STUDY OF ENVIRONMENTAL IMPACT

NEW PASSENGER TERMINAL OF ZAGREB AIRPORT



INSTITUT IGH, Plc. Janka Rakuše 1, 10000 Zagreb, CROATIA Tel:+3851 6125 413 Fax:+3851 6125 405 igh@igh.hr www.igh.hr

INSTITUT IGH, Plc.
IGH Applied hydraulics, Geotechniques and Ecology
10 000 ZAGREB, J.Rakuše 1

Client:	**ZRAČNA LUKA ZAGREB Ltd.**
Name of study:	**STUDY OF ENVIRONMENTAL IMPACT OF THE NEW PASSENGER TERMINAL OF ZAGREB AIRPORT**
Level of the study:	**FINAL VERSION**
Project number:	81010-467/11
Book:	I Study of environmental impact
Head of the making of the study:	Domagoj Vranješ, Mr. prosp. arch., univ.spec.oecoing.
Director:	Ivan Krstanović, PhD in engineering
Authorial team of the proposed design of the new passenger terminal of the Zagreb Airport:	Academic Branko Kincl, KINCL Ltd. Academic Velimir Neidhardt, NEIDHARDT ARHITEKTI Ltd. Prof.dr.sc. Jure Radić, INSTITUT IGH Plc.
Associates on the draw up of the study:	Doc.dr.sc. Aleksandra Anić Vučinić – *waste treatment* Mr.sc. Indira Aurer Jezerčić (*Institute for Research and Safety Plc.*) – *accidental situations* Davor Barać, B.Sc. engineering. – *geotechnical characteristics of the location* Mr.sc. Ivan Barbić, B.Sc. engineering. – *coordination of the NPT project of the Zagreb Airport* Ena Bićanić, B.Sc.arch. – *editorial board and graphics* Erol Čičić, B.Sc. engineering. – *light pollution* Hrvoje Damić, B.Sc.- *calculation of noise* Prof.dr.sc. Jagoda Doko Jelinić (Faculty of Medicine in the University in Zagreb, School of national health “Andrija Štampar”) – *influence on health* Dr.sc. Miodrag Drakulić, B.Sc.stroj. (*CTP Projekt Ltd.*) – *description of the work/energetics* Mr.sc. Biserka Dumbović Bilušić, B.Sc.arh. – *cultural heritage*

Zlatko Franolić, B.Sc. – *calculation of noise*
Zoran Golob, B.Sc.bioteh. *(TEH Projekt Kemo Ltd.)* - *variations of purification of polluted rain water*
Draško Holcer B.Sc. (*Croatian Museum of Natural History*) – *mammal fauna*
Ines Horvat, B.Sc.arh. – *spatial design analysis*
Prof.dr.sc. Stjepan Husnjak – the land
Mr.sc. Slobodan Kljaić, B.Sc. traffic – *analysis of traffic*
Mr.sc. Stjepan Kralj, B.Sc. engineering – *description of the work/ traffic solution*
Prof.dr.sc. Vladimir Lay – *sociological analysis*
Mato Lujić, B.Sc.građ. - *description of the work /water supply and drainage*
Darija Maletić Mirko, B.Sc.arh. - *spatial design analysis*
Prof.dr.sc. Darko Mayer - *hydrogeology*
Natalija Mavar, B.Sc.arh. - *spatial design analysis*
Vanja Medić, B.Sc.biol.- *ecology - flora, habitats and protected regions*
Mr.sc. Mirta Patarčić *(State Weather Bureau) – meteorological data*
Marija Pašalić, Mr. of spatial planning – *towns and their population*
Dr.sc. Igor Pavlinić, *(Croatian Museum of Natural History) - mammal fauna, bat fauna*
Dr.sc. Natalija Pavlus, B.Sc.biol.- ecology – *ecological network*
Mr.sc. Zlatko Perović – *quality of air, model of air pollution*
Dr.sc. Ivan Pilaš – *forests and forestry*
Dr.sc. Martina Podnar *(Croatian Museum of Natural History) -*
amphibian fauna, reptile fauna
Dr.sc. Božo Prtoljan - *geology*
Vanda Sabolović, Mr.prosp.arch. - *landscape*
Prof.dr.sc. Sanja Steiner – *description of the work /operational area of the Zagreb Airport, risk of airplane accidents*
Mr.sc. Željko Štromar, B.Sc.engineering – *protection from noise*
Dinko Tvrtković, B.Sc.stroj. – *project description/*
Product pipeline
Dr.sc. Vesna Tutiš - *ornithofauna*
Amelio Vekić, dipl.arheolog – *cultural heritage*

Place and date: Zagreb, October 2012.

COPY NO.

REVISION E

Contents of the study – complete list of books

REPUBLIC OF CROATIA

MINISTRY OF ENVIRONMENTAL PROTECTION, SPATIAL PLANNING AND CONSTRUCTION

10000 Zagreb, Ulica Republike Austrije 20 Tel: 01/37 82-444 Fax: 01/37 72-822

Class: UP/I 351-02/10-08/108

Reg No.: 531-14-1-1-06-10-2

Zagreb, October 26th, 2010

The Ministry of Environmental Protection, Spatial Planning and Construction, based on the regulations of Article 39, Paragraph 3 of the Environmental Protection Act ("Official Gazette" No. 110/07) and Article 22, paragraph 1 of the Ordinance on the conditions for granting approval to legal persons for performing activities of professional environmental protection ("Official Gazette", No. 57/10), on the occasion of the request from the Institute IGH, Plc., with headquarters in Zagreb, Janka Rakuše 1, represented by a person authorized by the law to represent for giving consent for the performance of technical activities for environmental protection: the draw-up of studies on environmental impact; drawing up surveys on environmental protection related to operations which do not have regulated obligatory evaluation of environmental impact; drawing up benchmark proposals for product groups; drawing up reports on safety and the draw-up of the evaluation of damage in the environment; the draw-up and examination (verification) of that analysis and monitoring the condition of certain jobs and groups of jobs from the area of environmental protection and for the needs of the Registry of Environmental pollution; The draw-up of the basic categorization of waste and disposal in accordance with a special regulation on the manner and terms of disposing waste, categories and terms of work for waste depots; Draw up of an analysis and report on the technological procedures of processing waster, the solidification or composition of waste and issuing (drawing up) reports on the types of waste, polluting substances and products and the material obtained by the processing and recycling of waste brought a

R E S O L U T I O N

I. The Institute IGH, Plc. with headquarters in Zagreb, Janka Rakuše I, is given consent for performing professional activities for environmental protection:

1. The draw up of the study on the influence of the work on the environment also includes the tasks of preparing and processing documentation along with a request for the estimate of the need of evaluating the work on the environment and jobs regarding the preparation and processing of documentation along with a request for issuing instructions on the contents of the study.
2. The draw up of a report on the protection of the environment which regards the work which does not have regulated obligatory evaluations of the influence on the environment and the draw up of a report on the recovery of the environment.
3. The draw up of a proposal of benchmarks for product groups.
4. The draw up of a report on the coordination of products with benchmarks in the procedure of issuing the sign of environmental protection.
5. The draw up and examination (verification) and analysis of monitoring the condition of certain jobs and groups of jobs from the area of environmental protection and for the Registry of Environmental Pollution.
6. The draw up of a basic categorization of waste for disposal in accordance with a special regulation regarding the manner and terms of disposing waste, and categories and terms of work for waste depots.
7. The draw up of an analysis and report on the technological procedures of processing waste, solidification or the composition of waste and issuing (drawing up) reports on the types of waste, polluting substances, and products and material obtained by processing and recycling waste.

II. Consent from Item 1 of this statement stops being valid within three years from the day this resolution was issued.

III. Along with this resolution there is a list of employees of the Authorized Person: the head of professional work in the protection of the environment and experts with which the regulated terms regarding employed experts are fulfilled for issuing consent from Item 1 of this statement.

IV. This resolution is entered in the Inquest Register of issued consents for the execution of professional jobs regarding environmental protection which is led by the Ministry of Environmental Protection, Spatial Planning and Construction.

E x p l a n a t i o n

The Institute IGH Plc from Zagreb (hereinafter: authorized person) submitted to this Ministry a request for issuing consent for performing professional work regarding environmental protection from the group of jobs from Article 4, Item B from the Codebook on the terms of issuing consent to legal persons for performing professional jobs regarding environmental protection (hereinafter: Codebook) "the draw up of the study on the influence of the work on the environment including the draw up of a study on the acceptability of planned work in the area of nature and the draw up of a report on environmental protection that regards the work which has no regulated obligatory evaluations of environmental impact": The draw up of a study on the influence of the work on the environment which includes the jobs regarding the preparation and processing of documentation along with a request on the estimate of the need of evaluating the influence of the work on the environment and work regarding the preparation and processing of documentation along with a request for issuing instructions on the contents of the study: Drawing up a study on environmental protection related to operations which do not have regulated obligatory evaluations of environmental impact including drawing up a report on environment repair; drawing up benchmark proposals for product groups; drawing up a report on the coordination of products with benchmarks for the procedure of issuing a sign of environmental protection. The Authorized Person submitted a request also for issuing consent for the execution of professional jobs regarding environmental protection from the group of jobs from Article 4, Item E) of the Codebook "Draw up and examination - verification (revision) of special reports, budgets and projections for the need of the integral part of the environment and for the needs of the Registry for Environmental pollution": Draw up and examination (verification) of that analysis and monitoring the condition of certain jobs and groups of jobs from the area of environmental protection and for the needs of the Registry of Environmental pollution; draw up of the basic categorization of waste and disposal in accordance with a special regulation on the manner and terms of disposing waste, categories and terms of work for waste depots; Draw up of an analysis and report on the technological procedures of processing waster, the solidification or composition of waste and issuing (drawing up) reports on the types of waste, polluting substances and products and the material obtained by the processing and recycling of waste.

The Authorized Person, along with the request for issuing consent, has also attached the appropriate evidence according to the requests of the specified regulations of Articles 5, 17 and 20 of the Codebook.

In the presented procedure, following Article 4, Paragraph 1, of the Environmental Protection Act and Article 21, Paragraph 4 of the Codebook implemented in accordance with Article 50, Item 1, and Article 58, Paragraph 2, of the General Administrative Procedure Act ("Official Gazette", No. 47/09), it was found that the Authorized Person in the request stated the facts and had submitted evidence from which the real situation can be determined and it is was also determined that this body knows of facts regarding the conditions which the Authorized Person has because the body has official data on this according to their records.

After the performed review of the request and the submitted evidence, it has been determined that the Authorized Person:

Employs heads for professional jobs who have five years of experiences on jobs regarding environment protection and which have been the heads of the draw up of the study on the impact of the work on the environment, professional bases and reports of environmental protection and fulfil the terms in accordance with Article 7 of the Codebook;

Employs experts with appropriate professional profiles and the necessary years of work experience on jobs regarding environmental protection, who have participated in the draw up of the appropriate professional bases and reports on environmental protection and fulfilled the conditions in accordance with Article 10 and 13 of the Codebook;

Has a work area;

Has devices and equipment for performing jobs for which the consent is being issued.

Book I STUDY OF ENVIRONMENTAL IMPACT

The statement of Item I and III of this Resolution is based on the previously exhibited and determined factual state.

The deadline of the validity of the Resolution is defined in Item II and the statement of this Resolution is regulated by Article 22, Paragraph 3 of the Codebook.

Item IV of the statement of this Resolution is based on the regulations of Article 39, Paragraph 5 of the Environmental Protection Act and regulations in Article 29 of the Codebook.

Based on what was already stated, it was necessary to resolve as stated in the resolution. LEGAL REMEDY:

A complaint cannot be stated against this Resolution but an administrative dispute can be activated by filing a complaint to the Administrative Court of the Republic of Croatia within 20 days from when this Resolution is delivered.

