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Appendix 4-1: Aviation Risk Assessment

ROCHESTER AIRPORT DEVELOPMENT RISK ASSESSMENT

GENERAL

1. PURPOSE OF STUDY

The purpose of this study is to carry out a Risk Assessment (RA) following concerns raised by Highways England (HE) in an email of 9th October 2018, in relation to possible risks to the M2 motorway from potential changes to the operations of Rochester Airport. HE requested that the Risk Assessment be carried out in accordance with the Design Manual for Roads and Bridges (DMRB) for Workers, Users and Other Parties accessing the M2 motorway, which lies beyond and below the southern boundary of Rochester Aerodrome. The RA is equally applicable to the HS1 railway line further to the south beyond the M2, and as a result of input from the rail operators the scope of this paper was broadened to consider the HS1 rail line as well.

The genesis of the RA is the planned redevelopment of the hangar and operational facilities at Rochester Aerodrome and the proposed closure of the north-west / south east Runway 34/16 at Rochester, potentially resulting in increased take-off and landing movements on the North-North-East / South-South-West Runway 02/20. The Risk Assessment considers the existing situation, and the situation following completion of the new construction and proposed closure of Runway 34/16, resulting in possible changes to movements on Runway 02/20.

The study first sets out some background information, to set in context the discussions relating to the risk assessment.

Biographical notes about the author of this report are at Appendix 1.

The term ‘aircraft’ encompasses fixed-wing aeroplanes and helicopters; where necessary the text refers specifically to aeroplanes or helicopters.

The author has noted specifically the following references:

1. Highways England Design Manual for Roads and Bridges Risk Assessment Leaflet GG104
2. Lichfields Briefing Note 15328/05/Dg/TK, dated 31 October 2018 (Note: Concurred)
3. Email Knowles-Bowie FW: Rochester Airport - MC/18/2505 (your ref 82517 #5868) [NLP-DMS.FID504655] dated 03 December 2018 at 12:02.
4. Various emails Medway Council and Highways England relating to Rochester Airport development.
5. Email Olney (HS1)- Medway Council dated 29 Jan 18.
6. Civil Aviation Authority Publication CAP 168 Licensing of Aerodromes
7. CAP 760 Guidance to Aerodrome Operators of Hazard Identification, Risk Assessments and Safety Management
8. CAP 393 The UK Air Navigation Order 2016

2. BACKGROUND INFORMATION

2.1 Rochester Airport

Rochester Airport (EGTO) is a licensed aerodrome located approximately 2 nautical miles to the south-east of the M2 River Medway bridge and on the western edge of the Rochester/Chatham/Gillingham conurbation. The UK Air Information Publication (AIP) entry for the ground plan of Rochester Airport is attached as Appendix 2. Textual information also provided in the AIP has not been appended. Commercially produced aerodrome guides, such as the Pooley’s Guide and AFE Guide also give similar textual and graphical information for the aerodrome.

The Aerodrome is licensed (by the Civil Aviation Authority, CAA) as a Private Aerodrome, which requires that Prior Permission ('PPR') is obtained from the aerodrome operator for flights to and from the airfield. The aerodrome licence requires audit inspections by the CAA, and that the licensee has a functional Safety Management System.

The airfield lies just outside the south-western boundary of the Southend Control Area, and below the London Terminal Manoeuvring Area. It has a Flight Information Service, as opposed to Air Traffic Control: thus the aerodrome controls the movement of aircraft on the airfield, but can only give advisory information to aircraft taking off, landing, or in the vicinity. The aerodrome is for use in visual conditions only; there are no Instrument Approach procedures.

There are currently two runway directions, aligned approximately to compass headings 200/020 degrees and 340/160 degrees. The runways, known as 20/02 and 34/16 are grass only. Runway 20/02 has a parallel and slightly shorter 'Relief Runway'. Runway 34/16 is proposed to be closed as part of future redevelopment of parts of the airfield. Both landing points (Thresholds) of Runway 20/02 are inset, to give a greater vertical clearance over the aerodrome surrounds for aircraft approaching the runways, but take-off runs may be commenced on the runway before reaching the marked threshold, thus increasing the take-off distance available above the published runway length.

