SMART Flight Path Trial

Final Report 2014

1.0

Introduction

Airways Corporation of New Zealand (Airways), the Board of Airline Representatives New Zealand (BARNZ), representing airlines, and Auckland International Airport Limited (Auckland Airport) have been considering the use of new flight paths known as SMART flight paths, which were trialled recently.

SMART flight paths are instrument flight procedures using satellite navigation aimed at improving flight path, airspace, airport capacity and aircraft efficiency. The trialled SMART flight paths were specifically designed to maximise flying over industrial areas of Auckland city and to reduce the distance flown over residential areas.

This Final Report follows the issue of a draft report on 30 May 2014 (the Draft Report). The main purpose of this Final Report is to advise the public and industry participants of the overall findings and outcomes of the trial and to advise of Auckland Airport's decision. It summarises the origins and design of the SMART flight paths initiative, presents information on what the participating airlines and Airways have learned during the recent trial of the initiative, and outlines the public feedback received both prior to and after release of the Draft Report.

Airways is authorised by the Director of Civil Aviation under CAR part 173.9 to design instrument flight procedures. Auckland Airport is required to make a decision under Civil Aviation Rule Part 173.201(d) on whether to agree that the airport owned and operated by Auckland Airport at Mangere (Airport) may be used for new SMART flight paths. This Final Report includes that decision.

To assist interested parties to gain a deeper insight into the SMART flight paths trial and outcomes, the following reports which are available at www.aucklandflightpathtrial.co.nz were prepared along with the Draft Report:

- Airways Corporation of New Zealand SMART Approach Trial Report, 31 March 2014.
- Auckland SMART Approach Trial Review, An Airline Perspective, Prepared by BARNZ, 3 April 2014.
- Marshall Day Acoustics Auckland Airport Smart Approach Trial Noise Report, 3 April 2014.

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Auckland Airport

2.0

Aviation influence, roles and responsibilities in New Zealand

2.0 Aviation influence, roles and responsibilities in New Zealand

2.1 Overview

There are several parties that either influence the management of or assume roles and responsibilities for aviation within New Zealand. These include:

- International Civil Aviation Organisation;
- Ministry of Transport;
- Civil Aviation Authority;
- Airways Corporation of New Zealand;
- Board of Airline Representatives New Zealand;
- Airports;
- Airlines; and
- Pilots.

Below we outline the role each party plays in relation to flight paths and noise management at the Airport.

2.2 International Civil Aviation Organisation

The International Civil Aviation Organisation (ICAO) is a specialised agency of the United Nations responsible for the safe and orderly development of the world's aviation industry. It sets standards and regulations necessary for aviation safety, security, efficiency and regularity, as well as for aviation environmental protection. These standards and regulations flow through to New Zealand's aviation-related legislation.

In 2010, the ICAO Assembly resolved that states (i.e. member countries) should achieve a 2%pa improvement in fuel efficiency until 2020 and thereafter have an aspirational goal of maintaining that rate through to 2050[1]. How that is to be achieved is still being worked through by the aviation industry as a whole, and the International Aviation Transport Association has adopted targets that go towards meeting the ICAO resolution.

[1]Resolution A37-19: Consolidated statement of continuing ICAO policies and practices related to environmental protection – climate change.

2.3 Ministry of Transport

The Ministry of Transport (Ministry) is the New Zealand Government's principal transport adviser. The overriding objective of the Ministry is to:

1. improve the overall performance of the transport system across New Zealand;
2. improve the performance of transport Crown entities; and
3. achieve better value for money for the Government from its investment in the transport system[2].

The Ministry represents New Zealand's transport interests internationally, particularly in aviation. As such, the Ministry advises Government on policy and legislation to make air travel in New Zealand safer. The Ministry also acts as the Minister's agent in the Government's relationship with the Civil Aviation Authority and other transport agencies. An example of the Ministry's policy advice is the National Airspace Policy.

National Airspace Policy

The current National Airspace Policy (Policy) was created in response to a Global Air Navigation Plan which ICAO issued in 2007, recognising the step-change from land-based navigational aids to performance-based navigation technology and global positioning satellites (GPS), which is the essence of the technology used in the SMART flight paths.

The Policy states that it is consistent with the Government's goal for New Zealand's economic growth and its objective of an effective, efficient, safe, secure, accessible and resilient transport system that supports that growth. The Policy includes the principle of a safe airspace which is compatible with international standards and best practice. The Policy aims to deliver an airspace system which is efficient, environmentally responsible, integrated and enhances the ability for systems and organisations within the aviation sector to work more collaboratively.

[2]Source: http://www.transport.govt.nz/about/

2.4 Civil Aviation Authority

The Civil Aviation Authority of New Zealand (CAA) regulates civil aviation in New Zealand and enforces ICAO's standards and regulations to the extent they are incorporated into relevant New Zealand legislation. The CAA was established by the Civil Aviation Amendment Act 1992 and operates under the Civil Aviation Act 1990. It is focused on establishing civil aviation safety and security standards, and monitoring adherence to those standards[3].

The CAA develops Civil Aviation Rules (CARs) under the Civil Aviation Act 1990 and those govern how aircraft are to manoeuvre in New Zealand airspace, as well as how aircraft are to approach and depart New Zealand airports.

The New Zealand Government agreed in August 2011 to the development of the Policy and a National Airspace and Air Navigation Plan (Plan) which was released in June 2014[4]. The CAA led the development of the Plan, and one of its most significant aspects is the proposed move from land-based systems to space-based satellite navigation and surveillance, or performance-based navigation (PBN).

2.5 Airways Corporation of New Zealand

Airways Corporation of New Zealand (Airways) manages 30 million km^2 of airspace, providing air traffic control, surveillance, communication, flight inspections, mapping and airspace design services. Airways operates under rules set down by the CAA, which are developed using ICAO guidelines. Airways is a State-owned Enterprise, a fully-owned subsidiary of the New Zealand Government operating as a commercial business.

Airways' main role in relation to the SMART flight paths trial was designing the SMART flight paths and procedures for use of those flight paths, and integrating the SMART flight paths trial aircraft into the overall air traffic approaching and departing the Airport.

[3]Source: http://www.caa.govt.nz/about_caa/about_the_CAA.htm
[4] Source: http://www.nss.govt.nz/documents/web-national-airspace-and-air-navigation-plan-fa.pdf

2.6 Board of Airline Representatives New Zealand

The Board of Airline Representatives New Zealand Inc. (BARNZ) is an incorporated society comprising 21 member airlines which operate scheduled international and domestic services into and within New Zealand. BARNZ focuses on representing the airlines across the following four broad areas:

- consultation on airport pricing;
- airport capital expenditure;
- Government departments and agencies; and
- noise issues around airports.

BARNZ's main role in relation to the SMART flight paths trial was representing the airlines that use the Airport.

2.7 Airports

Airports provide the infrastructure for aircraft to land and take off, and facilities for processing passengers as they arrive and leave. An airport's main influence in relation to aircraft noise relates to its role in on-airport development, influencing off-airport development (e.g. via designations in District Plans), and airline schedules management.

The CARs state that *"an Instrument Flight Procedure must not be designed for an aerodrome or heliport unless the operator of the aerodrome or heliport agrees in writing that the aerodrome or heliport may be used for IFR [Instrument Flight Rules] operations using the intended instrument flight procedure"*[5].

The main role of Auckland Airport in relation to the SMART flight paths trial is agreeing to the instrument flight procedures and responding to concerns raised by the public about aircraft noise.

[5]CAR Part 173.201(d)

2.8 Airlines

More than twenty airlines fly into and out of the Airport. Airlines decide their flight schedules, frequencies of operation, which markets to serve, what fares to charge and types of aircraft and equipment to operate. They do so in compliance with aircraft certification and operating requirements. In addition to the legal requirement to operate under New Zealand's CARs, airlines set their own standard operating procedures based on best business and operating practices. An airline's fleet replacement strategy determines the type of aircraft in operation and the timeframes for using newer aircraft.