The administrative fee for the request and this Resolution is legally paid through state revenue stamps in the amount of 70.00 kunas according to the Tariff No. 1 and 2 of the Tariffs of administrative fees of the Administrative Fees Act (Official Gazette, No. 8/96, 77/96, 95/97, 131/97, 68/98, 66/99, 145/99, 30/00, 116/00, 163/03, 17/04, 110/04, 141/04, 150/05, 153/05, 129/06, 117/07, 25/08, 60/08, 20/10 and 69/10).

Attachment: List of employees as in Item III of the statement of this Resolution.

DRŽAVNI TAJNIK

dr. Nikola Ružinski

Deliver to:

1.Institute IGH, Plc, Janka Rakuše 1, Zagreb, with a return receipt!
2.Board of Inspectional Affairs, here
3.Authorized Person, here
4.Subject registry, here

LIST employees of the Authorized Person: Institute IGH, Janka Rakuše 1, Zagreb, pursuant to which the Authorized Person has completed the stipulated requirements for granting approval to conduct professional environmental protection in accordance with the decision of the Ministry of Environmental Protection, Spatial Planning and Construction, Class: UP / 1351-02 / 10-08/108, Ref: 531-14-1-1-06-10-2 of 26 October 2010.			
GROUPS OF JOBS/TYPES OF JOBS		HEAD/S OF PROFESSIONAL WORK	EMPLOYED EXPERTS
B) Draw up of a study on the impact of the work on the environment including the draw up of the study of the acceptability of the planned work in the area of nature and the drawing up of the report on environmental protection which regards the work which is not covered by regulated obligatory evaluations of environmental impact			
1. Draw up of a study on the impact of work on the environment	X	IgorPleić, B.Sc.grad. nir.se. Anita Erdelez, B.Sc.grad. Domagoj Vranješ, mag.ing.agr., univ.spec.oecoing. Davor Barać, B.Sc.grad. Mr.sc. Zlatko Perović, B.Sc.pom.	Valentina Habdija. mag.ing.agr. Marijana Podrug, Mr.biol., univ.spec.oecol. Ena Bićanić, Mr.agr. Vanja Medić, B.Sc.biol.-ekol. Milena Lončar, B.Sc. engineering
2. Preparation and processing of documentation with the request for an estimate on the needs for evaluating the impact of the work on the environment	X	Igor Pleić, B.Sc.engineering. Mr.se. Anita Erdelez, B.Sc.grad. Domagoj Vranješ, mag.ing.agr. univ.spec.oecoing. Davor Barać. B.Sc.grad. mr.se. Zlatko Perović, B.Sc.	Valentina Habdija. Mr.ing.agr. Marijana Podrug, Mr.biol,, univ.spec.oecol. Ena Bićanić, Mr.ing.agr, Vanja Mcdić, B.Sc.biol.-ecol. Milena Lončar, B.Sc. engineering
3. Preparation and processing of documentation with a request for issuing instructions on the contents of the study	X	Igor Pleić. B.Sc.grad. mr.se. Anita Erdelez, B.Sc.grad. Domagoj Vranješ. mag.ing.agr,, univ.spec.oecoing. Davor Barać, dipl,ing.grad. mr.se. Zlatko Perović, B.Sc.pom.	Valentina Labdija, Mr.agr. Marijana Podrug, Mr.biol., univ.spec.oecol. Ena Bićanić, Mr.ing.agr. Vanja Medić, B.Sc.biol.-ekol. Milena Lončar, B.Sc. engineering.
4. The draw up of a report on the previous estimates of acceptability of the work for the ecological network			
5. The draw up of the main estimate on the acceptability of the work on the ecological network			
6. Preparation and processing of documentation for the implementation of the procedure of defining the main public interest and compensation terms according to special regulations from the area of environmental protection			
7. The draw up of a report on environmental protection which concerns the work which is not regulated with obligatory estimates of environmental impact including also the draw up of the report on the recovery of the environment	X	Igor Pleić, B.Sc. engineering. mr.se. Anita Erdelez, B.Sc.grad. Domagoj Vranješ, mag.ing.agr., univ.spec.oecoing. Davor Barać, B.Sc.grad. Mr.Sc, Zlatko Perović, dipl .ing.pom.	Valentina Habdija, mag ing.agr. Marijana Podrug, mag.biol,, univ.spec.oecol. Ena Bićanić, mag.ing.agr. Vanja Medić, B.Sc.biol.-ecol. Milena Lončar, B.Sc. engineering.
8. The draw up of a benchmark of proposal for groups of products	X	IgorPleić, B.Sc.grad, mr.se. Anita Erdelez, B.Sc.grad. Domagoj Vranješ, mag.ing.agr., univ.spec.oecoing. Davor Barać, B.Sc.grad. mr.se. Zlatko Perović, B.Sc.pom	Valentina Habdija, Mr.agr. Marijana Podrug. Mr.biol., univ.spec.oecol. Ena Bićanić, Mr.agr, Vanja Medić, B.Sc.biol.-ekol. Milena Lončar, B.Sc. engineering

9. The draw up of a report on the coordination of the product with benchmarks in the procedure of issuing the sign of environmental protection.	X	Igor Pleić, B.Sc.građ. mr.se. Anita Erdelez, B.Sc.građ. Domagoj Vranješ, mag.ing.agr., univ.spec.oecoing. Davor Barać, B.Sc.građ. mr.se. Zlatko Perović, B.Sc.pom	Valentina Habdija, mag.ing.agr. Marijana Podrug, mag.biol., univ.spec.oecol. Ena Bićanić. Mr.ing.agr. Vanja Medić, B.Sc.biol-ecol. Milena Lončar, B.Sc. engineering .
E) The draw up and examination – verification (revision) of special reports, budgets and projections for the needs of the integral part of the environment and for the needs of the Registry of Pollution			
1. Draw up and examination (verification) and analysis of monitoring the state for certain jobs and groups of jobs from the area of environmental protection and for the needs of the Registry of Environmental Pollution	X	Mr.se. Ana Vukelić, B.Sc.građ.	Mr.se. Anita Erdelez, B.Sc.engineering. Davor Barać, B.Sc. engineering .
2. Draw up of special reports for the needs of the integral part of the environment; drawing up reports on the budget (inventory), emission of greenhouse gas and other emissions of polluting substances in the environment; a draw up of a budget and projections for the needs of the integral part of the environment and reports on the implementation of policies and measures; the draw up and verification of reports and special reports on emissions to the environment.			
3. Draw up of basic characterizations of waste for disposal in accordance with the special regulation on the manner and terms of disposing waste, categories and terms of work in waste depots	X	Mr.sc. Ana Vukelić, dipt.ing.grad.	Mr.se. Anita Erdelez, B.Sc. engineering , Davor Barać, B.Sc. engineering ,
4. Draw up of an analysis and report on the technological procedures of processing waste, solidification or the composition of waste, polluting substances and products and material obtained by the processing and recycling of waste	X	Mr.se. Ana Vukelić, B.Sc.građ.	Mr.se. Anita Erdelez, B.Sc. engineering . Davor Barać, B.Sc. engineering .

CONTENTS OF THE STUDY I - STUDY OF ENVIRONMENTAL IMPACT:

1. DESCRIPTION OF THE WORK

1.1. REASONS FOR THE PROPOSAL OF WORK

The existing infrastructure of Zagreb Airport and spatial planning are not sufficient for the further development of transport. Because of this, it is considered necessary to expand the capacity by air and ground, as well as to upgrade the facilities for handling passengers and aircrafts for the acceptance of requirements related to the expected growth of traffic.

In December 2010, the InterVISTAS Consulting Group confirmed its prognosis of traffic for Zagreb Airport for the period 2011 – 2040. Based on the analysis of the 30th peak hour, new design parameters were executed that allow the construction of a new terminal in phases.

The aforementioned procedure is predicted to increase the capacity of Zagreb Airport to 5 million passengers per year in the first phase, and 8 million passengers a year in the second phase. The procedure consists of the construction of the passenger terminal and external traffic areas with access roads and other infrastructures in the first phase and their expansion in the second phase. The future concessionaire has a duty (as defined in the Concession Contract) to enable the terminal to accept up to 8 million passengers per year and achieve a minimum C level of service no later than 15 years after the handover.

One of the steps in the process of obtaining building permits for the project is the development of the Study of Environmental Impact. The Study of Environmental Impact (hereinafter: SEI) evaluates the impact of the planned project on the environment, in which potential adverse impacts are reviewed and environmental protection measures are adopted in order to reduce its adverse impacts to a minimum and to achieve the best possible preservation of environmental quality. The rendered environmental protection measures are incorporated into the project documentation for obtaining location and building permits.

The obligation to create a SEI exists under Art. 3, Annex I of the Regulation on the assessment of environmental impact (OG 64/08, 67/09), or for: 13 Construction of airports with a runway length of 2,100 m and more.

1.2. COVERAGE AND DESCRIPTION OF THE MAIN CHARACTERISTICS OF THE WORK

The subject of the Study is the following:

1. The construction and usage of the building of the new passenger terminal (NPT) with necessary connections to the infrastructural network
2. The construction and usage of traffic areas of the air part of the NPT
   - Apron
   - Quick exiting traffic trail
   - Access trails
   - Place for de-icing the airplane
3. The construction and usage of traffic areas of the land part of the NPT:
   - Access roads
   - parking (public, for employees, for buses, for taxi)
4. The construction and usage of energy plants with a connection to the gas network
5. The construction and usage of the drainage system and treating polluted rain water of the Zagreb Airport
6. The reconstruction and further use of the runway and driving trails in the part of the construction of the drainage system of polluted rain water. The runway will not be extended nor will another runway be built.
7. The reconstruction and further use of the existing apron in the part of the connection for the drainage of polluted rain water to a new mutual system of drainage and treatment of water.

For needs of the new passenger terminal, it will be necessary to build a new access road that will connect the NPT with the eastern bypass of Velika Gorica, which is currently under construction. The impact of the construction and use of access roads is viewed in this Study.

The supply of airline fuel, as an important part of the functional and technological scope of the airport, is also seen through the possible impact on the environment. Since the storage of air-fuel is done on a premises not owned by the Zagreb Airport, but rather on the location of INA Avioservis Zagreb, which has been in operation and has all the necessary permits, environmental protection measures are not proposed for that facility.

The existing terminal building, as well as all other facilities at Zagreb Airport, which are also the subject of the Concession Contract, will retain their current function, and as such are not subject to consideration within this study. It should be noted that all existing facilities of Zagreb Airport have a use permit and will be used in the future in accordance with their intended use.

1.2.1. Description of the current condition of Zagreb Airport

The project area includes the construction of a new passenger terminal at Zagreb Airport (hereinafter: ZA) with a total area of 1.3 km2 (3.2 km2 of concession area), located north of the town of Velika Gorica, in the vicinity of Zagreb Airport.

Picture 1.2.1-1 A view of the current Zagreb Airport

The location of the work is in the Zagreb Country in the area of the City of Velika Gorica in cadastre municipalities: Pleso, Mičevec and Kosnica.

In autumn 1959 a passenger building and platform was built and Pleso Airport was opened for passenger traffic. Zagreb Airport started operating on April 20, 1962. The concrete runway was then 2500 m long, and the passenger terminal had a surface area of 1000 m2. The platform was able to accommodate five smaller aircrafts. In the year of founding, 78,041 travelers, 633 tons of cargo in 5206 plane rotations passed through Zagreb Airport. Four years later, in 1966, a new passenger building surface area of 5,000 m2 was built, the runway was rebuilt and extended to 2860 m and the platform was extended to 60,000 m2. It was built in the new administration building with a control tower. That year the name was changed to the "Airport Zagreb." The next major renovation was in 1974, when the Zagreb Airport was closed for renovations for two months. The runway was reconstructed and extended to 3259 m, the radio-navigation systems were renewed and the equipment was modernized. Because of an increase in the frequency of traffic, in 1984 it entered into another phase, upgrading existing facilities and the construction of new ones. The customs office and international freight forwarding firm, cargo terminal and a new fire station were put into operation that year. The passenger building was also renovated that year on the total surface of 11,000 m2. In 1986 the platform area of 30,000 m2 was renovated and the taxiway was rebuilt.

