forecast representations of complex aircraft movement patterns for the purpose of calculating ANEF contours. The simplified noise model flight tracks are sufficient for forecasting average noise exposure from typical operations, but actual day to day operations will include complex variations from the model flight tracks;
- RAAF flying activity information is provided in the form of forecast scheduled events, including frequency and time of day at designated training spaces around each operating base for the upcoming month. The RAF provide similar information, though limited only to low flying training operations in designated Tactical Training Areas;
- Information generated for F-35A aircraft operations as part of the EIS has not been integrated into the website in a format that is readily accessible. However, consideration must be given to whether the information that formed the basis of the EIS will be superseded, noting there is a requirement of the approval decision to biennially report on actual F-35A aircraft operations;
- There are numerous factors which limit Defence's ability to announce which flight paths will be used by military fast jets every day or week. These factors include weather, other airspace users, security requirements and scheduling challenges;
- There is a consolidated page of current endorsed ANEF maps for several Australian RAAF bases. Only the RAAF Base Williamtown ANEF is accompanied by additional reports containing information on aircraft movements that formed the basis of the ANEF modelling; and
- The NFPMS and EIS reports on the *Defence Aircraft Noise* website provide most of the information recommended by SA HB 149, which is further evaluated in Section 4.4.

4.3 Defence Noise and Flight Path Monitoring System

4.3.1 Overview

Defence currently engage external contractors (Envirosuite) to install, maintain and operate a Noise and Flight Path Monitoring System (NFPMS) at RAAF Bases Williamtown, Amberley, and Townsville.

It has been in use at RAAF Base Williamtown and SAAWR since 2005, at RAAF Base Amberley since 2010, and at RAAF Base Townsville since 2013.

The public interface of the NFPMS is based on the Airport Noise and Operations Monitoring System (ANOMS) platform, discussed in Appendix D6, but has been extensively customised over 15 years to specifically cater for military aircraft operations.

Key features of Defence's system include:

- State-of-the-art system for the monitoring and reporting of aircraft noise and flight track data;
- The core of the system monitors aircraft noise in accordance with ISO 20906 but features additional technology and processes to address characteristics specific to noise and operations from military aircraft and to enhance the quality of the data measured by the system. This includes the referencing of additional records, including RAAF aircraft operations logs and Air Traffic Control (ATC) data; and
- Specific NMTs used to improve military aircraft event identification.

The system can record the information necessary for the reporting of F-35A aircraft noise and flight activity required to address conditions of the approval decision and to inform Defence's noise management programmes.

Given the substantial historic and ongoing investment in the customisation and development of a bespoke system for Defence, it is unlikely that alternative platforms would provide any added practical benefit over the current system.

4.3.2 Measured data

Data measured by the system for each radar track include, but are not limited to the following:

- Aircraft type;
- Runway used;
- Operation type;
- Airport origin and destination;
- Flight identification code;
- Altitude profile; and
- Airspeed profile.

Noise metrics measured at a NMT include, but are not limited to, the following:

- Maximum noise level (L_{Amax}), which can be used to derive Number Above values and event level histograms, as presented in the EIS;
- Sound Exposure Level (SEL or L_{AE}), which can be used to calculate average noise/exposure level metrics (e.g. L_{Aeq} , L_{dn} Day-night noise levels);
- Effective Perceived Noise Level (EPNL), which can be used to calculate noise exposure using the Australian Noise Exposure metric; and
- Aircraft noise event duration.

Monthly summaries of aircraft flight paths and noise level measurements at NMTs are published on an interactive map available on the *Defence Aircraft Noise* website. However, not all the measurement data listed above is presented in the monthly reports. Defence has nominated information they consider relevant and unclassified to be published publicly for communities surrounding bases following review of feedback from consultation activities and avoiding confusion due to complexity or excessive quantity of information.

The interactive map on the NFPMS website shows NMT locations and the number of events detected by each for a selected period. Each NMT icon shows an hourly breakdown of events measured at the NMT, and an option to show aircraft noise event statistics measured by the NMT for the month. The statistics are limited to a percentage breakdown of movements by aircraft category, daily and hourly counts of aircraft movements, and the average noise levels measured at each NMT (inclusive of all noise sources, not just aircraft noise).

Filtering options are available to display flight tracks and hourly/daily movement statistics during a given month using:

- Aircraft category – military fast jets, other military fixed wing aircraft, civilian jets, civilian propeller aircraft, helicopters and unknown aircraft types;
- Operation – arrival, departure, training circuits and SAAWR use;
- Weekday or weekend;
- Runway; and
- Counts of noise events of a maximum noise level over 70, 80, 90 or 100 dB L_{Amax} at each NMT, which can be used to calculate number above values.

It is important to note that the NFPMS can only provide noise level information at the noise monitoring terminal locations. The NFPMS cannot generate aircraft noise contours. Based on current industry-standard technology, noise contours can only be practically generated by an aircraft noise modelling software package which must inherently make simplified assumptions to calculate noise levels at the ground.

Importantly, the data collected by the NFPMS can be processed to generate the types of aircraft noise information presented in the EIS and other information formats identified in the literature review.

4.3.3 Limitations

The measurement and detection of aircraft noise levels is complex and subject to uncertainties which are compounded by the specific characteristics of military aircraft operations. The following limitations are noted to apply to any defence aircraft noise and flight tracking system:

- The system is not able to reliably detect all aircraft operations or operation types, due to factors such as limited radar coverage at low altitudes, military aircraft formation flying and training circuit movements;
- For most types of formation flying, only the lead aircraft of the formation activates their transponder which is traced by the secondary radar and recorded by the NFPMS. Therefore, no flight path data is recorded for subsequent aircraft in the formation. There are also occasions where pilots do not activate their transponder for the entire flight. The Primary Surveillance Radar can provide additional tracking information, however, it is purely positional and lacks additional information such as altitude, speed and aircraft type. The flight path of the lead aircraft and noise level data from additional NMT at the end of the runways and around SAAWR are used to provide indicative information regarding other aircraft in the formation;

- To generate a robust dataset of military aircraft flight tracks and noise events, there is a reliance of the provision and interpretation of ACG records and notes which requires manual review and processing. There is also a degree of human interpretation of flight paths and noise events for some military flying operations as described above. These inherently resource intensive factors that cannot be automated contribute to the lag between when flying operations occur and establishing records that are suitable for publishing; and
- The presence of ambient noise from inclement weather, wind-disturbed vegetation, local and distant traffic, and other anthropogenic noise sources also prevent some aircraft noise events from being clearly measured and defined. This is particularly the case at monitoring locations distant from the base where aircraft noise levels are typically lower. Where possible, NMTs are positioned to minimise ambient noise influence.

There are aircraft movements and noise events that can be reliably assigned to a category of aircraft (e.g. military fast jet, military helicopter, civilian propeller) following further analysis, but cannot be assigned to a specific aircraft type due to the limitations noted above.

The 'military fast jets' category includes movements and noise level information for F-35A aircraft, but also movements by a fast military jet that cannot be distinguished as either an F-35A, F/A-18A/B Hornet or Hawk 127 aircraft type. If the data was filtered to only report attributed F-35A aircraft movements, it would underrepresent actual F-35A aircraft flying activity.

Defence has elected to present a more complete dataset of flying activity and noise events to the public with a simpler breakdown of aircraft categories rather than specific aircraft types.

4.3.4 Noise monitoring locations around RAAF Base Williamtown and SAAWR

The approval conditions require a comparison of actual measurements of F-35A aircraft noise levels at noise sensitive receptors to those predicted in the EIS. The approval decisions define noise sensitive receptors as follows:

...places that are likely to have a high sensitivity to noise emissions and must include, but not be limited to residential dwellings, schools, hospitals, child care centres, churches and public buildings.

A review of noise monitoring locations relative to sensitive receptors as defined above has been undertaken. The review accounted for residential areas and Points of Interest (POI) identified in the RAAF Base Williamtown BANMP, the EIS as well as a high-level review for any changes to the POI since the publication of these documents. The POI identified were generally limited to an area within the N70 contours presented in the EIS, and subsequently in the BANMP, to reflect locations where F-35A aircraft operations occur most frequently.

The location and siting of NMTs is subject to the requirements of ISO 20906, with consideration to be given to:

- The presence of residual sound and extraneous noise sources other than aircraft that may influence aircraft noise level measurements. Examples of such sources include road traffic, industry, air-conditioning equipment, wind disturbed vegetation, birds and metal roofing during rainfall;
- Proximity to flight tracks; and
- Proximity to acoustically reflective surfaces such as buildings.

Other considerations that influence NMT locations include:

- Obstruction by terrain or buildings;
- Land use permissions;
- Ease of site access;
- Site security; and
- Access to necessary power and communication utilities to operate the NMT.

The current NMT locations were selected by Defence in consultation with stakeholders, with the primary purpose to record aircraft noise and flight activity at a significant number of sensitive receptors. In 2014-2015, RAAF Base Williamtown conducted a consultation process with the Williamtown Advisory Group, which resulted in an additional six (6) NMTs being provided on public sites in areas around the base in response to community feedback and Defence requirements.

An aerial image showing the current NMT locations relative to residential areas and POI is shown in Figure 4.



NMT and Points of Interest in vicinity of RAAF Base Williamtown and SAAWR

Figure number: 4

Legend

● Accommodation

● School

● Public Building

● Place of Worship

■ NMT

Report number: Rp 003 R01 20200162
Image source: Google Maps

MARSHALL DAY

Acoustics

0 1 2 km

N

The following sections review the locations of NMTs relative to residential areas, POI and F-35A aircraft flight tracks.