Three airlines participated in the SMART flight paths trial – Air New Zealand, Jetconnect[6] and Jetstar. Their main role in relation to the SMART flight paths trial was managing their aircraft operating fleets and setting operating procedures that met CAR requirements.

2.9 Pilots

Pilots have the ultimate responsibility for the safe operation of their aircraft. Although each airline can adopt procedures and recommended best practices, pilots still retain the operational authority and discretion to make final decisions regarding the safe operation of the aircraft. Pilots are expected and encouraged to adhere to special operational procedures for arrivals and departures. However, in the interest of safety, pilots may deviate from such procedures when necessary.

The main role of pilots in relation to the SMART flight paths trial was adhering to CAR requirements, including noise abatement procedures set by regulatory authorities, the airport and their airlines.

[6] Jetconnect is an airline based in Auckland, New Zealand. The airline is a wholly-owned subsidiary of Qantas and was established in July 2002.

3.0

Legal framework for aviation in New Zealand

3.0 Legal framework for aviation in New Zealand

3.1 Overview

The planning and operation of the Airport is regulated through a number of national and regional Acts, Rules and Plans. Aviation legislation and policy focuses on the safe and efficient operation of airports. Land use planning legislation and policy protects both the Airport's function and the surrounding communities from the impacts of the Airport, especially in relation to noise. These Acts, Rules and Plans include:

- Civil Aviation Act 1990;
- Civil Aviation Rules;
- Resource Management Act 1991; and
- Manukau District Plan.

3.2 Civil Aviation Act 1990

The Civil Aviation Act 1990 (Act) is New Zealand's central piece of aviation legislation. The Act is administered by the CAA. It establishes rules of operation and divisions of responsibility within the New Zealand civil aviation system in order to promote aviation safety. It also ensures that New Zealand's obligations under international aviation agreements are implemented and it consolidates and amends the law relating to civil aviation in New Zealand. CARs developed under the Act provide the framework to enact the requirements of the Act.

3.3 Civil Aviation Rules

The CAA governs civil aviation in New Zealand and sets rules relating to airport and aircraft operations using CARs. CARs cover topics such as aircraft, personnel, airspace, general operating and flight rules and noise abatement procedures.

3.4 Resource Management Act 1991

New Zealand's Resource Management Act 1991 (RMA) is the nation's central piece of environmental legislation. The RMA is managed by the Ministry for the Environment. Statutory regulation of aviation-related noise arises from the RMA, which provides mechanisms for placing limits on activities making noise, sets out duties and enables the taking of enforcement action to prevent excessive or unreasonable noise. The relevant sections of the RMA are sections 9 and 16.

3.5 Manukau District Plan

Auckland Airport is a requiring authority with designations which place various controls over activities on land at the Airport (the Designated Area in the Manukau Operative District Plan). The designation for the Airport includes conditions to control noise from aircraft operations and engine testing on aircraft generated at and by the Airport.

4.0

Flights into Auckland

4.0 Flights into Auckland

4.1 Operating procedures

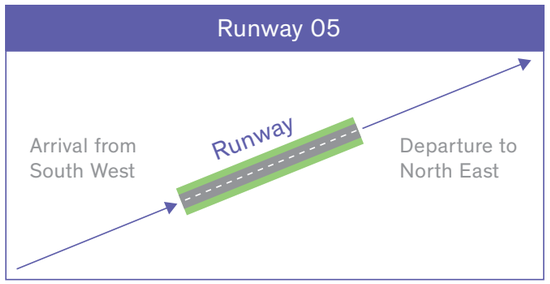
Each country has a set of operating procedures for aircraft operating within its designated airspace. General operating and flight rules for New Zealand are articulated in CAR Part 91. This CAR outlines general flight rules, visual flight rules (VFR), instrument flight rules (IFR) and other requirements to operate aircraft in New Zealand airspace[7, 8].

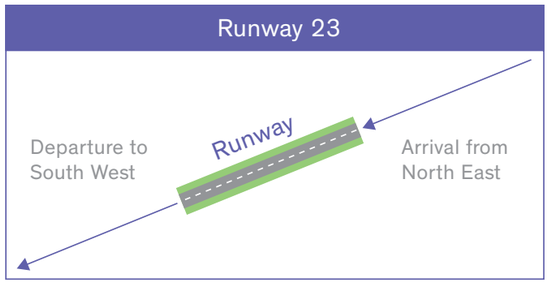
CAR Part 93 provides aerodrome traffic rules and noise abatement procedures for a number of New Zealand's airports, including the Airport. These rules include requirements for pilots to approach and depart runways under certain conditions to minimise noise impacts from landing and take-off operations.

The Airport's runway is orientated north-east to south-west. The runway's mode of operation is called either Runway 05 or Runway 23, representing the abbreviated magnetic compass direction of the runway. The runway is 50 degrees when approaching from the south-west or departing to the north-east, and is 230 degrees when approaching from the north-east or departing to the south-west. This is illustrated on the next page.

[7]IFR and VFR are the international requirements governing all aspects of aircraft operations. IFR rules are established for aircraft that fly and navigate by reference to instruments in the cockpit. IFR aircraft can fly in any weather conditions day or night and within clouds. IFR aircraft can also fly using visual references outside the cockpit (horizon, buildings, flora, etc.), this may be done when they are close to an airport and positioning to land. The SMART flight path trial flights operated under IFR using cockpit instruments. VFR rules are established for aircraft that fly and navigate by visual references outside the cockpit. VFR aircraft usually fly in clear skies during the day but not within clouds or in bad weather, and not normally at night.

[8]Specific details for each airport's flight rules are published in New Zealand's Aeronautical Information Publication (AIP).





Aircraft generally take off and land into the wind, therefore wind direction dictates whether Runway 05 or Runway 23 will be operated.

The predominant wind direction at the Airport is westerly, so Runway 23 dominates.

When there is tailwind of less than 5 knots and minimal air traffic, it is possible for Airways to operate the Airport's runway in a reciprocal mode (meaning aircraft can both land and take off over the Manukau Harbour). These conditions sometimes occur at night, and this reciprocal mode is one of the noise abatement procedures included in CAR Part 93.

4.2 Traditional flight paths

Aircraft fly from destination to destination within designated flight paths, which are effectively 'highways' in the sky. These allow aircraft to predictably, and therefore safely, fly along standard routes. These routes are marked on published charts and are used by pilots to plan their flights. In the vicinity of an airport, there are additional routes which guide aircraft to and from runways under IFR conditions[9]. Routes that guide aircraft to and from runways are known as Standard Instrument Departures (SIDs) and Standard Terminal Arrival Routes (STARs). SIDs and STARs have specified procedures, including directional and height limits, which pilots are required to observe when flying into and out of a destination, unless instructed otherwise by Airways.

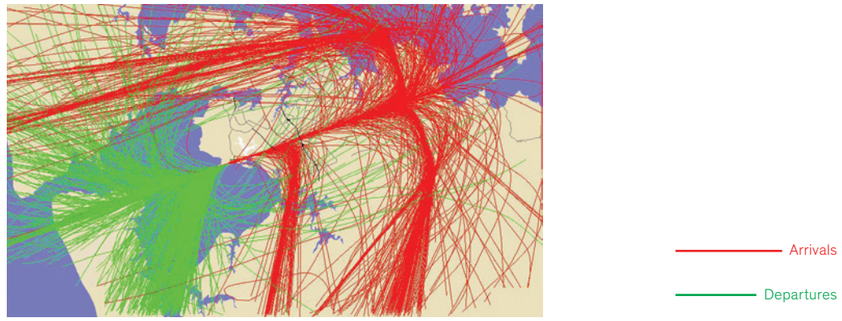
While flight paths are often depicted as single lines on a map, it is usually not possible for all aircraft following a particular flight path to fly precisely along the same line. In practice, individual flight paths tend to occur within flight corridors that can be a number of kilometres wide. The exception to this is when PBN paths are used (referred to as SMART flight paths in this Final Report)[10]. PBN utilises GPS technology on the aircraft and allows them to follow flight paths to a far greater degree of accuracy[11]. There is considerable variation in where aircraft fly day-to-day, for reasons including weather, airspace congestion and activity at other aerodromes (e.g. Ardmore, Whenuapai, etc.). Most areas of Auckland experience overflight[12] by arriving and/or departing aircraft.