Today the area of Zagreb Airport is a runway with the length of 3252 meters and width of 45 m, and along with the surface at the roadside (verges), is 60 meters wide. The runway landing thresholds are built from concrete, and the middle part of the trail is paved.
The building of the existing passenger terminal on the land side has two levels. The area of 2140 m2 serves as a lobby to wait for departures and arrivals. There are two waiting rooms, one for international passengers (865 m2) and one for domestic passengers (505 m2). Spaces for checking passengers and baggage have an area of 250 m2 (315 m2 plus control immigration /

passenger arrival) or 1420 m2. The terminal has 18 outputs and 18 check-in desks for passangers and baggage. The common area of 2640 m2 is located on the ground floor. It also has 597 parking spaces for terminal users.

In the eastern part of Zagreb Airport the 91st Pleso Air Force Base is located, which in its composition, other than transport planes and helicopters has one squadron of MiG fighters 21bisD. The Croatian Air Force and Air Defence commanding headquarters is also there. Zagreb Airport, before Croatian independence, was a major transit-airport transfer for the former state with the highest turnover achieved in 1979 with more than 1.9 million passengers a year, of which about 0.4 million were in transit (passengers who continue to travel on the same flight) and about 0.8 million in transfer (passengers changing flights), 37 000 civil aircraft operations, and tens of thousands of military aircraft operations annually.

Traffic after Croatian independence in wartime conditions set out with much smaller volumes, and in 2007 there were 1,992,455 passengers or 2 million passengers. According to the physical characteristics of the existing manoeuvre area and the apron, Zagreb Airport can accommodate all aircrafts which are used in civil aviation. But all of the elements of the airport area do not meet international and local regulations. The wide-body aircrafts in reception and dispatching break the surface of the transitional surface of restricting obstacles with their tails.

The Zagreb Airport today is a rare example in Europe – it is the capital's airport and an air base at the same time, and that is only a single runway for civilian and military purposes.

It should be emphasized that the location of the Zagreb Airport, in principle, is adverse considering the potentially negative impact on some aspects of the environment, particularly with regard to the possible contamination of ground drinking water reserves intended for the public water supply of the city of Velika Gorica and the entire eastern part of the Zagreb County. However, due to the fact that another suitable location is not found or planned and that it was decided that the Zagreb Airport continues to develop at its present location, the only thing left is enhanced protection measures to protect the vulnerable segments of the environment from the negative effects of this procedure.

1.2.2. Goals of the construction of the new passenger terminal in Zagreb Airport

The concept of airport capacity expansion is based on the following criteria:
Minimum requirements for the new terminal:

- handling 5 million passengers per year (Phase I)
- handling 8 million passengers per year (Phase II)
- a minimum C level of service
- existing security protocol for the public and travellers
- Minimum requirements for the air side:
- 70% of international aircrafts (the peak period) must have a connection to the output (via air bridges)
- 30% of domestic and international aircraft passengers can use the existing apron
- there must be a new apron built in front of the new terminal to ensure the above capacity. The new apron must have a double lane marked C / single lane track marked E and two ports for taxiways for accessing taxiway F
- New fast output on taxiway
- The new service road on the air side must connect the existing and the new apron
- The place for the de-icing system is equipped with a system for collecting liquid
- A sufficient number of parking capacity for receiving taxis, buses and cars from passengers and employees

1.2.3. Phased construction of the new passenger terminal at Zagreb airport

According to the procedure for the preparation of technical documents for the new terminal at Zagreb airport, the entire program must be implemented in two phases. The realization of each phase is based on traffic forecasts and the minimum requirements.
Part of the terminal and external paved areas with access roads and other infrastructure (water supply, drainage and energy) will be implemented in Phase 1. Phase 2 refers to the increase in carrying capacity in relation to the expected increase in air traffic and includes the extension of the terminal building, apron and parking areas.

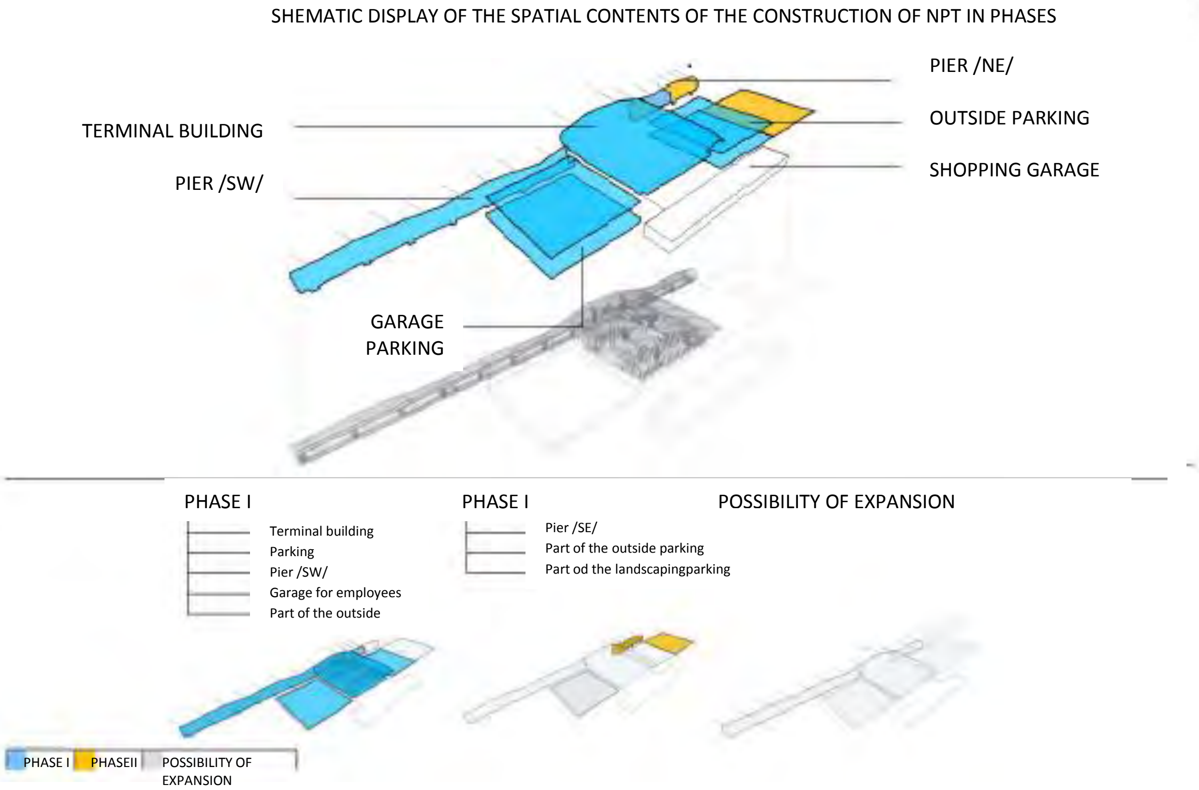


Figure 1.2.3.-1. Phased construction of the new passenger terminal at Zagreb airport

Duration of work in Phase 1: maximum of 3 years Duration of
work in Phase 2: maximum of 2 years
Start of work in Phase 2 is planned for 2022.

GRAPHIC ATTACHMENTS:
Attachment 1.2.3.-1. Display of the location of the work in the scale of 1 : 25 000.
Attachment 1.2.3.-2. The situation on the cadastre base on the scale of 1: 10 000
Attachment 1.2.3.-3. The situation in the scale of 1: 10 000

1.2.4. Ownership structure of the land

This report gives a display of the available data on the ownership structure of the land covering the expansion of Zagreb Airport. According to the data of Zagreb Airport, part of the land is owned by the Airport (green), part is in the process of being purchased and settling property and legal procedures (red) and the transition of ownership of Zagreb Airport, and part of the land is still in private possession and ownership.

The report includes a review of the military zones A and B, and the proposal of work in phases. The scope of Phase 1 and 2 is marked in red and should be the subject of interest of Zagreb Airport of concessioners. Within the first phase it is still delimited which would belong in the jurisdiction of Zagreb Airport and which would belong to Croatian Roads, Croatian railways, county roads or cities.

For part of the area that is marked in red it is necessary to resolve the legal property because it is a condition for connecting the new passenger terminal with the city. Here it is necessary to take into account the annex of that belt in accordance with the proposed construction proposal, as well as to continue with the resolution of other required land which is privately owned (yellow) that are needed for this project. External roads are in the jurisdiction of Croatian roads, county roads or the city of Velika Gorica and Zagreb, the Croatian Railways, and they will be in charge of solving property issues in the legal procedures of realization of these roads.

Picture 1.2.4.-1. *Ownership structure of the land*

1.3. OBJECTS AND NEW TECHNOLOGIES OF THE NEW PASSENGER TERMINAL OF THE ZAGREB AIRPORT

1.3.1. The new terminal

The new terminal will consist of:

- One main terminal unit (main building) which will cover the contents from the land side for domestic and international travellers as well as facilities of the air side for domestic and international passengers. Facilities will be located in the main building for reception and dispatch that is necessary for domestic and international operations, including: the roadside part, check-in, taking over, safety exams and exams of luggage which will be loaded into the luggage area.

- Two halls of passenger ramps at the air side for outgoing, incoming and transferred passengers which will be connected with the main terminal.

Main building

The new terminal is designed to receive 5 MPA (million passengers per year), which is the minimum requirement in order to maintain the C level of service.
In Phase II the terminal will be expanded so that it can accommodate 8 million passengers per year.

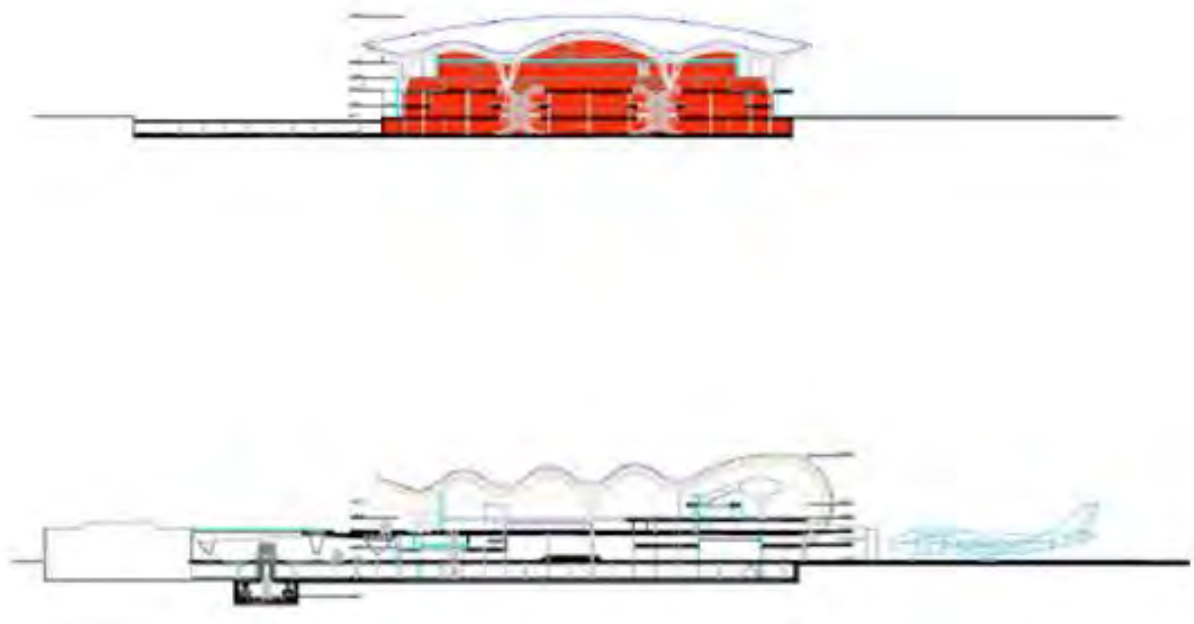


Figure 1.3.1.-1. *Longitudinal and transverse cross-section*

The basement level - Contains appropriate technical installations, a baggage sorting system with automatic output baggage sorting, which is six meters (-6) below ground.