Close to the base boundary

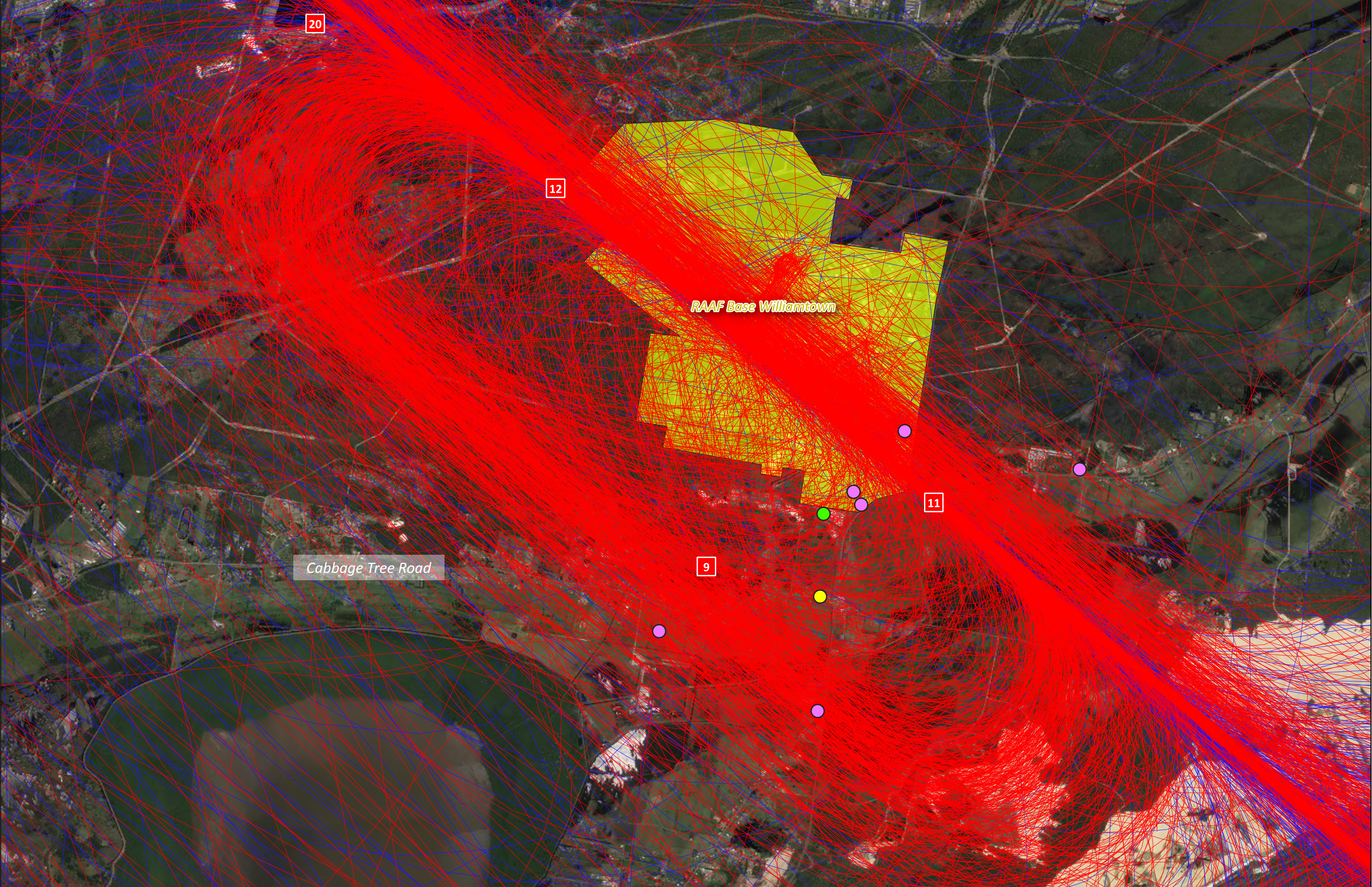
Figure 5 shows the NMTs, POI and F-35A aircraft flight tracks close to the base boundary.

NMT 11 and 12 are strategic NMTs that are used as a second source of information for identifying operations and initial and pitch arrivals for instances when radar data is of poor quality or missing. The NMTs are located immediately under flight tracks on the runway extended centreline, but can be used as an indication of aircraft noise levels at the Banksia Grove Village, the Newcastle Airport terminal or on-base.

NMT 9 is generally representative of Cabbage Tree Road residences closest to the initial and pitch circuit. Although there are relatively few dwellings in this area, the residences are located under the initial and pitch circuit and experience noise from military fast jet arrivals and departures, supporting the provision of an NMT in this location.

While sensitive receptor locations are up to 700 m further west from the current NMT location, there are other factors that influence the appropriate siting of the NMT as discussed above that may result in this offset.

It is acknowledged that there were F-35A arrival and departure flight tracks during the period December 2018 – December 2020 that were broadly distributed over residential properties along Fullerton Cove Road and Cabbage Tree Road in Fullerton Cove, to the west and southwest of the base. The broad distribution of flight tracks over the Fullerton Cove area and the location beyond the N70 contours of the EIS are such that further review of monitoring locations for this broad area is not currently warranted.



NMTs, POI and F-35A aircraft flight paths close to the RAAF Base Williamstown boundary

Figure number: 5

Legend

— NFPMS flight track arrival
— NFPMS flight track departure

● School

● Public Building

● Place of Worship

● Accommodation

■ NMT

Report number: Rp 003 R01 20200162
Image source: Google Maps

MARSHALL DAY
Acoustics

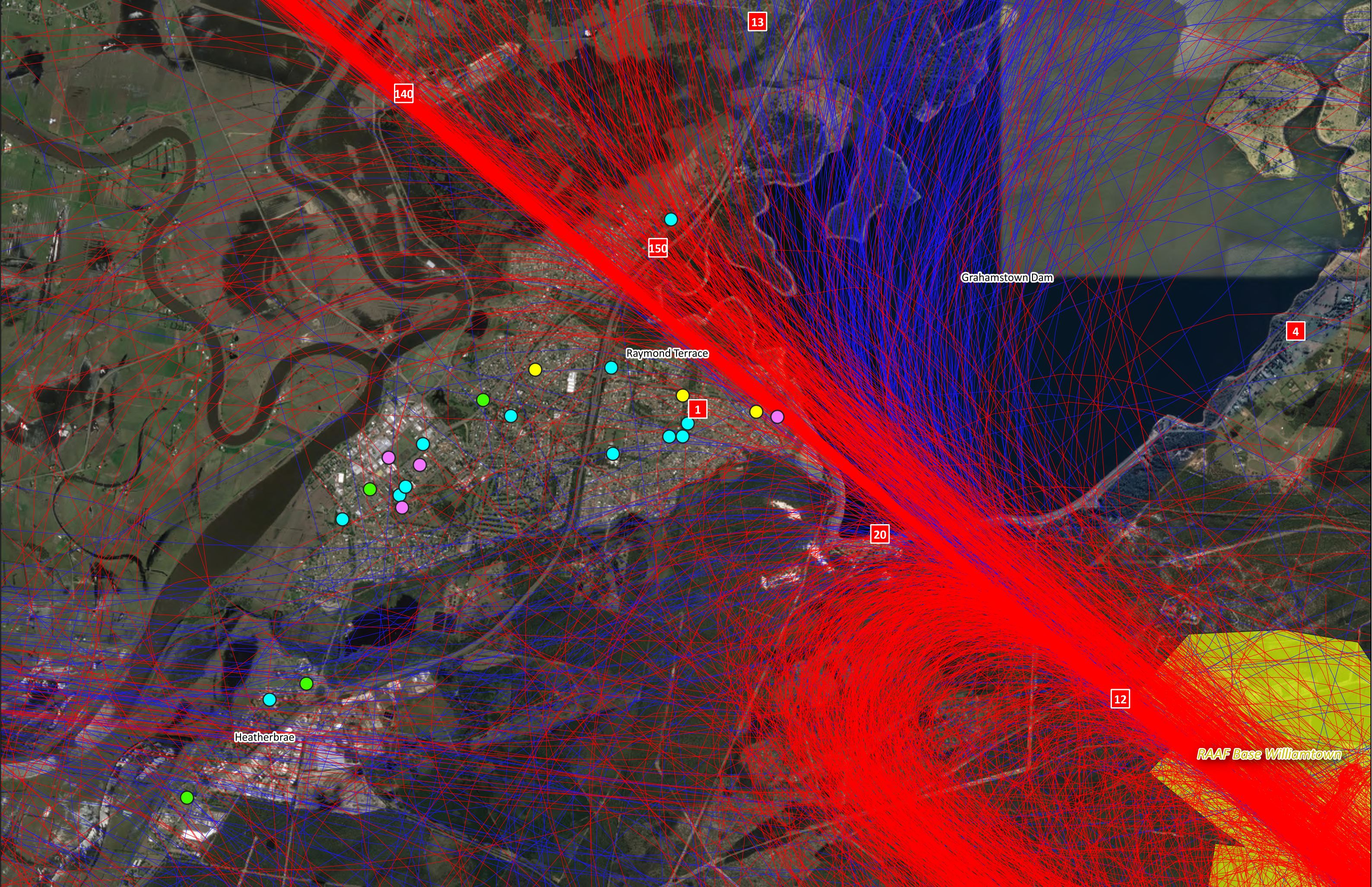
0 0.5 1 km
N

Raymond Terrace

Figure 6 shows the NMTs, POI and F-35A aircraft flight paths in the general area around Raymond Terrace.

Aircraft noise levels measured by NMT 1 and NMT 150 are considered representative of the Raymond Terrace residents closest to typical runway 12 arrival and runway 30 departure flight paths.

The current NMT locations are not representative of aircraft noise levels at residences or POI in the western extent of Raymond Terrace, however, Figure 6 shows that F-35A aircraft generally did not pass over this area as per the directives of the Fly Neighbourly Policy. Therefore, an NMT in this area is unlikely to be warranted, particularly if there is no history of complaints in this area.



NMTs, POIs and F-35A aircraft flight paths near Raymond Terrace

Figure number: 6

Legend

—

 NFPMS flight track arrival

—

 NFPMS flight track departure

●

 School

●

 Public Building

●

 Place of Worship

●

 Accommodation

■

 NMT

Report number: Rp 003 R01 20200162

Image source: Google Maps

MARSHALL DAY
Acoustics

0 0.5 1 km

N

Medowie

Figure 7 shows the NMTs, POI and F-35A aircraft flight paths in the general area around Medowie.

It can be seen from Figure 7 that NMT 19, NMT 5 and NMT 80 are broadly distributed around developed areas of Medowie and are generally located close to clusters of POI.

NMT 4 is located at a midpoint of a stretch of Grahamstown Road featuring large residential properties. While this location is closest to the runway, it is also furthest from runway 30 departure flight tracks that turn to the northwest and west as they pass over Grahamstown Dam.

The noise level information measured at the current NMT locations would not be representative of aircraft noise levels or the number of events experienced at the northern extent of the Medowie residential area. However, the Fly Neighbourly Policy includes procedures to avoid overflight of this area, and if overflight is required, the aircraft is to fly at a minimum altitude of 3,500 ft AMSL.



NMTs, POIs and F-35A aircraft flight paths near Medowie

Figure number: 7

Legend

—

NFPMS flight track arrival

—

NFPMS flight track departure

●

School

●

Public Building

●

Place of Worship

●

Accommodation

■

NMT

Report number: Rp 003 R01 20200162

Image source: Google Maps

MARSHALL DAY
Acoustics

00.51 km

N

Salt Ash

Figure 8 shows the NMTs, POI and F-35A aircraft flight paths in the general area around Salt Ash and SAAWR.

It can be seen from Figure 8 that NMT 18 is located at a residential area that is immediately below the flight path that leads to SAAWR. This is a strategic NMT for the enhancement of aircraft identification and NFPMS data collection for aircraft using the weapons range.

Figure 8 also shows F-35A aircraft arrival and departure flight paths were broadly distributed across the wider area during the period December 2018 – December 2020, including over residential properties distributed along Lemon Tree Passage Road and Marsh Road.



