PROJECT AIRPORT

Contractor: Rotterdam The Hague Airport
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Preface

Group 1J proudly presents the final report regarding the assignment to design a new airport. This project group consists of seven Aviation students from the University of Applied Sciences in Amsterdam:

- Patrick Brochard
- Emilie Erbé
- Joost van der Lans
- Barry van Niekerk
- Arjan van Olphen
- Tom Siebeler
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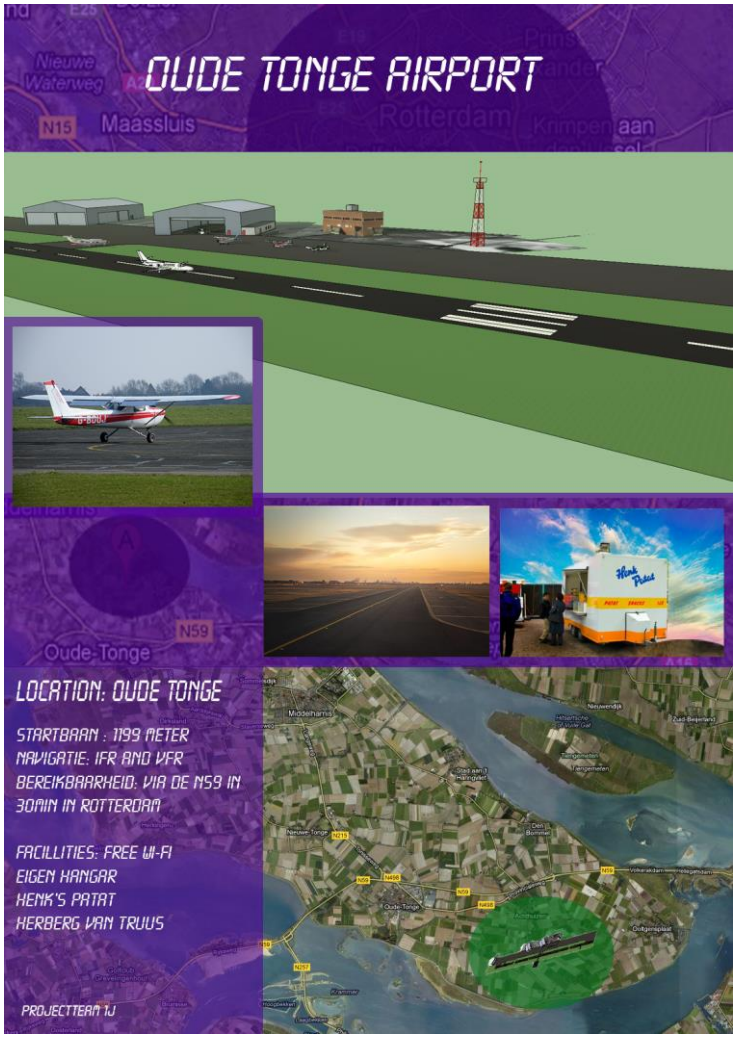
During the last seven weeks we familiarised ourselves with the problem of Rotterdam The Hague Airport, *"geluidszones"* and all the aspects of constructing a new airport south of Rotterdam. In these weeks we put as much effort in the project as we could to turn this assignment into a success.

The project also consisted of another assignment. We had to make a poster containing the chosen location and the facilities available at the new airport. This poster can be seen in the *"Hogeschool van Amsterdam, locatie Leeuwenburg"* or in the picture below.



Poster of Oude Tonge Airport made by Projectteam 1J

Summary

This report is a recommendation for Rotterdam The Hague Airport. This airport is looking for an alternative location to place there some of their aircraft. Because they have reached their noise limit, this limit called KE and is for the charters, cargo and other “grote luchtvaart”. This means we need to relocate aircraft which are under the KE regulations, and not the “kleine luchtvaart” or BKL regulations.

The relocated aircraft needed an own airport, a new airport, that must be located near the city Rotterdam. Which must be designed in form of “Annex 14” and de noise regulations. To find a location for the new airport we must first decide which requirements there are needed for this location. Then there is a selection process which determines the location for the new airport, this is mainly take into account the distance, the noise and the nearby nature reserves. Here we come to the conclusion that our airfield will be placed near the village of “Oude Tonge” and therefore we call our airport also Oude-Tonge Airport.

We cannot relocate too large aircraft because Rotterdam Airport has given us a limit of 7000kg. This means that we must identify the aircraft which fall under the regulations of KE and are maximum 7000kg. After figuring out we found that the flight schools and some planes of the Business Aviation with the heaviest aircraft Cessna Citation can be relocated.

Now we know what we need to design the airport, together with its facilities. According to the guidelines we define the facilities to the categories of airside and landside. We know the largest aircraft so we can calculate our runway length, this will be 1199 meter. And the heading for the runway depends on the most common wind direction, so the runway lays from 60 degrees east-north-east to 240 degrees west-south-west. Now we can design the flight paths and circuits for the aircraft.

Introduction

Rotterdam The Hague Airport would like to expand their capacity in order to increase the amount of business activities the airport can handle. These activities fit the objective of the airport more than the current activities. The direction of Rotterdam Airport asked group 1J to investigate the possibilities of excluding the so-called General Aviation flights in order to reduce the *"geluidshinder"* on and around the airport.

In order to exclude these flights, a new airport should be built. This new airport should have equal facilities in regard to Rotterdam Airport for the General Aviation flights. Another requirement for the newly designed airport is the fact that no aircraft with a weight above seven tonnes should land there. The two aircraft categories, General aviation flights and aircraft limited to 7'000 kg formed a part of the key to find out which aircraft could be transferred to the new airport. The other part lies in the separation of the *"geluidszones"*, where the type of flights matters and not the weight. With that in mind, all aircraft that land on Rotterdam Airport, the maximum take-off weights were looked up to see which aircraft capable of landing at the new airport is the heaviest. This information was needed to calculate the runway length, which is needed to find out where the new airport could be built. **(1)**

After finding out the length required for the runway, some locations were examined. These locations were also bound to a set of requirements such as distance from Rotterdam Airport, available airspace, flight routes, lack of urban areas and wildlife (bird) areas. First, a circle with a radius of 40km was drawn around Rotterdam Airport on an aeronautical chart to narrow the search area. Then three locations were chosen within this circle with regard of military low flying areas and tall building in the neighbourhood. After that, the three locations were examined for the requirements mentioned before. At last, all the locations were graded and the one with the best qualifications would become the chosen location. **(2)**

Then the chosen location is further investigated and the available area filled with a runway, taxiways, a platform, an area to take in fuel, hangars and other necessary aspects an operational airport needs. This is put on a map to give a general idea of the looks and capabilities of the airport. **(3)**

Building a new airport comes with a cost, therefor the costs of building and operating the airport is also examined. These costs are expected costs and could be different from the actual costs. Moreover, the assumption is made that the new airport is fully owned by Rotterdam Airport in order to calculate the increased income of Rotterdam Airport. **(4)**

At last, an inference is made regarding the relocation of aircraft to the new airport. The inference contains two sections, the conclusion and the recommendation. **(5)**

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1 The situation at Rotterdam airport

Rotterdam airport wants to expand their influence on the market, but has not the capacity for an expansion. This is because Rotterdam is limited by a noise law **(1.1)**. This means it is not possible to receive more aircraft that are covered by this category. The aircraft in this category are a large part of the daily flight movements at Rotterdam airport **(1.2)**. This is explained to the facilities at Rotterdam airport **(1.3)**. If we can relocate, these facilities and aircraft, it is possible to solve the capacity problem **(1.4)**.

1.1 Air traffic Rotterdam

Rotterdam has a wide range of air traffic. In order to proceed, the different kind of traffic at the airport needs to be examined **(1.1.1)**. Air traffic can be divided into two sectors, the General Aviation and *"de grote Luchtvaart"* **(1.1.2)**. The legislations and categories of air traffic overlap each other. **1.1.3** will explain which traffic is bound to which sector and profile.

1.1.1 Kinds of air traffic at Rotterdam

Most of the air traffic at Rotterdam consists of scheduled flights which are primarily used by business people. Holidaymakers use Rotterdam primarily for charter flight during holidays. However, there are a lot of passengers who use small business aircraft which are categorised as Business Aviation (BA). Rotterdam Airport would like to expand these kinds of flights. This selection is bound to the Ke noise profile.

All other kinds of traffic at the airport are the recreational flights or private aviators. A large portion of these recreational flights consist of training flights which use the navigation facilities the airport provides. This group is bound to the BKL noise profile. BA and this group are called General Aviation, which will be described in paragraph **1.1.2**.

All air traffic can be seen in **appendix I**, which shows that there are almost none cargo flights. This could also be deducted from paragraph **1.1**, since there are no facilities available for cargo flights. The appendix also shows a massive increase of flights during summer. This increase leads to a decrease of other traffic.

1.1.2 General Aviation and Grote Luchtvaart

The sector General Aviation (GA) is the largest sector in the Netherlands and distinguishes itself from *"de grote luchtvaart"* which is a collective noun for scheduled-, cargo-, charter-, military- and government flights. GA is more than recreational flights alone. GA is divided in the following categories:

1. Business Aviation
2. Ad-hoc flights
3. Aerial work
4. Training flights
5. Recreational flights

Ad 1 Business Aviation

Business Aviation is a large part of GA. BA is the term for people who fly with a business purpose, however it should not be confused with cargo flights or Aerial Work. Desired is the fact that the airport is in the neighbourhood of the actual business. These flights are also called taxi- or business flights.

Ad 2 Ad-hoc flights

These flights are flights of social importance and mostly commissioned by the government. Maintaining public order, security and health care are types of flights which apply for this category. Not only aircraft but also helicopters are bound to this category.

Ad 3 Aerial work
Aerial Work is just as BA flights with a commercial signature, but they are not the same. These kinds of flights are commissioned by enterprises and mostly consist of advertising-, photo flights, or round trips.

Ad 4 Training flights
Training- and practice flights are the largest part of the GA. Around 50% of all GA-flights are training flights. All flights of flight schools are bound to this category. The large amount of training flights is mostly due to the fact that aircraft almost immediately take off after landing. These exercises are also called touch-and-go´s.

Ad 5 Recreational flights
This part of aviation consists of the following parts: RC flights, *"snorvliegen"*, sky-riding, paragliding, gliding, ballooning, skydiving, *"motorvliegen"* and aerobatics. All these parts are members of the "*Koninklijke Nederlandse Vereniging voor Luchtvaart*" (KNVvL). The KNVvL is the overarching organisation for aerial sports and hobbies in the Netherlands.

1.2 Facilities Rotterdam

Earlier mentioned in the previous paragraph, Rotterdam airport receives a wide range of air traffic. All these ranges of air traffic need their own facilities; there are required facilities **(1.2.1a)** and non-required facilities **(1.2.1b)**. An airport is divided into two zones; these zones are landside **(1.2.1)** and airside **(1.2.1)**. These two zones are kept separated by security **(1.2.2)**. Besides this, Rotterdam airport offers the necessary navigation facilities **(1.2.4)**.

1.2.1 Landside

The landside is the area where passengers and goods enter the airport, until the point where the passengers pass through the gates. The landside is also the area where the goods are transported to the apron. Landside is the area of an airport where no aircraft operates.

1.2.1a Required facilities

Some facilities for airports are required. The required facilities are present to process the flights as safe as possible, these are:

1. Emergency services
2. Bird control

Ad 1 Emergency services
To make sure the airport is safe, it must have certain safety authorities. At first an emergency service must be located near the area of the airport. Next to this, a fire-fighting department is a required service on an airport. The laws that are made regarding to the fire-fighting department are depending on the size of the airport. Furthermore, it is required that medical staff is present at the airport. Rotterdam Airport is located near the Erasmus hospital; medical staff can come to the airport in limited time.

Ad 2 Bird Control
Birds could be very dangerous for the take-off or landing of an aircraft. Therefore, it is important that the birds round about an airport are chased away. This can be done by a sound system, which will chase the birds away by making the sound of scared birds. Another way to chase them away is with special fireworks; the popping sound will scare the birds.

1.2.1b Non-required facilities

The purpose of non-required facilities at an airport is, to make it as comfortable as possible for the passengers. In **appendix II**, a floor map can be retrieved from the facilities located on Rotterdam airport, and in **appendix III**, a floor map can be retrieved from the facilities near Rotterdam airport. Some facilities located at landside are:

1. Check in and ticket shop
2. Souvenirs, restaurant and coffee bar

Ad 1 Check-in and ticket shop

At the check-in, the passengers have to check-in for the flight and give away their luggage. Besides this, it is possible to buy a ticket at the ticket shop.

Ad 2 Souvenirs, restaurant and coffee bar

For the utter pleasure of the passengers, it is possible to buy souvenirs, coffee or something to eat at the airport. This can be done in the souvenirs shop, the coffee bar and in the restaurant.

1.2.2 Security

Getting to the airside area of an airport is only possible when going through the security checks, these security checks can be found at airports where it is possible to make flights to foreign countries. Rotterdam airport is a "*Schengen airport";* this means that most flights leaving this airport are destined to countries within Europe. The security check for a flight destined to a country within the European Union (EU) is not very extensive, that's why the security check at Rotterdam Airport is little and there isn't a lot of customs.

An airport also has a *"Non-Schengen"* area*,* the security checks will be much more extensive and stricter. After the identity control, the luggage of the passenger will be checked and the passenger itself has to walk through a detection port. The requirements for the hand luggage are different for every location. Banned substances will be seized by the customs.

For the safety in and around the airport, Rotterdam airport has hired a security company, they can be found all over the airport.

1.3.3 Airside

Located on the airside of an airport are the aircrafts, this area is specially customized for the aircrafts.

Several facilities are located here, including taxiways, runways, and aprons. Each airport has its own letter code allowing them to be distinguished. The letter code indicates the maximum dimensions of an aircraft the airport can handle. To enable the aircraft to taxi from and to the runway, taxiways are used. To enable the aircraft to take-off, runways are used. All facilities, such as de-icing and refuelling are located at the aprons.

On Rotterdam airport, a lot of navigation flights are being performed. The facilities used are described in paragraph 1.2.4. Other facilities from the airside consist of:

1. Runways and clearways
2. Meteo-field
3. Flight Control
4. Fire training area

Ad 1 Runways and clearways

From the runway, aircrafts can take off and land. The clearways are the paths used by aircrafts for getting to and from the runway. Rotterdam airport only has one runway. This runway (24-06) has an

area of 2200 by 45 meters. Runway 24 has an ILS system; this allows the landing of aircrafts trusting completely on their instruments in very bad weather.

Ad 2 Meteo-field
It is important for pilots to know the weather around an airport, so that they can prepare for every possible scenario. At every airport meteorological equipment is located, with this equipment the weather can be measured and predicted. These measurements are made by "*Koninklijk Nederlands Meetinstituut"* (KNMI) and are passed on to the "*Luchtverkeersleiding Nederland"* (LVNL). The airtraffic control will pass the information on to the pilots.

Ad 3 Flight Control
In the Netherlands, the air traffic is controlled by LVNL in the whole country. This is not done from Rotterdam, but mostly from Schiphol. When an aircraft wants to land on Rotterdam airport, the aircraft will be transferred to the air traffic control from Rotterdam airport. The ATC will control the air traffic on the airside of Rotterdam airport and the surroundings of the airport. Rotterdam airport has a separate tower that can be found at the airside.

Ad 4 Fire training area
The fire training area is a special area where the firemen can practice. This is located at the airside from Rotterdam airport, but it is also possible that this area is located outside the airside and around the airport.

1.3.4 Navigation
Pilots, who fly an aircraft from one airport to another, have to find their way with different air-routes. These routes can be navigated in two different ways. The first way to navigate is using Visual Flight Rules, which means using visual reference points on the ground like buildings and roads. The second way to navigate is using the Instrument Flight Rules, which means navigating along radio beacons. The most used way to navigate on Rotterdam airport is VFR, for this reason it is necessary that the needed facilities are present. Rotterdam also has an ILS-system. The ILS system consists of a localizer, glide slope, marker beacons and approach lighting. This system is called a precision approach system. Rotterdam airport has all of the above-mentioned equipment, that's why it is possible to perform navigation flights on this airport.