The incoming baggage is transported from the apron level (0 m) with the system of the tractor and cart, and then moves on ramps with a slope of 6.5% to the luggage sorting zone.

The minimum area requirement for receiving the foreseen traffic of the peak hour and maintaining the level of service C for 5 mppa is 4630 m2.

It serves the following types of outgoing passengers: domestic, international (non-Schengen) and International (Schengen). The project proposes a shopping centre in the basement as a possibility.

We also discussed the possibility of lifting (cancelling) the level and switching installations planned at this level to higher levels.

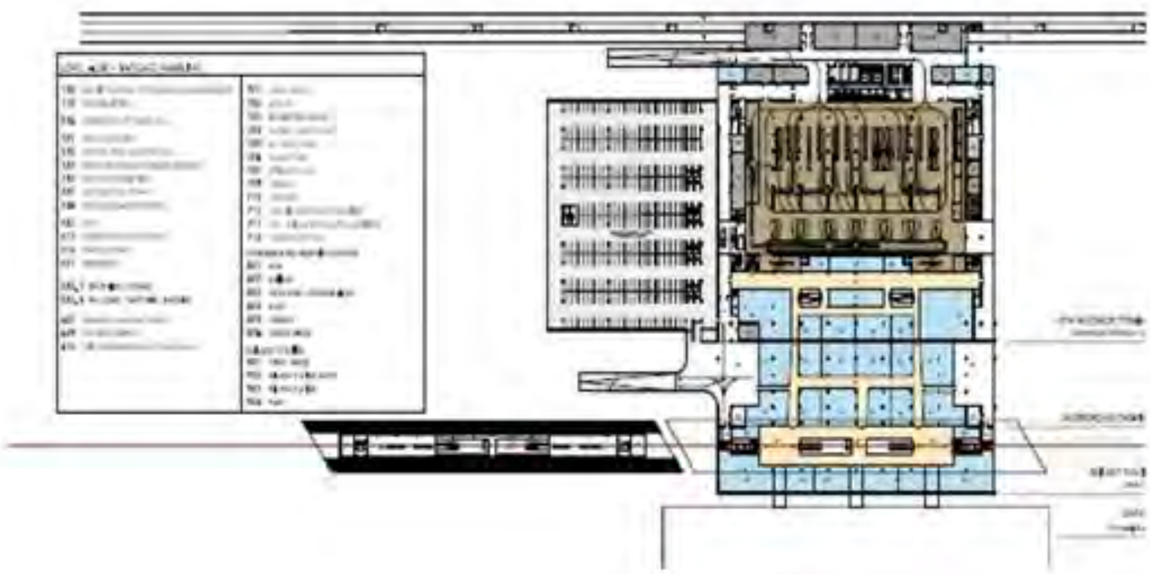


Figure 1.3.1.-2. *Luggage level*

Arrivals level – Includes the business exits of outgoing travellers. Includes immigration control, baggage takeover, customs and arrival hall for incoming travellers. It was designed at the ground level. It serves the following types of incoming passengers, domestic, international (non-Schengen) and international (Schengen).

The following are the minimum requirements in terms of the surface:

- 4633 m2 for sorting luggage.
- 1080 m2 for Immigration
- 965 m2 for bus exit
- 1478 m2 for the incoming hall

The minimum area needed for arrival on the land side must include commercial zones, retail units and commercial offices.

West ramp (Pier) - level of arrivals
The planned ramp represents a linear structure at three levels, different widths (17-19 m) and different heights depending on the construction and architectural layer. It includes business lounges at level (0), the transfer level (+5.4 m) used by incoming passengers, and the outgoing waiting room, which is planned at (+9.6 m).
It is used for all types of incoming, outgoing and transfer passengers.
The exit area requirement is 2194 m2 and includes waiting rooms and movement

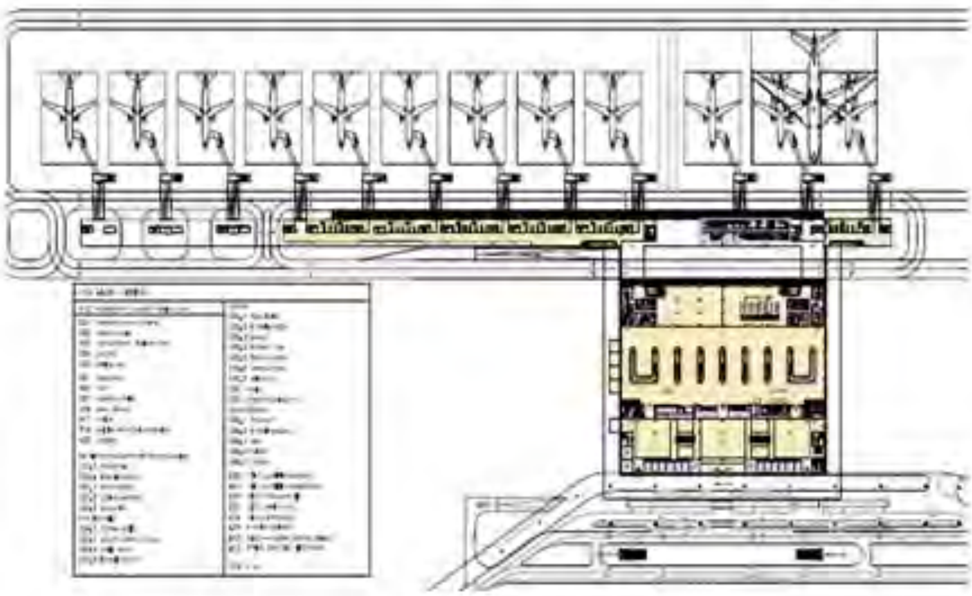


Figure 1.3.1.-3. *Level of arrivals*

Level of transfers

The surface for receiving incoming passengers from airline bridges includes security checks, passport checks, waiting rooms for transfers and airline counters.
It is located at 4.2 m above ground level
Serves the following types of transfer passengers:

- International (Schengen) on domestic flights
- International (non-Schengen) on domestic flights
- Domestic on international (Schengen)
- Domestic on international (non-Schengen)
- International (Schengen) on international (non-Schengen)
- International (non-Schengen) on international (Schengen)
- International (Schengen) on international (Schengen)
- International (non-Schengen) on international (non-Schengen)

The area requirement for the level of transfers is approximately 2517 m2 and includes 1203 m2 for transfer waiting rooms, 480 m2 for security and 72 m2 for passport checks. At this level there must be commercial areas and management offices.

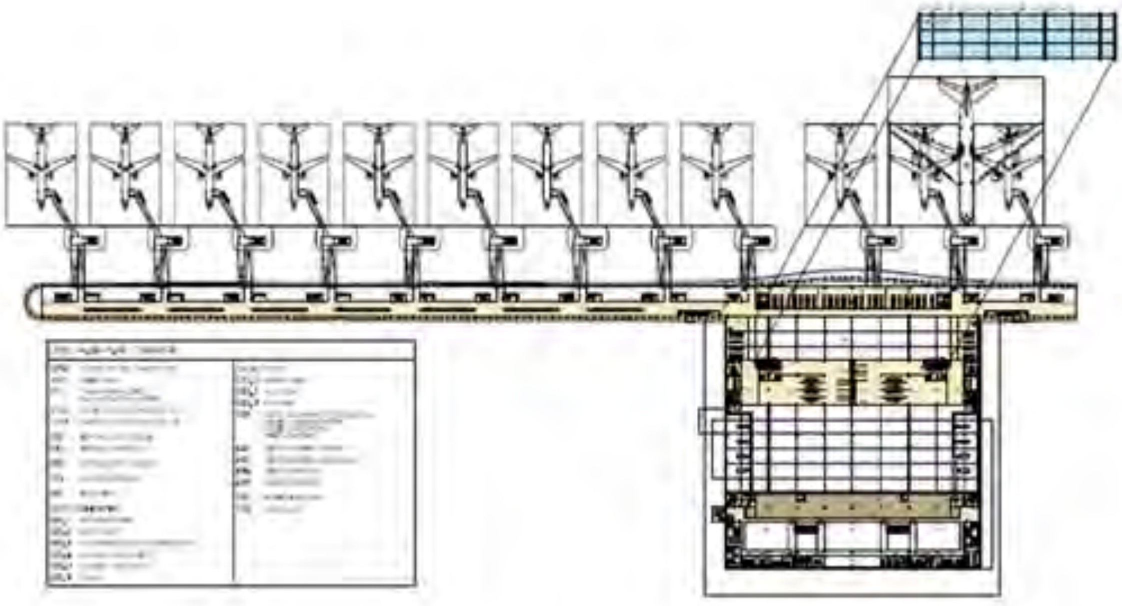


Figure 1.3.1.-4. *Level of transfers*

Level of departures

It is located at 9.6m and connected with the outgoing curb with a slope of 6% towards the level of arrivals. It consists of the ground hall, the check-in zone, emigration, safety and outgoing halls. It serves the following types of incoming passengers:

- Domestic
- International (non-Schengen)
- International (Schengen)
- All types of transfer passengers

The planned area for check-in is 4630 m2 and includes the outgoing ground hall, 60 check-in counters (minimum requirements in Phase 1, 42 counters), special counters to handle baggage of unusual size, group check-in counters and 5% for first and business class.

Designed surfaces
- Outgoing check-in = 3340 m2
- Security = 1200 m2
- Passport checks = 530 m2
- CIP lounge = 900 m2

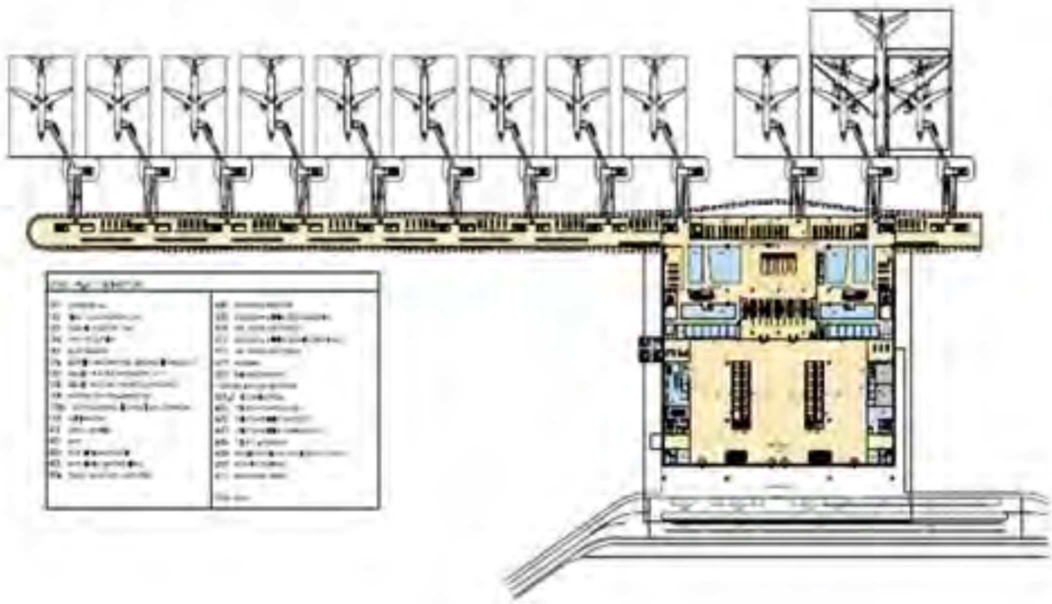


Figure1.3.1.-5. *Level of departures*

Restaurants level and level for visitors (optional surface)

The restaurant level would be useful to include small units for food and beverage (F + B), and commercial offices. It is located at 14.4 m, including waiting rooms, overlooking the apron and Zagreb panorama.