[9]IFR and visual flight rules (VFR) are discussed in footnote 7 on page 20.
[10]SMART flight paths are strictly Required Navigation Performance, which is a type of PBN.
[11]The Ministry of Transport website includes a discussion of PBN at the following location: http://www.transport.govt.nz/ourwork/air/performancebasednavigation/
[12]"Overflight" is a term used to describe the flight of an aircraft over a specific area or territory.

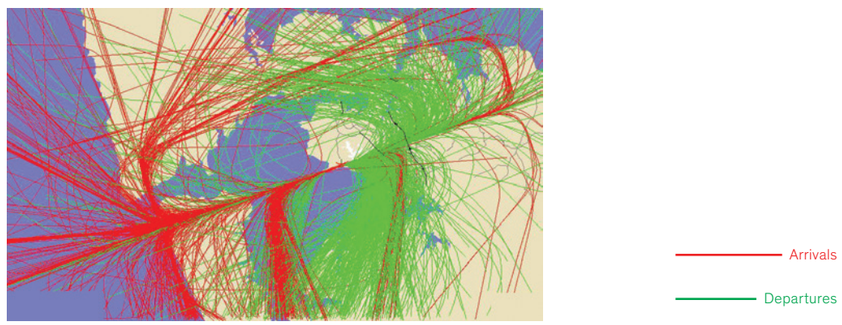
4.3 Movement numbers

Aircraft movements at the Airport have plateaued in recent years, falling from a peak of 162,000 movements[13] in 2008. Over the past three to four years there have been around 155,000 movements per annum (currently approximately 45,000 international and 110,000 domestic). Domestic movements are mostly to and from the south. International movements are mostly to and from the north, with some 80% of those to and from the North West. The diagrams below show two typical weeks of aircraft movements at the Airport before the SMART flight paths trial (in September 2011). The Runway 23 diagram shows when aircraft predominantly landed at the Airport from the north-east and departed to the south-west (red lines indicate approaches and green lines departures). The Runway 05 diagram shows when aircraft predominantly landed from the south-west and departed to the north-east. As noted above, the direction of approach and departure is wind-dependant.

Runway 23 predominant movements



Runway 05 predominant movements



[13]A "movement" is either the take off or landing of an aircraft.

5.0

SMART flight paths

5.0 SMART flight paths

5.1 What is driving the initiative?

As outlined earlier in this Final Report, in 2007 ICAO urged member countries to move to PBN. According to ICAO:

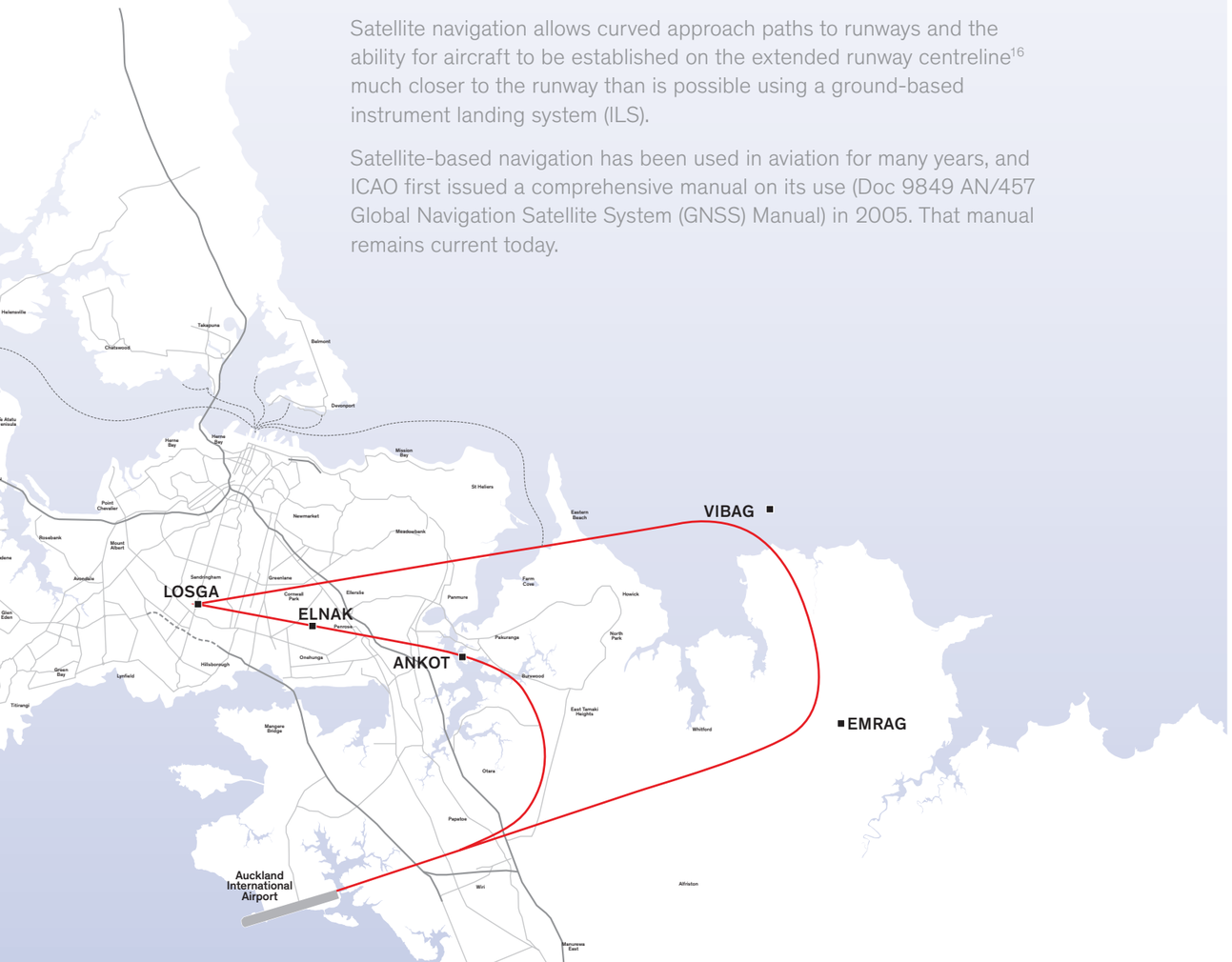
"PBN is helping the global aviation community reduce aviation congestion, conserve fuel, protect the environment, reduce the impact of aircraft noise and maintain reliable all-weather operations, even at the most challenging airports. It provides operators with greater flexibility while increasing the safety of regional and national airspace systems."[14]

The New Zealand Government has complied with that resolution and issued a National Airspace Policy[15] which recognises the step-change to PBN, allowing safer and more efficient airspace management.

5.2 The benefits of PBN for the Airport

Satellite navigation allows curved approach paths to runways and the ability for aircraft to be established on the extended runway centreline[16] much closer to the runway than is possible using a ground-based instrument landing system (ILS).

Satellite-based navigation has been used in aviation for many years, and ICAO first issued a comprehensive manual on its use (Doc 9849 AN/457 Global Navigation Satellite System (GNSS) Manual) in 2005. That manual remains current today.



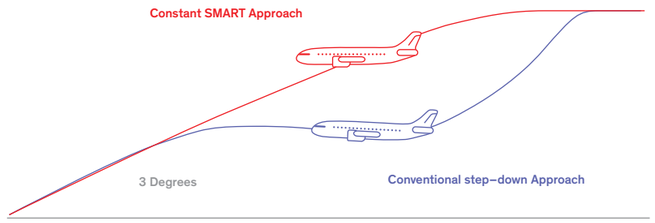
The ICAO GNSS Manual sets standards for accuracy, integrity and continuity. A high degree of accuracy is required for safe navigation. Integrity is about being sure that the GNSS position meets the accuracy standards required. Continuity is about ensuring that once a GNSS procedure has commenced, the GNSS position will be available for the full duration of the procedure. Aircraft System-generated alerts are required to be issued when accuracy, integrity or continuity standards are not being met, and alternative non-GNSS-based navigational aids are required to be available in these cases.