NMTs, POIs and F-35A aircraft flight paths near Salt Ash

Figure number: 8

Legend

— NFPMS flight track arrival

— NFPMS flight track departure

● School

● Public Building

● Place of Worship

● Accommodation

■ NMT

— EIS noise model flight track - SAAWR

Report number: Rp 003 R01 20200162
Image source: Google Maps

MARSHALL DAY
Acoustics

00.51

km

N

Tanilba Bay

Figure 9 shows the NMTs, POI and F-35A aircraft flight tracks in the general area around Tanilba Bay.

Aircraft noise levels measured by NMT 17 are representative of the residences closest to SAAWR flight tracks, while aircraft noise levels measured by NMT 70 would be representative of residences in the Tanilba Bay area.

Lemon Tree Passage is beyond the N70 contours presented in the EIS, however is further from SAAWR flight tracks and no closer to F-35A aircraft arrival or departure flight tracks than Tanilba Bay. The general F-35A aircraft noise trends at NMT 70 could be used as a guide on likely noise level trends in this area.



NMTs, POIs and F-35A aircraft flight paths near Tanilba Bay

Figure number: 9

Legend

- NFPMS flight track arrival
- NFPMS flight track departure
- School
- Public Building
- Place of Worship
- Accommodation
- NMT
- EIS noise model flight track - SAAWR

Report number: Rp 003 R01 20200162
Image source: Google Maps

MARSHALL DAY
Acoustics

0 0.5 1 km

N

Areas without a NMT

Key noise sensitive receptor locations in the vicinity of RAAF Base Williamtown and SAAWR and which are not covered by a NMT, include the following:

- Heatherbrae – Although mostly an industrial area, there is a small residential area and short term accommodation facilities that are located beneath F-35A aircraft flight paths to and from the western airspace, and that occur at altitudes as low as 4,000 ft AMSL. The EIS was based on 20 % of operations over this area, which was supported by the review of actual flying operations for 2018 to 2020.
- Brandy Hill – Located approximately 14 km north west of runway 12 and subject to direct overflight from military fast jet arrivals on runway 12 at altitudes typically in the order of 3,000 ft AMSL. The type of arrival operation over Brandy Hill (instrument) can result in higher community noise levels compared to initial and pitch arrivals which make up the majority (80 %) of arrivals. As F-35A aircraft pilots use simulators to practise instrument landing, there are reduced operations over this area. It is noted that NMT 140 is on the same instrument approach path and closer to the Base, however may provide representative aircraft noise level information for the residential area of Brandy Hill with some differences based on the elevation at the location and aircraft altitude.

In addition, exact locations of complaints following the introduction of F-35A aircraft operations were not available for review. This information can be considered by Defence to identify if there are any other additional noise sensitive locations that may benefit from a form of noise monitoring.

Defence has advised that aircraft noise complaints are often attributed to unusual operational circumstances (e.g. weather or air traffic control's direction). Where noise complaints cannot be explained by operational circumstances, measured aircraft noise levels and flight track information from the NFPMS can help to inform aircraft noise levels at a complainant's location.

4.3.5 RAAF Base Tindal

RAAF Base Tindal is home to Number 75 Squadron which currently operate F/A-18A/B Hornet but will operate F-35A aircraft once the F/A-18A/B Hornet is retired. RAAF Base Tindal also hosts visiting F-35 aircraft for specific training exercises.

The first biennial report has not considered F-35A aircraft operations at RAAF Base Tindal, as flying operations did not occur between December 2018 to December 2020.

RAAF Base Tindal does not have an equivalent NFPMS in place to that used at RAAF Bases Williamtown, Amberley, and Townsville, however, it is understood Defence's approach to monitoring F-35A aircraft noise at RAAF Base Tindal is currently being considered.

There are communities around the base that experience aircraft noise, but of significantly smaller populations than communities around other RAAF bases that have a permanent NFPMS. There is no current indication of a need for a permanent monitoring system to manage existing aircraft operations, and similarly, no clear indication that the introduction of F-35A aircraft operations would change this. A permanent monitoring system may ultimately be considered appropriate as noise management measures for F-35A aircraft operations are refined during the transition period. In the interim, Defence should consider a range of options to address any monitoring needs around RAAF Base Tindal, including:

- Targeted surveys of key operations or training exercises;
- Periodic noise monitoring at set intervals; or
- A limited permanent monitoring system based on relocatable units.

The F-35A EIS report for RAAF Base Tindal (Marshall Day Acoustics, 2014) identified residential areas and POI in the vicinity of the base. This figure is reproduced in Appendix E, and has been annotated to show locations where a histogram analysis of noise levels was undertaken as part of the EIS.

The EIS also presented the modelled F-35A aircraft flight tracks that were used to represent the majority of aircraft movements in the vicinity of RAAF Base Tindal, and are included in Appendix E.

From a review of these figures, it can be seen that:

- Most of the area around RAAF Base Tindal is uninhabited;
- The on-base community is the closest collection of sensitive receptors to the base and are generally within most noise contours presented in the EIS;
- There are several flight tracks that pass over the collection of residential properties in Uralla, approximately 5 km northwest of the runway (a similar distance as Raymond Terrace is to the runway at RAAF Base Williamtown). Some portion of this general area is within the extent of noise contours presented in the EIS;
- Some runway 32 departure flight tracks pass close to the small collection of residences distributed near Lansdowne Road approximately 5 km north from the base (a similar location and distance as the western extents of Medowie is to RAAF Base Williamtown). However, the EIS forecast 30 % of all departures to be on runway 32, and only 13 % of these are forecast to fly close to these properties;
- Katherine and Katherine East feature densely populated areas and points of interest as close as 9 km to the base and are close to a number of arrival and departure flight tracks; and
- Runway 14 departure tracks aim to minimise direct overflight of the small number of rural properties distributed along Napier Road approximately 10 km to the southeast of the base. Runway 32 arrival flight tracks pass close to the dwellings, however the EIS forecast the majority (70 %) of arrivals are expected to be on runway 14.

NMT locations should also consider any areas where noise complaints or enquiries have historically occurred. Consideration must also be given to any discussion of the requirements of an NFPMS as part of the development of the *RAAF Base Tindal Base Aircraft Noise Management Plan*.

As most of the area around RAAF Base Tindal is uninhabited, a limited number of NMT would likely be required to measure relevant noise level information at noise sensitive receptors in the vicinity. Defence may consider the use of temporary and mobile NMTs in prospective locations and gauge community feedback on the information that would be ultimately provided.

The information reported for RAAF Base Tindal should be consistent with the information presented for the other three bases with an existing NFPMS.

4.3.6 Forward Operating Bases

F-35A aircraft operations and noise levels at Forward Operating Bases (FOB) have not been considered in the first biennial reports as the aircraft have not operated extensively at FOB between December 2018 and December 2020. F-35A aircraft operations at FOB have been limited to a relatively small number of operations at RAAF Base Amberley associated with:

- The delivery of aircraft to RAAF Base Williamtown in instances of poor weather
- Small scale support for a training activity at RAAF Base Amberley in 2020, though most of the F-35A aircraft operations for this were conducted out of RAAF Base Williamtown.

The EIS only presented detailed F-35A aircraft flying activity and noise level predictions for two (2) FOB, RAAF Base Townsville, and RAAF Base Darwin.

RAAF Base Townsville has a permanent NFPMS that can be used to review F-35A aircraft flying operations and noise levels when the aircraft operates at the base in the future, albeit for short periods for specific training exercises. The location of the NMTs around RAAF Base Townsville may require review if F-35A aircraft flight paths are expected to differ significantly from those previously used as part of F/A-18A/B Hornet training exercises.

Consideration could be given to whether any short-term monitoring at noise sensitive receptor locations around RAAF Base Darwin is warranted during short term F-35A aircraft training exercises and hence a permanent setup may not be considered appropriate.

4.4 Recommended information to be reported

The key sources of reported information on F-35A flying activity and noise levels that is available to the public include:

- The *Defence Aircraft Noise* website (discussed in Section 4.2) is the primary tool for the delivery of concise, location-specific information on F-35A noise level and flight activity monitoring data to the community;
- Noise and flight monitoring data and reports for RAAF Bases Williamtown, Townsville and Amberley available on the *Monitoring* page of the *Defence Aircraft Noise* website. The current systems provide a high level of information for Defence operations, that is considered appropriate and proportionate for the nature of environmental noise considerations;
- The F-35A EIS reports for the MOB, RAAF Base Williamtown and RAAF Base Tindal, as well as FOB, RAAF Base Darwin and RAAF Base Townsville. The reports are available on the *Environmental* section of the *Defence Aircraft Noise* website; and
- The biennial reporting to satisfy consent conditions for F-35A aircraft operations in Australia to be made available on the *Defence Aircraft Noise* website. The reports will include detailed information on records of flying activity and noise level data since the introduction of the F-35A aircraft. The first report will be completed in the second quarter of 2021, with the ongoing publication of biennial reports as required by the consent conditions.

The level of F-35A aircraft noise information made available in the EIS is comparable with the nature and extent of information available for commercial aircraft operations and noise levels presented by large Australian and international airports.

The quantity and quality of information relating to F-35A aircraft operations and noise levels reported by Defence is beyond that presented by other international Air Forces operating the F-35A aircraft.

The Airservices Australia website *Aircraft Noise in your Neighbourhood* sets a high standard for the provision of aircraft flying activity and noise information to communities. The site integrates necessary educational and explanatory material with flight path usage statistics and noise level measurements on concise pages that are linked to flow in a logical manner. The content and presentation format can be considered as part of any ongoing or future updates to the Defence Aircraft Noise website, particularly with respect to the aspects of the website which are tailored to informing local communities about typical aircraft operations.

The *Melbourne Airport Noise Information Tool* is an example of how a single interactive and location-searchable map interface can be used in conjunction with switchable information layers to present extensive amounts of information on existing and forecast noise level information and typical flight path usage information.

Released after the publication of the F-35A EIS, SA HB 149 is the current best practice guide in Australia for providing and reporting aircraft noise information in a clearer, less technical and more informative manner for the general public. It represents the key components of an aircraft noise information package, to inform the development of concise location specific packages of key aircraft noise and operation information. Location-specific information packages are a way to address community concerns in an easily understandable manner and provide only relevant information for a local area. Consistent with the example of the Airservices Australia website, the location-specific information packages of SA HB 149 can be considered as part of any refinement of communication and reporting protocols.

A summary of the type of aircraft information recommended by SA HB 149 is presented in Table 7. Comments are also provided on the application, availability, and relevance of information to F-35A aircraft operations in Australia and opportunities to improve the existing information reported by Defence, subject to any security requirements. These findings are provided for reference as part of Defence's ongoing review of noise management programmes as outlined in Section 3.1.