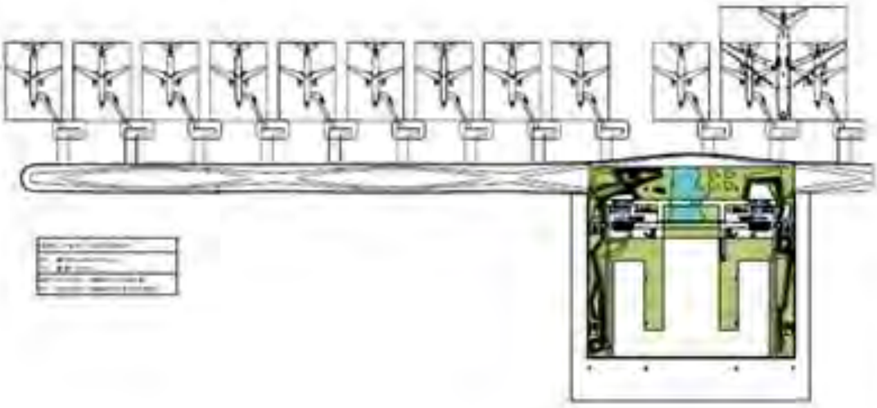


Figure 1.3.1.-6. *Restaurant level*

The level for visitors is located above the restaurant level, food and drinks should be offered while enjoying the view of the outer and inner space.

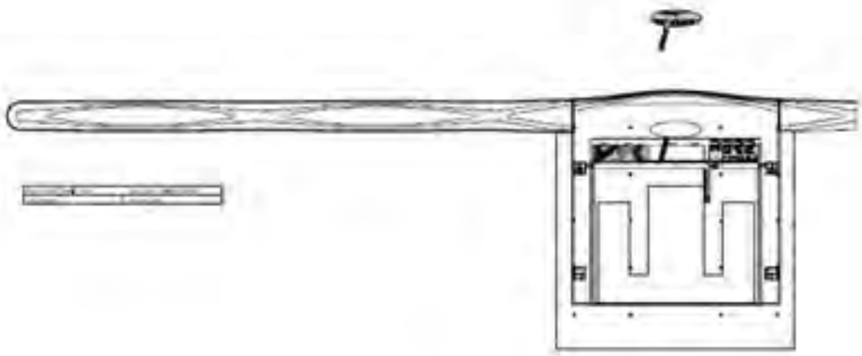


Figure 1.3.1.-7. Area for visitors

Roof concept

The surface of the roof structure is 152 meters wide and 158 meters deep. The roof consists of ridges and coves that are designed to have the largest possible radius. The roof shell rests on four vertical reinforced concrete cores and 16 pillars (8 internal and 8 perimeters). Belts grids are made of round steel pipes with the diameter of 355.6 mm and 30.0 mm in the wall. The height of the pillars on the surface between the concrete substructure and grids varies (4.8 m - 10.8 m).
The horizontal stability of the roof is secured with a hybrid system of sixteen branched pillars and four concrete cores. The planned protection of steel from corrosion foresees the use of appropriate coatings that provide long-term (L) protection, and the elements are distinguished by choosing two groups of steel, depending on the characteristics of corrosion loads. The factory production and assembly will be done by welding, and blunt connecting will be used for pipe connections and profiles.

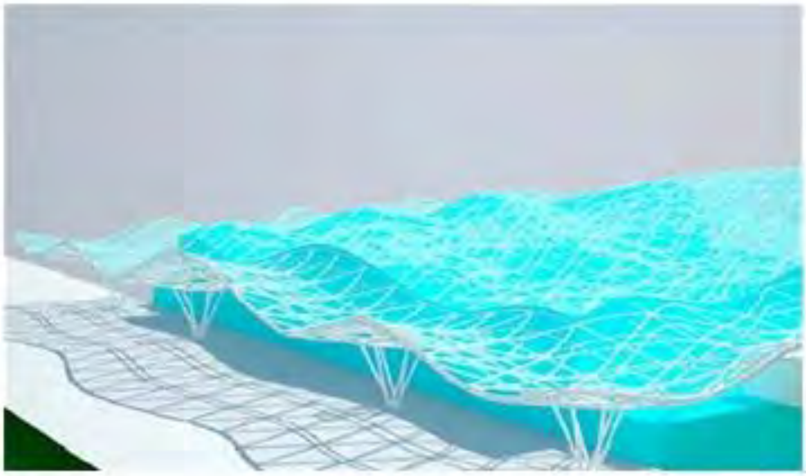


Figure 1.3.1.-8. Roof concept

1.3.2. Air side of the NPT

The construction of the air side in front of the new terminal provides a neatly organized layout with ample space and flexibility to meet the area requirements for the aircraft after complete construction of the terminal.

Positions on the air side
There is a new apron to accommodate positions for aircrafts that are required for the composition of the fleet that is expected for the Zagreb airport. Different variations are enabled in the fleet so the apron plan as well as the degrees of development take that possibility into account.
Based on the predictions of InterVISTAS Consulting Group of the absolute peak hour in 2024, based on higher traffic growth scenarios for processing 70% of international aircrafts in the peak period, 11 positions for aircrafts will be necessary.
During the first phase, 30% of the positions will be enabled (for international aircrafts) on the existing apron in front of the existing terminal. The plan of the apron on the air side provides a CODE C dual drive lane and one CODE E drive lane. This will allow each aircraft to bypass CODE C without disturbing other operations (ie, aircraft push-out).
Due to the enabled landing of aircrafts from both sides of the western gate, the possibility of moving the building approximately 30m in the direction of the runway is enabled.

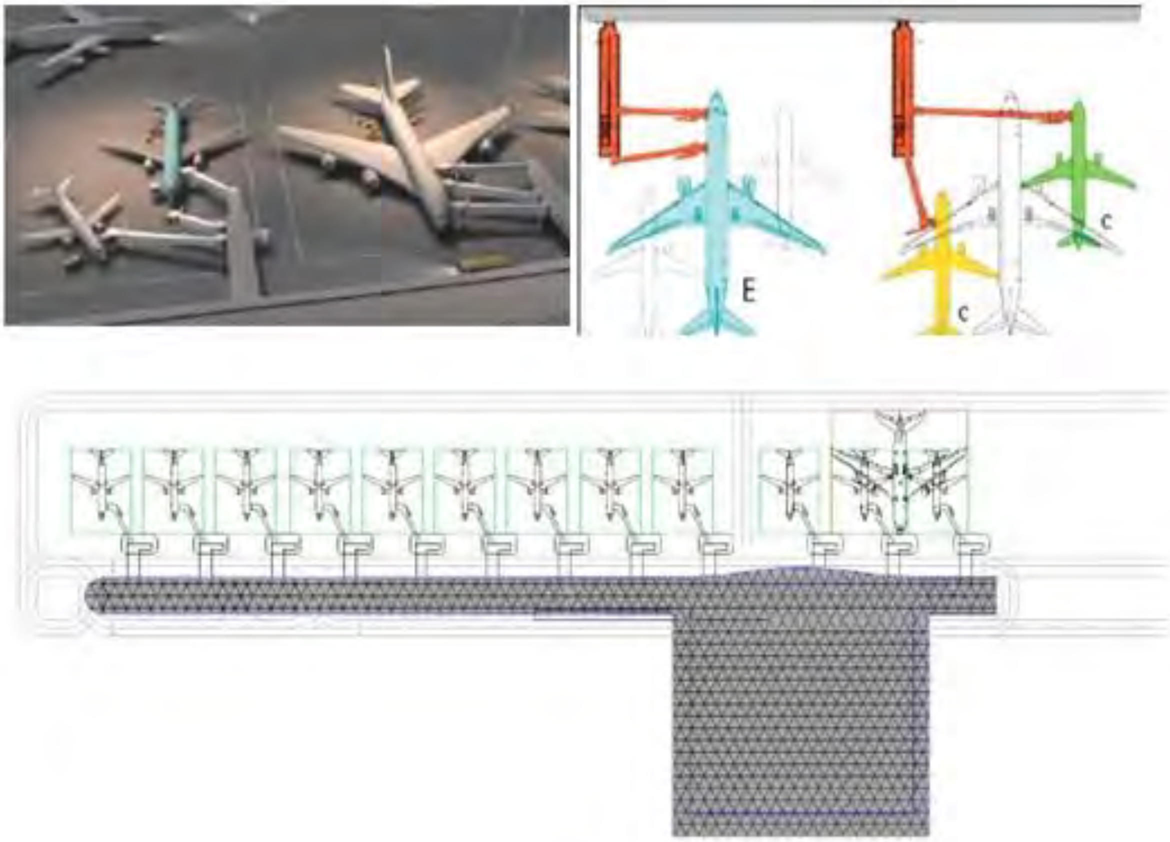


Figure 1.3.2.-1. Flexible use of a type E aircraft, or two type C aircrafts which gives an optimal flexibility with the efficient use of the available land apron.

Rapid exit drive lane

In order to enhance the capacity of the runway, it is necessary to build a rapid exit drive lane. The exact location of the rapid exit drive lane depends on the key CODE C aircraft.

The track will be located opposite of the approach lane to the apron in order to achieve maximum capacity of the drive lane.

Taxiway of the apron

Two drive lanes will connect the new terminal apron area with taxiway F for the flexibility of aircraft operations.

Position for de-icing / waiting area

A platform for de-icing is planned to be built. The position for de-icing is planned to be placed next to the end of the runway 05 because 90% of the traffic uses this runway to departure. It is planned to induce a separate collection of fluid from de-iceing or the use of a valve to close the drain system so the liquid would not be mixed with the rainwater. The waiting area will be built on the edge of the apron, west from the terminal.

Air side service road

The integrated system of internal roads will provide the air-side traffic service between the building and the standing aircraft. Operations on domestic flights will be carried out by the same buses on the same road systems in combination with lanes.

As technology projects predicted that 30% of international aircrafts and aircrafts in domestic traffic can use the existing apron, the airport project design by NPT, predicts the new service road on the air side that connects the existing and new apron.

1.3.3. Land side NPT

On the ground level, access for incoming passengers with the help of a new roadside will be ensured. Access for outgoing passengers will be provided with the construction of an outgoing roadside with a ramp. Traffic can be two-way on the ground level and one-way on the departure level. Both exterior yards provide access to taxis and buses.

In a future phase of implementation, the ground-level parking is predicted in the form of a multi-storey parking lot with retail space on the ground floor and underground space for a light rail station.

The incoming platform at ground level is 40.0 m wide and divided into parking lots for taxis, buses and personal vehicles. The pavement surfaces are separated with "islands" for travellers with a size of 3.2 m (7.20 in front of the airport building). Transient pavements are separated with “islands” that are 12.0 m wide, and the circular movement of traffic is enabled. The service or the parallel extra road for platforms has two straps. The service road will divide into roads towards parking areas and supply ramps of the building (and the road will also serve as a fire escape).

The outgoing platform is 20 feet wide. The pavement surfaces are also divided into the areas for parking taxis, a bus station and a short-term parking lot. The platform on the north-east side will be realized with the capacity that will meet future demands.

At the edges of the access ramps and platform, a pavement will be placed with the width of 3.0 m with a fence and lighting.

The minimum requirements for parking on the ground side:

- Parking for taxis (339 spots)
- Parking for buses (48 spots)
- Short-term parking (1298 spots)
- Parking for employees at Level -1 (168, including parking for the disabled), with personal controlled access south-east of the terminal.