GPS approach procedures are commonplace around the world today, and have been used in New Zealand since the 1990s. The PBN technology trialled at the Airport[17] has been in use through the mountains around Queenstown since 2003. The requisite integrity and continuity standards are required to be in place before an aircraft can begin an approach. There have been no safety-related events in New Zealand as a result of those standards not being achieved, because there are backup procedures to ensure safety is maintained.

In westerly wind conditions, most international aircraft approaching the Airport have to fly over the region to align with the appropriate runway to land into the wind. Satellite navigation provides the opportunity for shorter and curved approach paths, resulting in fuel and carbon emission savings and fewer residents being overflown. The diagram on the previous page highlights the Airport's traditional ground-based instrument landing arrival path to Runway 23 and the much shorter SMART flight path's performance-based navigation approach. The diagram also shows the waypoints[18] aircraft use to guide them into the Airport.

[14] Source:http://www.icao.int/safety/pbn/Pages/default.aspx
[15] Refer to s.2.3.
[16] Aircraft need to approach and land on a runway by establishing on the extended runway centreline.
[17] SMART flight paths are strictly Required Navigation Performance, which is a type of PBN.
[18] The waypoint names illustrated in the aerial photo are computer-generated words. Their locations are approximately as follows: LOSGA is above the Mt Roskill end of Sandringham; ELNAK is above One Tree Hill; ANKOT is above Pakuranga; EMRAG is above Brookby/Clevedon; VIBAG is above the Tamaki Strait of Maraetai.

PBN technology also allows constant descent when aircraft are on final approach to a runway, allowing aircraft engines to run close to flight idle when the SMART flight path design is correctly integrated with the preceding STAR. PBN technology almost eliminates the traditional step-down approach, where aircraft descend in steps separated by intervals of level flight and engine thrust (see diagram below). Due to the longer flight path and level flight engine thrust of traditional approaches, more fuel is used, delivering more carbon emissions into the environment, and more noise is generated. In summary, the conventional step-down approach, which largely relies on ground-based navigational aids, is noisier, less fuel efficient and less environmentally friendly than a continuous descent using PBN technology, as used in the SMART flight paths trial.



Traditional land-based navigational technology requires flights approaching the runway to join the extended runway centreline seven to ten nautical miles from the runway. Satellite-based PBN technology allows a curved approach with aircraft joining the extended runway centreline within three to four nautical miles of the runway. The maximum benefits from PBN technology are achieved when flight paths join the extended centreline as close as practical to the runway, thereby reducing the distance flown as much as possible.

5.3 Auckland's SMART flight paths trial

At the request of one of the participating airlines, Airways designed and proposed four SMART flight paths in line with various civil aviation requirements. CAR Part 173 requires Auckland Airport to agree that the Airport may be used for the SMART flight paths before any flight path can be implemented.

Auckland Airport required that three of the four proposed SMART flight paths be trialled, two from the north and one from the south. The diagram below highlights the three trialled SMART flight paths. One SMART flight path descends from the north to Runway 23 (Green X23) and one from the south to Runway 23 (Red Y23). The third SMART flight path (Blue X05) approaches and descends from the north to Runway 05. This Final Report refers to each of the trialled SMART flight paths individually as Green X23, Red Y23, or Blue X05 as shown in the diagram below.

Location of SMART flight paths

Legend

Red Y23

Green X23

Blue X05

From the outset, all of the SMART flight path trial partners were committed to designing procedures and using technology that utilised the highest standards, with safety of operations being paramount. All of the SMART flight path trial partners are involved directly in aviation, and that requires safety to be a core principle for each organisation. It was not possible for any of the SMART flight path trial partners to design or use a SMART flight path procedure or to use technology that was not appropriately reviewed and authorised under an overarching requirement of safety.

An important aspect of the SMART flight path design is to control aircraft speed so that the aircraft is both stable and able to negotiate approach curves with the minimum deployment of braking devices such as air brakes and excess flap extension, as those tend to generate excessive noise. The aircraft speed that is important is air speed (i.e. speed relative to the air) not speed relative to the ground. Air speed is critical for aircraft flying downwind, such as international aircraft to the Airport from the west in westerly wind conditions.

With that in mind, Airways and the airlines designed and proposed flight paths which had minimum noise impacts.

The Red Y23 approach from the south is within the long-established flight corridor for both jet and turboprop aircraft above the Weymouth peninsular. That flight corridor is restricted to the east by the airspace dedicated to Ardmore Airport, and to the west by the need to curve onto and get established on the extended runway centreline a safe distance out from touch-down. The trialled Red Y23 flight path veered a little further to the east so that at the estuary north of Wattle Downs it is some 600m east of the published path which defined the long-established flight corridor. The Red Y23 path is so shaped because it is the optimum combination of approach heights, turn radius and length of final approach to the runway that could be fitted into the airspace available and still accommodate jet aircraft operations.

The Green X23 approach from the north (west) was designed in the first instance to achieve the minimum flight-path length while still remaining within the requirements of the CAR Part 93 noise abatement procedures. Considerable effort was then applied to utilise industrial areas when the aircraft would be below 4000 ft (i.e. to the east of Rockfield Road), by keeping south of the South Eastern Highway, south of Ti Rakau Drive and west of Te Irirangi Drive. Less of a noise issue was expected from aircraft above 4000 ft. Also, there was a desire to keep flight paths simple and employ long-established STARs for the descent to the SMART flight path. The main STAR from the north (west) passed through LOSGA, overflying predominantly residential areas. As a result, it was decided that the SMART flight path would overfly residential land west of Rockfield Road.

It was always recognised that there would be little demand for an 05 approach from the north (east) as only about 20% of international flights are from that direction, and Runway 05 is only used for 30% of landings. The Blue X05 flight path was effectively a mirror image of Green X23, but unlike Green X23, below 4000 ft it was over water.

To limit the impact of the trial on the public, especially in relation to aircraft noise, the trial was limited to a maximum number of flights that could use each SMART flight path per day. Flights were also only permitted to use the SMART flight paths between 7am and 10pm. The number of flights per SMART flight path was to be increased progressively over the trial period. The table below outlines this process for the Green X23 and Blue X05 flight paths.

Trial period	Maximum daily arrivals	
	Green X23	Blue X05
Stage 1 (month 1)	5 flights	5 flights
	Review	
Stage 2 (months 2 & 3)	10 flights*	10 flights*
	Review	
Stage 3 (months 4–7)	20 flights*	10 flights*
	Review	
Stage 4 (months 8–12)	30 flights*	10 flights*

**These numbers were initial recommendations to be confirmed at each review before progressing. However, the increases to the Stage 3 and 4 levels were not implemented, and months 4 to 12 remained at the Stage 2 maximum of 10 flights per day.*

The table below outlines this process for the Red Y23 flight path.

Trial period	Maximum daily flights
	Red Y23
Stage 1 (months 1 & 2)	10 points*
	Review
Stage 2 (months 3 & 4)	15 points*
	Review
Stage 3 (months 5–7)	25 points*
	Review
Stage 4 (months 8–12)	50 points*

** For the Red Y23 flight path only, a points system was used, based on the 2 aircraft types using this path (the noisier type was allocated 2 points and the other type 1 point).*

*** These numbers were initial recommendations to be confirmed at each review before progressing, and the increases did occur.*

Prior to the SMART flight paths trial commencing, Auckland Airport engaged sound experts Marshall Day Acoustics[19] (MDA), which determined that the trial impacts could be accommodated within the noise provisions in the Manukau District Plan[20]. MDA measured the noise of five pre-trial flights, using the proposed Green X23 SMART flight path, to confirm that the SMART flight paths trial would not breach the noise provisions in the Manukau District Plan.