Table 7: Recommendations of SA HB 149 and application to F-35A aircraft operations in Australia

SA HB 149 item	SA HB 149 recommended information	Comments and opportunities
Where aircraft fly (Flight corridor maps)	A map should show and label a set of departure and arrival corridors, such that at least 95 % of all airport movements are captured within one of the corridors. Graduated shading can be used to depict flight paths of differing rates of use, or the expected altitude of aircraft on the flight path. The Handbook notes that military aircraft are subject to greater variability and flexibility regarding flight track use.	The EIS reports present forecast F-35A aircraft flight tracks and typical altitudes to inform the noise modelling. Many publications include presentation of common aircraft flight corridors and information on the frequency in those corridors. Military fast jet flight tracks are prone to higher degrees of variation compared with civilian and commercial aircraft and result in flight tracks spread over large areas away from a RAAF base. For RAAF bases with an NFPMS, it is recommended that consideration be given to reporting density plots for flight tracks as an alternative method to show where military fast jets commonly fly. The NFPMS can generate the data necessary to prepare this information.
How often aircraft fly (Flight corridor use)	Labelling flight corridors with the following: • Average daily aircraft movements; • The daily range of movements, in the form of a minimum and maximum number of movements; • Movements in that corridor as an annual percentage of all movements at the airport; and • The percentage of days per year with no movements. Separate flight corridor maps may be necessary should the above information vary significantly for different times of the day, weekdays or seasons.	The EIS reports for RAAF Bases Williamstown and Tindal included forecast percentage flight track use for F-35A aircraft for noise modelling purposes. However, reporting of actual flight activity is based on individual operations and not by flight corridors. The RAAF Base Williamstown NFPMS website provides the number of noise events measured in areas around the base for any given day, as well as the times of operations for a given month. The Defence Aircraft Noise website also provides monthly forecasts for days of upcoming flying activity in different airspaces away from a base. Information on flight corridors that may be used by aircraft travelling to and from the various airspaces are not presented, noting this can be influenced by several factors, including security requirements as well as weather conditions and existing air traffic on the day. The more recent ANEF maps prepared by Defence include information on the number of day and night operations by each aircraft on each runway.

SA HB 149 item	SA HB 149 recommended information	Comments and opportunities
How much noise aircraft make (How to describe and define aircraft noise)	Aircraft noise metrics include: • ANEF; • N-contours and Number above, including for different times of day, airport operating modes or seasonal trends; • Maximum noise level contours, noting that they should be supplemented with sufficient descriptive advice to allow them to be interpreted carefully; and • Average noise contours (L_{Aeq}) for the purpose of comparing the contribution of aircraft noise with other sources of transport noise. Reactions to the same L_{Aeq} noise level can differ depending on the noise source. Consider providing information on factors specific to the airport that result in variations in aircraft noise, such as unusual flying patterns during specific weather conditions or aircraft training activities.	ANEF maps are published by Defence on the <i>Defence Aircraft Noise</i> website. Measured number above values and typical hourly average noise levels (L_{Aeq}) are available at NMT locations around the base. To indicate seasonal trends, the reported data can be filtered by month. The EIS reports and accompanying information package also included other noise metrics, including maximum noise level contours for an F-35A aircraft on a given flight track. The current level of information provided by Defence is adequate, however could be improved by describing noise metrics and creating a system that consolidates the key noise level and flight activity monitoring data into a location specific package, further discussed below.
When aircraft fly	Information on aircraft noise exposure needs to consider variations in aircraft movements during the day or during different seasons, noting that these variations can influence an individual's judgement of aircraft noise.	The EIS reports included information on days and times of F-35A aircraft flying operations. Actual records of daily and hourly movements by military fast jets are available at NMT locations around the base. The limitation is however that all military fast jets are combined, and therefore does not separate out F-35A aircraft from other fast jet operations at the base. Actual F-35A aircraft flying operations are addressed as part of the biennial reporting requirements to address conditions of the approval decision. The more recent ANEF maps prepared by Defence include information on the number of day and night operations by each aircraft on each runway.
How widely aircraft noise will be heard	Aircraft noise will be heard over a much wider area than shown on diagrams and it is important to note that aircraft noise can be audible well beyond contour lines on commonly produced aircraft noise maps.	The <i>Defence Aircraft Noise</i> website provides information on the use of training airspaces that are well beyond ANEF contours of bases. A review of NFPMS noise monitoring locations around RAAF Base Williamtown and SAAWR is presented in Section 4.3.4. Reviews will be undertaken at other bases as part of future reporting to address consent conditions.

SA HB 149 item	SA HB 149 recommended information	Comments and opportunities
Current and projected future noise impacts	Forecasts should set out clearly and explicitly state the assumptions and timeframes on which they are based. Supporting information should include comparison with current activity for context, explanation of changes due to aircraft fleet developments or changing technologies, and assumptions about runway usage.	The EIS report discusses background information to inform the noise modelling and the assessment of noise from F-35A aircraft operations. However, of all the ANEF maps made available on the <i>Defence Aircraft Noise</i> website, only the RAAF Base Williamtown and SAAWR ANEF is accompanied by modelling information that forms the basis of the contours. The information is provided in the form of a noise model summary report, which is not commonly made available to the public by other airports that prepare ANEFs. Although the information is provided during consultation phase when developing a new Defence ANEF, when subsequent ANEF are published by Defence and provided on the website, there is an opportunity for the maps to be supplemented with supporting input information, including assumptions on flight tracks, aircraft types and forecast movement numbers.
Other factors that affect community and individual responses to airport noise	People are more affected by aircraft noise in the wake of significant changes to the level or pattern of noise exposure, for example: • Upcoming permanent or temporary changes to flight paths and flight activities; • Likely duration of individual noise events; • Likely respite between noise events; • Likely variability due to regular and irregular circumstances; • Specific acoustic characteristics; and • Foreseeable variations in response to weather events.	There are several locations on Defence websites where notifications are provided: • The Flying Operations page for each base within the Ops Near Me section: – An announcements section and an RSS feed subscription service – An activity calendar for each airspace, and an RSS feed subscription service • A Flying Activity page on the Air Force website, and an RSS feed subscription service; • Social media posts on multiple platforms (Twitter, Facebook etc). Defence should ensure that notifications by these services are consistent or consider how to effectively consolidate the notification services. The <i>Operations Near Me</i> pages provide forecast monthly flying activity in air space around each base. The site also provides general information on unique aspects of military operations that differ to civilian aviation, including locations of training areas where the aircraft does not actually land. A guide on how to subscribe and receive RSS feed announcements would benefit the public not familiar with the service. It is noted that other formats of communication (i.e. social media platforms) continue to grow in popularity and evolve with time.

SA HB 149 item	SA HB 149 recommended information	Comments and opportunities
Future advanced aircraft noise tools	The information described in the Handbook can be presented in a variety of media forms. The best or most effective form of presentation will vary according to the specific audience, but could include the following: • Paper based material; • Physical exhibits; and • Online material including downloadable material and material provided through an app or web interface. As technology progresses and the development of advanced tools becomes less resource intensive to produce, novel ways to convey information should be explored. Examples include: • Interactive maps with address search functionality and noise modelling outputs; and • Visual and audible simulations of aircraft noise events.	The presentation of forecast monthly flying activity in air space around bases and the use of the RSS feed are two examples of how advanced tools are being utilised by Defence. A guide on how to subscribe and receive RSS feed announcements may benefit members of the public not familiar with the service. It is recommended a system allowing the public to locate their house relative to noise contour forecasts and other noise information data be implemented. The Melbourne Airport Noise Tool is a good example. Such a system would allow consolidation of aircraft noise information for each base to be available in a single location, which could be accessed with an address lookup. Defence should continue engagement with communities to understand what additional information communities may wish to be provided from the NFPMS. It is acknowledged that it is not appropriate for Defence to provide a 'live' flight tracking service for security reasons.

5.0 CONCLUSION

The first two (2) F-35A Lightning II (F-35A) aircraft arrived in Australia on 10 December 2019. Royal Australian Air Force (RAAF) commenced F-35A aircraft flying operations at RAAF Base Williamtown in mid-January 2020.

This report addresses specific subclauses of Condition 3 of the approval decision (EPBC Act 2010/5747) for the flying operations of the F-35A aircraft in Australia.

Defence's existing aircraft noise management programmes and the methods of reporting aircraft noise levels and flying operations to the public have been reviewed to address elements of Condition 3.b., Condition 3.c., 3.e.i. and 3.f., and evaluated for their suitability for managing noise levels associated with F-35A aircraft operations.

The ongoing management of aircraft noise requires a careful balance between the needs of national defence infrastructure, the safe operation of aircraft and the effective management of associated adverse noise impacts.

The review indicated the aircraft noise management programmes are considered appropriate for the following reasons:

- Defence's policies and systems are comprehensive and contain the necessary elements to effectively manage F-35A aircraft operational noise;
- Each element of Defence's policies and systems is appropriately documented, integrated and communicated at different organisational levels to support the management of F-35A aircraft noise levels;
- There are mechanisms that aim to limit the occurrence of noise events, and where practical, minimise noise levels when they do occur;
- Processes are in place to register and investigate noise complaints to identify further opportunities to reduce aircraft noise;
- The systems in place are dynamic (i.e. reviewed and updated regularly) and effective at resulting in changes to reduce community noise impacts. This is evidenced through improvements that have been implemented or are in the process of being implemented, including the recommendations identified by the ANO audit in 2016. Much of the improvements have been tailored to address the requirements of military fast jet operations and the introduction of F-35A aircraft operations;
- F-35A aircraft noise mitigation measures are consistent with those reviewed nominated by other international air forces (i.e. the United States Air Force and Royal Air Force);
- The noise management programmes are proportionate to the requirements to manage F-35A aircraft noise levels, and include review processes to enable management measures to be adjusted as and when required; and
- The number of complaints for RAAF Base Williamtown and SAAWR have been relatively consistent over the past eight (8) years, and less than half compared to 10 years ago, providing further support that existing noise management programmes, including the review and update processes are appropriate. Although the number of complaints in 2020 were higher than the number of complaints for the years immediately prior to the delivery of the F-35A aircraft, this may be attributed to changes arising from the COVID-19 pandemic, the increased publicity of the retirement of the F/A-18A/B Hornet, the delivery and increased awareness of the F-35A aircraft and the ongoing trials of differing flying procedures as part of the transition.

A review of how information on aircraft noise is monitored, reported and communicated was undertaken to address elements of Condition 3.c. and 3.e. The review determined that:

- The level of information provided by Defence is comparable to that of major civilian airports in Australia, and well beyond that relative to other international air forces; and
- There were areas where information could be refined or improved when benchmarked against relevant aircraft noise information guidelines and other systems. These items have been noted to inform Defence's internal review processes and identify how the reporting of F-35A aircraft noise and flying operations could be adapted in future if and where required.