The length of the runway 02/20 at Rochester at 830 metres for the main runway and 684 metres for the relief runway is typical of other grass-runway aerodromes in the area, such as Lashenden (Headcorn) and Redhill; it is generally more than adequate for the general aviation aircraft using the aerodrome, thus allowing a margin of error for occasional pilot misjudgements during take-off and landing. Additionally, along runway centre-line, at the northern end of Runway 02 there is an overrun distance from the Runway 20 threshold to the northern airfield boundary of approximately 250 metres, and at the southern end of Runway 20 approximately 85 metres from the Runway 02 threshold to the southern airfield boundary.

2.2 Users and Classes of Users.

The aerodrome is home to a variety of privately owned light aircraft, fixed-wing flying schools, an auto-gyro flying school, and is a relief landing base for the Kent, Surrey and Sussex Air Ambulance helicopters, whose headquarters is on the airport. Police, National Rail, and TV helicopters are frequent visiting aircraft.

2.3 Movements data

See para 6.2.

2.4 M2 and HS1 Railway Alignment in the Vicinity of the Aerodrome

The M2 lies approximately 20 metres below the elevation of the threshold of Runway 02. The elevation of the HS1 rail-track is approximately 40 metres below the Runway 02 threshold. These measurements are in relation to where the (notionally extended) centre-line of the runway crosses the M2 and railway line.

SAFETY BASELINES AND OBJECTIVES

3. CHARACTERISTICS OF AERODROMES AND OBSTACLE LIMITATION REQUIREMENTS

3.1 Regulatory Requirement

Civil Aviation Publication (CAP) 168 'Licensing of Aerodromes' sets out the requirements for the licensing of aerodromes and the requirements for the assessment and treatment of obstacles are set out in Chapter 4. In simple terms, an Obstacle Limitation Surface (OLS) has to be established to prove that obstacles will not impinge on the safe passage of aircraft taking off, landing or in the aerodrome vicinity. Detailed instructions for the measurement of obstacles are given in CAP 232 'Aerodrome Survey Requirements'. However, in simple terms, the OLS extends upwards and outwards from a runway.

3.2 Applicability to the M2 and HS1 Railway Line adjacent to Rochester Airport.

Since the M2 and HS1 railway lines are below the level of the airport, and particularly the Runway 02 threshold, there is no impingement on the OLS. The effects of new building at the Airport were considered at Reference 2 and satisfy the OLS criteria.

3.3 Aircraft Performance and Handling

Aircraft performance of both aeroplanes and helicopters is mainly determined by aircraft design, particularly aerodynamic shape and the power output of the installed engine(s). Performance is affected by Weight, Altitude and Temperature (known as WAT factors). Although an aircraft will have a maximum weight specified, performance will generally be better at lower all-up weights. Increases in altitude and temperature decrease the air density, which adversely affects the performance of lifting surfaces; i.e. wings and rotor blades. Aircraft Flight Manuals provide the certificated data for take-off and landing distances required for differing weights, altitudes and temperatures, generally in tabular or graphical form.

Other environmental factors affect performance too. So, as examples, for aeroplanes an asphalt surface is preferable for performance reasons to grass, a flat runway surface better than a slope, and dry conditions preferable to wet. And, of course, it is preferable to take off and land into wind, or at least with a head-wind component, as lift depends greatly on airspeed, and into a 20 knot wind an aircraft will reach 40 knots airspeed whilst only travelling at 20 knots groundspeed: so take-off distance will be reduced. The CAA provides advisory information on how to factor Flight Manual data for such environmental factors to ensure that a safe take-off and landing distance is available in all circumstances. Whatever the aircraft type, the pilot in command has a statutory duty (UK Air Navigation Order 2016, Article 69) to ensure, inter alia, that the loading and performance of the aircraft are suitable for take-off and landing given the aerodrome characteristics.

Airfields with Runways on different, crossed, headings give flexibility to aeroplane pilots to minimise potential handling difficulties due to cross-winds on a runway, by choosing the Runway with the lesser crosswind: if indeed the wind is not on, or close to, Runway heading. Aeroplane flight manuals for each aeroplane type will specify crosswind limits, or recommended maximum crosswind. Thus on occasions runways will be unusable by certain aeroplane types due to excessive cross-wind component.