The trial of the Green X23 and Blue X05 SMART flight paths commenced in November 2012, and Auckland Airport gave approval for the maximum number of allowable flights per day for each of these flight paths to increase from 5 to 10 in December 2012, but no further increases occurred after that date. The trial of the Green X23 and Blue X05 SMART flight paths concluded on 31 October 2013.

[19] Founded in 1981, Marshall Day Acoustics is New Zealand's leading firm of acoustic engineering consultants who provide the highest standard of environmental and architectural acoustic consulting services.

[20] Those provisions require the following: Aircraft noise outside the High Aircraft Noise Area (HANA) is not allowed to exceed Ldn 65 dB, and aircraft noise outside the Moderate Aircraft Noise Area (MANA) is not allowed to exceed Ldn 60 dB.

The trial of the Red Y23 flight path commenced in February 2012, and Auckland Airport gave approval for the number of allowable points[21] per day for this flight path to increase as originally designed for each of the Stages (refer to table on previous page). Auckland Airport gave approval for the trial for the Red Y23 flight path to advance to Stage 4 in February 2014, and the trial for the Red Y23 flight path concluded on 30 April 2014. Red Y23 has continued to be flown at the Stage 4 level of activity since the actual trial concluded.

Because the Red Y23 flight path largely replicated the visual approach to Runway 23 from the south, and Green X23 and Blue X05 had been designed to minimise low-altitude flight over residential areas, community noise impacts were expected to be minimal. On that basis, Auckland Airport, Airways and BARNZ decided that more could be learnt about public reaction if the trial was not given pre-publicity. Instead, material relating to the trial was made available on a website so that members of the public could be referred to that if they made enquiries. This approach was discussed at several meetings of the Aircraft Noise Community Consultative Group (ANCCG)[22] and was supported at the ANCCG meeting on 13 June 2012.

A consideration in flight path design over urban areas, and one raised in public submissions, is exhaust emissions. ICAO engine emissions certification (ICAO Air Quality Manual Document 9889) focusses on the operation of aircraft below 3000 ft on the basis that much of the total emissions of an aircraft in operation occur below that altitude, and that above that altitude emissions are subject to significant dispersion. In other words, while emissions above 3000 ft contribute to overall air quality they do not materially impact local air quality, irrespective of whether the flight path is SMART or traditional.

However, controlling aircraft noise effectively reduces emissions, because the aircraft flight factors that increase or reduce noise also increase or reduce emissions. Aircraft exhaust emissions during any part of a flight are directly proportional to the engine thrust being employed, and that in turn influences the aircraft noise experienced.

[21] Note that because of distinctly different noise-levels of the two aircraft types flying this flight path, a points system was used, rather than a specific maximum of flights.

[22] This group includes appointees of Auckland Council and representatives of the Council's local Boards.

6.0

Results

6.0 Results

6.1 Noise monitor results during trial

During the course of the trial, five noise monitors operated in the community, in the following locations:

- Marsden Avenue, Balmoral.
- Coronation Road, Epsom.
- Moana Avenue, One Tree Hill.
- Torokina Place, Oranga.
- Reinheimer Place, Flat Bush.

Location of noise monitors and SMART Approach tracks

The noise monitor at Coronation Road was a portable monitor from the Airport's noise monitoring system. The four other monitors were stand-alone monitors and were not connected to the Airport's noise-monitoring system. MDA and Airways collaborated to match data collected from the four stand-alone monitors with radar data to identify the individual aircraft and noise activity.

The exact correlation between objective noise measurements and public response is a difficult process, as the relationship is a complex interaction between many attitudinal, social, and noise-related factors. However, a large amount of research has been carried out overseas and there is wide agreement that annoyance due to aircraft noise depends on both the number of noise events and the loudness of these noise events, creating an overall noise exposure known as day/night level or Ldn.

Ldn measures the 'noise energy' of each event and then combines the events over a 24-hour period, with a 10 dB penalty applied to any noise events at night (10pm-7am). Ldn is the most widely-used metric for aircraft noise in Europe, the USA and New Zealand.[23]

A further noise metric, LAmax, is useful for comparing the noise level of one individual aircraft event with another aircraft event. The LAmax is simply the maximum noise level recorded during the single noise event.

MDA undertook considerable analysis of the noise exposure (Ldn) and maximum sound levels (LAmax) of SMART and non-SMART flight path flights during the trial. While there was limited pre-trial monitoring other than the continuous noise monitoring in Manukau, during the trial MDA was able to identify separately the noise attributable to the SMART flight paths flights as opposed to the non-SMART flight path flights. MDA identified that individual SMART flight path flights had marginally higher noise levels, with an LAmax of approximately 3 dB higher. However, MDA expected this difference would generally be regarded as 'only just perceptible' if one event was immediately compared with another. When five SMART flight path flights are mixed with 25 non-SMART flight path flights over the day, this difference of 3 dB would not be expected to be perceptible.

MDA found the difference in LAmax of 7 dB at Reinheimer Place would be expected to be noticeable. However, the SMART flight path flights make up only a small percentage of total flights, thus MDA judged the change in noise exposure would not be noticeable. MDA calculated the overall change in noise exposure due to the SMART flight paths trial was 0.3 to 0.6 dB (Ldn) at all five monitoring locations.

[23]The Airport's designation under the Manukau District Plan restricts aircraft noise outside the High Aircraft Noise Area (HANA) to less than Ldn 65 dB, and aircraft noise outside the HANA and Moderate Aircraft Noise Area (MANA) to less than Ldn 60 dB.

6.2 Public feedback

6.2.1 During trial and prior to Draft Report release

Auckland Airport has a long-established process in place for handling public feedback on aircraft noise.

In April 2013, five months after the Green X23 trial began, a Mt Eden resident identified that the SMART flight paths trial was taking place and contacted Auckland Airport. On 3 May 2013, the Central Leader newspaper published the first media story about the trial[24]. Following the Central Leader story, there was an increase in interest in the trial from the public, media and political stakeholders. The number of calls to Auckland Airport through the established feedback process escalated. Many members of the public also used other means to express their concerns, such as direct email contact with Auckland Airport's management.

Members of the public also directly approached Airways seeking information, and approached local and central government representatives.

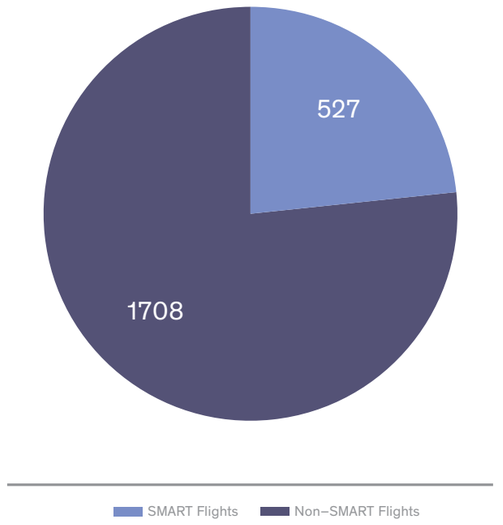
As a result, Auckland Airport met with certain members of the public and local and central government stakeholders, and two public meetings were convened by local residents. The first meeting on 12 September 2013 was attended by representatives of Airways, BARNZ and Auckland Airport. The second meeting on 10 October 2013 was attended by BARNZ. As a result of those meetings and questions from political stakeholders, a formal list of 44 questions was put to Airways, BARNZ and Auckland Airport. These were responded to in a joint letter dated 5 December 2013.

Detailed analysis by MDA of public feedback revealed that in the period from the initial media coverage on 3 May until the end of the Green X23 trial on 31 October, approximately 76% of the noise event feedback Auckland Airport received was attributed to conventional rather than SMART flight paths (refer to diagram on next page)[25].

[24] Source: http://www.stuff.co.nz/auckland/local-news/central-leader/8623168/flight-path-turbulance

[25] Previous figures Auckland Airport has made public in this respect related to the 111 aircraft noise event complaints received during April, May and June 2013, analysis of which revealed approximately 10% of the noise events feedback could be attributed to the aircraft using conventional rather than SMART flight paths.