APPENDIX A GLOSSARY OF TERMINOLOGY AND ABBREVIATIONS

ABCP	Air Base Command Post
ACG	Air Combat Group
AFHQ	Air Force Headquarters
AMSL	Above mean sea level
ANEC	A set of noise contours showing forecast of aircraft noise exposure around an aerodrome for a future year. It is based on a forecast of aircraft movement numbers, operating times, types, destinations and flight paths.
ANEF	A set of noise contours reviewed and endorsed by Airservices Australia or Department of Defence. It is the only contour map with status in land use planning decisions for aircraft noise exposure.
ANEI	Australian Noise Exposure based on historical data from a previous year, where the numbers and types of aircraft which used the aerodrome are known. ANEI are typically used as benchmarks or an indicator of change in aircraft noise exposure
ANO	Aircraft Noise Ombudsman
ANOMS	Airport Noise and Operations Monitoring System
ATC	Air Traffic Control
BANMP	Base Aircraft Noise Management Plan
DAWE	Department of Agriculture, Water and the Environment
dB	Decibels – the unit of sound pressure
EIS	Environmental Impact Statement
EPNL	Effective Perceived Noise Level is a measure of the relative noisiness of an aircraft noise event, measured in EPNdB. EPNL forms the basis of the ANEF metric.
Flight profile	A flight profile relates the aircraft's ground distance with its altitude, true airspeed, and engine thrust setting.
FNPF	Fly Neighbourly Policy
FOB	Forward Operating Base
HQAC	Headquarters Air Command
Initial and pitch	An approach to the base from a(n) (initial) point approximately 10 km along the runway centreline to overhead the airfield, followed by a turn (pitch) into the circuit pattern while decelerating for landing
Instrument approach	An approach to the base using navigation aids such as ILS and TACAN, usually required in poor visibility conditions
$L_{Aeq}(t)$	The equivalent continuous (time-averaged) A-weighted sound level. This is commonly referred to as the average noise level. The suffix "t" represents the time period to which the noise level relates, e.g. (8 h) would represent a period of 8 hours, (15 min) would represent a period of 15 minutes and (2200-0700) would represent a measurement time between 10 pm and 7 am.
L_{Amax}	The A-weighted maximum noise level. The highest noise level which occurs during the measurement period

L _{dn} or DNL	Day Night Level, the average noise level over a 24-hour period, where a +10dB penalty is applied to noise levels between 10 pm and 7 am to take into account the increased likelihood of disturbance caused by lower ambient noise levels during the night.
L _{dnmr}	The Onset Rate-Adjusted Day-Night Average Sound Level, used primarily in United States' noise assessments to describe additional annoyance from startle effects associated with military aircraft. The metric is based on the L _{dn} measure, which is increased in value depending on how quickly noise levels rise as an aircraft passes by.
MOB	Main Operating Base, for the F-35A aircraft, RAAF Base Williamtown and RAAF Base Tindal
Movement	Refers to a departure or arrival by an aircraft
Number Above	The number of daily aircraft events that are higher than a given noise level threshold in a day. For example the term N70 20 events means 20 or more daily aircraft noise events with a noise level 70 dB L _{Amax} or greater
RAF	United Kingdom Royal Air Force
RAAF	Royal Australian Air Force
RCAF	Royal Canadian Air Force
SAAWR	Salt Ash Air Weapons Range
SEL or LAE	Sound Exposure Level – the sound level of one second duration which has the same amount of energy as the actual noise event measured. Usually used to measure the sound energy of a particular event, such as a train pass-by or an aircraft flyover
Sensitive receptor	Places that are likely to have high sensitivity to noise emissions and must include, but not be limited to residential dwellings, schools, hospitals, childcare centres, churches and public buildings.
Time Above	A noise metric to describe the cumulative amount of time an aircraft noise event exceeds a given noise level threshold per day.
Transition period	The period anticipated to span between 2018-2022 during which F/A-18A/B Hornet operations reduce and cease and the F-35A aircraft operations commence and increase until all aircraft have arrived in Australia.
USAF	United States Air Force

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APPENDIX C APPROVAL CONDITIONS CROSS REFERENCE TABLE

No.	Condition	Report section
3.	<i>Prepare and implement Aircraft Noise Management Plan(s), as described in the Aircraft Noise Management Strategy, at RAAF Base(s) to minimise noise disturbance at sensitive receptors from the flying operations of the F-35A Lightning II aircraft. The plan(s) must include, but not be limited to, the following measures:</i>	
	...	
3.b.	<i>A review of existing noise management programmes</i>	Section 3.0
3.c.	<i>Monitoring, to validate predicted noise impacts to sensitive receptors at RAAF Base Williamtown (including Salt Ash Air Weapons Range), RAAF Base Tindal and RAAF Base Townsville. This must include, but not be limited to:</i>	
3.c.i.	<i>An investigation of alternative noise measurement and analysis methods;</i>	Section 4.1.2
3.c.ii.	<i>utilisation of Noise and Flight Path Monitoring Systems (where installed), to provide ongoing noise information, and the development of a noise measuring system at RAAF Base Tindal;</i>	Section 4.3
3.c.iii.	<i>comparison of actual measured F-35A Lightning II aircraft noise levels with those predicted in the Environmental Impact Statement; and</i>	The comparison for the period December 2018 to December 2020 is addressed separately in the first biennial report (Marshall Day Acoustics, 2021), with findings referenced throughout this report.
3.c.iv.	<i>biennial review of noise monitoring locations, unless agreed with the Minister.</i>	Section 4.3.4
	...	
3.e.	<i>Reporting, to ensure clear and timely public access to noise levels and flight activity monitoring data. This must include, but not be limited to:</i>	
3.e.i.	<i>conducting a biennial evaluation of the effectiveness of flight activity monitoring and programmes at RAAF Base(s) until agreed in writing by the Minister;</i>	Section 4.0
	...	
3.f.	<i>Consultation activities, to ensure adequate communication with stakeholders, including local residents and relevant authorities. Consultation activities must include, but not be limited to:</i>	Section 3.2
	...	
3.f.iv.	<i>development of a concise location specific package of key information related to noise levels and flight activity monitoring data that addresses community concerns in an easily understandable manner for the lay person.</i>	Section 4.4

APPENDIX D REPORTING OF AIRCRAFT NOISE INFORMATION – LITERATURE REVIEW

D1 Standards and guidelines

Reference	Summary of aircraft noise information
Australian Standard AS 2021:2015 <i>Acoustics - Aircraft Noise Intrusion - Building Siting and Construction</i> (AS 2021)	AS 2021 is the primary tool for land use planning in the vicinity of Australian airfields, based on the Australian Noise Exposure Forecast (ANEF) metric. It includes information on building siting, estimates of typical external maximum noise levels for commercial aircraft in Australia, and a method for defining building element sound insulation performance requirements. The 2000 version of the Standard was considered in the F-35A EIS. AS 2021 was updated in 2015, with the only notable change relevant to this review, the addition of an informative appendix which recommended the following information be provided when preparing an ANEF: • Clear runway diagrams; • Annually averaged daily movements for: - each aircraft type in the noise model - each runway - each operation type - each of the day and night periods; • Movement profiles showing hourly changes in aircraft movements; and • Flight tracks and their use. Standards Australia excluded the review of any new noise metrics as part of the 2015 update.
Standards Australia Handbook HB 149:2016 <i>Acoustics—Guidance on producing information on aircraft noise</i> (SA HB 149)	SA HB 149 provides guidance on presenting aircraft noise information in a clearer, less technical and more informative manner for the general public. SA HB 149 provides recommendations for information to be presented to cover key features of aircraft noise: • Where aircraft fly; • How often aircraft fly; • How much noise aircraft make; • When aircraft fly; • How widely noise will be heard; • Current and projected future noise impacts; and • Other factors. Despite being released after the EIS was published, information presented in the EIS included most of the recommended information outlined in SA HB 149. SA HB 149 remains the current best practice guide in Australia for providing aircraft noise information.

Reference	Summary of aircraft noise information
National Airport Safeguarding Framework (NASF)	The purpose of the NASF is to enhance the current and future safety, viability and growth of aviation operations. <i>Guideline A: Measures for Managing Impacts of Aircraft Noise</i> provides guidance to Commonwealth, State, Territory and Local Government decision makers to manage the impacts of noise around airports including assessing the suitability of developments. NASF was considered in the EIS assessment. Guideline A was finalised in November 2016 following the review and update of AS 2021. There were no significant changes, and the NASF still references the ANEF and number above (N60, N65, N70, N60_{11pm-6am}) metrics for guidance on land use planning near airports.
ISO 20906 Acoustics — Unattended monitoring of aircraft sound in the vicinity of airports (ISO 20906)	ISO 20906 prescribes the specifications for aircraft noise monitors, data recording requirements and reporting requirements for aircraft noise events. The standard specifically excludes methods for validating noise predictions. Key aircraft noise information to be reported includes: • Sound exposure metrics, including sound exposure level of the event (SEL), equivalent (energy averaged) noise level (L_{Aeq}) for given time periods, such as hourly, for day, evening or night periods, or whole day rating levels such as the day-night average sound level (DNL) metric; • Maximum noise level (L_{Amax}) of events; • Hourly background noise at the time of events; • The time that events occurred, and the duration of events as defined by the time that noise levels are above given noise level thresholds; • Meteorological conditions at the time of events; • Flight information related to events, including aircraft type, operation type, runway used, route information, and flight ID; • Daily, monthly, and annual summaries of event numbers and average noise levels; and • Ambiguous aircraft noise events and monitoring outages. There are no alternative noise metrics or aircraft operation information presented that is not already covered by other publications.

D2 Australian aircraft noise assessments – recent EIS

Reference	Summary of aircraft noise information
Western Sydney Airport EIS Appendix E1 <i>Aircraft Overflight Noise</i> (WSA EIS)	The Western Sydney Airport EIS was published in 2016. Appendix E included the technical noise report that assessed different stages of the airport's development and likely runway operating modes. Aircraft noise and flying activity information presented in the WSA EIS included: • Flight tracks and noise analyses for a forecast of initial airport capacity, a forecast of a single runway approaching maximum capacity and a long term forecast of parallel runways at maximum capacity; • Single event maximum noise level contours; • ANEC maps; • Number above contours; • Upper 90th percentile N70 contours. i.e. N70 contours for a typical worst-case day (featuring higher daily movement numbers that were only expected to be exceeded for 10 % of days per year); • Flight track density charts depicting the dispersion of flight tracks and the average number of daily flights for each flight path; • The average noise level (L_{Aeq}) during school hours and during the night period; • A chart of hourly aircraft movements at the airport for the annual average day; and • Days of respite when there are no aircraft movements in an area near the airport were discussed in the report. However, no analysis was presented, as there would be few days of respite for key areas around the airport due to the proposed single and parallel runway configurations. Days of respite were most relevant for airports with cross runways where it is necessary to limit arrivals and departures on these while other runways are in use.
Sunshine Coast Airport Expansion EIS <i>Aircraft noise information booklet</i>	The Sunshine Coast Council (2014) developed an <i>Aircraft Noise Information Booklet</i> to accompany the EIS for the replacement runway. The booklet presented N70 contours as well as typical aircraft altitudes for arrival and departure flight tracks for various runway operating modes during and after the construction of the replacement runway. A table of the minimum and maximum number of flights, and the percentage of days with no flights for each track, were also given in a tabular format.