1.3 The noise created at Rotterdam airport
The Rotterdam airport threatens to exceed the noise standard **(1.3.3)**. This is because the traffic from Rotterdam airport is limited by the law of noise **(1.3.1)**. This legislation for noise consists of two various calculation models, namely the *"Kosten-eenheid"* **(1.3.2a)** and the *"Belasting Kleine Luchtvaart"* **(1.3.2b)**.

1.3.1 Noise pressure
It is not allowed to take off and land on an airport other than provided for this purpose only, according to the Dutch aviation law. For this reason airplanes can only land and take off for designated airports. Because airplanes need a lot of power to get airborne and taxi to and from the runway, this power creates a lot of noise nuisance for the surroundings. The amount of noise nuisance depends on the type of engines, weight of the aircraft visiting the airport and the flight paths. Because Rotterdam airport is located near the urban area, there are strict rules established for noise nuisance. Such rules are limiting the flight movements of certain aircraft from and destined to Rotterdam airport.

1.3.2 Noise nuisance calculation models
In order to establish a controllable noise standard, there should be a reliable calculation model created. However, as discussed in **1.1.1**, there are several factors that determine which amount of noise

nuisance are experienced within the surrounding. Therefor the airplanes are subdivided into different categories. The first calculation is the *"Kosten-eenheid"* Ke calculation, discussed in **1.3.2a**. The second model is the *"Belasting Kleine Luchtvaart"* BKL calculation, discussed in **1.3.2b**.

1.3.2a Kosten-eenheid (Ke)

This calculation is mostly used for the major aviation, needed for aircraft weighing more than six tonnes. When aircraft are lighter than 6 tons, but heavier than 390 kg (small aircraft) and use Instrument Flight Rules (IFR) routes, they are also included in this model. These calculations also include the helicopters and airplanes using turbojets engines. For more information about the Ke calculation see **appendix IV**.

1.3.2b Belasting Kleine luchtvaart (BKL)

The second calculation is used for the small aviation, needed for aircraft weighing six tons or less, excluding helicopters and airplanes with turbine engines. Only the airplanes that use Visual Flight Rules are included. For more information about the BKL calculation see **appendix V**.

1.3.3 Limitations of the current noise policy

In order to explain the threat of exceeding the noise standard, there are two figures representing the realization of the noise regulations around Rotterdam airport. The first figure indicates the load of the Ke model. The second indicates the load on the BKL model. The red lines represent the limits of the noise pressure required by the law. The blue lines represent the pressure of existing air traffic using Rotterdam airport. The first figure clearly shows that Rotterdam airport almost exceeds the prescribed Ke noise pressure **(figure 1)**. Therefore, the airport is not allowed to have more flights in the Ke regulations. This means that airplanes covered by Ke, as discussed in **1.1.2a** may no longer operate from Rotterdam airport. The Ke standard is therefore a limiting factor for the expansion of the airport in the future.

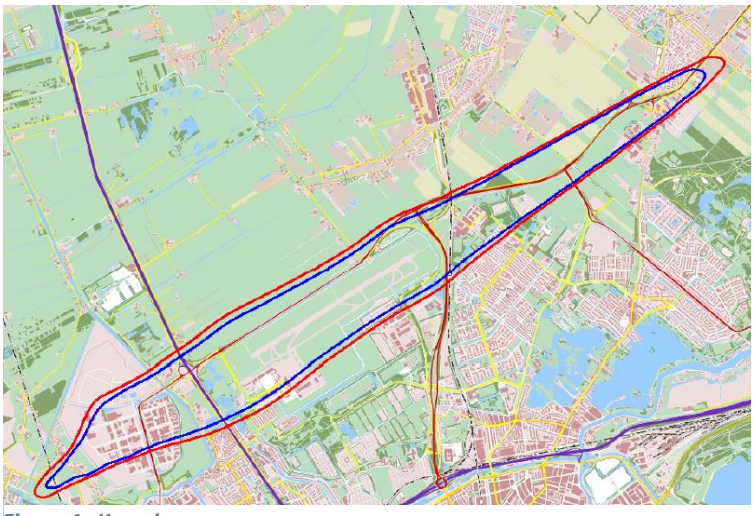


Figure 1 Ke noise pressure

The second figure shows that there is still space in the BKL noise pressure **(figure 2)**. This means that the BKL noise pressure regulations is not a limiting factor for air traffic that uses Rotterdam airport. If we compare the two figures with each other, we can conclude that the problem of noise pressure is caused by the airplanes that are classified as Ke air traffic.

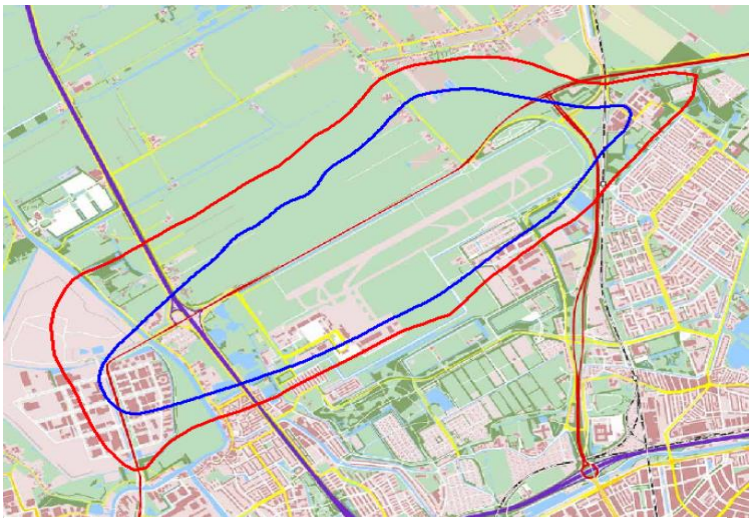


Figure 2 BKL noise pressure

The aircraft that are responsible for the noise pressure are shown in **figure 3**. This figure show al the daily flight movements in the category Ke traffic in percentage.

Appendix-categorie	Representatief vliegtuigtype	Gebruiksplan 2012 (Ke) (%)	Jaartotaal 2011 (Ke) (%)
4	Cessna 310 R	14,3	15,9
10	BO-105	16,4	11,1
11	R-22	0,3	0,5
12	S-76	2,1	0,5
14	S-61	0,1	0,1
39	B747-400		< 0,1
40	HS-121	< 0,1	< 0,1
65	Mystere 20	< 0,1	0,1
69	B737-300	0,4	0,2
70	Cessna Citation	9,1	10,2
71	F50	20,5	21,5
72	Jetstream 31	1,6	3,5
74	Bae146	5,1	1,5
77	X-200	0,6	0,6
78	X-250		< 0,1
79	F27	0,1	1,8
80	4-MOT prop.	< 0,1	< 0,1
469	B737-300/800	29,4	32,5

Figure 3 Aircraft responsible for noise pressure

1.3.4 Overlapping of noise profiles and aviation sectors

Aviation knows a lot of rules and legislations. With such a variety of rules, the chances of one rule overlapping the other is present. This is the case with noise profiles and categories of aviation. The BKL noise profile, also called *"kleine luchtvaart"*, however the Ke profile does not mean *"grote luchtvaart"* due to the fact that helicopters and small aircraft fitted with jet engines are also bound to the Ke profile.
"Grote luchtvaart" is the opposite of GA. In **table 1** the overlapping of noise profiles and aviation sectors is shown. Some categories have exceptions, for instance a training flight is bound to the BKL, but Ke when only navigation is used to fly. At Rotterdam Airport, most of the training flights consist of these navigational flights.

	Noise profile	Aviation sector	Remark
Business Aviation	Ke	GA	
Ad-hoc flights	Ke	GA	Aircraft below 6 tonnes are BKL
Aerial work	BKL	GA	Helicopters are Ke
Training flights	BKL	GA	Navigational flights are Ke
Recreational flights	BKL	GA	
Scheduled flights	Ke	*"Grote luchtvaart"*	
Charter flights	Ke	*"Grote luchtvaart"*	
Cargo flights	Ke	*"Grote luchtvaart"*	

Table 1 Noise profile and aviation sector

1.4 Relocation

To design the new airport there must be decided which aircrafts of aircraft companies are going to be flying at the new airport. So which groups are going to be relocated **(1.4.1)**? But these groups have some facilities at Rotterdam Airport, which they need at the new location. So what facilities are needed at the new airport **(1.4.2)**? In the end a conclusion **(1.4.3)** can be made, which flights are going to be relocated with the required facilities.

1.4.1 Which groups are going to be relocated

To keep the growing possibility of Rotterdam Airport a part of the aviation at the airport must be relocated to a new airport. To look at the groups, which can be relocated, there are a few things that needs to be checked first:

1. Flights at Rotterdam Airport
2. Flights that can be relocated
3. Largest aircraft

Ad 1 Flights at Rotterdam Airport

To relocate flights, there has to be looked at all the aircrafts that land at Rotterdam Airport. All the aircraft companies and other companies, like aero clubs, at Rotterdam airport must be examined. Of all this flights a list is made with all the companies at Rotterdam Airport and their fleet. **(Appendix VI)**

Ad 2 Flights that can be relocated

With the list of all aircrafts who land at Rotterdam Airport, a selection can be made which aircrafts are going to be relocated to the new airport. Hereby there will be looked at the take-off weight of the aircraft. Only aircrafts with a take-off weight up to 7000 kg can take-off and land at the new airport. Of all the aircrafts at Rotterdam, the take-off weight is determined and a selection has been made which aircrafts are going to be relocated. **(Table 2)** Because the helicopters at Rotterdam are medical transport or Police helicopters, these flights will not be relocated, because the traveling time from the new airport to Rotterdam will be too long in case of an emergency.

Type	Maximum take-off weight	Relocate?
Avro RJ85	42,185	No
Boeing 737-300	56,450	No
Boeing 737-400	62,900	No
Boeing 737-700	70,800	No
Boeing 737-800	79,150	No
Boeing 757-200	98,880	No
Bombardier Dash 8-400	29,260	No
Cessna Citation Jet II (Bravo)	6,849	Yes
Cessna Citation Jet III	10,183	No
Cessna Citation Jet Excel/XLS	9,163	No
Cessna Citation Jet Mustang	3,930	Yes
Cessna Citation Jet Ultra	7,394	No
Cessna F152	0,757	Yes
Cessna F172P (Skyhawk II)	1,111	Yes
Dassault Falcon 2000 7X	31,750	No
Dassault Falcon 2000 EX	18,597	No
Diamond DA40 (DA40 TDI)	1,198	Yes
Dornier Do 328-100	13,990	No
Fokker 50	20,820	No
Fokker 100	45,810	No
Gulfstream G200	16,080	No
Gulfstream G550	38,600	No
Hawker 400 (Beechjet 400A/400XP)	7,303	No
Hawker 750/800XP	12,701	No
Hawker 4000	17,917	No
Piaggio Aero P180 Avanti II	5,239	Yes
Piper Archer III / Arrow IV / PA28 / Warrior II / Warrior III / Warrior Cadet	0,975	Yes
Piper Seminole PA44	1,732	Yes
Robin DR400	0,900	Yes
Robin R2160	1,000	Yes
Saab 2000	22,800	No

Table 2 Which plane gets relocated?

Ad 3 Largest aircraft

The largest aircraft, which will land on the new airport, is the Cessna Citation II **(figure 4)**. This aircraft will decide the length of the runway. The Cessna Citation II has a maximum start weight of 6,849 Kg and a maximum take-off distance is 1,024 m. This take off distance is measured in normal weather conditions so in case of rain or other weather situation, the runway will be 1199m

Figure 4 Cessna Citation II

1.4.2 What facilities do the relocated groups need?

The groups that are going to be relocated to the new airport have certain facilities at Rotterdam Airport that they need at the new location. There are five groups, which are going to be relocated, or at least a part from that group is going to be relocated:

1. Vliegclub Rotterdam
2. Rotterdam Aero Club
3. JetNetherlands
4. NetJets
5. LionAir

Ad 1 Vliegclub Rotterdam

Vliegclub Rotterdam (VCR) is one of the largest aero clubs in the Netherlands with around 600 members and also one of the largest and most experienced trainers of private flight school. With around 14 aircrafts the VCR has its own hangars and parking spaces for its fleet. And as a fully licensed flight school it has its own training centre/clubhouse with classrooms and flight simulators.

Ad 2 Rotterdam Aero Club

Rotterdam Aero Club (RAC) is the oldest Aero Club in Europe. The RAC is a fully equipped flight training school. It has a fleet of four modern aircrafts and members have the opportunity to bring fly with their own aircrafts. The RAC has its own hangar at Rotterdam Airport and its own flight clubhouse. So these facilities have to be relocated to the new airport.

Ad 3 JetNetherlands

JetNetherlands provides a wide range of services related to private jet management and chartering. It has a fleet of nine types of aircrafts, but since the most of these aircrafts have a maximum take-off weight above the 7000 kg, only three types can be relocated. These jets need a parking space in front of the airport building so the passenger can leave the airport as quickly as possible to go to their destination. JetNetherlands also provides passengers with pickup and return service. So the airport needs a place where taxi companies can pick up and return passengers from and to the airport.

Ad 4 NetJets

Netjets is large private airline company with around hundred aircrafts in Europe. Two aircraft types are going to be relocated. These aircrafts needs parking spaces and taxi services from and to the airport just like JetNetherlands**.**

Ad 5 LionAir

LionAir is a company that provides Flight lessons, Sight Seeing Flights and air photography productions. The carrier has a fleet of Cessna's, Pipers', a Fokker 50 and two Dakota's. This company has its own hangar and building. As lion air also is a training school for pilots it also has the ability of flight simulators.

1.4.3 Conclusion

The flights that are going to be relocated to the new airport are ten different types of aircrafts. These aircraft need facilities at the new location, which were present at Rotterdam Airport, so these have to be relocated as well. Those facilities are: A platform with enough parking spaces for the aircrafts, hangars and buildings for the RAC, VCR and Lion Air and pickup and return places for taxi companies. So these facilities have to be placed at the new airport.

2 Locations

Before the airport can be designed a suitable location is needed. Using different aspects from which the best location can be chosen **(2.1)**. After explaining the aspects, 3 different locations will be carefully selected and sifted for each of the aspects **(2.2)**. At last *"Oude-Tonge"*, *"Strijen"* and *"Zevenbergen"* will be rated. The best location of these three will be selected **(2.3)**.

2.1 Aspects

To select the optimal location for the new airport the following aspects must be discussed for every selected location:

1. Surrounding areas
2. Airspace
3. Accessibility
4. Bird areas
5. Area and obstacles

Ad 1 Surrounding areas

Because of noise nuisance created by low flying aircrafts, as few people as possible should live around the new airport. This also gives the airport growth opportunities. The runway heading is forced by the wind direction. The runway will be headed in the most common wind direction. The new airport cannot be built near open water. This is because of birds and mist, which is not desirable at an airport. Water also causes turbulent air, because air is cooled above water. This makes approaching the runway difficult.

Ad 2 Airspace

Military flying activities should be avoided. It's illegal to fly in this area without authorization. The low flying areas cover the *"Hoeksewaard"* and the *"Maas/Waal"* area. These areas should be avoided in all conditions without authorization. The new airport will be located within a reach of 40 km from Rotterdam Airport. This means the new location for the airport will be within the Rotterdam TMA. Rotterdam TMA 1 is E class airspace with a range between 1500ft MSL and FL55. Above FL55 up to FL195 there is Schiphol CTA, which is not accessible for VFR traffic

Ad 3 Accessibility

The new airport should not be too far away from Rotterdam Airport. A maximum distance of 70 kilometers from Rotterdam airport has been chosen. All locations further then 70 kilometer aren't an option. To make the airport easily accessible for traffic, highways must be located close to the new airport. The same applies to public transport.