Public feedback after initial media coverage (3 May 2013 – 31 Oct 2014)

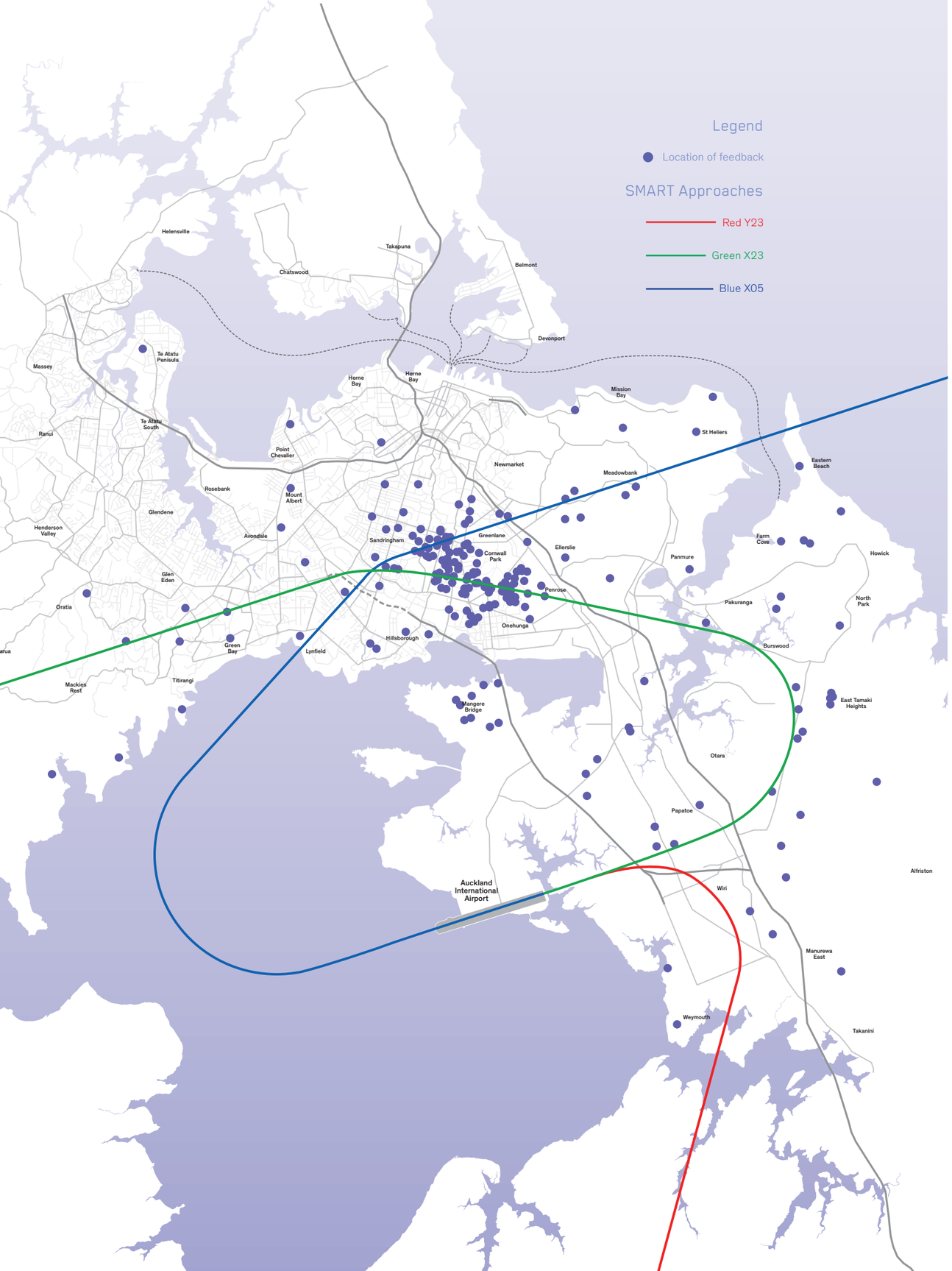


Auckland Airport requested Airways to investigate claims by members of the public that more than 10 flights were using the Green X23 flight path per day, and/or that SMART flight path flights were occurring between 10pm and 7am. Airways' investigation concluded that no flights used the SMART flight paths between 10pm and 7am. However, Airways found that on three days during the trial the number of SMART flight path flights using the Green X23 flight path exceeded the maximum allowable flights per day as follows:

- 24 June 2013 – exceeded the maximum of 10 flights by 2 flights.
- 29 June 2013 – exceeded the maximum of 10 flights by 1 flight.
- 01 July 2013 – exceeded the maximum of 10 flights by 4 flights.

Airways undertook at that time to ensure additional measures were put in place to ensure the maximum number of flights was not exceeded for the remainder of the SMART flight paths trial.

Positive and negative feedback was received from members of the public in areas which experienced a reduction in the number of flights over their homes due to the SMART flight paths trial.



Feedback in relation to aircraft noise and flight paths was investigated by both Airways (using SkyView) and MDA (using the Brüel & Kjær Airport Noise and Operations Management System, or ANOMS)[26].

Analysis of historic radar data showed altitudes of normal flights over Epsom/Royal Oak were slightly higher during 2013 than in previous years.

MDA's investigations concluded that *"based on noise measurements, complaint analysis and community-wide effects studies, the noise effects of the SMART procedure trialled are not considered to be significant".*[27]

The focus of much public concern shifted during the trial. Concern was expressed that there had been flight path changes, other than SMART flight paths trial, which had caused increased noise over Auckland. Some concerns cited new air traffic control software called the Collaborative Flow Manager (CFM) and Arrivals Manager (AMAN), as the causes of increased aircraft noise. The CFM system had already been in operation for four years before the SMART flight paths trial commenced, and AMAN was introduced in April 2013.

CFM and AMAN are air traffic control tools which collectively maximise airport capacity by ensuring arriving aircraft are efficiently sequenced for final approach to the runway.

CFM delays aircraft at their originating airports to help ensure that any wait for an arrivals slot is spent on the ground at the originating airport, rather than in the air en route or in the vicinity of the destination airport.

AMAN manages the aircraft en route to ensure that the aircraft arrives for final approach when there is an arrivals slot available. It does that by allocating an optimum standard arrival and approach profile for each aircraft prior to it reaching the top of descent. AMAN's work is done by the time an aircraft is within 40 to 50 NM of touchdown, so that from there all aircraft are flying consistent flight paths. As part of that process, Airways has the ability to instruct aircraft to bypass STAR waypoints, in the same way it did before the advent of AMAN.

The use of CFM and AMAN has not changed the manner in which aircraft are flown over the final 40-50 NM of their journey.

During the trial, 352 members of the public provided 1360 pieces of feedback in relation to 2236 separate events. Feedback about what was believed to be SMART flight paths-related flights continued even after the trial of the Green X23 and Blue X05 flight paths had concluded and no aircraft were using those SMART flight paths.

[26] SkyView is an air traffic control replay tool that can show aircraft flight paths in a vertical and lateral sense and this information can be accurately overlaid onto a geographic background. It is not a noise monitoring tool, but it can provide very accurate information on aircraft heights and positions sequenced with times and dates. ANOMS is the world-leading system for accurate monitoring and management of noise at any size airport and across multiple airport locations.

[27] Marshall Day Acoustics: Auckland Airport SMART Approach Noise Report, 3 April 2014.

Analysis of this feedback showed that, in relation to the 2236 events, five members of the public identified 1307 events (i.e. approximately 60% of the total event feedback). One member of the public identified 19% (i.e. 430) of the events, and in the two months following the end of the trial of the Green X23 and Blue X05 flight paths, this particular member of the public identified a further 374 events (i.e., not relating to SMART flight path flights).

The locations of the 352 members of the public who expressed concern during the 12-month trial period are shown on the map on page 40.

6.2.2 Public consultation

The Draft Report was released on 30 May 2014 and submissions were invited until 27 June, with the opportunity to present submissions in person on one of three dates at three different venues.