D3 F-35A operations in Australia – EIS and other technical studies

Reference	Summary of aircraft noise information
<i>RAAF Base Williamtown and SAAWR F-35A Aircraft Noise Impact Assessment (EIS)</i>	The following is a summary of the F-35A aircraft noise and flying activity information included in the EIS (Marshall Day Acoustics, 2014) for the Main Operating Bases (MOB), RAAF Base Williamtown and RAAF Base Tindal: F-35A flying activity: • General days and times of military fast jet flying operations; • SAAWR use; • Noise modelling flight tracks; • Percentage flight track use • Noise model flight profiles; and • Aircraft altitude as function of flight profile and track Comparisons of F/A-18A/B Hornet and F-35A aircraft noise modelling: • Noise exposure maps (ANEC and ANEF); • Number above contours and tabulated values at discreet sensitive use locations, including points of interest, residential areas, schools etc; • Histograms of average daily occurrences of aircraft noise levels at discrete sensitive use locations; • Single event maximum noise level contours; • Population counts within noise level contours; and • Seasonal variations – presented as number above contours.
<i>Fauna Management Plan RAAF Base Williamtown Flying Operations of the F-35A Lightning II</i>	The F-35A aircraft consent conditions included a condition to undertake an assessment the change in noise levels with the introduction of the F-35A aircraft, at environmentally sensitive locations around RAAF Base Williamtown and SAAWR.

D4 F-35A operations outside of Australia – Impact Assessments

Reference	Summary of aircraft noise information
United States Air Force (USAF) Air Force Reserve Command <i>F-35A Operational Beddown EIS</i>	The USAF Air Force Reserve Command (AFRC) published an EIS on 8 October 2020 which included a noise impact assessment for F-35A Operational Beddown operations at four alternative bases to replace existing F-16 Fighting Falcon and A-10 Thunderbolt II aircraft operations. F-35A aircraft noise and flying activity analyses presented in the EIS included: • Forecast F-35A aircraft annual movements, percentage night flying, training airspace and weapons ranges utilised, altitudes where supersonic flight occurs and typical mission duration; • Tables of predicted sound exposure levels and maximum noise levels at various altitudes for existing military fast jets and F-35A for thrust settings commonly associated with take off, landing, cruising and representative training airspace activity; • Tables of predicted SEL and L_{max} noise level information of existing military fast jets and F-35A at key points of interest; • Day-night average sound level (DNL) contours to inform land use planning, and single values at key points of interest; • Onset Rate-Adjusted Day-Night Average Sound Level (L_{dnmr}) predictions to inform an assessment of potential increased annoyance from startle effects. The metric considers flying activity for the busiest month of the year and is used to estimate the percentage of the population likely to be highly annoyed by aircraft noise; • C-Weighted Day-Night Average Sound Level predictions to describe noise from sonic booms generated during supersonic flight. The ACG <i>Fly Neighbourly Policy</i> (Section 3.1.3) restricts supersonic flight near populated areas in Australia, therefore assessments of sonic booms are generally not necessary; • Average aircraft noise levels (L_{Aeq}) during school hours; • Number of average daily speech-interfering events per hour within key public buildings (defined as events exceeding 50 dB L_{Amax} indoors) with windows open and closed. The N60 and N70 number above metrics respectively could be considered similar metrics as they are based on outdoor noise levels, with an open or closed window expected to provide approximately 10 dB and 20 dB reduction in noise levels respectively; • Percentage probability of sleep being disturbed at least once per night is estimated based on the number of overflight events and the SEL of each event following a standard procedure published by the American National Standards Institute. Maximum noise levels are generally used in conjunction with sound energy exposure metrics for assessments of sleep disturbance in Australia; and • Hearing damage from ongoing aircraft noise exposure (Average Noise-Induced Permanent Threshold Shift) using a process defined in the US Environmental Protection Agency's <i>Guideline for Noise Impact Analysis</i>.

Reference	Summary of aircraft noise information
USAF Air Combat Command <i>F-35A Wing Beddown at Tyndall AFB and MQ-9 Wing Beddown at Tyndall AFB or Vandenberg AFB</i>	The USAF Air Combat Command (ACC) published an EIS on 19 November 2020 which included a noise impact assessment of F-35A operations at Tyndall Air Force Base. Tyndall Air Force Base had been home to F-22 Raptor operations, but sustained damage due to Hurricane Michael, resulting in the relocation of the F-22 Raptor squadrons to other bases. The F-35A aircraft noise and flying activity analyses are comparable to those presented in the F-35A Operational Beddown EIS.
USAF Air National Guard <i>F-35A Operational Beddown EIS Draft</i>	The USAF Air National Guard (ANG) published a Draft EIS in August 2019 for the Beddown of F-35A aircraft operations at two of five alternative ANG bases. A final version of the EIS is not yet publicly available. The F-35A aircraft would replace the existing F-15 Eagle, F-16 Fighting Falcon, or A-10 Thunderbolt II fighter attack aircraft at the two selected bases. The F-35A aircraft noise and flying activity analyses presented in this EIS are comparable to those presented in the ARFC EIS discussed above. Additional information presented in this EIS included the percentage time spent by the aircraft at different altitudes, and the use of the time above metric regarding the annual average number of minutes per day where F-35A aircraft noise levels could result in speech interference at schools.

D5 Australian civilian airport noise websites

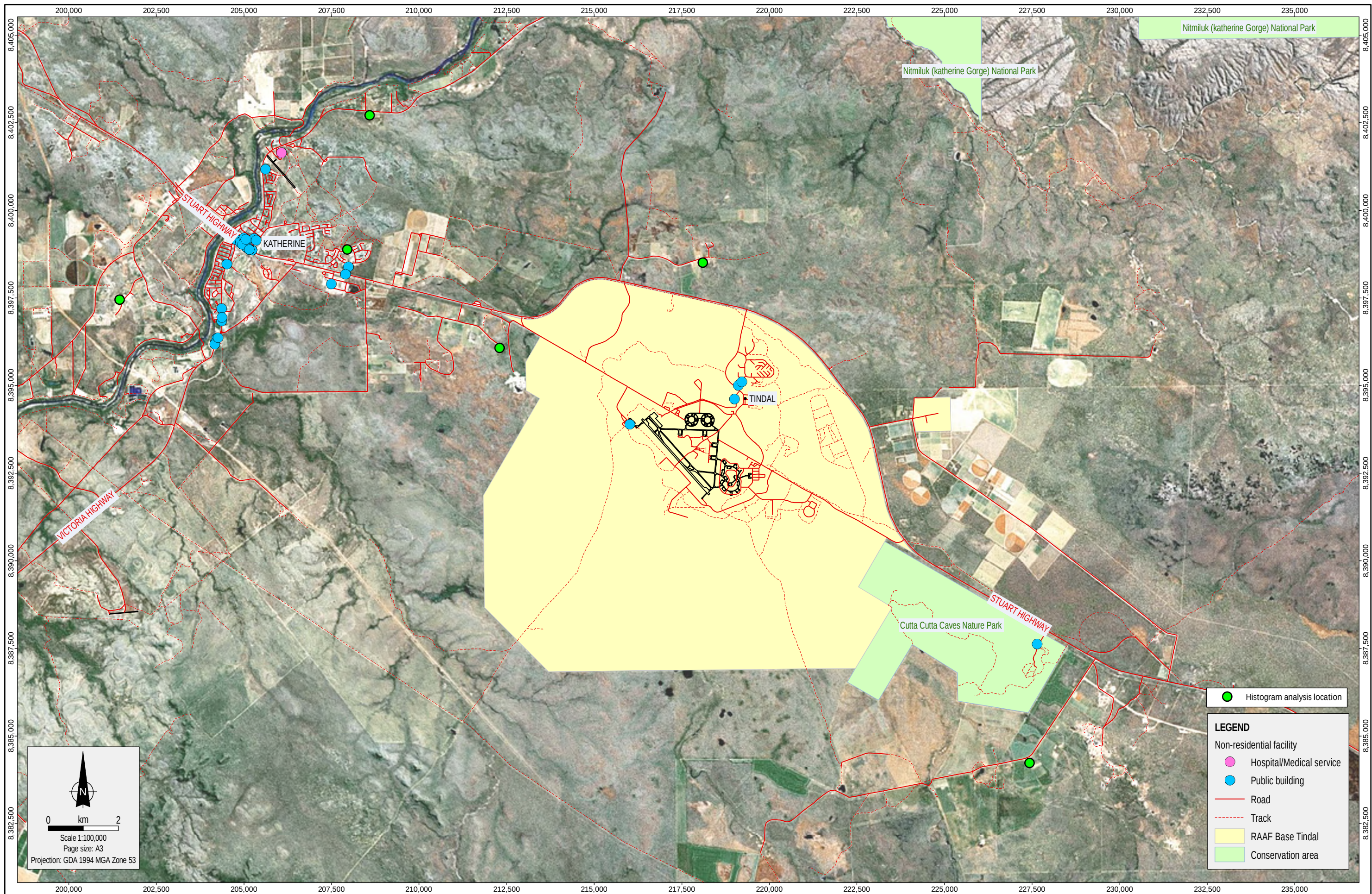
Reference	Summary of aircraft noise information
Airservices Australia's website <i>Aircraft Noise in your Neighbourhood</i> has been prepared to inform NSW, Queensland and Tasmanian residents on aircraft activity and noise information due to operations at their nearest airports. Link to site: https://aircraftnoise.airservicesaustralia.com	The website is intended to be educational as well as informative, combining statistics with explanatory information on aircraft activity and noise. After selecting an airport or location of interest, the site is broken into information packets under the following topics or questions: • What are the flight paths in my area? • What is normal in my area? • How much variation should I expect in my area? • What rules apply? • What flight disturbed me? • Resources. The following information is provided on separate pages: • Flight paths and aircraft flow under certain weather conditions or runway modes; • Runways and their usage; • Aircraft movement statistics at the closest noise monitoring terminal (NMT) and totals for the airport; • Simplified noise level statistics at the closest NMT; • High level information on flying rules and curfews; • Peak and seasonal variations; • Lodging complaints; • General aircraft information; and • Links to flight tracking, airport master plans and other useful information sources.
Melbourne Airport's <i>Aircraft Noise Information Tool</i> presents flight path and noise contour information from the 2018 Melbourne Airport Master Plan on an interactive map. https://www.melbourneairport.com.au/noisetool/index.html	An interactive map with the following features: • ANEF and ANEC contours for the current two (2) runway and future four (4) runway configurations; • Melbourne Airport Environs Overlay boundaries utilised by the Victorian planning framework; • Forecast long term number above contours; • Existing and forecast commonly used flight corridors for different runway use/modes; and • Address look-up functionality.