Ramp to Level -1 will also serve for access to different areas at Level -1(Supplies, luggage, space for rent, etc.).

1.3.4. Traffic solution

WIDER TRAFFIC NETWORK

Taking into account the complete solution to traffic problems and access to the location of the new passenger terminal of Zagreb Airport, we carried out a deeper analysis of the existing and planned transport network in the environment.

This research was conducted under the "Spatial traffic studies of road and railroad traffic of the wider area of Zagreb", IGH Zagreb 2008/2009.

Based on that, the comprehensive transport solutions were proposed, from which it is then possible to perform stepwise and phase construction solutions as a part of future solutions.

From the traffic- planning point of view, the subject location of the future airport is located in a common environment of natural or man-made barriers such as highways and the existing runway (USS) from the northwest, the town of Velika Gorica in the south and south-east, well-field, bypass roads and a number of rural settlements on the east side of the location.

Future access to the new airport building is planned to be by road (and at future state rail lines, which is not the subject of this study on environmental impact), with direct connections to the inner city centre. The main access road to the airport building (mark D) is a road that connects the eastern bypass of Velika Gorica (mark 1) on the location slightly south of the junction Velika Kosnica on the A3 motorway and across an access avenue (mark A) traffic area NPT (internal roads) (Figure 1.3 .4. -1).

The eastern bypass of Velika Gorica (1-currently under construction) is the link of the motorway A11 Zagreb - Sisak and the motorway A3, the Zagreb bypass and connection across the Homeland Bridge to the city centre (central train station, Zrinjevac, the Ban Jelačić Square), as shown in Figure 1.3.4.-2.

The existing access road from the direction of Velikogorička cesta (southwest) remains in function of access to the existing terminal, and in phase 1 also the service access to the new passenger terminal (NPT). The route of the access road is defined in the Regional Plan for the City of Velika Gorica.

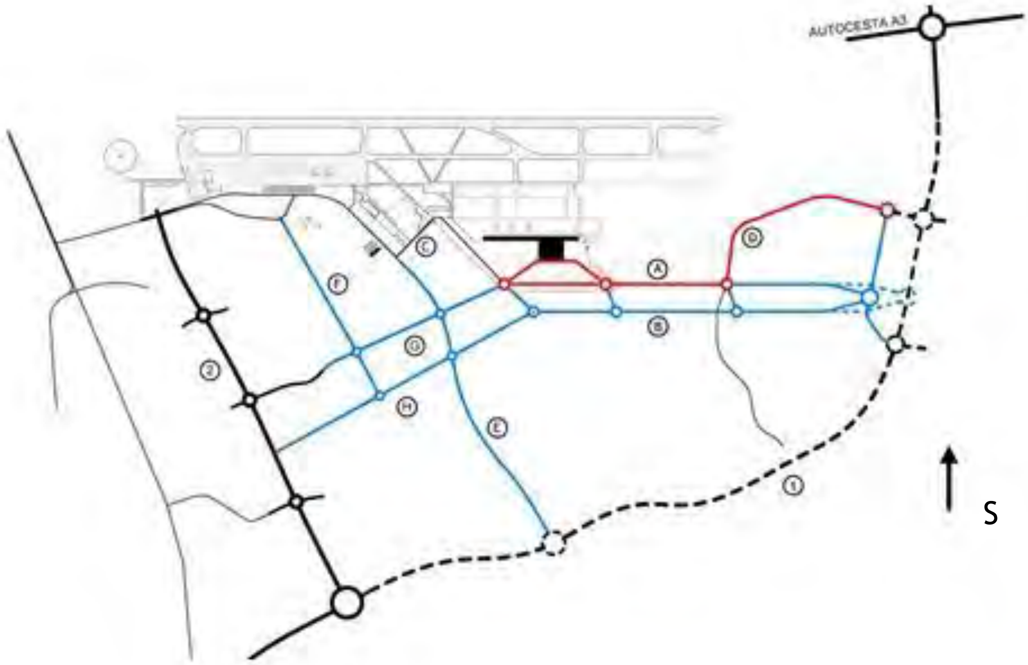


Figure 1.3.4.-1. Schematic presentation of a wider network of roads

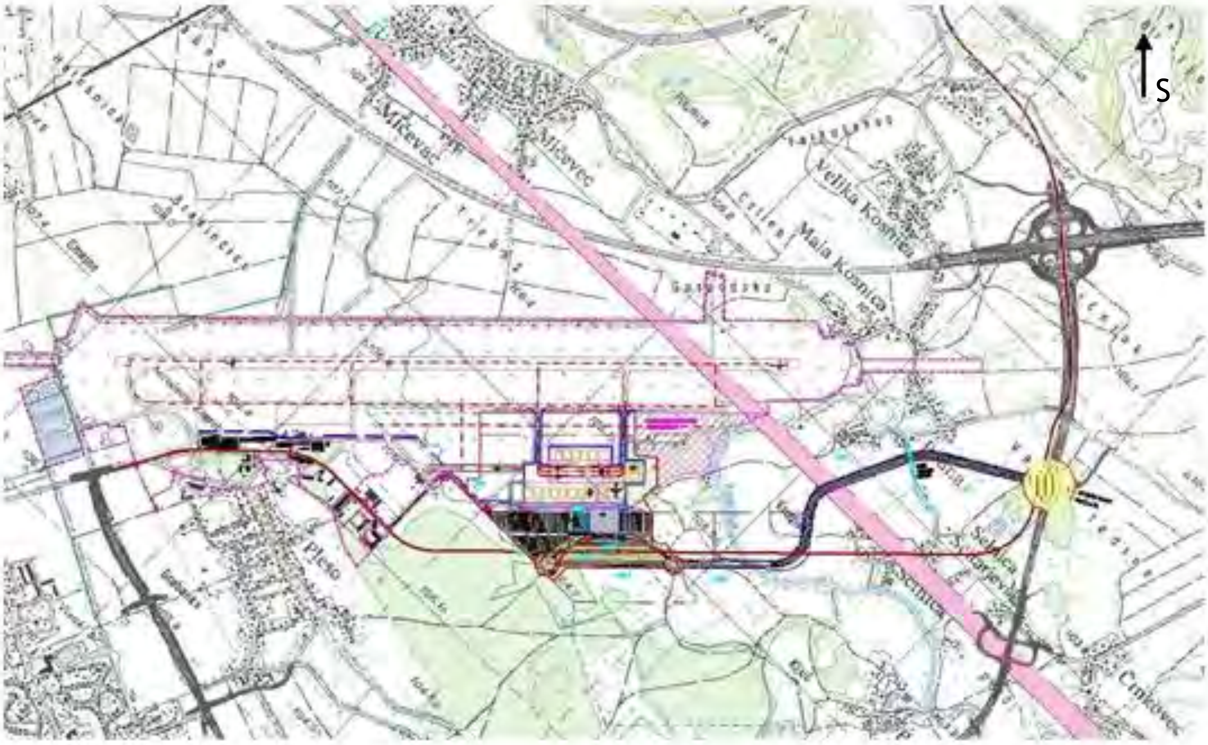


Figure 1.3.4.-2. Presenting wider road network in relation to the project

ACCESS ROADS NPT (D + A)

The Decision of the Regional Plan for the City of Velika Gorica (Official Bulletin of Velika Gorica, 10/06) in the diagram no. 1 "The use and intent for areas", access roads from the eastern bypass of Velika Gorica to the limits of Zagreb airport is drawn in the category "State Roads", with a 100 m wide corridor.

The area of coverage and the planned route of the access roads, is cut by the local road L-31 154 (V. Mlaka (F 3109) - Mićevec - M. Kosnica - Selnica Ščitarjevska (Ž 3068) with an asphalt roadside curtain. Within the coverage area in the local road L 31154, the water supply pipeline profile Ø 200 mm is laid. Within the coverage area there are no buildings.

The Conceptual Design of access roads to the new passenger terminal at Zagreb Airport determines the construction of the access road from the eastern bypass of Velika Gorica to the new borders of the Zagreb airport, determined by the borders of coverage that are approximately 2009.90 m long.

The positioning of 0 +000.00 km is determined by the intersection of the major axis of the eastern bypass of Velika Gorica and the access road. The zone of crossing these roads is outside the coverage limits of the access roads, and the solution is taken from "The project plan for the building permit for the bypass of Velika Gorica", created by architectural bureau PALMOTIĆEVA Ltd. for design and engineering, April 2007.

The actual start of the access road at the end of the subject crossing (realized) in km is 0 +135.20, so that the real length of the work is 1874.70 m. In the middle of the corridor of the access road is a secured belt of 10.50 m (part D), and 6.00 m (at point A) for the construction of the lighting, vegetation and a drainage collector.

On the part of the access road designation A, northwest approximately 60 m from the axis of the road is a planned corridor of light rail vehicles for the public transport of passengers (light metro) from Zagreb across the Homeland bridge, junction Kosnica, crossing the eastern bypass road for Ščitarjevo and access road (part A) to a new passenger terminal at Zagreb airport. The rail system, in the part after coming down from the overpass at junction Kosnica, enters the underground and towards the airport it is designed as a subway. The NPT has reserved space turntables (possibility of phase variations) and the route ends in the area of the existing passenger terminal. In the future it is planned to lead a corridor running from the junction Kosnica to the railway station Velika Gorica, in the corridor of the eastern bypass of Velika Gorica (partly underground / above ground).

The access road is planned with two roads with two lanes, separated by a green belt, the design speed is 60 km / h. Duplex pavements are 7.0 m wide between the northwest roadway and bicycle paths for two-way traffic a green belt 1.4 m wide is planned. Beside the bicycle path of 2.00 m, a footpath 1.60 m wide, and green belt that is 1.50 m wide are planned.

Along the south-eastern roadway a 1.50m green belt is also planned. The bicycle and walking paths should be separated by height or horizontal markings.

The design solution determines the construction of local road crossing L 31154 by the overpass through the access road for the new passenger terminal at Zagreb airport (in km 0 +709.25 km).

Longitudinal gradients of level crossings are 6% and 8% in the eastern part because of the existing residential buildings. The radii of vertical curves are R = 500 and R = 300 m and R = R = 250 m and 400 m in the eastern part of the transition.

Conditions for the construction of municipal infrastructure

In the zone within the control line of the access roads it is possible to provide belts for cable installations for the utility infrastructure designed for all standard types, serving both a local and wide area along the road.

Expert guidelines for obtaining a building permit (preliminary design) will determine the distribution of belts and corridors of the public infrastructure.

Situational solutions will also be displayed for certain types of utility infrastructures.

The cross-section in the conceptual design will also show the arrangement of belts of the utility infrastructure that will include the display of certain belts of utility infrastructure and their relation to the major axis and the regulation lines.
All lines of utility infrastructure should normally be deposited into the middle of the belts that area intended for them. Transverse lines crossing municipal infrastructure should generally run in the zone of crossing roads.
All existing and new transverse lines crossing municipal infrastructure should be physically protected in a technically correct manner (tubing, etc.) and it is considered a liability during the construction or reconstruction of any traffic or green space, or the infrastructure itself.

Drainage

For surface drainage of the pavement and pedestrian paths it is predicted to lay down a sewer in the north-western and south-eastern road in the axis of the side lanes, for which a belt that is 20 m wide is secured. Because of the water conservation area of Črnkovec well field, a sewage system should be built with a closed drainage system with waste water treatment plants. The drainage and treatment system will be defined by special water rights conditions while obtaining the building permits for the access road. The treatment system will most likely involve grease and oil separators with an additional device with a high degree of purification and removal of suspended and floating matter over 80%, and metals and dissolved salts more than 70%.