Ad 4 Bird areas

Bird areas can divided in three different areas. Where the birds breed during summer, second, where they breed during winter and last where birds breed the whole year. It is prohibited to fly near the bird area during a designated period.

Ad 5 Area and Obstacles

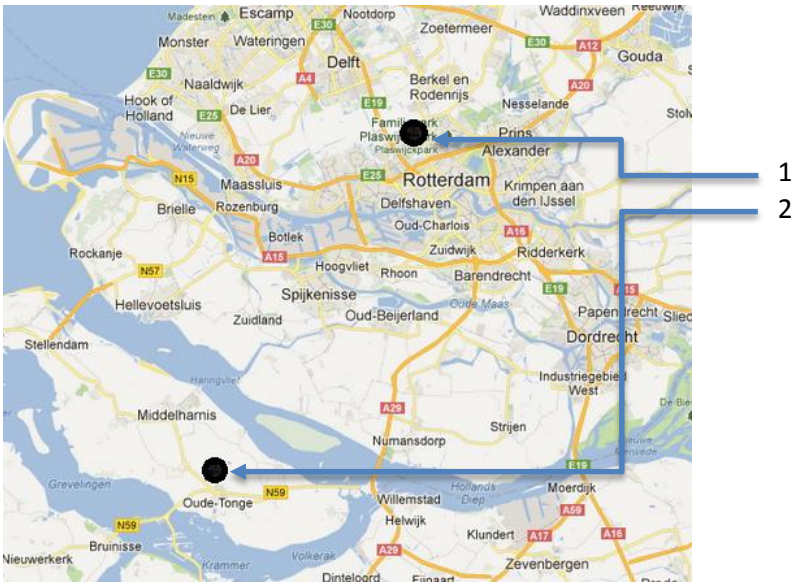
To provide a save approach route, there should be no obstacles near or on the approach route of the airport. The most dangerous obstacles are high object like windmills, trees or buildings near the airport. Those obstacles should be avoided at all time.

2.2 Available locations

After examining all the possible locations within a 70km range from EHRD. Three locations have been chosen. **(Appendix VII)** These locations are suitable locations for the new airport. The first selected location is *"Oude-Tonge"* **(3.2.1)**, which is located at *"Goeree-Overflakkee"*. The second location *"Strijen"* **(3.2.2)**, is located south-east of Rotterdam Airport. And the third location is *"Geertruidenberg"* **(3.2.3)**, which is located south of Rotterdam Airport.

2.2.1 Location A Oude-Tonge

The first selected location is *"Oude-Tonge"* **(figure 5)**, which is located at *"Goeree-Overflakkee"*. *"Goeree-Overflakkee"* has a population of 48.200 residents, as few people as possible should live around the airport because there has to be enough space between ground and aircraft **(3.2.1a)**. What is also important is the airspace in which *"Oude-Tonge"* is located **(3.2.1b)**. Oude-Tonge should be accessible by car. Therefore highways and public transport must be available **(3.2.1c)**. Another factor are the so called bird areas **(3.2.1d)**



1. Rotterdam Airport
2. Oude-Tonge

Figure 5 Location Oude- Tonge

2.2.1a Surrounding areas

Location *"Oude-Tonge"* is an optimal location for a minimum noise nuisance area. There are no major cities located near the airport location. However, there is one wind farm in the vicinity of the airport. **(Appendix VIII)** The new airport will be built on top of a thick layer of clay, which is very strong, and therefore could be an optimal location. The runway will be headed in the most common wind direction. The most common wind direction **(figure 6)** in the Netherlands is southwest, heading 235, 82% of all time. That's why the runway will be 06-24.

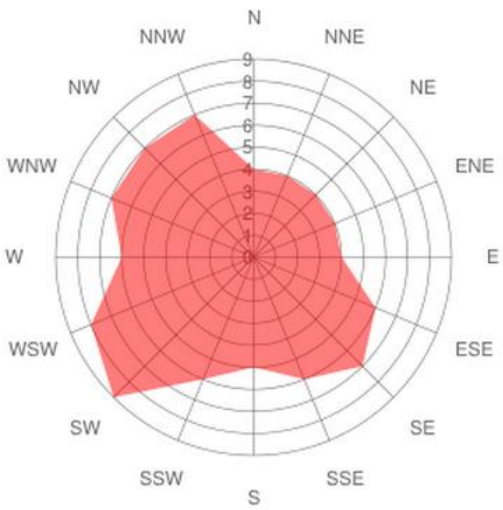


Figure 6 Wind direction during a year near Oude-Tonge

2.2.1b Airspace

Location *"Oude-Tonge"* is located in Rotterdam TMA airspace, which range from 1500ft up to FL55. All VFR flights are allowed to enter the airspace without authorization. Above FL55 Amsterdam CTA 1 is located, which is an A class airspace. VFR flights are not allowed in an A class airspace. Rotterdam TMA 1 is an E class airspace, which means that there's no separation between IFR and VFR. Near *"Oude-Tonge"* there are no military activities or low flying zones.

2.2.1c Accessibility

The connection by car between *"Oude-Tonge"* and Rotterdam Airport is approximately 40 minutes. Highways and provincial roads connect both airports with each other. **(Figure 7)** At *"Goeree-Overflakkee"* there are no train stations. So this new airport will be limited accessible. The closest train station in *"Zevenbergen"* is approximately 30 km away.

A29	58.8 km, 40 mins
A15 and A29	60.1 km, 41 mins

Figure 7 Suggested routes

2.2.1d Bird areas

Near *"Oude-Tonge"* there is one sanctuary during the whole year. This place is called *"Haringvliet"*. **(Appendix IX)** Because birds can cause a lot of damage to airplanes this location must be avoided at all times.

2.2.1e Area and obstacles

Location "Oude-Tonge" is a flat location with almost no obstacles on the approach. The runway 06 approach is clear of obstacles, on the runway 24 approach route a few high trees on the end of the runway could cause a problem with take-off or landing. Further there are no particular obstacles near the airport that could cause problems during the take-off or landing.

2.2.2 Location Strijen

Location Strijen is located near "*Zuid-Beijerland*" and "*Klaaswaal*". If the location fit the set up requirements it would be an optimal location. This means that it should be examined for four different aspects:

1. Surrounding areas **(2.2.2a)**
2. Airspace **(2.2.2b)**
3. Accessibility **(2.2.2c)**
4. Bird area **(2.2.2d)**
5. Area and obstacle **(2.2.2e)**

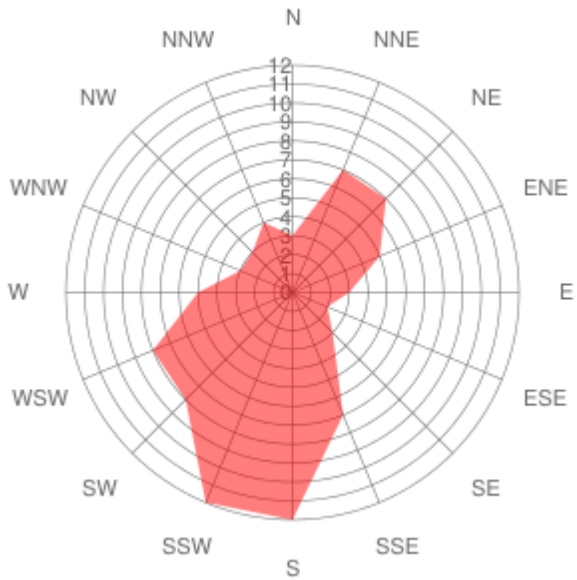


Figure 8 Wind direction near Strijen

2.2.2a Surrounding areas

The nearest city located is in the south called "*Zuid-Beijerland*" with 2,745 inhabitants, it is located 2 kilometres from the airport. "*Zuid-Beijerland*" is the nearest city near the approach route of the airport, but still not underneath the approach route. Another city near the approach route is "*Klaaswaal*" this town lays 2.5 kilometres east from the airport and has 3,485 inhabitants. The advantage of this airport location is that there are no town or cities near the airport, and that there is no town or city in the direct approach route of the airport in a radius of 10 kilometers around the airport. The nearest water body is "*Kleine Gat*" this river channel could cause for problems since it is located 500 metre away from the airport and direct underneath the approach route of the airport. This also makes it dangerous to land because of birds that could be near the water and cause bird strikes. Through it is an open field without any cities near so the airport could move or grow. The most common wind direction for *"Strijen"* is South-South-West. This means the runway heading will be 020-20.

2.2.2b Airspace

The airspace above *"Oude-Tonge"* also applies for location *"Strijen"*. *"Strijen"* is located in Rotterdam TMA airspace, which range from 1500ft up to FL55. All VFR flights are allowed to enter the airspace without authorization. Above FL55 Amsterdam CTA 1 is located, which is an A class airspace. VFR flights are not allowed in an A class airspace. Rotterdam TMA 1 is an E class airspace, which means that IFR flights are provided with ATC services. VFR flights get flight information as far as practical. Strijen is located in a low flying area, which makes founding an airport unable. **(Appendix X)**

2.2.2c Accessibility

The location is with 23 kilometres within reach of the target of 70 kilometres around Rotterdam Airport. Because of the outlaying location of Airport Strijen it is not easy to reach it fast by car. It takes 33 minutes from Rotterdam The Hague Airport to "*Beijerlandschedijk, Nieuw-Beijerland*". It takes one and a half hour if the public transportation is used from Rotterdam The Hague Airport to Strijen Airport. This makes it a bad location to set up the new airport.

2.2.2d Bird area

There is one bird are near the chosen location *"Strijen"* called *"Oudeland van Strijen"*. **(Appendix XI)** This makes it dangerous to set up an airport at this location cause of the bird-strikes that could happen near the airport. Most of the birds stay in this area during winter when flying must be possible at the airport.

2.2.2e Area and obstacles

Location "Strijen" is like the other locations a flat area. The only disadvantage is that on the runway 20 approach there are electricity cables located. Those cables are perpendicular to the approach route and this makes it a high risk obstacle. It is expensive to reconnect and replace those electricity poles so this makes it a disadvantaged location.

2.2.3 Location C Zevenbergen

Location C is located between *"Zevenbergen"* and *"Raamdonksveer"*. The location should meet the requirements of the optimal location. This means that it should be examined for four different aspects:

1. Surrounding areas **(2.2.1a)**
2. Airspace **(2.2.1b)**
3. Accessibility **(2.2.1c)**
4. Bird areas **(2.2.1d)**

2.2.3a Surrounding areas

First, there are three small towns **(figure 9)** in the immediate proximity of the airport: *"Zevenbersche Hoek"* with 1'635 people at a distance of 1 km perpendicular to the runway. The second town is called *"Wagenberg"*, has 2201 residents and is also 1 km perpendicular in the extension of the runway. Two kilometres NNE from the airport lays the town *"Hooge Zwaluwe"* with 1632 inhabitants. The location of *"Hooge Zwaluwe"* makes this town most prone to noise nuisance from planes landing and taking off from the airport. Secondly, the runway is headed as a 6-24, because the most common wind direction near Zevenbergen is south-west. **(Figure 10)**

Figure 9 Towns surrounding Zevenbergen Airport

2.2.3b Airspace

The location is not located in any military training areas according to the *"Luchtkaart Nederland 2010"*. This location was primarily chosen due to the fact that there would be no interference with military zones, Rotterdam Airport approaches and zones that are only accessible to planes on their way to Schiphol Airport. Same as location A, this airport is located in Rotterdam TMA Airspace.

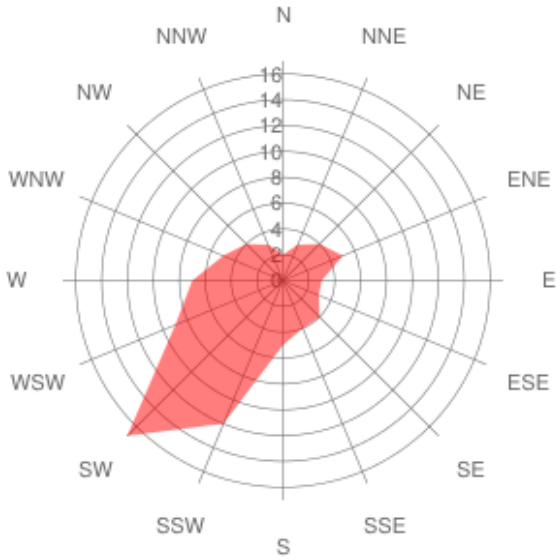


Figure 10 Wind direction near Zevenbergen

2.2.3c Accessibility

The location is with 35 km within reach of the target of 40 km around Rotterdam Airport. The new airport is highly accessible by car due to the close proximity to the A59. It takes 34 min from Rotterdam The Hague Airport to *"Driehoefijzerstraat, Zevenbersche Hoek"*. Since public transportation is a common way of transportation too, the time for the same trip is calculated as well. This takes close to one hour from Rotterdam Airport to the new location.

2.2.3d Bird areas

At last, the water body closest to the location is an artificial swimming lake *"De Winput"*, 1,5 km away. *"Amer"* is the river closest by the airport. Both bodies of water are not located underneath the final approach routes, so therefor they should not pose any problem. The only official bird area in the neighbourhood is *"de Biesbosch"* but is not located underneath the approach routes and therefor aircraft could fly around this area.

2.2.3e Area and obstacles

Location "Zevenbergen" has no obstacles that could cause any problem by taking off or landing, there are no high obstacles near or on the approach route and the area is flat. There is a highway on the approach of runway 24 but it is not located underneath the glide path of 3 degrees so it would not cause any problem.

2.3 Conclusion

The best possible location is chosen on the basis of the following elements: infrastructure/surrounding areas, airspace and accessibility. All these three elements have their own weight factor **(table 3)**. For example, airspace is more important than accessibility, because without available airspace no airport could be built. So this element will have a higher weight factor, which means it will count more in the number of points to obtain. The location, which will have the highest number of points, will be chosen as the best possible location. Every element will be graded from one to ten points, wherein ten will be the best, down to one, which will be the worst.

Elements	Weight factor
Surrounding areas	5x
Airspace	7x
Accessibility	3x
Bird areas	5x
Area and obstacles	5x

Table 3 Weight factors

As seen in **table 4**, location *"Oude-Tonge"* has scored a high grade for its infrastructure/surrounding areas; this is because the surrounding area is not very populated. The airspace of *"Oude-Tonge"* scores a seven, because the airspace tolerates a new airport at this location but there are certain areas that need to be taken into account. The accessibility to *"Oude-Tonge"* is limited for public transport, but reasonably accessible by car, so it's given a five.

Location *"Strijen"* has been given a four for infrastructure/surrounding areas; this is because the surrounding area is relatively populated. Besides, there is a water body near the location, which is also a huge disadvantage. The airspace of *"Strijen"* has a very high grade, an eight; this is because there are no limitations for the airspace at this location. The accessibility to *"Strijen"* is also limited for public transport, but reasonably accessible by car, so it has been given a five as well.

Location *"Zevenbergen"* has been given a five for its infrastructure/surrounding areas; this is because of the slightly populated surrounding area of *"Zevenbergen"*. The airspace of *"Zevenbergen"* has a nine as well; this is because there are no limitations for the airspace at this location. *"Zevenbergen"* is also reasonably accessible by car and public transport, that why this element has been graded with a six.

	Location Oude-Tonge	Location Strijen	Location Zevenbergen
Surrounding areas	45	20	25
Airspace	49	56	56
Accessibility	15	15	18
Bird areas	20	15	15
Area and obstacles	15	15	20
Total number of points	144	121	134

Table 4

As seen in **table 4**, location *"Oude-Tonge"* is the best possible location for our new airport. So group 1J will locate the new airport at *"Oude-Tonge"*.