D6 Aircraft noise measurement and flight tracking systems

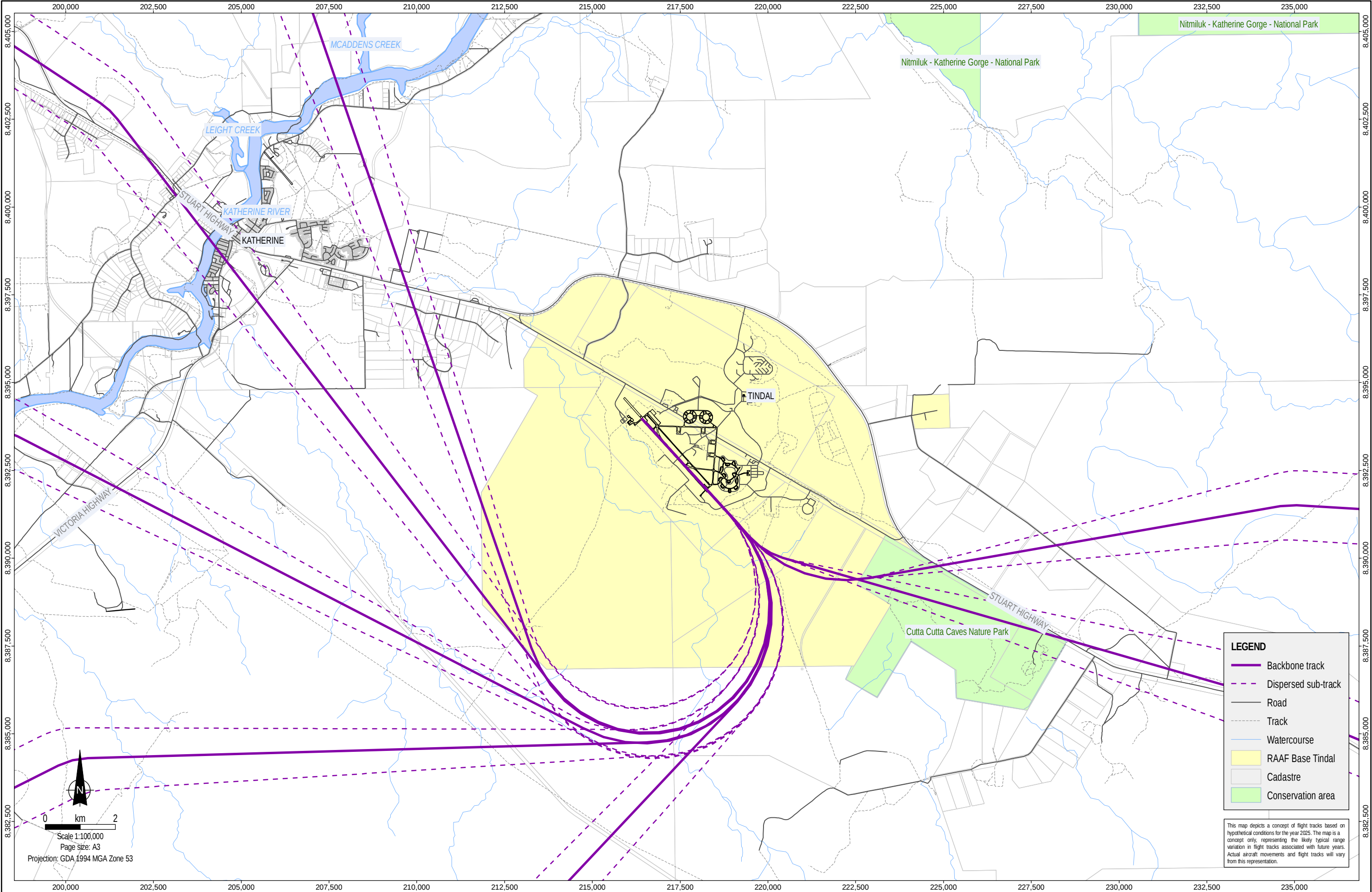
System	Features
ANOMS / NFPMS (publicly accessible as WebTrak) ANOMS forms the basis of the bespoke system used by Defence. The WebTrak public interface is utilised by Airservices Australia at Australian civilian airports, and by numerous airport operators in Spain, UK, USA, and Canada, amongst others. Example site (Melbourne Airport): https://webtrak.emsbk.com/mel3	• An interactive ‘Live’ aircraft tracking map (40 minute delay) with: - ‘Live’ instantaneous noise levels at NMT; - Individual flight information including flight ID, aircraft type, airport origin and destination, flight paths, altitude and airspeed; - Ability to lodge a complaint direct for any event/aircraft on the map - Weather conditions; - Address look-up functionality; and - Historical aircraft tracking for events up to three months prior. • A link to an interactive page for historic movement data including: - Flight corridor percentage use, hourly and daily events, counts of hours of no movements (respite); - Histograms of aircraft event maximum noise levels, N65 and N70 events, and average max level by aircraft type at each NMT; and - Custom filter for user-defined dates, times of day, aircraft operation type and day of week.
Casper Provides a range of airport analytic tools, including Flight Tracking and Noise Lab as utilised by airports worldwide, including Schiphol Airport Amsterdam, Edinburgh Airport and Leeuwarden and Volkel Air Bases in the Netherlands where F-35 aircraft will operate. Example site (Edinburgh Airport): https://noiselab.casper.aero/edi/	• A page providing educational material on aircraft noise, local flight paths, and various fact sheets; • Daily and hourly aircraft events and maximum noise level histograms per noise terminal for user defined time periods; • Interactive ‘live’ flight tracking (5 minute delay), including: - ‘Live’ instantaneous noise levels and time traces at NMT; - Individual flight information including flight ID, aircraft type, airport origin and destination, flight paths, altitude and airspeed; - Ability to lodge a noise enquiry for any event/aircraft on the map; - Weather conditions; - Address look-up functionality; - Historical aircraft tracking. • An interactive map of track density plots for monthly arrival and departures on the various runways; and • Other pages with airport specific information. e.g. The Edinburgh Airport site includes pages for temporary noise monitoring reports, authority compliance reporting, housing noise insulation schemes, vortex and ice fall damage, FAQs and submitting enquiries.

System	Features
Topsonic TANOS and TraVis aircraft monitoring systems used at eight of Germany's major airports and select airports in the UK and South America. Example site (Berlin Airport): https://travisber.topsonic.aero/travis.php?lang=en	• Interactive 'live' flight tracking (5 minute delay), including: - 'Live' instantaneous noise levels and time traces at NMT; - Individual flight information including flight ID, aircraft type, airport origin and destination, flight paths, altitude profile and airspeed; - Weather conditions; - Address look-up functionality; - Point of closest approach calculation and estimates of noise level at any given position on the map due to a flight; and - Historical aircraft tracking. • NMT day/night and monthly movement statistics and noise level histograms.
Aerovision The Aerovision system by ACOEM is a tool intended for airport operators to monitor flight tracks, aircraft noise levels and air quality to provide information on the airport's environmental impacts.	• A scalable solution to meet the needs of airports of all sizes; • 100 % web-based; • Integrates monitoring and storage of range of data sources, including noise, air quality, flight tracks and weather parameters; and • A public interface for presenting live and historic aircraft operations, NMT statistics, lodging complaints and presenting ongoing reporting is available.

**APPENDIX E SENSITIVE RECEPTORS AND F-35A AIRCRAFT FLIGHT TRACKS AT RAAF BASE TINDAL
AS PRESENTED IN THE EIS**



Source:
Non-residential facilities, RAAF base boundary and roads from Department of Defence, 2012-13.
Place names from GEODATA250K (Optimum scale 1:250,000).
Additional reserves from NRETS, 2013.
Aerial imagery from ArcGIS Online (capture date unknown).
Spatial data management and map production by Coffey, 2013.



Source:
Departure tracks on runway 14 from 2025 ANEC, prepared by SKM on behalf of Department of Defence, 2009.
Base boundary, cadastre and roads from Department of Defence, 2012.
Place names, watercourses and reserves from GEODATA250K (Optimum scale 1:250,000).
Additional reserves from NRETAS, 2013.
Spatial data management and map production by Coffey, 2013.

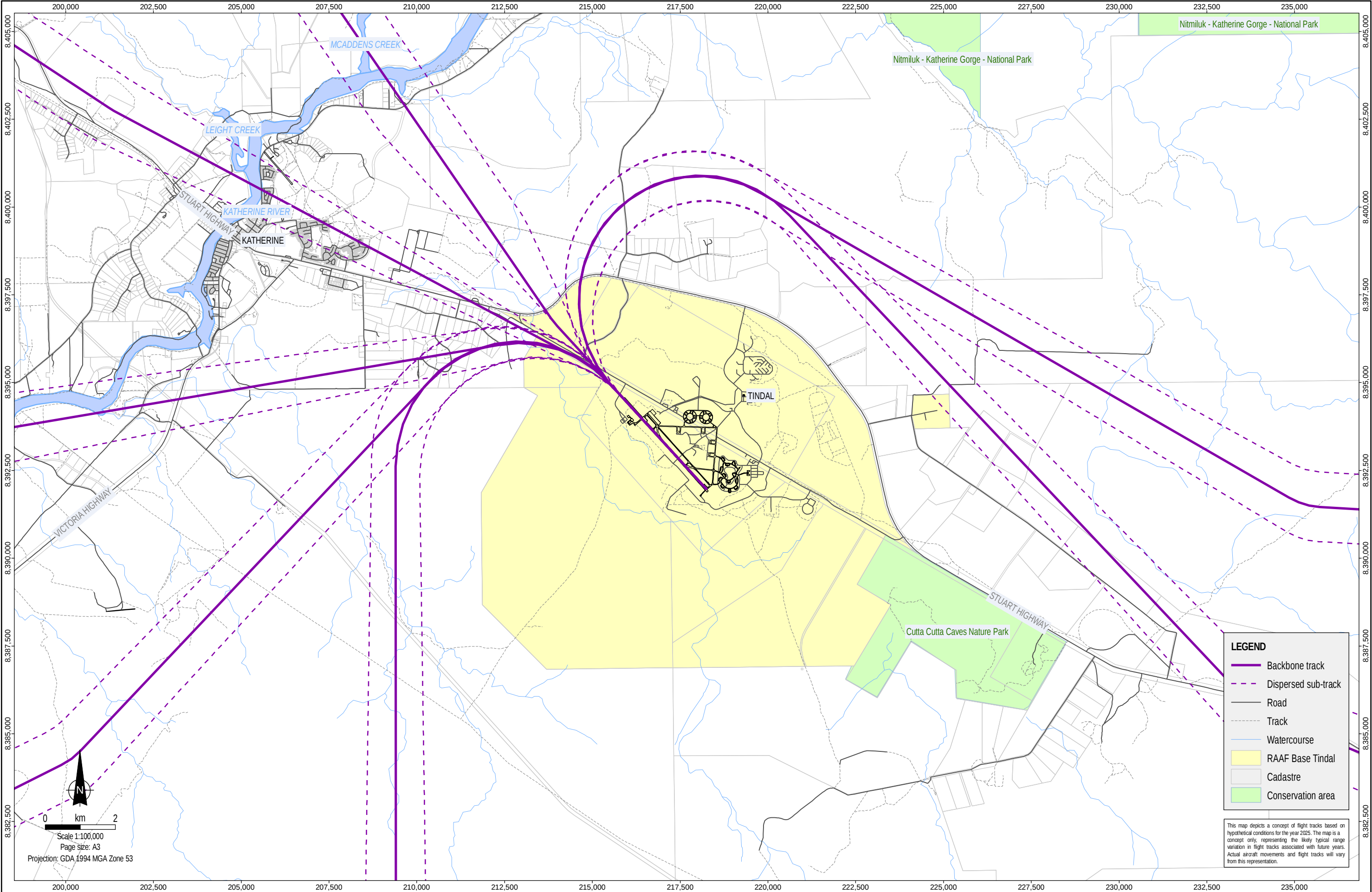


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Department of Defence
F-35A Lightning II Aircraft EIS