4. Aircraft Operation

4.1 Aeroplanes

At the risk of being simplistic, aeroplanes take off and land on runways; normally for the classes of aircraft using an airfield such as Rochester, the final approach will be commenced at or before 500 ft above runway level, with the aeroplane aligned with the centre-line of the runway. For a ‘normal’ or ‘standard’ approach with engine power the approach angle will be approximately 3 degrees, or greater. For a 3-degree approach angle the aircraft will be at 300 ft relative to the runway threshold at 1 nm from touchdown. However, as indicated in the (official) UK Air Information Publication (AIP) Rochester Prefers a 5-degree approach, for noise abatement reasons. unless using the PAPI’s or conducting flapless approaches. Steeper approach angles are associated with idle power or ‘glide’ approaches, which are typically used to simulate the latter stages of a forced landing in the event of engine failure as this manoeuvre cannot usually be practiced below 500 ft off an airfield. As such, the glide approach is essentially a training manoeuvre. Aeroplanes normally use wing flaps for landing, which enable them to fly safely at a lower airspeed for their approach and landing. Flap failures are rare, but nevertheless ‘flapless’ approaches and landings are practiced; in these cases, the approach angle will be slightly flatter than normal, in order for the pilot to maintain a view over the nose and maintain the correct perspective relative to the runway. With flaps down the pilot’s forward view is better than with flaps up, because effectively the wing is now a different shape.

4.2 Helicopters

Although helicopters do not need runways for take-off and landing, it is usual at airfields where there is also aeroplane activity for helicopters to depart or approach from or to the runways or to adjacent grass areas. Some aerodromes have dedicated landing spots or areas for helicopters. Part of the essence of the helicopter is its ability to operate into and out of relatively small areas. So, for example, the 'worst case' scenario amongst currently certificated helicopters on the UK civil register requires for two different helicopter types, at Maximum All-Up Weight and in still air in the Standard Atmosphere for Sea Level, a take-off run of 500m from the hover until attaining 100 ft above the surface at the departure point. This distance is calculated using the manufacturer's 'Recommended' take off profile, although alternate procedures, requiring less distance, may be an option to the pilot.

Landing distances required from 100 ft above the surface level of the touch-down point are always shorter, using the recommended profiles, than for the take-off distance. Additionally, the normal approach angle for a helicopter is approximately 7 degrees, so in comparison to an aeroplane's height of 300 ft at one mile from touchdown a helicopter would be at approximately 700 feet at that range. Unless there is an Air Traffic Control requirement, it is unusual for a helicopter to make its approach directly to, or abeam, the runway threshold. It is also common for helicopters to make offset approaches or departures, either to increase separation from aeroplane traffic, or to take advantage of being able to land in a wider variety of wind conditions than an aeroplane.

5. Certification Standards and Accident Causal Factors.

The certification standard for civil aircraft and components is that the probability of failure is between
1×10^{-7} and 1×10^{-9}, which in descriptive terms is classed as 'Improbable'. Only where the possibility of a catastrophic failure, most significantly an event causing structural failure, need the standard meet or exceed 1×10^{-9}, which is defined as 'Extremely Improbable'. So aircraft design means that that as a system an aeroplane or helicopter is very unlikely to 'fail'.

Analysis of most aviation accident databases bears out that technical failures are statistically rare, although human inter-action with otherwise benign technical failures, is, along with human factors per se, a common cause of accidents. One example of this is take-off and landing accidents caused by engine failure.

Most aircraft using general aviation aerodromes, such as Rochester, are single-engined. Twin-engined aircraft generally have the ability to suffer a failure of one of their engines and continue safe flight. In the general aviation spectrum, there has historically been a tendency to regard turbine engines as more reliable than piston engines, the latter class being more common in light aeroplanes than turbine engines. However, in recent years it has been generally accepted that piston engine reliability is greater than had been assumed. For single-engined aircraft, the concept of single engine reliability is accepted readily by the Federal Aviation Administration (FAA) in the USA and by many other countries where, for example, single engined operations over congested areas (and often at low altitude) are permitted: whereas in the UK and Europe this is not legal, except when taking off and landing at aerodromes and in accordance with normal aviation practice.