3 Airport design

Firstly to describe the design of the airport we must first know the criteria we can use for the airport **(3.1)**. After that we know what is needed on this airport and we can describe the airport location and the flight paths which are needed **(3.2)**. The airport location will have a map **(3.3)** where we can find all the buildings and facilities that are needed. When the airport is designed there must be calculated of the airport will not make too much noise, this will be calculated with the Lden calculation **(3.4)**.

3.1 The criteria for the airport

To design a safe, secure and well-ordered airport, the airport must classify to a number of criteria, such as landside **(3.1.1)** and airside **(3.1.2)**. Landside and airside will be divided into different subjects.

3.1.1 Landside

A few main structures the landside must have is a terminal **(3.1.1a)**. There also has to be different facilities **(3.1.1b)** for the passengers and employees. All those people should have the possibility to visit the airport, the parking area **(3.1.1c)** should provide enough space to park the cars. The second main subject is the airside.

3.1.1a Terminal

A few criteria a terminal should fulfil is that it provides all the goods needed for the employees and visitors. There should be a clear opening time and closing time.

3.1.1b Facilities

Passengers must be provided from facilities such as restaurants, souvenir shops and toilets on the airport. A main criteria is that those facilities should be clean and employed at all time during opening time of the airport.

3.1.1c Parking

The airport should be able to visit at all time while opened, this could only be able if there are enough parking space near the airport. A main criteria for the parking area is that there is enough space for employees as visitors during the opening times of the airport.

3.1.2 Airside

The airside must have a runway **(3.1.2a)**. An aircraft should be able to move over the airside area over the taxiways **(3.1.2b)**. Those run- and taxiways must classify to a number of criteria and designed by it so the aircraft could move properly over the run- and taxiways. To guide the aircraft while landing and taking off an air traffic control **(3.1.2c)** tower is needed. If there are aircraft that are not in use, they are parked on the apron **(3.1.2d)** or in the hangars **(3.1.2e)**. The apron should be arranged properly so the parked aircraft do not stand in the way for the moving aircraft that are on their way to fuel **(3.1.2f)** or parking. All those subjects are bond to different types of criteria.

3.1.2a Runway

A runway is used to let aircrafts take-off and land. The runway is the most important part of an airport. Runway heading and position depend on wind direction and available space at an airport. The runway has to be long and strong enough to enable an aircraft to land. On the runway are runway markings, these marks enable the pilot to navigate while on the runway. Runway requirements are made to ensure a runway is long, strong and wide enough to handle a specific type of aircraft. To make sure an aircraft can land, pilots include the weight of the aircraft, pressure altitude, temperature at ground level, runway slope and wind direction into their calculation. With this calculation the pilot can calculate the minimum length of runway needed, which he can compare with available runway at the airport. **(Appendix XII)** The width of a runway depends on its length.

Numbers found in the first table shows the width in the second table. When an aircraft take off the sometimes has runway length than if the aircraft land, because there is a runway threshold for the runway or a stop way behind the runway. All this distances have their own name. **Figure 11** shows the meaning of these distances:

1. take off run available (TORA)
2. take off distance available (TODA)
3. landing distance available (LDA)
4. accelerated stop distance available (ASDA)
5. clearway
6. stop way

Ad 1 Take Off Run Available
The TORA is the available distance for an aircraft to make the ground roll.

Ad 2 Take Off Distance Available
The TODA is the available distance for an aircraft to make the ground roll, including the distance to climb to 50 feet. (Take-off run + clearway)

Ad 3 Landing Distance Available
The LDA is the distance available for an aircraft to land and stop. The available length of the runway, available for an aircraft to accelerate to 'the point of no return' and stop again.

Ad 4 Accelerated stop distance available
The ASDA is the available distance for an aircraft to accelerate to its take-off speed and come to a full stop again. (Take-off run + stop way)

Ad 5 Clearway
A clearway is an area at the end of the runway, which enables the aircraft to climb to 50ft AGL.

Ad 6 Stop way
A stop way is an area at the end of the runway in which an aircraft can be stopped in case of an aborted take-off.

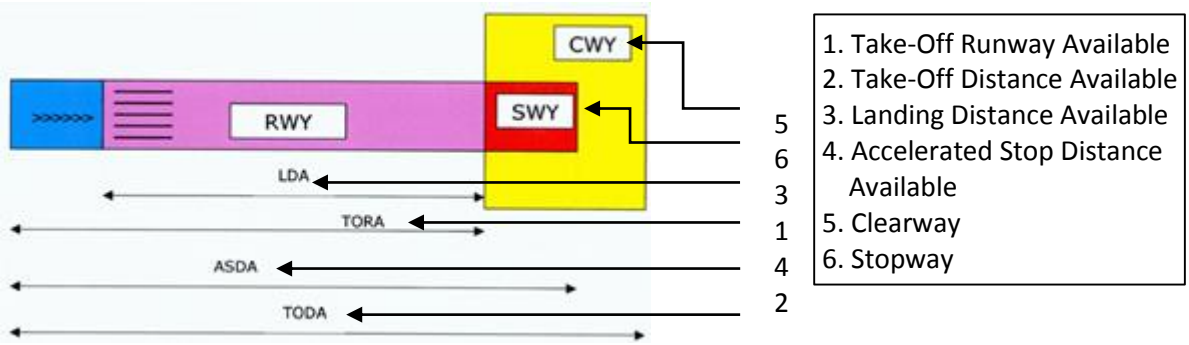


Figure 11 Runway

Also the runway has to comply with strict rules. Runway marks and signs are white. This enables the pilot to separate the taxiway from the runway, because the taxiway marks are yellow. On a runway there are several marks available which can be found at. **(Appendix XIII)**

3.1.2b Taxiway

The taxiway is there to lead the aircraft to and from the runway in a save en way. There should be enough taxiway on strategic places. Taxiways should be built by strict rules and criteria, such as wide and markings. The wheel base of an aircraft depends the wide of the taxiways and have their own code. **(Appendix XIV)** The wheel base is the distance between the geometric center of the main landing gear and the nose wheel. The markings are always yellow; therefore the pilot can easily distinguish the taxiways from the runways and aprons, which have white signs. **(Appendix XV)** Yellow lines show the edge of the taxiway. The centreline of the taxiway is the line followed by the nose wheel of the aircraft. Also holding points can be found at the taxiway, these are mostly located where taxiways cross each other, or at a runway entrance. These marks show the pilot where to stop.
All taxiways have dimensions that have to comply with strict rules. The width of the taxiway depends on the wheelbase **(figure 12)** of the aircraft. The wheelbase is the distance between the geometric center of the main landing gear **(1)** and the nose wheel **(2)**. All aircraft are split into classes (Appendix II), which depend on the dimensions of the wheelbase.

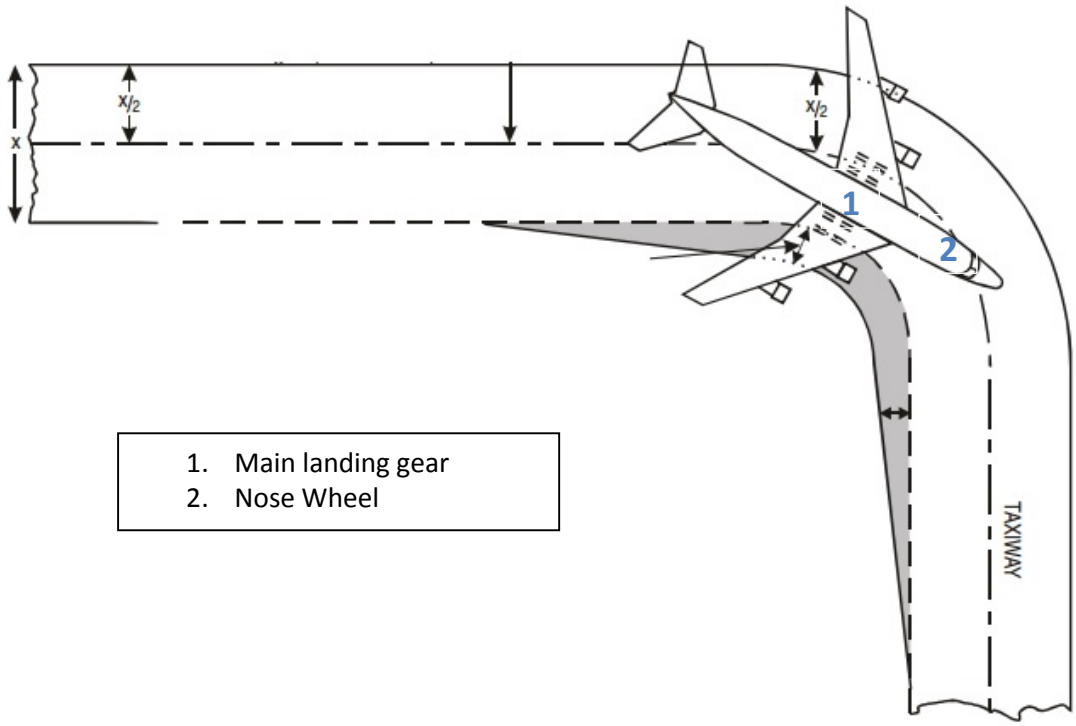


Figure 12 Wheelbase of an aircraft

3.1.2c Air traffic control

There will be one air traffic control tower needed to guide the aircraft for landing and taking of. A main criteria for the air traffic control tower is that there are enough air traffic controllers while the airport is open. These air traffic controllers are also responsible for the aircraft on the ground which means that they guide each aircraft to and from the apron. Another criteria is that the ATC should always be able to have a good view over the airport.

The airspace above and around the airport is classified in categories. These categories are: General air traffic control service to controlled flights serving areas (CTA, UTA=Upper Airspace), Approach control service serving inbound and outbound traffic to/from the airport (TMA) and Local air traffic serving the airport traffic (CTR).

3.1.2d Apron

While loading, unloading, boarding, de-icing and refueling an aircraft is parked at the apron. The apron has to comply with very strict rules, places must be at least 100 meters separated from each other and fuel tanks and other facilities may not be located under the apron.

3.1.2e Hangars

The hangars on the airfield should provide the right amount of space so different aircraft could be parked in the hangars. They also should stay near a taxi way of apron so the way to and from the runway is visible and clear to find for the pilots. On the way to and from the hangars there be no obstacles because of accidents that could happen while parking the aircraft in the hangar.

3.1.2f Fuel

There must be fuel available for the airplanes landing and taking off from the airport. Jet aircrafts needed other fuel than a small aircraft. The fuel must be stored on a save way.

3.2 Chosen location and flight paths

The chosen location of the airport is near the Dutch city: *"Oude Tonge"*. The area of the airport will be described in paragraph **(3.2.1)**. For the airport there are several different flight paths needed, because we use different kind of navigation, this paths are described in paragraph **(3.2.2)**.

3.2.1 Airport Area

The area chosen for the airport, the fields behind the "Langstraat" in "Oude Tonge". This area consists of an area of 2.71 square kilometres and has a circumference of 7.28 kilometres, as shown in **figure 13**. The yellow line is the fence of the area where "Oude-Tonge Airport" shall be located. The map of airport "Oude Tonge" is shown in figure 14. At the airport there are all kind of different facilities. Each facilitie needs to be described for the costs of the airport. On te map you can see that the facilities are divided in the Landside **(3.2.2)** and the Airside **(3.2.3)**.

Figure 13 Area where the airport will be located

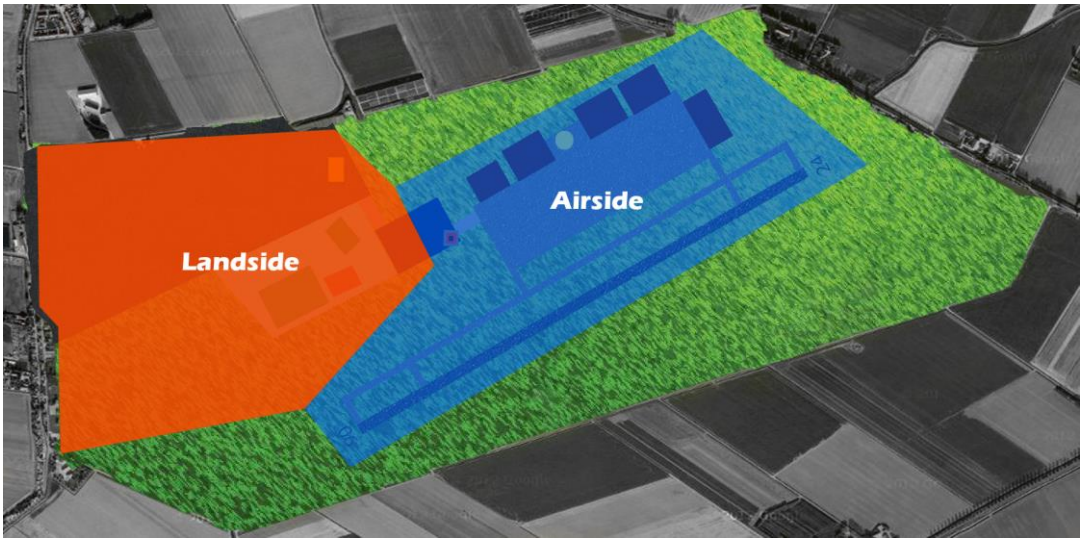


Figure 14 Landside and airside

3.2.2 Landside

In **figure 15** is the map of the landside of the airport shown. The terminal **(3.3.2a)** is for the visitors the border between the landside and airside. On the landside there will also be a hostel and catering available **(3.3.2b)**, the visitors can park there car at the parking facilities **(3.3.2c)** and visit the visitation area. The airport is very accesable by car **(3.3.2d)** from visitors from Rotterdam.

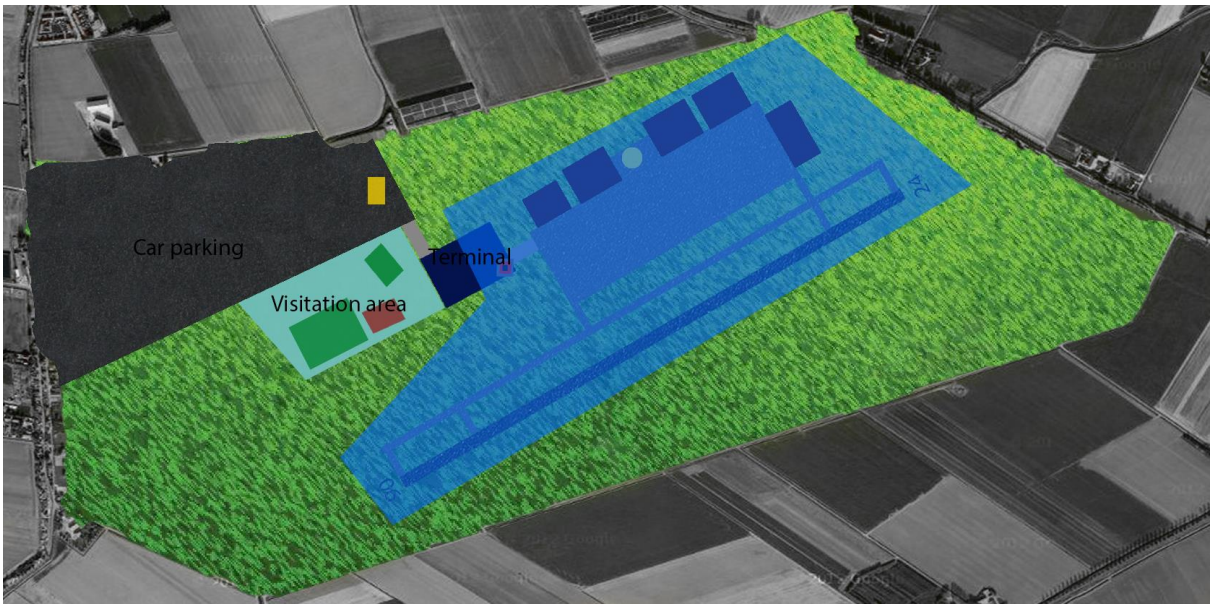


Figure 15 Landside

3.2.2a Terminal

The terminal on the airport will be 50 by 60 meter, and will not make use of a terminal with customs because there are no international flights to or from the airport. The opening time is 09.00 and the terminal will close on 22.00, when the terminal is closed the airport will also be closed. When the terminal is open there will be a catering for employers open in the terminal. There will be an information point for the visitors.