F-35A Departure tracks Runway 14

Figure No:
A-3



Source:
Departure tracks on runway 32 from 2025 ANEC, prepared by SKM on behalf of Department of Defence, 2009.
Base boundary, cadastre and roads from Department of Defence, 2012.
Place names, watercourses and reserves from GEODATA250K (Optimum scale 1:250,000).
Additional reserves from NRETAS, 2013.
Spatial data management and map production by Coffey, 2013.

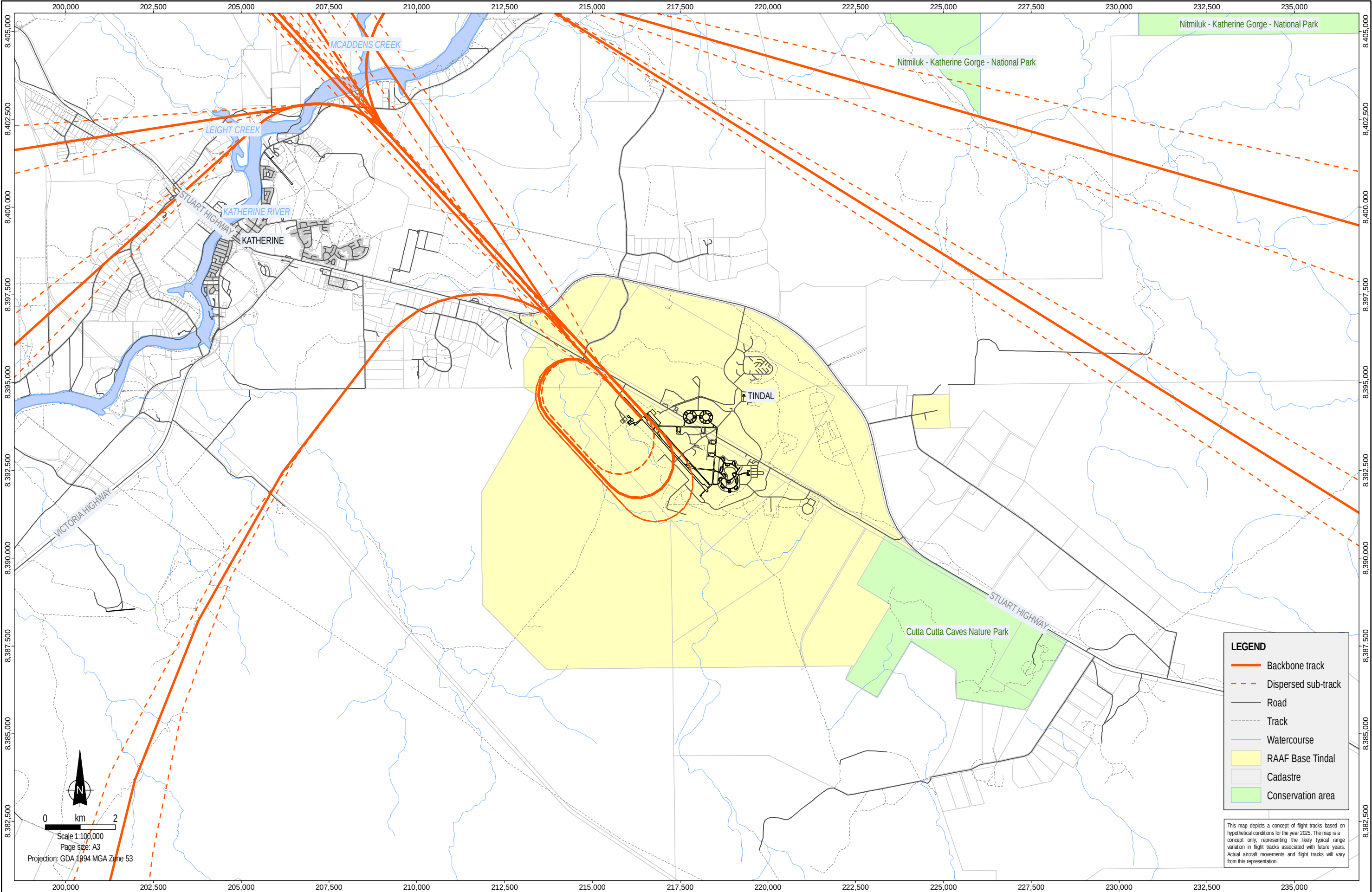


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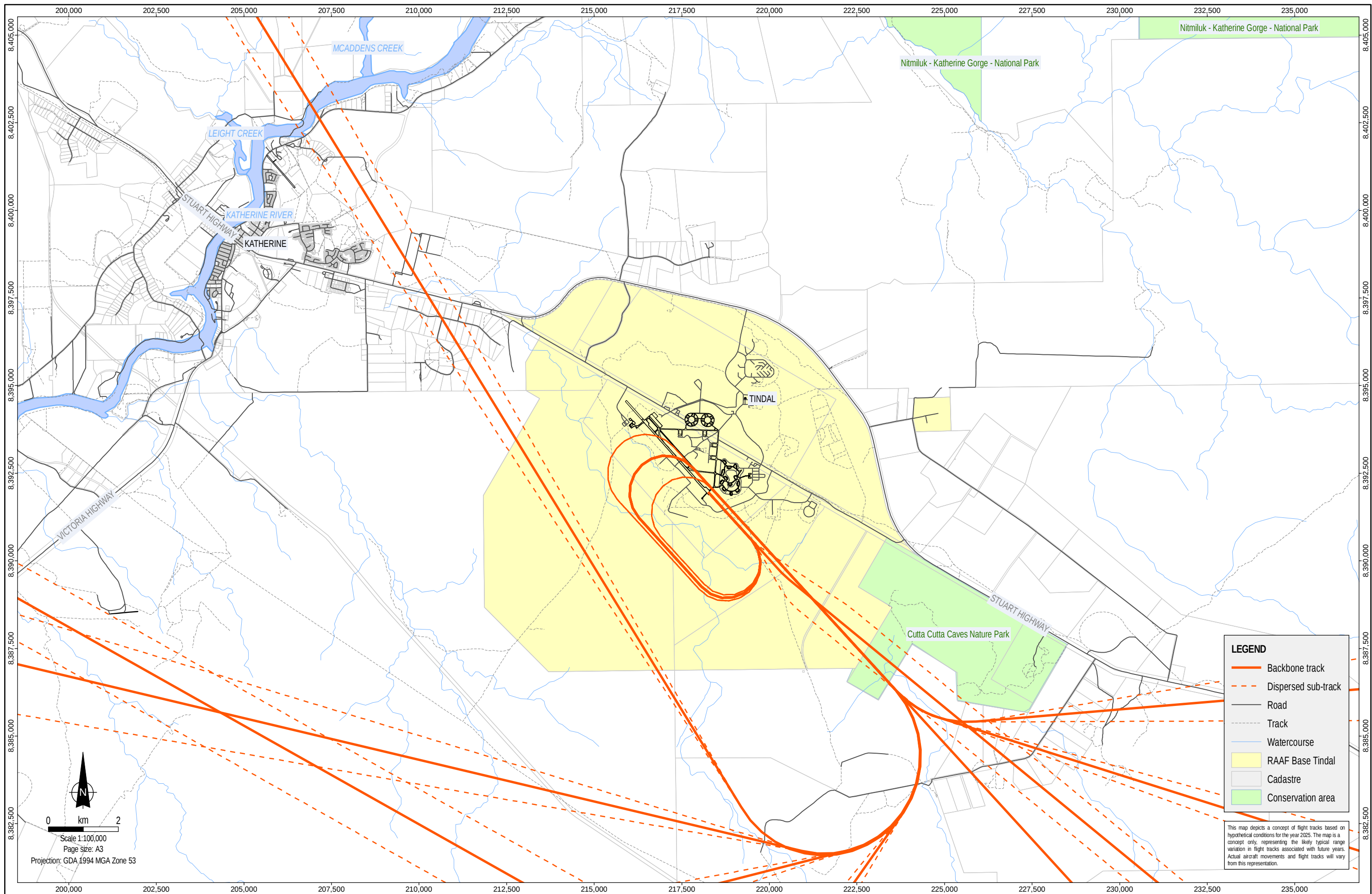
Department of Defence
F-35A Lightning II Aircraft EIS

F-35A Departure tracks Runway 32

Figure No:
A-4



Source:
Arrival tracks on runway 14 from 2025 ANEC, prepared by SKM on behalf of Department of Defence, 2009.
Base boundary, cadastre and roads from Department of Defence, 2012.
Place names, watercourses and reserves from GEODATA250K (Optimum scale 1:250,000).
Additional reserves from NRETAS, 2013.
Spatial data management and map production by Coffey, 2013.



Source:
 Arrival tracks on runway 32 from 2025 ANEC, prepared by SKM on behalf of Department of Defence, 2009.
 Base boundary, cadastre and roads from Department of Defence, 2012.
 Place names, watercourses and reserves from GEODATA250K (Optimum scale 1:250,000).
 Additional reserves from NRETAS, 2013.
 Spatial data management and map production by Coffey, 2013.

MARSHALL DAY
 Acoustics

Date:
 15.01.2014
 MXD:
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 File Name:
 TDL_A-6

Department of Defence

F-35A Lightning II Aircraft EIS

F-35A Arrival tracks Runway 32

Figure No:

A-6