Some statistical data of 'engine failure' skews the results. For example, where engine failure has been the result of lack of fuel, due to either running out of fuel or incorrect fuel tank selection; or due to other human factors such as where an engine has failed to deliver the anticipated power which might have been determined during pre-take-off and /or initial runway acceleration checks, which were omitted by the pilot.

6. Take-off and landing data

6.1 General

There are a number of authoritative accident databases, for example those of the American National Transportation Safety Board (NTSB) the Canadian Transport Safety Board, the Australian Civil Aviation Safety Agency (CASA) and the UK DoT Air Accident Investigation Branch (AAIB) and the CAA.

Take-Off and Landing accidents account for between 25% and 50% of General Aviation accidents or Serious Occurrences. This is, in many ways, unsurprising, since these are the phases of flight requiring the highest degree of pilot skill, attention and judgement. They are also regimes of flight where the aircraft is both closest to the ground and, in the case of aeroplanes, closest to stalling speed (i.e. the speed at which the wings no longer produce lift) and for helicopters where the function of the pilot’s flying controls changes subtly between the regimes of hover and forward flight, or vice-versa.

6.2 Rochester Data

The Airport operator states that the aerodrome movements in the past 10 years are as follows:

2007 - 30,601
2008 - 27,010
2009 - 24,840
2010 - 21,688
2011 - 24,289
2012 - 18,747 (movements reduced, due to airspace restrictions imposed during the London Olympics)
2013 - 23,540
2014 - 23,893
2015 - 23,765
2016 - 22,321
2017 - 23,800

In this 10-year period there was only one take-off or landing incident, not contained on the runway, on 21st February 2009, when a landing aeroplane over-ran the end of Runway 20 at the south-western end, but remained within the aerodrome boundary. The DoT Air Accidents Investigation Branch was informed, but did not deem it necessary to attend the incident.

The proposed closure at Rochester of Runway 34/16 means that there may be increased movements on Runway 20/02, but, as has been noted in Reference 2, above, it is difficult to predict, since the effect of limiting crosswinds on the number of aeroplanes using a single runway orientation is difficult to quantify.

RISK ANALYSIS AND CONCLUSIONS

7. RISK ANALYSIS

7.1 Methodology

For compliance with DMRB, the standard methodology of Risk Analysis, likelihood vs severity, is adopted, and the GG104 Appendix D Risk Matrix with numerical scores is at Appendix 3 to this paper. Risk Ratings of 10 or greater, according to this table, must be mitigated.

7.2 Specific Hazards

In relation to the effective change of use of Runway 20/02, as it becomes the only runway at Rochester, the hazards to the M2 and HS1 rail line users are from:

1. An aeroplane or helicopter landing on Runway 20 over-running the runway at the SSW end, beyond the Runway 02 threshold and impacting the highway or railway line
2. An aeroplane or helicopter having an engine failure after take-off and impacting the highway or railway line
3. An aeroplane or helicopter having an engine failure on final approach to Runway 02 and impacting the highway or railway line
4. For the M2 only, a low-flying aircraft distracts a driver, or drivers, and the distraction results in a road traffic collision

7.3 Likelihood and Severity

In terms of Likelihood, there is a continual flow of traffic along the M2, whilst trains pass the extended threshold area of Runway 20/02 only several times an hour, and at high speed: thus with a reduced likelihood of potential collision. The effects of each case are likely to be the same on any class of protected person, be they workers or users. The potential of an aircraft landing on the highway or railway line, even with low energy, is likely to result in a road vehicle collision or impact with a train. Major damage and possibly multiple fatalities could be expected.

Considering again the hazards listed above:

1. An aeroplane or helicopter landing on Runway 20 over-running the runway at the SSW end, beyond the Runway 02 threshold and impacting the highway.
    a. **Likelihood:** One overrun event known in more than 10 years. (Aircraft remained within aerodrome boundary and did not impact the highway).
    b. **Severity:** Potential multiple fatalities and major damage.
    c. **Risk Rating:** 10

2. An aeroplane or helicopter having an engine failure after take-off and impacting the highway or railway line
    a. **Likelihood:** Very unlikely to occur.
    b. **Severity:** Potential multiple fatalities and major damage.
    c. **Risk Rating:** 5