3.2.2b Hostel and Catering

On the airport a hostel will be present for the people who live far away from the airport, where they can sleep in the night. There is also a catering service where visitors of the airport are able to get some food and drink. These 2 facilities can be find on the visitation area. On the parking lot is also a Dutch “friettent” for aircraft spotters.

3.2.2c Parking facilities

On site is a part furnished with parking, especially for visitors, but also for the plane spotters. For parking will be a parking fee. The parking area has an area of 0.035 square kilometres. The income of all the fees are entirely for the airport. The car park is protected by camera surveillance and there are fences around it so the plane spotters stay behind the fences and not enter the airport. There will be a total of 175 parking spaces for visitors and 25 parking spaces for employers. Parking will cost 2 euro 50 each hour with a maximum of 15 euros a day.

3.2.2d Accessibility

The new airport is located next to the N59 which end onto the A29, this highway leads to the ring road of Rotterdam. Visitors who drive from Rotterdam will reach the airport in about 35 minutes. In comparison Lelystad Airport is 45 minutes away from Schiphol. So the new airport is very accessible.

3.2.3 Airside

In **figure 16** is the map of the airside of the airport shown. To control the aircraft on the airside and in the air we have an Air Traffic Control tower **(3.2.3a)**. The runway and next to that the taxiways **(3.2.3b)** have a special class and code. When an aircraft leaves the runways and taxiways they will drive over or park on the apron or platform **(3.2.3c)**, on the apron there are a few fuel facilities **(3.2.3d)** and after that the aircraft can drive to there own hangar **(3.2.3e)**.

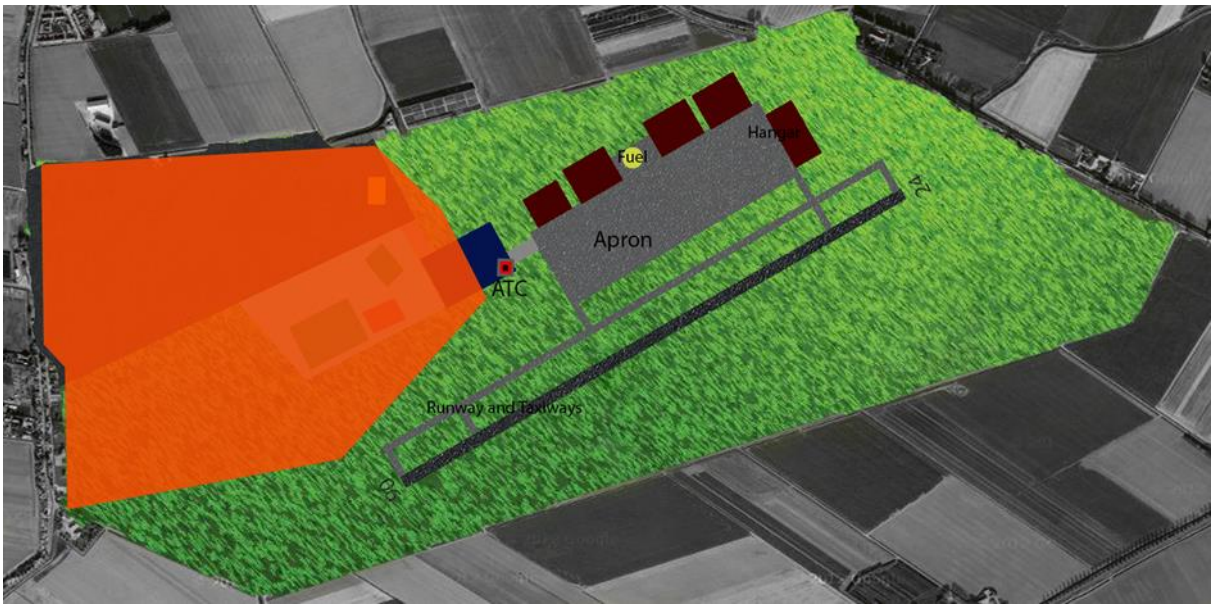


Figure 16 Airside

3.2.3a Air Traffic Control Oude-Tonge

Air traffic control on “Oude Tonge” Airport is a small ATC which is only allowed to handle traffic within a radius of 3500ft. If an aircraft leaves this area of the ATC of “Oude Tonge” and needs to speak with an ATC they will be guided by the ATC on Schiphol Airport. The ATC is also responsible for the aircraft on the ground which means that they guide each aircraft to and from the apron. They also provide clearance to aircraft ready to take off. In order to provide a clear view of the airport and sky around it, the ATC should be placed on top of the terminal. The airspace of “Oude Tonge” is a controlled airspace with CTR classification to 3500ft. **(Figure 17)**

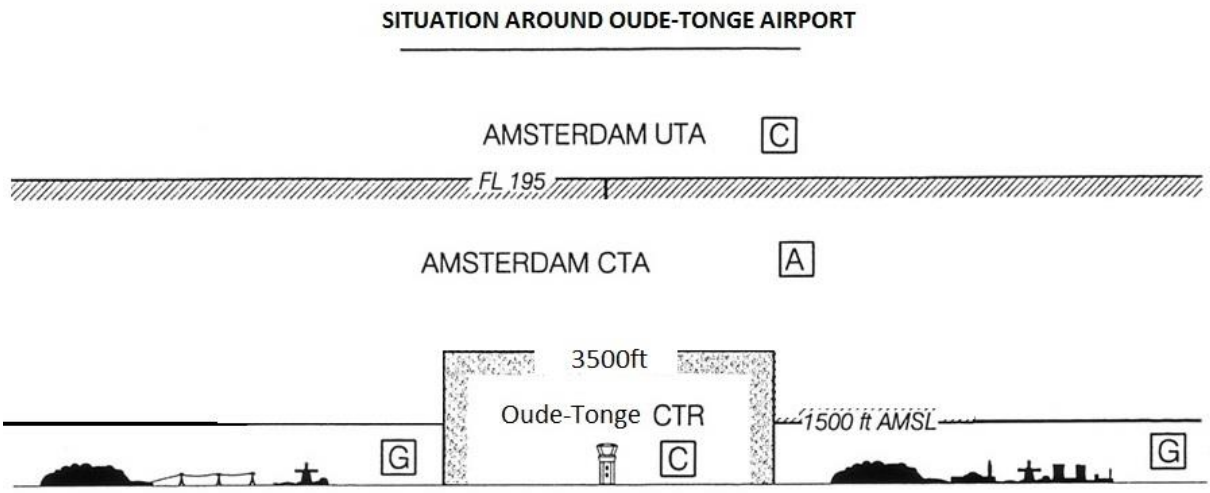


Figure 17 Airspace

3.2.3b Runway and Taxiways

Every runway has its own number, which indicates the heading of the runway, the heading numbers of airport. The approach routes are along 60 degrees east-north-east and 240 degrees west-south-west. Which give runway code 06 and 24. The airport is 1199 meter long and 30 meter wide, so we can made up that airport "Oude Tonge" has the runway class 2C. The runway is exactly 1199 meter without a stop way and clearway. That means that the ASDA, LDA, TODA and TORA are all 1199 meter. The following marks can be found at the runway of "Oude Tonge": 8 stripes, Centerline, Aiming point on 400 meter, Touchdown zone on 350 meter.

The taxiways to and from the runway, are responsible for guiding the aircraft to and from the runway. At our airport there are 4 taxiways, so planes when needed can quickly leave the runway. The designed airport has a code letter C taxiway width. The rules bonded to this is that the taxiway width should be 15 meter if the taxiway is intended to be used by aircrafts with a wheel base less than 18 meter, the taxiway should be 18 meter width if the aircraft has a wheel base equal to or greater than 18 meter.

3.2.3c Apron

The Apron on Oude-Tonge Airport should be 400 by 200 meters, with a total of 80.000 square meters. So there is much space for the aircrafts to park and manoeuvred. On the long side you can find four hangars and on the other side one large hangar **(3.3.2e)**. In the middle of the four hangars there is a fuel pomp **(3.3.2d)**.

3.2.3d Fuel facilities

The new airport has two types of fuel facilities, there is the stationed fuel pump and the mobile fuel truck. The stationed pump consists of four underground storage tanks with each a capacity of 50 cubic meters. Two storage tanks are intended for avgas for the smaller aircraft. And the other two are filled with Jet A1 fuel, intended for the aircraft using a jet engine. The mobile fuel truck can transport the fuel to a parked aircraft, this is ideal for aircraft such as the Cessna citations.

3.2.3e Hangar

At our airport you can find 5 hangars that can be used for maintenance and storage of the aircraft. Furthermore each hangar has his own small living space so that users of the hangar can do their own maintenance. There will be a 2 hangars, both of the sizes 50 by 60 meter, leased to the flight schools, the flight schools may operate from there itself, and the income of the rent is for the airport. There is one hangar, of the size 40 by 60 meter, used for major maintenance on the aircraft, this is done by the airport. The aircraft owners can repair their plane there, this works the same as a garage and the income for repairs are for the airport. There will also be one hangar for business jets, this hangar is 70 by 80 meters and there will be place for 4 business jets (size Cessna Citation is about 15 by 15 meters). This is our largest hangar. The last hangar is 60 by 70 meters and here fit up 6 small aircraft (Cessna 172 size is about 8.2 by 11 meters). Purchase a hangar costs about 16,000 euros per 10 by 10 meters ($100m^2$).

3.3 Flight paths

For the airport there are several different flight paths needed, because we use different kind of navigation. To avoid mid-air collisions flight routes are created, Oude-Tonge Airport has two flight routes for departure and arrival with holding patterns:

1. VFR
2. IFR
3. Holding pattern

Ad 1 VFR

Pilots, who are flying with Visual Flight Rules (VFR), have to follow a certain circuit when departing or arriving at Oude-Tonge Airport. Every aircraft on VFR that wants to take off or land has to follow the circuit. This avoids aircraft collisions and it will also minimize the noise pollution for the surrounding villages.

The circuit around Oude-Tonge Airport **(figure 18)** could be followed in different directions, which depends on the runway designation used, runway 06 or 24. Because not all flights, who fly VFR, staying within the circuit area two exits and two entries are added. They are situated in a way in which they produce the least noise nuances. The exits are after the first 90-degree turns, exiting in a 45 degrees turn to the right away from the circuit when flying runway 06 and to the right when flying runway 24. The entries are placed at perpendicular to the runway 06-24.

Figure 18 VFR route

VFR flights have to fly a circuit. Each part of this circuit is characterized by wind. Just after departure, the aircraft will fly upwards in the upwind leg (1). After the first turn of 90 degrees the crosswind leg (2) is reached, here the circuit can be exited (3) with a 45-degree turn to the right. After another 90 degrees turn the downwind leg (4) will be reached, flying parallel to the runway. The base leg (5) will be reached after another 90 degrees turn and after one more 90 degrees turn the final approach stage (6) will be entered, in this way the runway will then be reached again. This circuit will be flown at 700 ft.

Ad 2 IFR

Pilots, who are flying IFR, will approach the airport in a different way than the VFR-circuit. Pilots will have to use Standard Instrument Departures (SIDs) and Standard Arrival Routes (STARs) to guide the aircraft to the runway.

These beacons have to be placed, just in front of the runway, for the final approach. **(Figure 19)** These beacons are plain VHF Omni-directional Radio Ranges (VOR) beacons with Distant Measurement Equipment (DME), which can measure the distance from the beacons to the aircraft with a very high degree of accuracy. The SIDs and STARs have been made for both directions of the runway.

Figure 19 Beacons

It is preferable that the SIDs are leading in the direction of other main airports. That is why the departure routes **(figure 20)** are connected to the existing airways of Rotterdam airport. The STARs leading to the airport come from the existing airways. So the Arrival routes **(figure 21)** at Oude-Tonge Airport are connected with the international airways.