A total of 90 written submissions were received, and 25 submitters took the opportunity to present their submissions in person. Some of those presentations contained material additional to their written submissions. Very few submitters wished to present at the nominated Manukau venue, so it was decided to cancel that meeting and to hear submissions on 3 July at the Ellerslie Event Centre from 10am to 6pm and on 10 July at the Fickling Convention Centre from 10am to 6pm.

Included in the 90 written submissions was a submission from the Weymouth Residents and Ratepayers Association which included a petition of 531 signatures, and a submission from a group in Flat Bush which included a petition of 17 signatures. Neither of those groups presented their submissions in person.

Submissions were also received from the Maungakiekie-Tamaki and Puketapapa Local Boards, and from the Auckland Chamber of Commerce.

Six of the submissions received were clearly supportive of the SMART flight paths concept.

30 of the submissions asserted that there had been changes made recently to air traffic management beyond the SMART flight paths trial, as set out in s5.3 of this Final Report. The submitters considered those changes to be either SMART flight path flights outside the 7am to 10pm window or other modifications which the submitter had perceived as coincident with the SMART flight paths trial. 16 of those 30 submitters cited AMAN or CFM in that context.

54 submitters (not including the petition signatories) provided their addresses in sufficient detail to establish their proximity to the trialled Red Y23 and Green X23 SMART flight paths. Of those, only 36[28] were under the trialled SMART flight paths.

[28] Four of the 36 submitters were under Red Y23, and the remainder were under the Green X23 SMART flight path.

Over all the submissions (including the presentations at the public meetings), the three concerns raised most frequently were;

- the concentration and/or lowering of flight paths (in 38% of the 90 written submissions),
- the balance between fuel savings and increased noise impacts (also 38%), and
- sleep disturbance (34%).

The next five most-frequently raised matters were;

- poor process (28%);
- departure impacts (21%);
- moving from established flight paths (19%);
- moving flight paths off residential areas (19%); and
- the safety of GPS technology and/or of low, slow-flying aircraft over residential areas (19%).

6.2.3 Public feedback highlights need for further detail

After full consideration of the public feedback received during the trial and from the public submissions process, the participants in the SMART flight paths trial realised that there were some matters that were not sufficiently addressed in the Draft Report, and that therefore warranted additional explanation.

Those matters are listed below and have been expanded upon in this Final Report as follows:

1. Aviation safety in relation to the reliability of GPS (refer s5.2);
2. The basis for the trialled SMART flight paths (refer s5.3);
3. The role of AMAN/CFM (refer s6.2.1);
4. Aircraft exhaust emissions (refer s5.3);
5. The rationale for “average” rather than peak noise (refer s6.1);
6. How baseline noise levels were established (refer s6.1);
7. The on-going performance of Red Y23 (refer s6.3).

6.3 The airlines' operational objectives

The objectives of the trial from an airline perspective were to assess:

- the performance of aircraft flying the flight paths in the various weather conditions across a year; and
- how effectively Airways would be able to utilise SMART technology and merge aircraft on the SMART flight paths and aircraft on conventional flight paths onto the extended centreline for final approach. In assessing this, the airlines also wanted to ensure that runway capacity in terms of aircraft movements per hour was not adversely affected.

Three aircraft types took part in the Green X23 and Blue X05 SMART flight paths. These were Air New Zealand Boeing 777s, Air New Zealand and Jetstar Airbus A320s and Jetconnect Boeing 737s. The two aircraft types that took part in the Red Y23 flight path were Airbus A320s and Boeing 737s.

Before each aircraft participating in the trial entered the SMART component of its entire journey, they would generally have flown on a STAR[29].

Airlines anticipated prior to the trial that the transitions from STAR to SMART would be seamless. However, Auckland Airport's understanding from the airlines is that all three aircraft types had difficulty with the transition in relation to the Green X23 flight path[30]. Both the A320 and the B737 tended to fly a level section, as opposed to a constant descent operation, around and downstream of LOSGA to the next waypoint ELNAK, a distance of 2.6 nautical miles. In addition, Auckland Airport's understanding from the airlines is that all three aircraft types had difficulty keeping below the maximum specified descent speed downstream of LOSGA, and that meant measures such as air brakes, extended flaps and early lowering of landing gear were required to slow the aircraft. The airlines informed Auckland Airport that these measures created additional airframe noise that was not anticipated by them prior to the trial.

[29] As discussed earlier in the Final Report, STAR stands for Standard Terminal Arrival Routes. An aircraft approaching the Airport which was given approval to utilise, for example the Green X23 flight path would have used a STAR until the waypoint LOSGA, at which point the SMART flight path component of its journey would have commenced.

[30] Auckland Airport did not receive advice from airlines about such aircraft performance on the Red Y23 flightpath or the Blue X05 flight path. Nevertheless, the lessons from Green X23 have been applied to the Blue X05 flight path as outlined on the following pages and were applied to Red Y23 in July 2014.

The airlines involved in the trial initially believed that the SMART flight paths could be improved from both an operational and noise perspective by commencing SMART flight paths further out, and by raising the altitude of the flight path at LOSGA to steepen the profile and increase the maximum permitted speed within the SMART section of the approach.

As a result of the trial and further consideration after the trial, it was found necessary to widen the curves[31] onto the extended runway centreline to allow the maximum speed into those curves to be increased. This change should eliminate the need for pilots to use noisier measures (such as air brakes) to prevent the aircraft exceeding the maximum speed allowed around those curves.

Widening the curves and increasing altitude near LOSGA have implications for both Green X23 and Blue X05 in that those modified paths would slightly differ from the paths of the trialled tracks.

In relation to Blue X05, increasing altitude near LOSGA to at least the 4800 ft recommended in the Draft Report and providing wider curves would significantly shift the Blue X05 flight path out of the Manukau Harbour and make it closer to populated areas. Airways and BARNZ consider that increasing the altitude at LOSGA (but by less than the amount recommended in the Draft Report), and thereby retaining the path below 4000 ft within the Manukau Harbour, would be a better noise outcome for the total community.

In relation to Green X23, increasing altitude near LOSGA to at least the 4800 ft recommended in the Draft Report and providing wider radii curves, while slightly differing from the alignment of the trialled flight path, reduces the impact of the flight path on the areas under it. Auckland Airport will monitor the performance of a modified Green X23 flight path at selected locations.

On the basis of feedback received through the submissions process it has become apparent to BARNZ, Airways and Auckland Airport that the use of the Red Y23 SMART flight path has increased the concentration of aircraft operations over a narrow corridor of the Weymouth Peninsular. Those organisations have therefore agreed to investigate whether it is feasible to design and operate a further SMART flight path from the south to Runway 23 to alleviate that concentration. If such a path can be designed and operated, it will be trialled and the public will have the opportunity to provide feedback prior to a decision being made on its ultimate use.

[31] The approach curves are comprised of a joined series of arcs of circles and are proposed to be widened by increasing the radius of each arc in the flight path.

Auckland Airport understands from BARNZ that the airlines were satisfied with the second of the two operational objectives, that air traffic management was effective and runway efficiency was not compromised.

In summary, the airlines found that while PBN technology supports low-thrust engine operations, the trialled SMART flight paths were not optimised for low-noise operations.

The Draft Report noted that BARNZ and Airways would cease instrument-based visual approaches from the north in two stages, the first on 18 September 2014 and the second on 17 September 2015. The first stage happened as proposed, and the second stage will coincide with a second SMART flight path to Runway 23 from the north, which was indicated in the Draft Report. As set out in the next section of this Report, this additional flight path will be trialled from September 2015.

6.4 Airways' operational objectives

Airways advised Auckland Airport that it had eight objectives for the trial. As set out below, Airways considers those objectives were largely achieved.