3. An aeroplane or helicopter having an engine failure on final approach to Runway 02 and impacting the highway or railway line
    a. **Likelihood:** Very unlikely to occur.
    b. **Severity:** Potential multiple fatalities and major damage.
    c. **Risk Rating:** 5

4. For the M2 only, a low-flying aircraft distracts a driver, or drivers, and the distraction results in a road traffic collision
    a. **Likelihood:** Very unlikely to occur; not known to occur in the vicinity of Rochester Airport.
    b. **Severity:** Potential multiple fatalities and major damage.
    c. **Risk Rating:** 5

7.4 Comment and Mitigation

In relation to 7.3.1, the raw Severity rating is possibly misleading. Given the low energy of an overrun case, it is probable that the embankment between the aerodrome boundary and motorway would further decelerate the aircraft and arrest its movement before reaching the motorway. Thus I consider that this mitigates Likelihood to 'Very Unlikely' and thus the Risk Rating is reduced to **5**.

With regard to cases 7.3.2 and 7.3.3, although below the Risk Ratings require mitigation, the likelihood of conflict with the motorway or railway is reduced by the probability that a pilot would attempt to manoeuvre away from these areas.

Turning to 7.3.4, the difference in elevation between the Runway 02 threshold and the eastbound carriageway of the M2 is 20 metres (approximately 65 feet), and departing aircraft on Runway 20 will normally be at least at a height of 100 ft above aerodrome elevation before reaching the aerodrome boundary on departure, or above this on approach to the inset threshold of Runway 02. There is no question of an aircraft 'skimming' the rooftops of vehicles on the M2. For possible visual distraction, a driver, when relatively close to the aerodrome, would have to look significantly upwards from his normal field of regard in his driving position in order to see an aircraft. Furthermore, as regards distraction by aircraft noise, in general, and in my experience, vehicular noise is likely to mask the noise of aircraft at typical heights above the road traffic under consideration. For traffic on the westbound carriageway of the M2 the lower elevation of the carriageway and increased distance from the aerodrome boundary further reduce any possible visual or aural hazards from passing aircraft departing or approaching Runway 20/02.

In passing, I comment that had the proposed paved Runway 20/02 been progressed, in my professional opinion this would result in an enhanced environmental impact for aeroplane operations as regards decreased aircraft noise. The take-off phase is generally the noisiest phase of flight. The reduced rolling resistance of a paved surface versus a grass runway would, for most aeroplane types using Rochester Aerodrome, result in a shorter take-off run in both distance and time, and thus an earlier reduction in noise footprint as the aircraft climbs. Furthermore, for aeroplanes, the shorter take-off run would mean that aircraft on reaching the aerodrome boundary would be at greater height and have more room for manoeuvre in the event of an engine failure after take-off.

8. Conclusions

As stated elsewhere, the closure of Runway 34/16 at Rochester Airport provides an unquantifiable change in the usage of Runway 20/02, since whilst additional runway usage might be expected, this may be limited by crosswind limitations on aircraft taking off or landing on that runway.

Most importantly, if Runway 20/02 is the sole runway at Rochester Airport, the hazards and risks are essentially unchanged from the existing in relation to potential conflict by an aircraft with road or rail traffic or rail traffic, or to persons in those vicinities.

All this should be set against the fact that there has only been one take-off or landing incident at Rochester in over 10 years that resulted in a runway excursion.

In each of the cases considered the residual Risk Value is Low: but this should be monitored and reviewed as part of normal aerodrome operators' process.

G Connolly
Aviation Consultant
Canterbury
13 December 2018, revised 18 December 2018

Appendices:

1: Biographical Notes, Geoff Connolly

2: UK Air Information Publication Chart of Rochester Airport (EGTO)

3: Risk Matrix from GG104 with Numerical Scores

Appendix 1: Biographical Notes, Geoff Connolly

Geoff Connolly began flying in the RAFVR with the University of London Air Squadron, gained his Private Pilot Licence (Aeroplanes) in 1970, and has maintained proficiency in light aeroplanes since then. After a legal training, he joined the RAF and was an operational helicopter pilot before becoming a flying instructor, and later graduating from the 1986 Class at the Empire Test Pilots School.