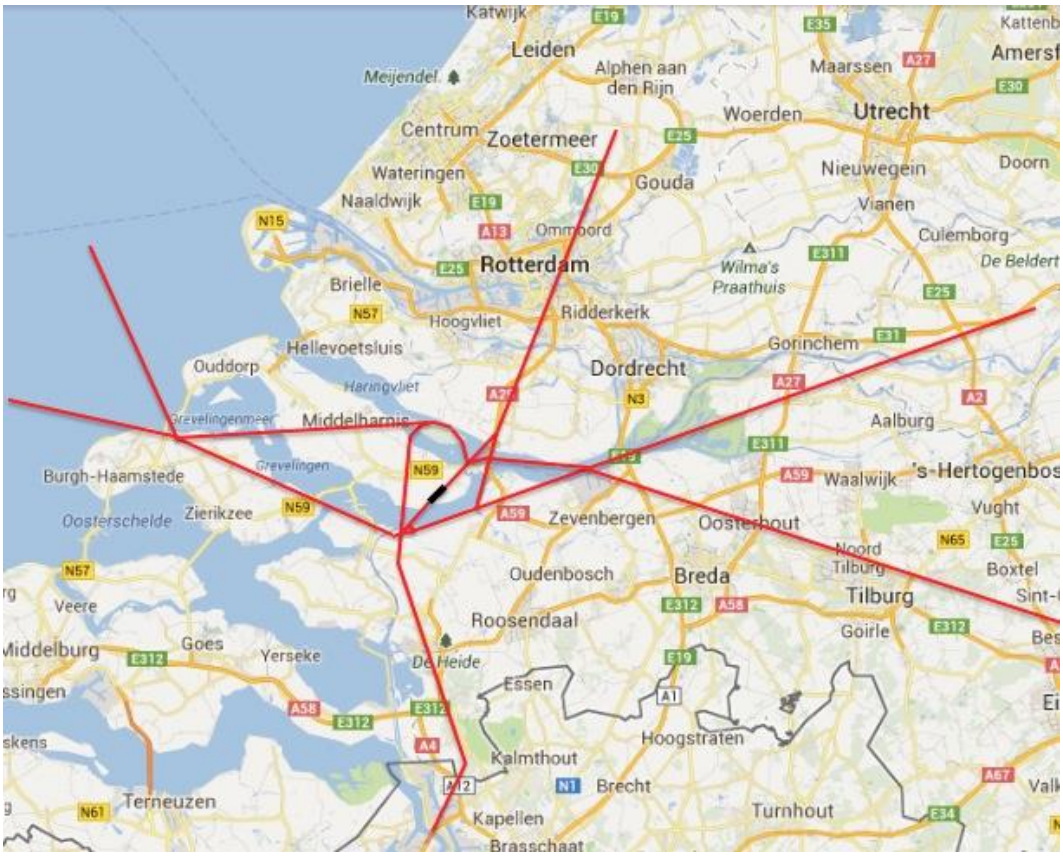


Figure 20 Departure routes

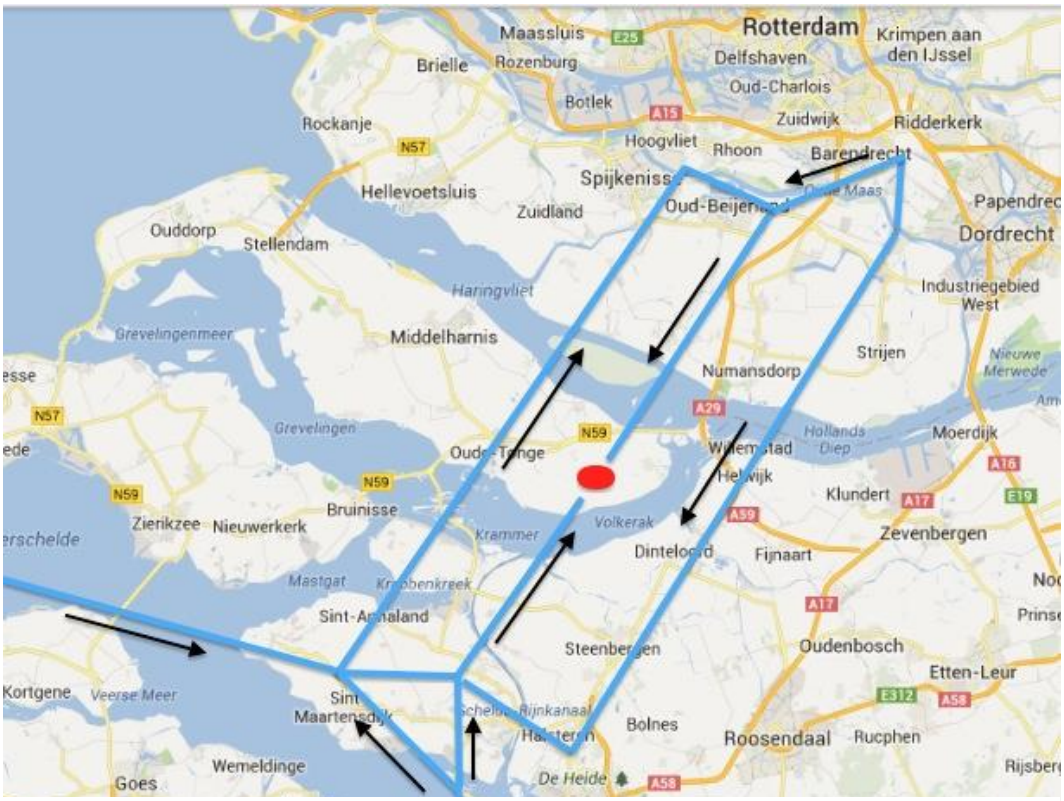
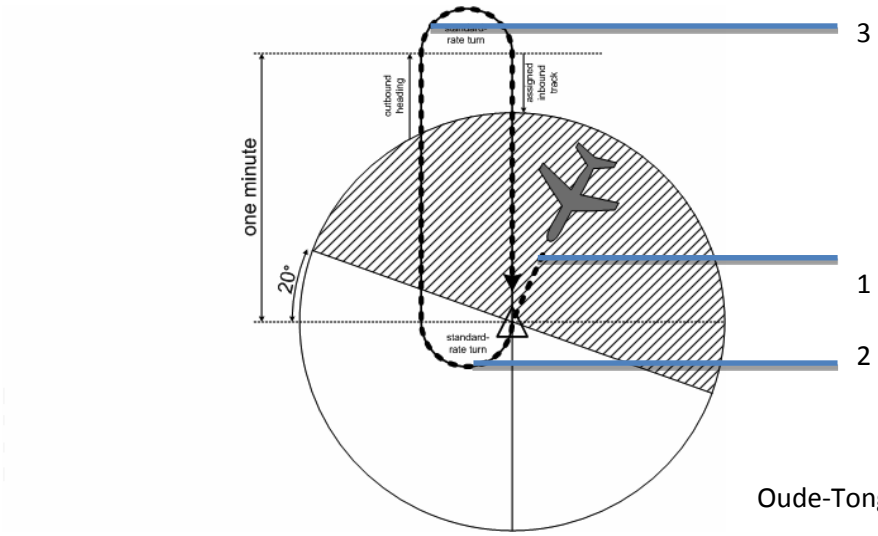


Figure 21 Arrival routes

Ad 3 Holding pattern

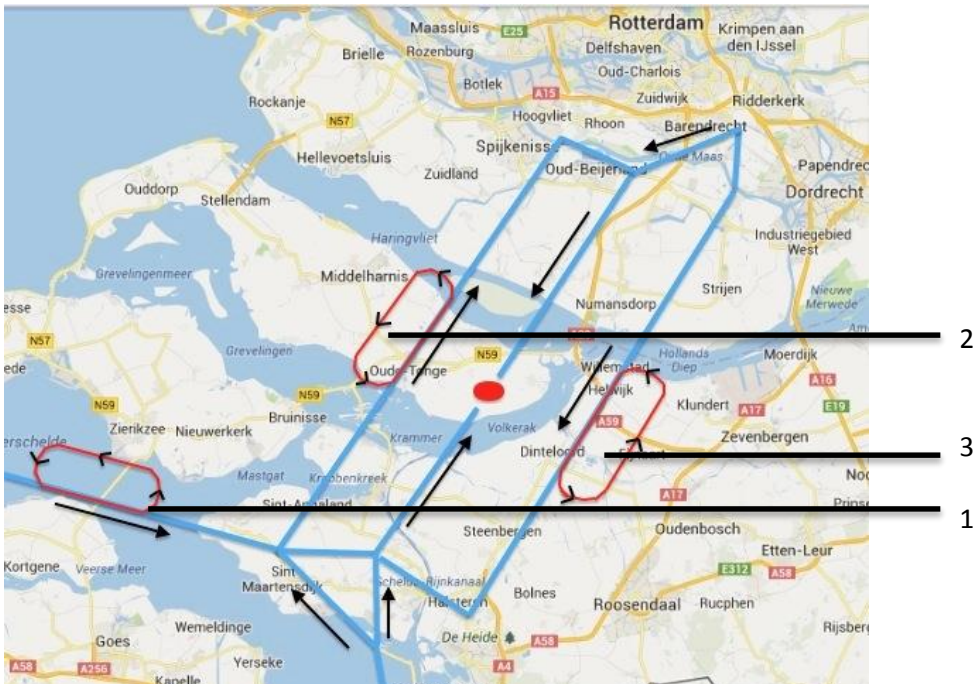
The prospect of flying a holding pattern **(Figure 22)** is really straightforward. The pilot flies inbound **(1)** on the assigned track on which the hold is defined, and, after the fix is crossed, the pilot turns outbound **(2)** and flies the reciprocal heading. The straightforward line in the holding pattern should be one minute of flying. After another turn of 180 degrees **(3)** the plane follows the original flight route. In calm winds, the procedure is relatively easy and can get more difficult when dealing with heavy crosswinds.



1. Entry holding pattern
2. Turn outbound
3. Turn to original flight route

Figure 22 Holding pattern

Oude-Tonge has three holding patterns **(figure 23)**, one for every arrival route. The first is located at *"Zierikzee"* for arrivals from the North Sea. The second holding pattern is located at *"Middelharnis"* for flights from the south with a runway 24 approach. And the third one is located at *"Fijnaart"*, for flights from the east or north with a runway 06 approach. The straightway on the holding pattern is one minute travelling.



1. Holding Zierikzee
2. Holding Middelharnis
3. Holding Fijnaart

Figure 23 Holding patterns near Oude-Tonge Airport

3.4 Lden noise calculation

The direction of Rotterdam Airport asked to provide one calculation of an Lden-point since new airports are bound to the new laws. The formulas used are stated below.

$LAX = 10 * \log\left(\frac{LAmax^2}{P0(t)^2}\right)$	LAmax = the noise of one Cessna 172 Skyhawk, which is 61,0 dB or 0,02244 Pa $P_0(t)$ = reference pressure of $20*10^{-6}$ Pa

Formula 1 LAX-formula

$$LAX = 10 * \log\left(\frac{0{,}002244^2}{(20 * 10^{-6})^2}\right) = 60{,}9998\ dB$$

$Lden = 10 * \log\left(\sum N * 10^{\frac{LAX}{10}}\right) - 74,99$	∑ = summation of the noise intensity of cycles of all aircraft in a year N = weight factor, depending on which part of the day it is. (Table xxx) Since the new airport will be opened from 08.00 till 19.00, the weight factor will be equal to one. LAX = the time integrated noise intensity of one reference point, for one second when an aircraft passes [dB] 74,99 = 10 log(number of seconds in one year)

Formula 2 Lden-formula

Part of the day	00.00 – 07.00	07.00 – 19.00	19.00-23.00	23.00 – 00.00
Weight factor	10	1	3,6	10

Table 5 Weight factor per part of the day

$$Lden = 10 * \log\left(30500 * 61 * 1 * 10^{\frac{60{,}9998}{10}}\right) - 74{,}99 = 48{,}7061\ dB$$

New airports are bound to an Lden maximum. This maximum is 56 dB. Therefore the conclusion is made that all aircraft could land and take off at Oude-Tonge Airport.

4 Business case

With building and maintaining an airport, also a financial side comes with it. For building the airport there are investment cost **(4.1).** Next to this, the financial side can be divided into two parts. These parts are the yearly costs **(4.2.1)** and the yearly benefits **(4.2.2).**

4.1 Investment costs

When constructing the airport the costs can be separated into two different parts. The landside costs **(4.1.1),** and the airside costs **(4.1.2)**.

4.1.1 Landside cost

The landside cost can be separated into:

1. Terminal
2. Emergency services
3. Hangar
4. Information point
5. Parking area
6. Safety
7. Bird control

Ad 1 Terminal

The terminal will be a public place. Both for employees as visitors, and will be equipped with facilities for visitors such as restaurants. Because most of the traffic is national, there will be no permanent customs. Because there are no permanent customs, International flights will be sending to Rotterdam The Hague Airport. The Terminal will be open from 7:00 AM until 11:00 PM, these are the same hours the entire airport is open. In the period between 7:00 AM and 11:00 PM the IFR flights are allowed to land on our airport. The costs for the terminal will be €2.000 per square meter (source: business case Lelystad). In total, the terminal of airport Oude-Tonge will have an area of 50 by 60 meters, so 3000 square meters. The total costs for the terminal will be 2000*3000 = €6.000.000.

Ad 2 Emergency services

The maximum time that the emergency service reaches the emergency scene is three minutes because the largest aircraft that will be landing on Oude-Tonge Airport is a Cessna Citation II. This makes the airport a category 3C airport. The 3C category makes it necessary to have at least one fire-fighting vehicle, which can transport water and foam to stop a fire. The nearest hospital from the airport is in *"Middelharnis"*, 10 km away from the airport. This makes an ambulance unnecessary at the airport. The employees of the airport do have an emergency certification and there will be different first-aid kits located at the airport. The cost of a fire-fighting vehicle is €110.000 (source: alibaba.com). The costs of 15 professional first-aid kits will be 15*15 = €225 (source: redcrossstore.org). So the total costs for emergency services will be €110.225.

Ad 3 Hangars

There will be five hangars on the new airport. These are two hangars with an area of 50 by 60 meters, one hangar with an area of 40 by 60 meter, one hangar with an area of 70 by 80 meters and one hangar with an area of 60 by 70 meters. The costs to build the hangars will be 160 euros per square meter (source: readconstructiondata.com). The total area of the hangars will be around 18200 square meters. So the total costs of the hangars will be 18200*160 = €2.912.000.

Ad 4 Information point
Near the entrance on a logic place an information point is located were the visitors of the airport can get information about the airport and its functions. To build this, it will cost around €243 per square meter (source: readconstructiondata.com). The information point will have a total area of 5 by 4 meter, so a total of 20 square meter. The total costs of the information point will be 243*20 = €4.860.

Ad 5 Parking area
The parking area will be made for visitors as employees in such a way that employees always have an parking spot and that there are enough left for the visitors. There will be 200 parking spots, determined by how many people will work and visit the airport. The parking area will cost €1.500 per parking spot (source: business case Lelystad). So the total costs of the parking area will be estimated at 200*1500 = €300.000.

Ad 6 Safety
To secure the airport, security cameras will be placed around the airport and a security fence will surround the entire area. There will be 18 security cameras, each camera will cost €289 (source: bewakingscamera.nl). So the total costs of the cameras will be 289*18 = €5.202. The security fence will cost €30 per meter. The total area of the airport will be 2710000 square meters. The root of this is around 1646 meter, so the total costs of the fence will be 1646*30 = €49.380. The total costs for safety will be €54.582.

Ad 7 Bird control
Oude-Tonge airport will use a 'Scare Crow Ultima' sound system to scare birds away from the airport. So these birds will not cause any problems with aircraft take of or landing. This system will cost around €2.200 (birdbusters.com).

4.1.2 Airside costs
The airside costs can be separated into:

1. Runway
2. Taxiways
3. Apron
4. Fuel
5. ATC

Ad 1 Runway
The price, which must be paid for the runway, consists out of several factors: strength, length and width. The runway will be 30 meters width and 1199 meters long, so a total of 30x1199=35970 square meters. The costs of one square meter is €150, so the total costs will be
35970x150 = €5.395.500. (*Source: Business Case Lelystad Airport)*

Ad 2 Taxiways
The taxiways dimensions will be around the same taxiways dimensions located at EHLE, which is 48.300 square meters. The costs of one square meter taxiway is €68 euro. That means that the total costs will be 48300 x68= €3.284.400. (*Source: Business Case Lelystad Airport)*

Ad 3 Apron
The size of the apron will be around the size of the apron located at EHGG, which has an area of 450 by 100 meters, a total of 45000 square meters. The price of one square meter apron is €65,2. This means that the apron will cost €65,2x45.000 m^2 = €2.934.000. (*Source: Business Case Lelystad Airport)*

Ad 4 Fuel
The price, which must be paid for the fueling system, will cost around €1.000.000. (Based on other airports, and assumption).

Ad 5 ATC
The ATC building including interior and radar equipment will cost around €1.000.000. (*Source: Business Case Lelystad Airport)*

4.1.3 Total costs of investment
The costs of investment can be found in **table 6**. These investment cost consist of landside costs and airside costs. The total costs of investment will be €22.997.767.

	Costs
Terminal	€6.000.000
Emergency services	€110.225
Hangar	€2.912.000
Information point	€4.860
Parking area	€300.000
Safety	€54.582
Bird control	€2.200
Runway	€5.395.500
Taxiways	€3.284.400
Apron	€2.934.000
Fuel	€1.000.000
ATC	€1.000.000
Total costs of investment:	€22.997.767

Table 6 Costs of investment

4.2 Costs and benefits
Some of these buildings and facilities also provide benefits **(4.2.1)**. However there are also annual costs to be paid **(4.2.1).** Besides benefits from facilities and buildings, Oude-Tonge Airport is part of Rotterdam Airport, and therefore the space made available at Rotterdam Airport is a part of the benefits as well **(4.3)**.

4.2.1 Annual costs
There are several costs that have to be paid annually by the airport. These costs are for:
1. Salaries
2. ATC
3. Maintenance

Ad 1 Salaries
The price that must be paid for the salaries depends on the amount of people who work on the airport. The amount of people who will work at Oude-Tonge Airport will be the average staff of Eelde Airport (40 FTE'ers) and the staff of Lelystad Airport (16 FTE'ers). That means 28 FTE'ers will work at Oude-Tonge Airport. The average income of a FTE is €50,000 euro per year. This means the salaries will cost 28x€50,000= €1.400.000 euro per year.

Ad 2 ATC
The price for using ATC will be around the same price handled at Lelystad, which is €2.000.000 every year (based on business case lelystad).

Ad 3 Maintenance
To keep the airport safe and clean, the airport has to be maintained. Due to the yearly maintaining, the facilities and other services will have a longer life spam. The costs for this maintenance will be around €200.000 per year (based on "airport Groningen jaarverslag"). Everything, from the hangars to the terminal, will be maintained yearly. The total annual costs can be found in **table 7**.

	Costs
Salaries	€1.400.000
ATC	€2.000.000
Maintenance	€200.000
Total costs:	€3.600.000

Table 7 Total annual costs

4.2.2 Yearly benefits
Airport Oude-Tonge will make several benefits in the future. These benefits will generate an extra income for the airport. Depending on the level of extra income, it can compensate the costs for the airport in short- or long term. These benefits will come from the following services and facilities:

1. Parking area
2. Landing fees
3. Hangers
4. Shops
5. Fuelling

Ad 1 Parking area
To park on the parking area, parking money has to be paid. €2,50 will be asked per hour, with a maximum of €15 per day. Assuming that 30 cars will be parked at the airport per day, with an average of four hours, the expected benefits per year will be €109.500.