Airways key objectives	
Be aligned with the public ICAO 2013 – 2028 Global Air Navigation Plan 4th Edition	Achieved
Be aligned with ICAO Aviation System Block Upgrades. Block 0 – Performance Based Navigation, Continuous Decent Operations, Continuous Climb Operations.	Achieved
Be aligned with ICAO Performance Based Navigation – Safety, Capacity, Efficiency, Environment, and Access (With a focus on Environment and Access).	Achieved
Have alignment with the New Zealand Government National Airspace Policy and New Zealand Civil Aviation Authority National Airspace and Air Navigation Plan Documents.	Achieved
Operate, validate and integrate SMART flight path approach traffic in Air Traffic Management real–world operations for A320, B738 and B777 aircraft types.	Achieved
Measure lateral and vertical flight paths for conformance to design profiles.	Achieved
In conjunction with Auckland Airport, assess aircraft noise feedback to ensure recorded values are as expected for the SMART flight paths trial.	Achieved
Determine suitability of SMART flight paths for continued use beyond trial period.	Achieved

Airways has calculated the following operational benefits of the trialled Green X23, Blue X05 and Red Y23 flight paths:

SMART flight paths	Green X23 & Blue X05			Red Y23	Totals
Assessment period	1 Nov 2012 – 31 Oct 2013			10 Feb 2012 – 30 April 2014	
	Green X23	Blue X05	Total		
Number flown	1,558	146	1,704	10,118	11,822
Distance saved (nautical miles)	23,370	2,190	25,560	112,725	138,285
Time saved (mins)	4,674	438	5,112	22,498	27,610
Average number of flights per day	4.3	<0.5	5	14	19
Fuel not burned (kgs)	213,984	20,052	234,036	776,845	1,010,881
CO^2 emissions reduced (kgs)	675,982	63,300	739,282	2,450,000	3,189,282

Comparative one-way flights possible from saved mileage	Green X23 & Blue X05	Red Y23	Totals
Auckland – Wellington	106	470	576
Auckland – Christchurch	64	282	346

Airways also advised that the extent to which SMART flight paths removed holding patterns over Auckland was a key improvement in terms of efficiency measures. By reducing overall in-flight holding delays from around 3 minutes to less than 20 seconds per flight, Airways delivered additional fuel, environmental and overall noise benefits well beyond the objectives of just the SMART flight paths trial.

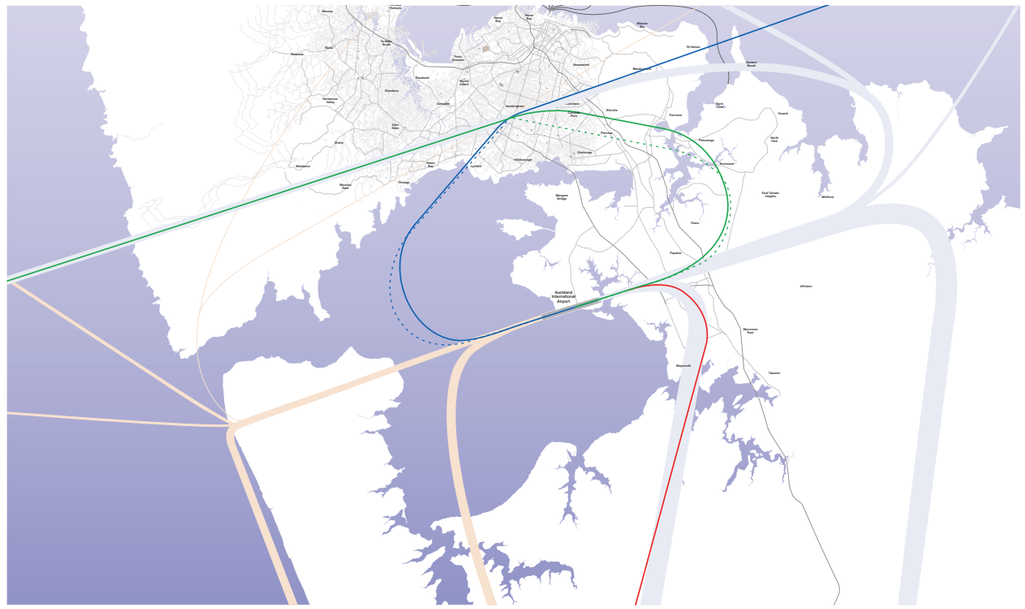
6.5 Procedural enhancements

6.5.1 SMART flight paths

As a result of the trial and the public feedback on the recommendations contained in the Draft Report, Airways and BARNZ now propose the following:

1. That a modified Green X23 flight path to Auckland Airport from the North to Runway 23 (Green X23A) cross LOSGA at 4930 ft (higher than 4800 ft recommended in the Draft Report) and its curved approach onto the extended runway centreline be widened.
2. That a modified Blue X05 flight path to Auckland Airport from the North to Runway 05 (Blue X05A) cross 300 metres south of LOSGA at 4400 ft (higher than the trial's 4000 ft, but lower than the 4800 ft recommended in the Draft Report) to reposition part of the flight path above the ocean. Blue X05A's curved approach onto the extended runway centreline should be wider than the curved approach trialled for Blue X05. The use of Blue X05A will be limited, as only approximately 20% of international flights approach Auckland Airport from the east and Runway 05 is only used for approximately 30% of landings.
3. That the Red Y23 flight path to Auckland Airport from the South to Runway 23 be adopted and an investigation undertaken to determine whether it is possible to design an additional SMART flight path for trial from the South to Runway 23.
4. That a further SMART flight path to Auckland Airport from the North to Runway 23 (Yellow X23) be trialled from September 2015. The trial of the Yellow X23 flight path will not be undertaken until all trial methodology and assessment criteria have been confirmed, including public notification prior to the trial and a public consultation process at its conclusion.

The Green X23A, Blue X05A and Red Y23 flight paths proposed above are shown in the following diagram.



6.5.2 Future public engagement on aircraft noise

The purpose of this Final Report is primarily to support the decision that Auckland Airport is required to make under CAR Part 173.201(d).

However, there were other lessons from the trial and from seeking and receiving public feedback that could be applied to airspace management.

Prior to the commencement of the SMART flight paths trial, the two primary avenues Auckland Airport used to communicate with the public about noise matters were:

- the Aircraft Noise Community Consultative Group (ANCCG) (established in 1997); and
- a complaints-handling protocol.

Auckland Airport acknowledges that the recent SMART flight paths trial exposed the limitations of those avenues. The primary limitations were that representation on the ANCCG was limited by the District Plan to communities immediately surrounding the Airport with properties within the defined HANA, MANA and ANNA[32]. The complaints-handling protocol was geared to handling the small number of complaints that were being received prior to the trial.

While the ANCCG was set up initially as a voluntary initiative, it was absorbed into the Manukau District Plan in 2002. It is thus difficult for Auckland Airport to change how the ANCCG operates.

Notwithstanding this difficulty, and acknowledging the limitations of the existing channels of communication, Auckland Airport intends to work with the aviation industry to improve public and industry understanding of the impact of noise, to keep the public better informed about aircraft and airport operations and development, and to continue being a responsible neighbour.

[32]ANNA means Aircraft Noise Notification Area under the Manukau District Plan.

7.0

Decision on whether to approve under CAR Part 173.201(d)

7.0 Decision on whether to approve under CAR Part 173.201(d)

As a result of the SMART flight paths trial and the public feedback on the recommendations contained in the Draft Report, Auckland Airport agrees:

1. That the Green X23A Instrument Flight Rules SMART flight path to Auckland Airport be used between 7.00am and 10.00pm, with a maximum of 10 flights per day.

2. That the Blue X05A Instrument Flight Rules SMART flight path to Auckland Airport be used between 7.00am and 10.00pm, with a maximum of 10 flights per day.

3. That the Red Y23 Instrument Flight Rules SMART flight path to Auckland Airport be used between 7.00am and 10.00pm, and that an investigation be undertaken to determine whether it is possible to design an additional SMART flight path for trial from the South to Runway 23.

4. That a further SMART flight path to Auckland Airport from the North to Runway 23 (Yellow X23) be trialled from September 2015 provided that all trial methodology and assessment criteria have been confirmed including public notification prior to the trial and a public consultation process at its conclusion.