Following several years as a military test pilot at MoD Boscombe Down, Geoff joined Bristow Helicopters as Deputy Company Test Pilot. He progressed to become the company's Flight Test Manager and its Head of Flying for the UK MoD. Latterly he was also the Bristow Company Flight Safety Officer, auditing, carrying out investigations, and supervising a safety database for worldwide operations. In 1999 Geoff took a step away from increasing management duties and returned to full-time flying, as a Civil Servant with the Metropolitan Police. He set up his own consultancy company and returned to Bristow as a Consultant Test Pilot in 2002. Additionally, for nearly 8 years he was Head of Training and Chief Pilot for a small training and charter helicopter company; then for a further 4 years that company's Compliance Monitoring Manager. He is EASA Compliance Manager and a visiting Flight Test Instructor at the International Test Pilot School in Canada, a Compliance Verification Engineer (Flight Test) for Bristow, and is also a Transport Canada Designated Engineer. Geoff has led the Safety Audit Team for each Farnborough International Airshow since 2010.

Geoff has over 11,000 hours flying experience, gained on over 70 types of helicopters and aeroplanes. He holds UK, EASA, and Canadian professional pilot licences, and has over 5000 hours as an aeroplane and helicopter instructor. He has considerable experience as an expert in litigation and planning matters as an aviation technical specialist. He has advised on aerodrome planning matters concerning numerous airfields and heliports.

Geoff is an Associate Fellow of the Society of Experimental Test Pilots, a Fellow of the Royal Aeronautical Society, an Upper Freeman of the Honourable Company of Air Pilots, and an Associate Member of the British Helicopter Association.

Geoff previously served as a member of the UK Flight Safety Committee and of the UK Airprox Board. He currently serves on the BHA/CAA Onshore Committees, and the Air Pilots Technical Committee. He is the Regional Safety Officer (London and South East) for the General Aviation Safety Council, and in this role helps present CAA-sponsored Safety Evenings at airfields and flying clubs. He is in current flying practice on light aeroplanes, and on a variety of single and twin-engined helicopters.

Appendix 2: UK Air Information Publication Chart of Rochester Airport (EGTO)