Ad 2 Landing fees
A profit will be made from landing fees. The landing fees depend on the estimated number of flights that lands on the airport, the average weight of the aircrafts, the kind of operation, the most common time of the day the aircrafts will fly, which month of the year and which day of the week.

	Landing fees	Expected number of aircrafts taking off/landing per day	Total costs
Aircrafts weighing up to 6000 kg	€12,20 per 1000 kg with a max of €48,80	30269 (average weight of 2000 kg)	€738.563,6
Aircrafts weighing 6000 kg – 20000 kg	€43,90 plus €6,95 per 1000 kg	204 (average weight of 7000 kg	€18.880,2

Table 8 Landing fees

The total landings fees will be €757.443,8.

Ad 3 Hangars

The hangars from airport Oude-Tonge have to be hired. The hangars will be used by the flight school, the business jets and for maintenance checks. We expect that these hangars will be fully occupied the whole year. The cost to hire a hangar per square meter has an average of €130 per year (source: Funda). The total area of the hangars is 18200 square meters. So the total benefits will be 18200*130 = €2.366.000.

Ad 4 Shops

The shops on airport Oude-Tonge have to pay rent. The average rent will be €4.000 (source: Funda). Airport Oude-Tonge will have four shops. So the total benefits will 4000*4*12 = €192.000 per year.

Ad 5 Fuelling

The fuel that is available on Oude-Tonge airport is Avgas and Jet fuel. Oude-Tonge airport calculates a profit for the fuel per litre. The profit is set at 10% from the current sales value. With approximately an average of 83 flight movements per day, it is expected that 40 flights need to fuel per day. The average number of litre that will be tanked each time is estimated at 200. An estimation has been made that one litre will cost around €2,20. So the total benefits will be 40*200*2,2*365*0,1 = €642.400 per year. The total annual benefits can be found in table XXX

	Benefits
Parking area	€109.500
Landing fees	€757.443,8
Hangars	€2.366.000
Shops	€192.000
Fuelling	€642.400
Total benefits:	€4.067.343,8

Table 9 Yearly benefits

4.2.3 Total profit

The total profit is the annual benefits – the annual costs. This leaves a profit of €467.343,8, which is not enough to pay for the investment costs. Since Oude Tonge Airport is a part of Rotterdam Airport, the costs of building the airport could be gained from the space made available with relocating the General Aviation

4.3 Recover the costs of investing

There are 30.296 flights from aircraft below 6000 kg. 17.021 of them are training flights. When IFR is used on training flights, these aircraft apply to the Ke rules. Due to the weather in the Netherlands, it is safe to assume that 60-70% of the training flights use IFR. From the other 13'275 flights, the same amount is estimated. This means that 65% of 30'296, 19'692 flights use IFR. These aircraft produce 15,9% *"Kosteneenheden"* so that is 5.565 Ke for the flights from aircraft below 6000 kg.

The Cessna Citation II is considered as Business Aviation and is always bound to the Ke rules. 204 Citations produce 10,2% Ke, that is 3,57. That means that the total amount Ke that becomes free is 9,135. Rotterdam uses 35 Ke now of the 35 Ke available by law. With the extraction of GA, Rotterdam only uses 25,865 Ke and has 9,135 Ke left to attract more scheduled flights. These can be filled with 1224 Boeing 737NGs **(appendix XVI).** The total benefit from a 737NG is €5958.82 **(appendix XVII)**. Therefor 1224 737s provide an extra of 7.412.772,08 each year. $^1/_5$ of 7,4 million is 1,5 million. The $^1/_5$ comes from the difference between the benefits and exploitation costs. **(Figure 24)** This extra money is used to pay for the expenses made by building Oude Tonge Airport. This means that the airport is paid for in 16 years.

EUR miljoen	Rotterdam The Hague 2010	2009
Totale omzet	25,9	24,7
Exploitatieresultaat	5,4	4,8
Vaste activa per 31 december	20,5	22,0

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Figure 24 Profit versus exploitation

5 Conclusion

Chapter 1 has made clear that the Ke rule forms the problem at Rotterdam Airport. This means that Rotterdam Airport will not be able to expand in the future. The management of Rotterdam Airport came up with the idea to relocate the small aircraft to a new airport in the vicinity of Rotterdam and so creating more space in the Ke rule to attract more large aircraft.
Group 1J researched the possibility and realisation of this solution and came to the conclusion that it is possible. The location chosen to build a new airport is in the vicinity of *"Oude-Tonge"*. This location meets all the requirements the direction or Rotterdam Airport had set. Therefore *"Oude-Tonge"* forms the base of constructing the new airport..

The largest aircraft relocated will be the Cessna Citation II. This aircraft bounds the length of the runway. The runway will be 1199m by 30m asphalt. Jet A1 fuel and avgas will be the types of fuel provided at the airport. To provide fuel to the large aircraft such as the Citation, a fuel truck is available.

There will be five hangars available for rental. These will be rented to aero clubs, air services and individuals who own an aircraft. Besides, there is a small terminal for the users of the airport. Outside on the parking lot there will be snack car, called *"Henk's friettent".*

For the flight routes group 1J has chosen for Visual Flight Rules and Instrument Flight Rules. There are several holding patterns for the air traffic. The flight routes are obstacle free.

At last group 1J has investigated when the airport is profitable. The airport is profitable after approximately sixteen years. That is why the relocation of flights to the new airport is profitable and a great solution for the problem.

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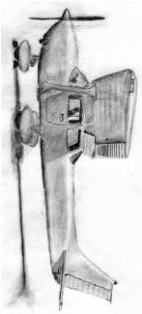
Appendices



Overzicht verkeer en vervoer 2012 per maand

Rotterdam The Hague Airport

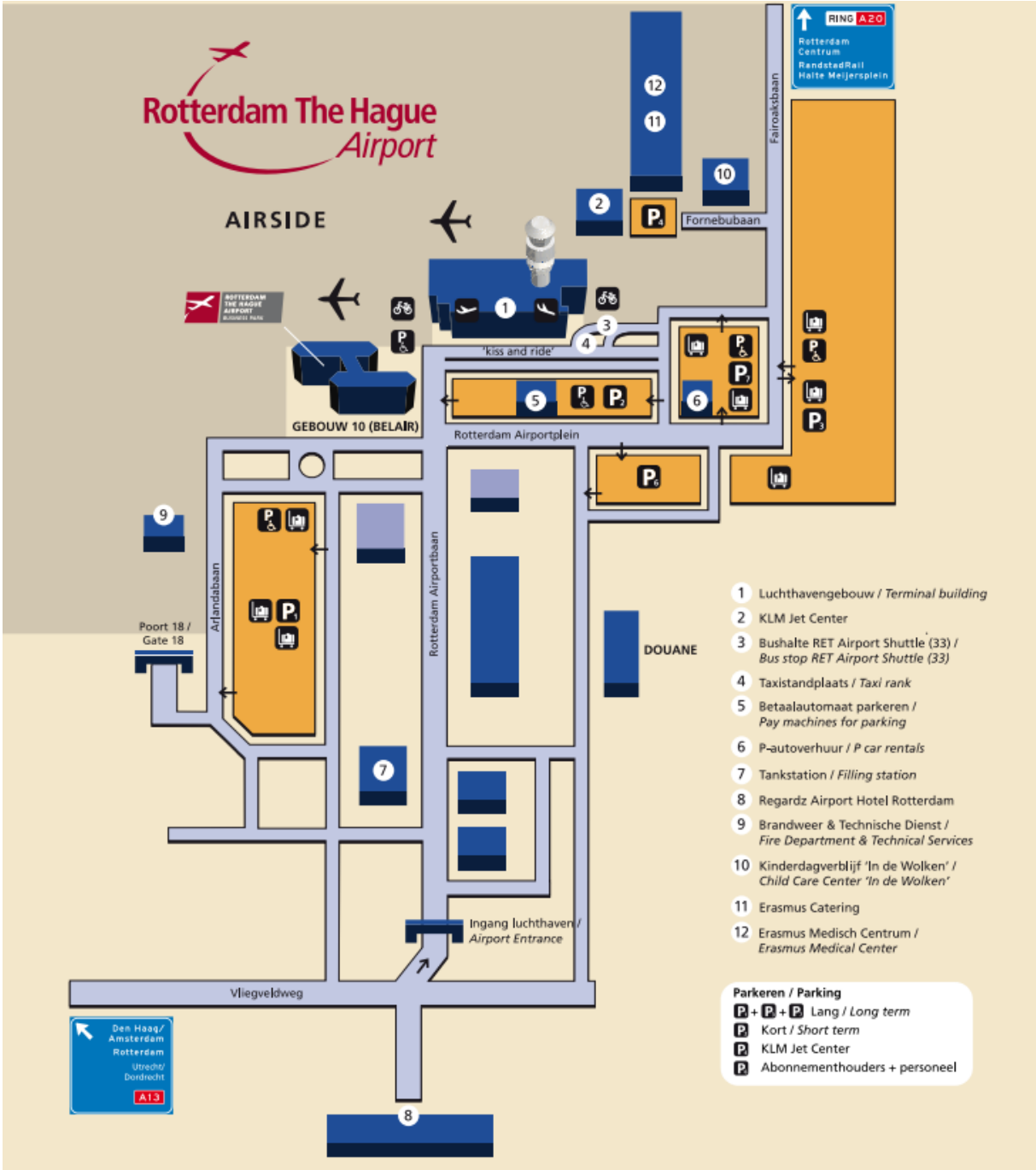
		Jan	Feb	Mrt	Apr	Mei	Jun	Jul	Aug	Sep	Okt	Nov	Dec	Totaal
Vliegtuig-bewegingen	Lijndiensten	988	970	1.040	849	1.070	1.033	1.005	1.002	1.010	1.131	766	829	11.693
	Vakantievluchten	20	18	17	90	219	223	251	245	212	151	20	18	1.484
	Ad hoc vluchten	24	35	33	31	37	25	50	60	32	28	13	4	372
	Vrachtvluchten	2	1	3	2	2	0	2	0	0	0	4	0	16
	Taxi-/zakenvluchten	266	318	317	275	337	321	333	252	302	314	283	251	3.569
	Lesvluchten	1.157	1.114	1.594	1.478	1.772	1.518	1.601	1.560	1.744	1.577	1.155	751	17.021
	Overig verkeer	816	955	1.510	1.194	1.521	1.326	1.258	1.410	1.382	1.069	791	742	13.974
	Totaal	**3.273**	**3.411**	**4.514**	**3.919**	**4.958**	**4.446**	**4.500**	**4.529**	**4.682**	**4.270**	**3.032**	**2.595**	**48.129**
	Totaal overlandvluchten	2.027	2.083	2.518	2.139	2.770	2.552	2.714	2.617	2.572	2.416	1.622	1.545	27.575
	Totaal terreinvluchten	1.246	1.328	1.996	1.780	2.188	1.894	1.786	1.912	2.110	1.854	1.410	1.050	20.554
	Totaal grote luchtvaart (>6 ton)	1.358	1.388	1.581	1.281	1.697	1.682	1.664	1.565	1.635	1.688	1.145	1.149	17.833
	Totaal kleine luchtvaart (<6 ton)	1.915	2.023	2.933	2.638	3.261	2.764	2.836	2.964	3.047	2.582	1.887	1.446	30.296
	Nachtvluchten (23.00-07.00)	47	62	67	65	75	91	101	84	66	86	60	61	865
	Uitwijkers	1	19	3	5	6	11	1	1	1	4	8	20	80

		Jan	Feb	Mrt	Apr	Mei	Jun	Jul	Aug	Sep	Okt	Nov	Dec	Totaal
Passagiers	Lijndiensten	71.750	73.250	88.002	72.053	95.875	93.713	101.123	100.976	98.288	98.594	50.899	59.778	1.004.301
	Vakantievluchten	2.419	2.427	2.267	8.389	24.086	23.565	27.828	27.039	23.513	16.822	2.312	2.369	163.036
	Ad hoc vluchten	897	2.455	1.149	1.191	1.956	991	1.995	2.951	1.854	2.424	910	429	19.202
	Overig verkeer	1.015	1.127	1.590	991	1.222	1.165	1.290	782	1.202	1.254	1.068	932	13.638
	Transito	28	436	50	4.216	11.634	12.176	12.636	12.058	12.116	6.752	678	190	72.970
	Totaal (incl transito)	**76.109**	**79.695**	**93.058**	**86.840**	**134.773**	**131.610**	**144.872**	**143.806**	**136.973**	**125.846**	**55.867**	**63.698**	**1.273.147**

		Jan	Feb	Mrt	Apr	Mei	Jun	Jul	Aug	Sep	Okt	Nov	Dec	Totaal
Vracht/Post	Totaal vracht (in tonnen)	2	1	1	1	30	0	3	0	0	0	9	0	46
	Totaal post (in kg)													0

Appendix II Ground plan Rotterdam Airport terminal

Appendix III Ground plan Rotterdam Airport



Appendix IV Calculation of Ke

Kosten-Eenheid (Ke)

In de KE-berekeningsmethodiek worden de volgende vliegtuigbewegingen meegenomen:

- vliegtuigen zwaarder dan 6 ton (grote luchtvaart)
- vliegtuigen met een gewicht van 6 ton of minder, maar zwaarder dan 390 kg (kleine luchtvaart) die dezelfde routes vliegen als bovenstaande categorie (IFR-routes)
- vliegtuigen voortbewogen door turbinestraalmotoren
- helikopters

Als zoneringstoets geldt de 35 Ke-zone zoals vastgesteld in het vigerende aanwijzingsbesluit.

De gehanteerde berekeningsmethodiek staat beschreven in "Voorschrift voor de berekening van de geluidbelasting (Ke) ten gevolge van het vliegverkeer", document RLD/BV-01.2.
De bijbehorende appendices-gegevens zijn gepubliceerd in "Appendices van de voorschriften voor de berekening van de geluidbelasting". NLR contract rapport CR 96650 L. In 2007 is versie 10 van de appendices gepubliceerd; deze is meegenomen in de geluidberekeningen.

Appendix V Calculation of BKL

Belasting Kleine Luchtvaart (BKL)

In de BKL-berekeningsmethodiek worden de volgende vliegtuigbewegingen meegenomen:

- vliegtuigen met een gewicht van 6 ton of minder (met uitzondering van helikopters en vliegtuigen uitgerust met turbine-straalmotoren) die geen IFR- maar VFR-routes volgen.

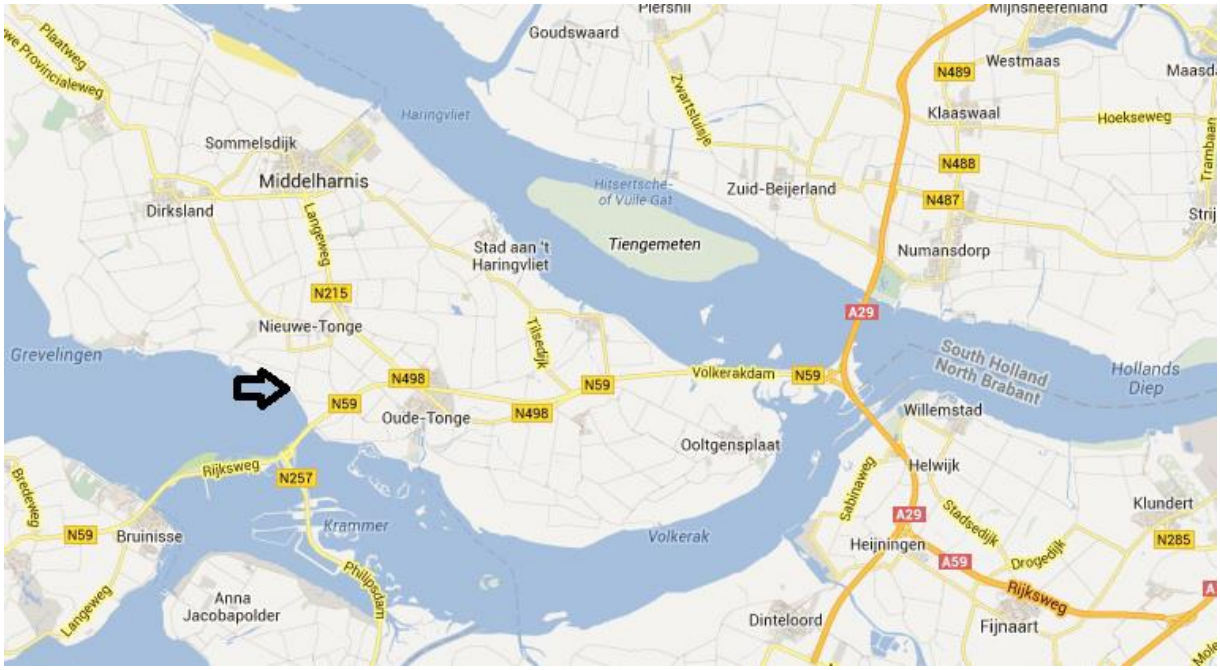
Als zoneringstoets geldt de 47 BKL-zone zoals vastgesteld in het vigerende aanwijzingsbesluit.

Appendix VI List of companies and respective fleet

Company	Fleet
Cityjet	Avro RJ85, Dornier 328, Fokker 50
Corendon	Boeing 737-300, 737-400
Iceland Express	Boeing 737-700, Boeing 757-200
JetNetherlands	Beechjet 400A, Cessna Citation Jet (II / III / Mustung / Excel / XLS), Dassault Falcon 2000 EX, Gulfstream 200, Piaggio Aero P180 Avanti II
NetJets	Cessna Citation (Bravo, Excel/XLS), Dassault Falcon (2000/EX, 7X), Gulfstream G550, Hawker (400, 400XP, 750/800XP, 4000)
OLT	Fokker 100, Saab 2000
Rotterdamsche Aero Club	Diamond DA-40, Piper PA28-181
Sky Work Airlines	Bombardier Dash 8-400, Dornier Do-328-100, Cessna (550 Citation Bravo, 560 Citation Ultra, 560 Citation Excel)
Transavia.com	Boeing 737-700, 737-800
Vliegclub Rotterdam	Cessna (F152, F172P), Diamond DR40 TDI, Piper (Archer III, Arrow IV, Seminole PA44, Warrior II, Warrior III, Warrior Cadet), Robin (DR400, R2160)
Welcome Air	Dornier 328(-100)
LionAir	Cessna Skyhawk II

Appendix VII Locations

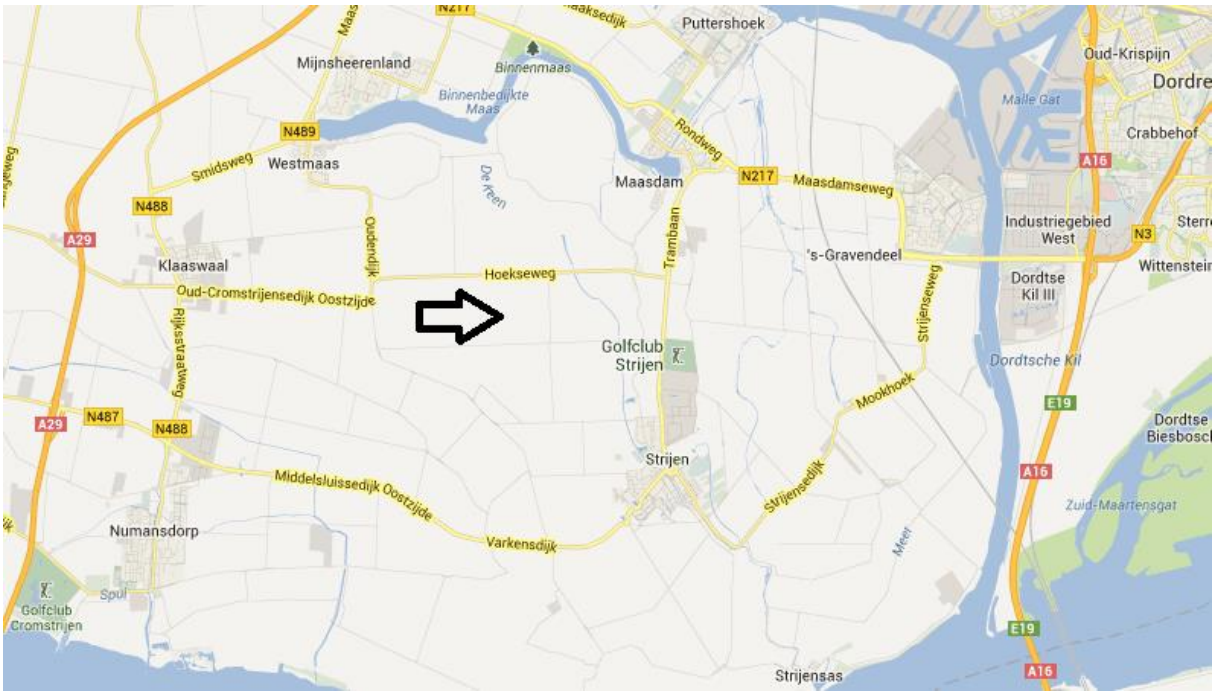
Appendix VIII Wind mills near Oude-Tonge



Appendix IX Bird sanctuary near Oude-Tonge

Appendix X Low flying area near Strijen

Appendix XI Bird sanctuary near Strijen



Appendix XII ICAO airport code number

Code number	Aircraft reference field length	Code letter	Wing span	Outer main gear wheel span[a]
1	Less than 800 m	A	Up to but not including 15 m	Up to but not including 4,5 m
2	800 m up to but not including 1200 m	B	15 m up to but not including 24 m	4,5 m up to but not including 6 m
3	1200 m up to but not including 1800 m	C	24 m up to but not including 36 m	6 m up to but not including 9 m
4	1800 m and over	D	36 m up to but not including 52 m	9 m up to but not including 14 m
		E	52 m up to but not including 65 m	9 m up to but not including 14 m
		F	65 m up to but not including 80 m	14 m up to but not including 16 m

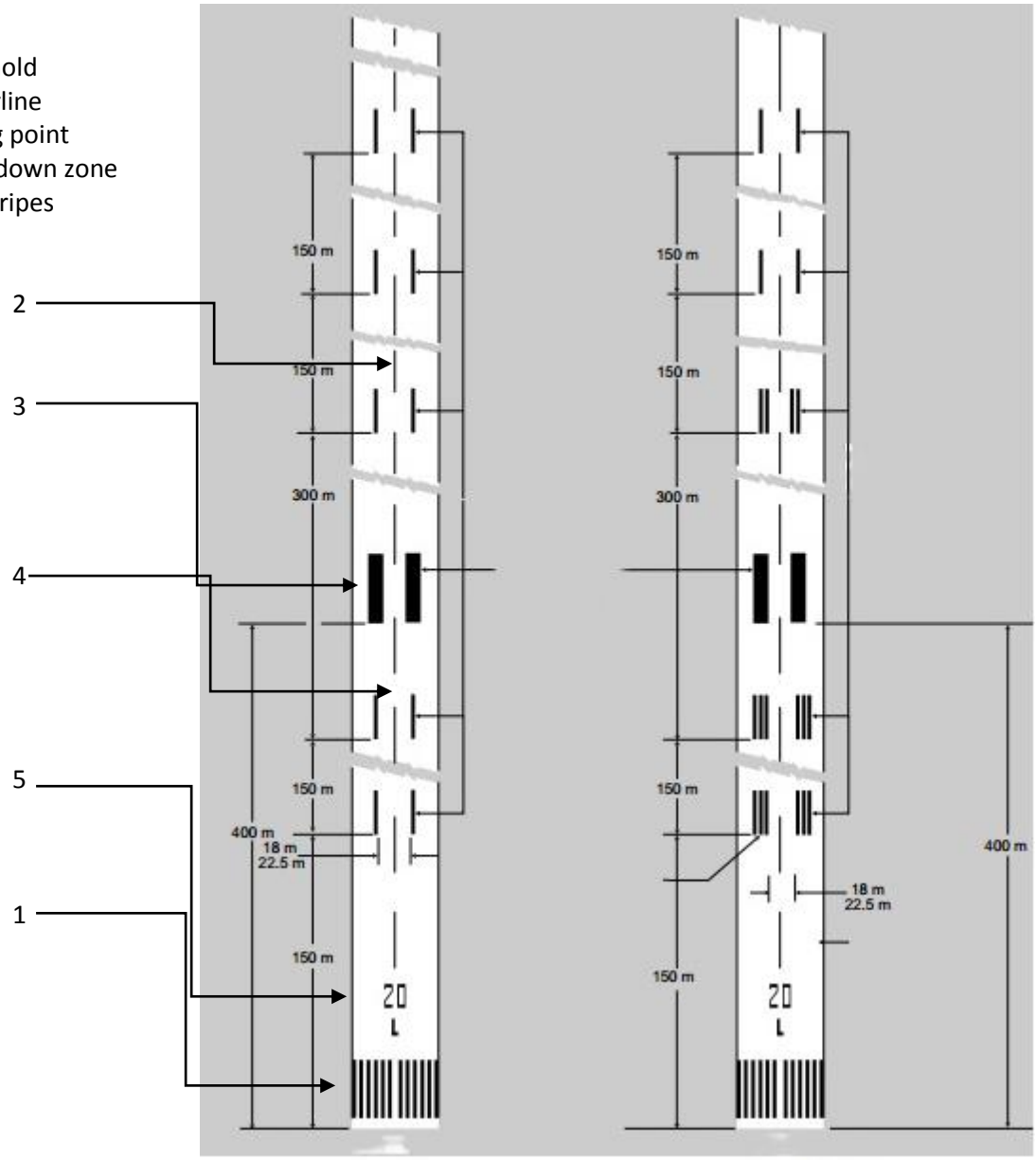
[a] distance of the outside edges of the main gear wheels

Code number	Code letter					
	A	B	C	D	E	F
1[a]	18 m	18 m	23 m	--	--	--
2[a]	23 m	23 m	30 m	--	--	--
3	30 m	30 m	30 m	45 m	--	--
4	--	--	45 m	45 m	45 m	60 m

[a] The width of precision approach runway should not be less than 30 m where the code number is 1 or 2

Appendix XIII Runway markings

1. Threshold
2. Centerline
3. Aiming point
4. Touchdown zone
5. Side stripes

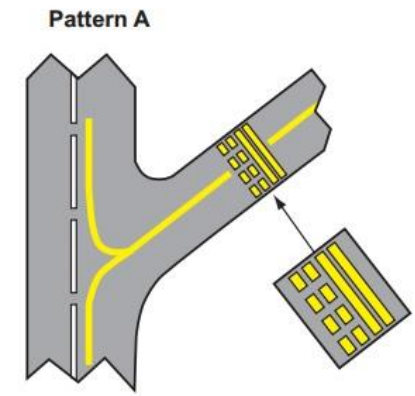


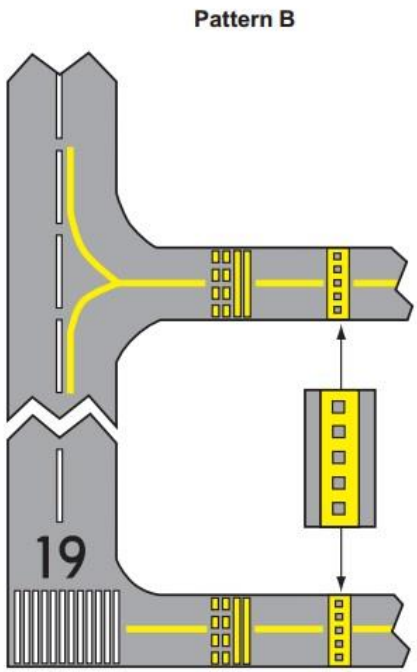
Runway width	Number of stripes
18m	4
23m	6
30m	8
45m	12
60m	16

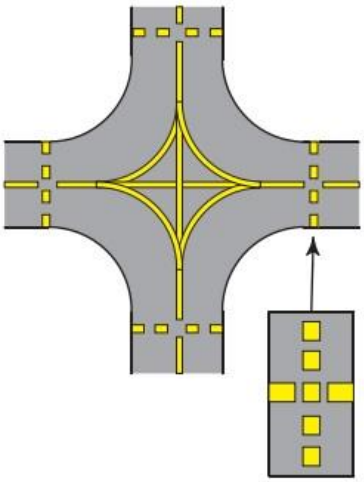
Appendix XIV Taxiway width code letters

Code letter	Taxiway width
A	*7.5 m*
B	*10.5 m*
C	*15 m if the taxiway is intended to be used by aeroplanes with a wheel base less than 18 m;*
	18 m if the taxiway is intended to be used by aeroplanes with a wheel base equal to or greater than 18 m.
D	*18 m if the taxiway is intended to be used by aeroplanes with an outer main gear wheel span of less than 9 m;*
	23 m if the taxiway is intended to be used by aeroplanes with an outer main gear wheel span equal to or greater than 9 m.
E	*23 m*
F	*25 m*

Appendix XV Yellow taxi lines







Appendix XVI Amount of 737s extra

	dB	Ke available
Boeing 737 Next Generation	74	9,135

Sound and availble Ke for the Boeing 737 Next Generation

$$B = 20\log\left(\sum_{i=1}^{n} g_i 10^{Li/15}\right) - 157$$

The amounts of aircraft n have the same dB and only land between 07.00 and 22.00LT. This means that $g_i = \frac{1}{15}6 + \frac{2}{15}4 + \frac{1}{15}3 + \frac{1}{15}2 + \frac{10}{15}1 = 1{,}9333333\ldots$ and $L_i = L = constant$

$$B = 20\log\left(1{,}93333n * 10^{L/15}\right) - 157$$

$$20\log(1{,}93333n) + 20\log(10^{L/15}) - 157$$

$$20\log(1{,}93333n) + \frac{20L}{15} - 157$$

$$B = 20\log(1{,}93333n) + \frac{4}{3}L - 157$$

L=74dB
B=9,135

$$9{,}135 = 20\log(1{,}93333n) + \frac{4}{3}74 - 157$$

$$20\log(1{,}93333n) = 67{,}468333\ldots$$

$$\log(1{,}93333n) = 3{,}3741666\ldots$$

$$1{,}93333n = 10^{3{,}374166} = 2366{,}827827$$

$$n = 1244{,}221292 \approx 1244$$

Therefore, it is safe to assume that Rotterdam Airport could handle 1224 scheduled flights (Boeing 737NGs) extra after the opening of Oude Tonge Airport.

Source: Gebruiksplan Rotterdam The Hague Airport 2012

Appendix XVII Benefits of a landing 737

	Costs
Landing fee	$€139.30 + €9.40 * \frac{MTOW}{1000}$
Passenger charge	$€16.91 * amount\ of\ passengers$
Security surcharge	$€12.15 * amount\ of\ passengers$ (with a minimum of €97.20)

Costs of landing an aircraft over 20'000 kg

	Boeing 737-700	Boeing 737-800
MTOW	70'080	79'000
Passengers	149	189
Aircraft landing on EHRD	10	20

Specifications of the 737 Next Generation models Transavia.com uses

Boeing 737-700:

$$€139.30 + €9.40 * \frac{70080}{1000} + €16.91 * 149 + €12.15 * 149 = 5127{,}992 \approx €5128{,}00$$

Boeing 737-800:

$$€139.30 + €9.40 * \frac{79000}{1000} + €16.91 * 189 + €12.15 * 189 = €6374.24$$

⅓ of the total amount of Boeing 737NGs is the 737-700 and ⅔ is the 737-800. Therefor the average revenue is: $\frac{1}{3} * 5127{,}992 + \frac{2}{3} * 6374{,}24 = 5958{,}824 \approx €5958{,}82$

Sources:

http://downloads.rotterdam-airport.nl/documenten/afbeelding/file/Summarylandingfees04-2013.pdf
https://www.transavia.com/corporate/nl/organisatie/vloot