UK AIP (19 Sep 13) AD 2-EGTO-2-1

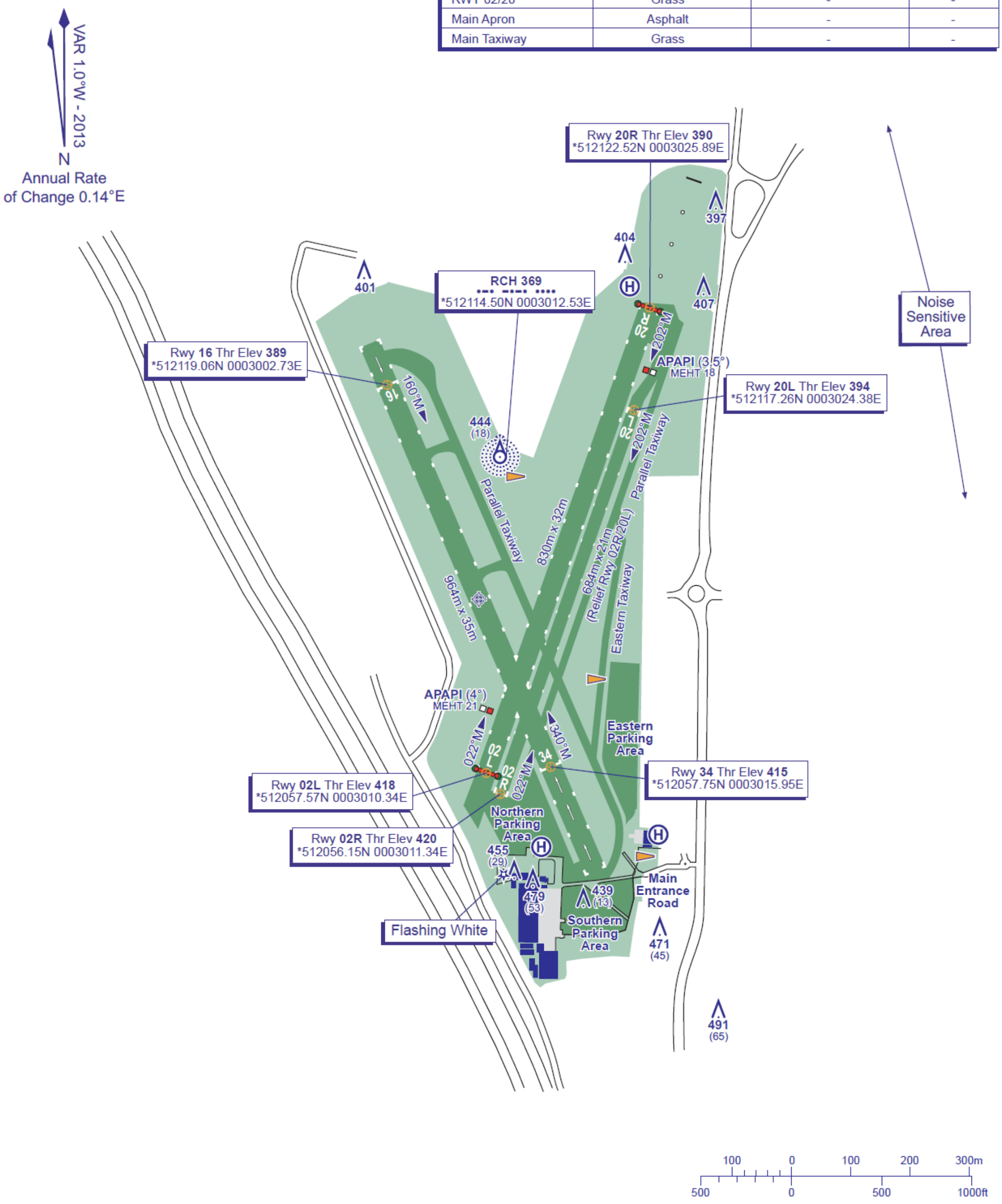
AERODROME CHART - ICAO ARP 512107N 0003010E AD ELEV 426FT **ROCHESTER EGTO**

BEARINGS ARE MAGNETIC
ELEVATIONS AND HEIGHTS ARE IN FEET

ELEVATIONS IN FEET AMSL	491
HEIGHTS IN FEET ABOVE AD	(65)

RUNWAY/TAXIWAY/APRON PHYSICAL CHARACTERISTICS

APRON / RWY / TWY	SURFACE	BEARING STRENGTH	ELEVATION
RWY 16/34	Grass	-	-
RWY 02/20	Grass	-	-
RWY 02/20	Grass	-	-
Main Apron	Asphalt	-	-
Main Taxiway	Grass	-	-



COM		
AFIS	122.250	ROCHESTER INFORMATION

LIGHTING	
THR 02L/20R	LI green.
RWY 02L/20R	LI. End lights red.

CHANGE (10/13): RUNWAY DIMENSIONS. RUNWAY 16/34 HEADINGS.

AERO INFO DATE 15 JUL 13

Civil Aviation Authority AMDT 10/13

Appendix 3: Risk Matrix from GG104 with Numerical Scores

Table D.1 Risk value, likelihood and severity of outcomes that may be assigned to qualitative data for the purposes of assessment

Likelihood (L) x Severity (S) = Risk value (R)		**Severity (S)**				
		Minor harm; Minor damage or loss no injury	**Moderate harm; Slight injury or illness, moderate damage or loss**	**Serious harm; Serious injury or ill-ness, substantial damage or loss**	**Major harm; Fatal injury, major damage or loss**	**Extreme harm; Multiple fatalities, extreme loss or damage**
Likelihood (L)	Very unlikely; Highly improbable, not known to occur	1	2	3	4	5
	Unlikely; Less than 1 per 10 years	2	4	6	8	10
	May happen; Once every 5-10 years	3	6	9	12	15
	Likely; Once every 1-4 years	4	8	12	16	20
	Almost certain; Once a year or more	5	10	15	20	25

Risk Value (R)	**Required action**
Low (1-9)	Ensure assumed control measures are maintained and reviewed as necessary.
Medium (10-19)	Additional control measures needed to reduce risk rating to a level which is equivalent to a test of "reasonably required" for the population concerned.
High (20-25)	Activity not permitted. Hazard to be avoided or risk to be reduced to tolerable.

GG 104 Revision 0