Electro-energetic lines and public lighting lines

Two belts 1.5 m wide are predicted in the main axis of the road in the green belt between the north-west pavement and bicycle paths for laying power lines and street lighting lines within the corridor of the access road

Conditions for formation and urban equipment

Conditions and guidelines of this ruling also apply to the part of the urban equipment and formation that are directly used for street improvements. Roads and footpaths will be constructed in asphalt concrete.
With the solution of constructing a roadside, by selection of material and processing of pavement surfaces, conditions should be provided for the safe movement of vehicles, surface water drainage, and to minimize the emission of noise and transmission of vibration.
Furthermore, one must ensure the conditions for the controlled precipitation of all polluted rainwater and eventually effluents from the pavement and all other surfaces within the corridor area of the road and prevent runoff of contaminated rain water to the surfaces of the contact zones. Public lighting should meet the aesthetic and functional characteristics of space and light - technical norms.

Requirements for landscaping

The green belts between the pavement and the bike paths is predicted for planting low vegetation and hedges in the division belt, at the proper distance to ensure the horizontal visibility. The Selection of plantation species (ornamental grasses and low shrubs) and landscaping of these areas according to their dimensions, relations in the primary street level and in particular in relation to underground belts for utility infrastructure lines, should be carried out within the appropriate project documentation.

Conditions for the free movement of persons with disabilities

While preparing the project documentation and during the execution of works it is necessary to apply the provisions of the Regulations on Accessibility of buildings for people with disabilities and reduced mobility (OG 151/05).

Protection measures

The planned road in the mentioned area allows the free movement of fire fighting vehicles in order to adequately protect buildings, assets and people from fire. With the construction of the road, it is necessary to comply with the Law on Fire Protection, Regulations on technical standards for indoor and outdoor hydrant network, as well as all other applicable regulations in this matter.

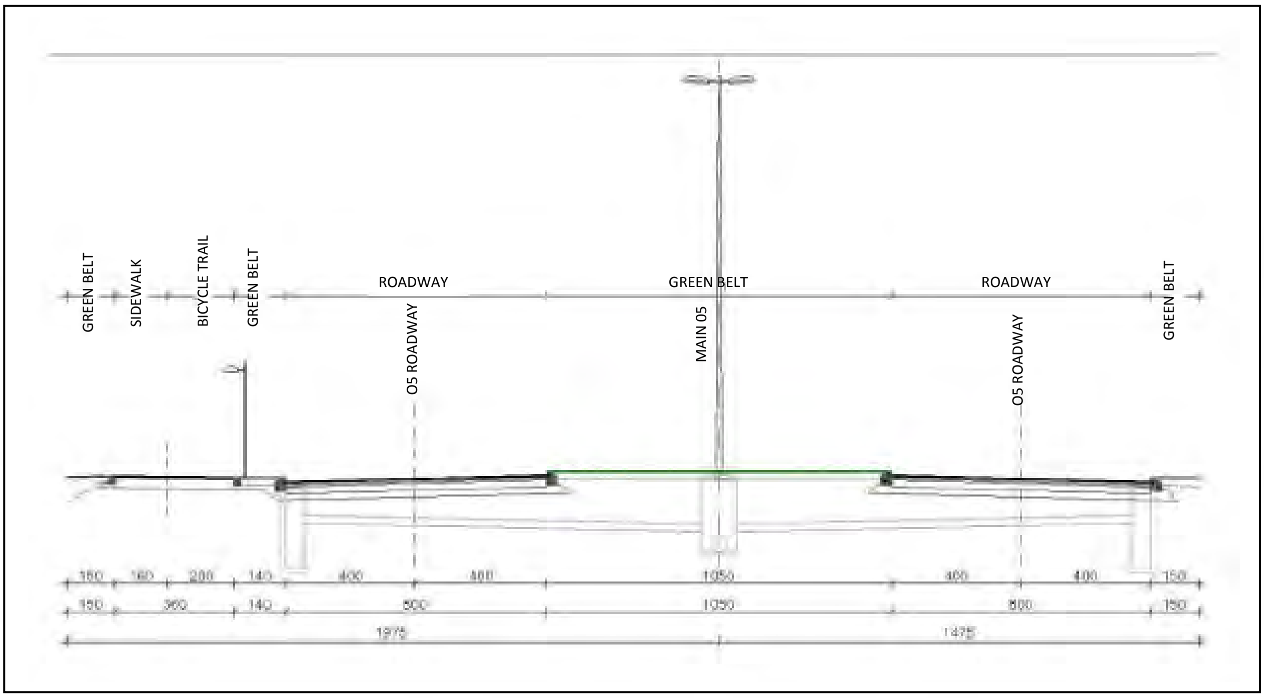


Figure 1.3.4.-3. A typical cross section of the access road

THE CONCEPT OF MOVING TRAFFIC IN THE AIRPORT ZONE OF THE NPT

Access to the airport building and other support facilities, is solved by the separation of the access road with two circular intersections (R = 27 m, Rv = 34.5 m). After crossing, the service roads are separated by an incoming part (the ground level) and the outgoing part on + 9.40 m (ramp). Traffic at ground level can be bidirectional, and unidirectional on the outgoing area.

With over two circular intersections it is possible to service all directions. From service roads, access is provided to parking or garage spaces in the area of the airport building.

Access road A is connected over the circular crossing to the access road B, which allows the possibility of mirror traffic solutions in the next phases of expansion and development of the airport complex (according to another airport building and / or runway). A prerequisite for the realization of such a program is definitely moving military facilities from that area.

Parking and garage spaces are between the access road A and the airport complex. The parking spaces are separated according to the purpose and length of parking. Employees, taxi and bus vehicles have their own parking spaces. Public parking spaces are divided into short-term and long-term parking areas.

Garage spaces are placed between the access road and airport building and footbridges are connected with the airport building.

Rationalization and the phase level are mostly related to the current capacity needs and possibilities of the NPT and the property-legal availability of space. In this context, a rellocation of parking spaces and the related internal roads has been performed.

The phase level is graphically shown in attachment 1.2.3. of the Situation with a scale of 1: 10 000.

PHASE 1

The Incoming platform at ground level is 40.0 m wide and is functionally divided into the apron for taxi vehicles, apron for bus and parking lot. Traffic areas are separated by 3.0 m pedestrian islands (7:20 in front of the airport building). Transient pavements are separated by a 12.0 m wide island with the possibility of an internal circular flow of traffic (for searching for parking spaces).

The service road is a two lane road. From the service roads, branches are predicted towards parking areas and supply ramps of the building (also the fire roads).

The outgoing platform at +9.40 m is 20.0 m wide. The traffic flow is carried out un-directionally from arrival to departure. Traffic areas are functionally divided into a taxi aprons, a bus apron and a parking lot for the short-term parking of cars.

The platform and access ramps (two-lane roads, at least 160 m long) were constructed on the facility (poles in dividing islands at floor level). Longitudinal slope of the ramp is 5.86%, and the platform on the north side is performed in such a length that it can meet the future expansion of the airport building in the second phase.

Along the edges of the access ramps and the platform, a footpath 3.00 m wide is constructed with a boundary fence and lighting.

Parking areas are standard dimensions for certain types of vehicles, with vertical space (optimal utilization of the area), with accompanying pedestrian communications and landscaping.

Along the airport building a taxi parking lot is located at the north-eastern side, with 339 PM (waiting to go to the apron in front of the light-regulation). Following are further parking lots for buses (48 PM). Short-term parking is located in the southwest side of the building (1298 PM, including the necessary number of parking spaces for disabled people, approximately 5%).

Through the space of this parking lot passes an access road from the existing terminal to the NPT.

On these roads there are secured controlled approaches to the parking area.

On the southeast side of the building is a parking lot for the personnel (156 +16 invalids PM) with its own controlled access. Parking is performed on level -1, and in this stage only descending / ascending ramps and outer walls (no roof panels) are performed. Through these ramps is access to parts of the building to -1. floor (supplies, luggage, space for rent, etc.).

Between the access platforms and access road A, a garage facility is planned at a minimum unfinished version at this phase (due to the possibility of performing the construction of the metro station) with access from the platform (1 input / output) and from access road A (2 inputs / outputs). The facility is connected by pedestrian communication (underground, above ground) to main building. If there was commercial interest, the realization of the garage in full extent is possible.

In the zone covering the works on the building, and access platforms, it is necessary within the scope of works on NPT in phase 1 (building construction), to perform the construction of a 480 meter long metro station. The route then continues towards the city and the existing terminal, a special investment procedure and is not the subject of this study on environmental impact.

PHASE 1b

The works of phase 1b on the realisation continue to relate to the content of phase 1 and the expansion of the parking lot on the northeast. A parking lot for the disabled (338 PM) is predicted behind the bus parking and north (803 AM) and south (832 AM), short-term parking between which the larger dividing island (green) with shuttle bus stations. The entrance to the parking lots is from the access road A between the two rotors. In case of lack of possibility to solve the legal issues for the area of the mentioned expansion of the parking lot to the north-east in due time, the parking area can be temporarily located in the green belt in front of the building, between two avenues (A and B). Another option is to immediately build a multi-level garage in front of the approaching platform to the building of the NPT.

A cover plate and its contents are predicted on the parking lot for the employees.

The solution of property - legal issues on the mentioned area, would be in interest of the state institutions, because the space in front of the building would be given better economic use than to use it for temporary parking spaces.

PHASE 2

In this phase it is planned to upgrade the parking lots for long term parking (2610 AM) on the north-east side, in addition to the parking spaces for short-term parking. Inputs to these parking lots (two inputs) are from the access road A. The construction of a dividing island with shuttle bus stations is also predicted.

TECHNICAL ELEMENTS OF TRAFFIC AREA

Access roads

Mp :	60-70 km/h
Rmin:	160-300 m
Roadway width:	2 x 3.50 m
Width of edge band:	2 x 0.50 m
Dividing belt width:	10,50 m
Circular intersections at the entrance to the airport:	Ru = 27.0 m
	Rv = 34.5 m
inner lane boundary	r_t = 2.0 m
Planned Central crossing (phase 3) the Eastern bypass:	Ru = 77.0 m
	Rv = 89.0 m
inner lane boundary	r_t = 2.0 m

Service roads

Access to platforms	2 x 3.50 m (ground floor) + 2 x 3.5 m above floor
Approaches to parking lots	2 x 3.00 m
Internal roads in parking	6.00 m
Internal roads in platforms	3.50 m (one with a longitudinal parking - taxi) 4.00 m (one with a longitudinal parking - BUS) 2 x 3.5 m (two-way, with parking personal vehicles)

Access ramps
facilities (garage, supply) 2 x 4.0 m (1 x 4.0 m)

Pedestrian paths

tracks, crossings	min 3.0 m (4.50 m, 11.70 m - regarding the width of the entrance to the building)
Islands	min 3.0 m

Parking-garage spaces

width	2.50 m (personal), 3.5 m (BUS) - vertical
	2.20 m (personal), 3.5 m (BUS) - longitudinal
depth of	5.00 m (personal), 12.0 - 15 m (BUS) - vertical
	6.00 m (personal), 13.0 m (BUS) - longitudinal
Internal roads	one-way 4.50 m, two-way 6.0 m 6.0 m (1.5 m),
Rmin	12.0 m (BUS)
slope of the ramp (garaža)	max 12 % (rounded or fracture alignment)

SPECIFICATION OF TRAFFIC AREA

Number of parking spaces:

Incoming platform (ground)

taxi	14 PM	(Posted length 85.0 m) - - longitudinal extension option in the second phase of the building)
BUS	8 PM	(Posted length 104.0 m) - Longitudinal possibility of extension of the second phase of the building)
Passenger	38 PM	(Posted length 228.0 m)

Outgoing Platform (+9.40 m)

taxi	12 PM	(Posted length 72.0 m) - longitudinal extension option in the second phase of the building)
BUS	6 PM	(80.0 m length setting) - longitudinal extension option in the second phase of the building)
Passenger	30 PM	(Posted length 180.0 m, Duplex)

Outside parking:

Parking for staff:	301 PM+ 16 Handicap PM
Parking for taxi:	339 PM
Parking for bus:	48 PM
Parking lot short:	1072 PM + 1635 PM (Phase 1B) + 56 handikap + 338 PM (Phase 1B)
Parking lot Long-term:	2610 PM (Phase 2)
Total Phase 1:	1832 PM (1973 PM - Phase 1B)
Total Phase 2:	2610 PM

Garage building: 5 floors, 342 PM / floor, total: 1710 AM

ORGANIZATION OF CONSTRUCTION

Concrete plant type "ORU ONE-DAY 2250" which is planned to be installed on the project area of construction meets all the criteria, regulations and legal acts and has all certificates conditioned by the Croatian authorities.
When installing and using the same, particular attention will be paid to the impact on the environment and the production of concrete. Accordingly, the process of procurement and delivery of materials needed for production (aggregate, cement, water, ...) to the site and storage of the same, to achieve the final product (concrete) besides the disposal of waste resulting from the manufacturing process (waste concrete and water), all necessary measures shall be taken to reduce the impact of manufacturing on the environment.
According to the above, the fraction is transported by trucks from the contracted gravel company and then stored in designated "boxes" that are properly covered, the cement will be transported in tanks and stored in silos containing prescribed filters, technical water will also be transported in tanks and stored in the containers, and waste concrete and water will be recycled in a recycling plant, which is an integral part of the concrete factory.
All materials for the production of concrete needed for the construction work in ZLZ will be shipped from the Factory of concrete products (TBP) Pojatno - Viadukt Plc. Vehicles for the transportation of material will be trucks with the total weight of 20-27 t. From TBP Pojatno the vehicles enter the state road A2 and move in the direction of Zagreb, then in the junction Zaprešić they enter on the A2 motorway and continue in the direction of the Zagreb bypass (A3) to the junction Kosnica, where they are separated on the eastern bypass of Velika Gorica and over the temporary junction (D road - image 1.3.4. - 1) entering the construction site of the new Zagreb Airport.

Asphalt for the construction of the Zagreb Airport will be transported by trucks with the total weight of 20-27 t from the asphalt base Trstenik Nartski - Viadukt Plc. Vehicles will move from the base to the county road Ž1036 to Ivanja Reka, where they will through Slavonska Avenija and the junction Ivanja Reka, through the Zagreb bypass (A3) continue to move west towards the junction Kosnica. Here they separate at the eastern bypass of Velika Gorica and enter through a temporary connection to the construction site of the new Zagreb Airport.

All machinery and construction machines will be shipped from Radnička cesta (base of Viadukt) through the junction Kosnica to the eastern bypass of Velika Gorica, and through a temporary connection to the construction site.

1.3.5. Power supply and distribution

The energy block that will be used for the new passenger terminal at Zagreb Airport is predicted to be about 1km west of the new passenger terminal, next to the existing road south of the plot of Croatia Airlines (complex). Given that the location of the energy block at the moment is not yet definite, a possibility exists for its relocation closer to the building of the new passenger terminal.
The parcel on which the power plant will be placed with its equipment and accessories takes up approximately 50 x 50 m. The power plant will be connected with the positions of the final users through the installation channel.
The architectural scheme also proposes the use of solar photovoltaic systems to generate electricity. Solar panels are placed on the solid parts of the roof. Similar systems have been used successfully in the Munich Airport.

The proposed energy supply system has the basic attributes of the "green" concept because it uses:

- Highly efficient tri-generation system that significantly reduces fuel consumption Compared with conventional energy production through separate processes of reducing emissions
- Natural gas as "the cleanest fossil fuel," regarding the possibility of environmental pollution
- Bio-gas as an alternative in the future exploitation
- Photovoltaic elements as optional solution for the production of electricity and the coverage the basic needs of emergency during power failures and changes in the electricity supply.

Technologies for producing energy

The solution for the production of electricity that will be used in the new airport is based on tri-generation (which is known as "combined heat, cooling and production of energy "or CHCP). Tri-generation is a term derived from the well-known process of cogeneration (CHP) and can be defined as the transformation of the (primary) fuel in the three types of energy: electricity, heat (steam or hot water) and cooling (energy for cooling; chilled water), with a parallel reduction of environmental pollution (less emissions such as CO2, CO, NOx, SO2, etc.), and a higher overall efficiency compared to the situation in which these types of energy are produced in a separate process. Thanks to the use of exhaust gases from the gas turbine operation within tri-generation block, it can be estimated that the rate of efficiency of complex systems is as much as 76%, and in some cases more.
Given that electricity is derived by tri-generation, it is mainly used to meet local needs within the airport facilities and auxiliary units (in this particular case, such use may be extended to the existing airport facilities, cargo facilities, airport city, etc.), losses due to the transmission of electric energy are negligible. For these reasons, the energy savings from the use of tri-generational plants amounts to approximately 15 to 40% when compared with conventional solutions for the supply of energy (steam / hot water boilers, electric refrigeration compressors, etc.).

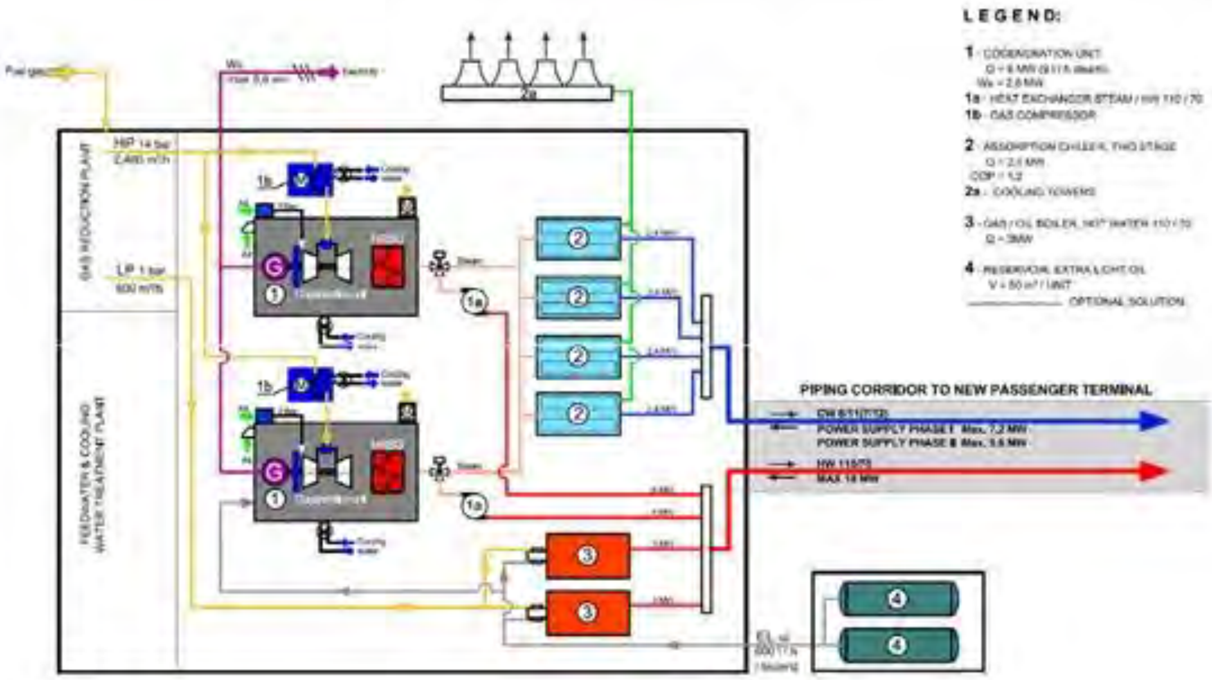


Figure 1.3.5.-1. Design of the energy block

The planned solution for energy supply implies a modular capacity increase in accordance with the tiered construction of the new airport and its facilities. The transmission channel for energy pipelines and power lines connecting the power plant to the consumer in the new passenger terminal and passes along the route for the internal roads will be realized for the needs of the final capacity in Phase I of the energy supply.

Table 1.3.5.-1. - Phases of energy supply for the new terminal

SUPPLY ENERGY PHASE	CONSTRUCTION PHASE	THERMAL ENERGY (MW)	COOLING ENERGY (MW)	ELECTRIC POWER (MW)	NOTE
Phase I	Phase I	18 (2 x 6; 2 x 3)	7,2 (3 x 2,4)*	5,6 (2 x 2,8)	2 cogen. block
Phase II	Phase I + II	18 (2 x 6; 2 x 3)	9,6 (4 x 2,4)	5,6 (2 x 2,8)	2 cogen. block

* Planned are three absorption chillers, and maybe an extra set if becomes necessary due to an increasing demand for cooling energy. Generally, the requirements for cooling strongly depend on the percentage of glass facade elements (for insulation).

Phase I of energy supply plans the installation of two cogeneration blocks with a gas turbine as a plant and with a possible peak production of 2.8 MW of electricity energy and combined production of high pressure steam in the steam generator for waste heat (HRSG) and the amount of energy produced from 6 MW (9.0 tones of steam per hour). In the winter mode, the production is planned of hot water at 110/70 ° C in the supplementary changers of heat on steam / hot water to heat the building of the new passenger terminal. The air compressor for the supply and compression of air for ignition is located next to the gas turbine.
Figure 1.3.5.-2. shows the cogeneration plant (one block) recorded in open space. The cogeneration plant of the NPT of Zagreb Airport will consist of 2 blocks and will be located within the building of the power plants, so in that sense there can be minor changes in the supply of fresh air for combustion in the gas turbine, as well as the position of the chimney.

COGENERATION PLANT – GPC 30 DLE
Nominal strenght 2.8 Mwe, water steam 9 t/h

Figure 1.3.5.-2. Display of cogeneration plant

As for the emissions from the cogeneration plant, technology is the most important thing underlying the combustion process in a gas turbine cogeneration unit. At the facility of the NPT of Zagreb Airport, world-renowned manufacturers of equipment with the latest technology in reducing emissions will be used. According to data provided by Kawasaki for their cogeneration unit GPC 30 DLE, using the technology of "Dry Low Emissions" and natural gas as fuel, declared emissions of dangerous gases, in the presence of 15% of O2 in smoke gases are: NOx = max. 25 ppm (mg / Nm ^{3}) and CO = max. 60 ppm (mg / Nm ^{3}). Given the low NOx concentration there was no need for its further reduction, which significantly reduces the operating costs of the plant. And all the other components of smoke gases meet the rigorous demands of the German TA-Luft standards. The amount of exhaust emissions are primarily determined by the combustion process in a gas turbine, heat output and type of fuel. For the anticipated operating conditions at the level of the project plan, that are defined as:

Fuel:	natural gas
Inlet air temperature:	15 ° C
Pressure:	101.3 kPa
Rated output al. power:	2.9 MWe
Thermal effect:	9.17 t / h steam

The mass flow of exhaust gases through one cogeneration unit is 57,000 kg / h, with exhaust gas temperatures at the exit of the turbine of 531 ^{0} C. At the exit from the stack, depending on the cogeneration mode, the exhaust gas temperature is 120-180 ^{0} C. The final choice of the cogeneration unit with a different type and manufacturer of gas turbines can lead to variations in the mass flow rates of the exhaust gas of approximately + / - 5%.

The noise level of the cogeneration unit with a standard anti-noise encapsulation (acoustic insulation) is 80 dB at a distance of 1 m, as measured in the open. The noise level of the cogeneration unit with enhanced anti-noise encapsulation (increased acoustic insulation – so-called "Low noise version") is 65 dB at a distance of 1 m, measured in an open space. Given the effect of indoor space and simultaneous operation of both cogeneration blocks, the overall level of the noise sources within the power plant area will certainly be greater than individual values declared above. However, the effect of sound damping the power plants, as a facility significantly reduces dispersed noise to the surrounding area.

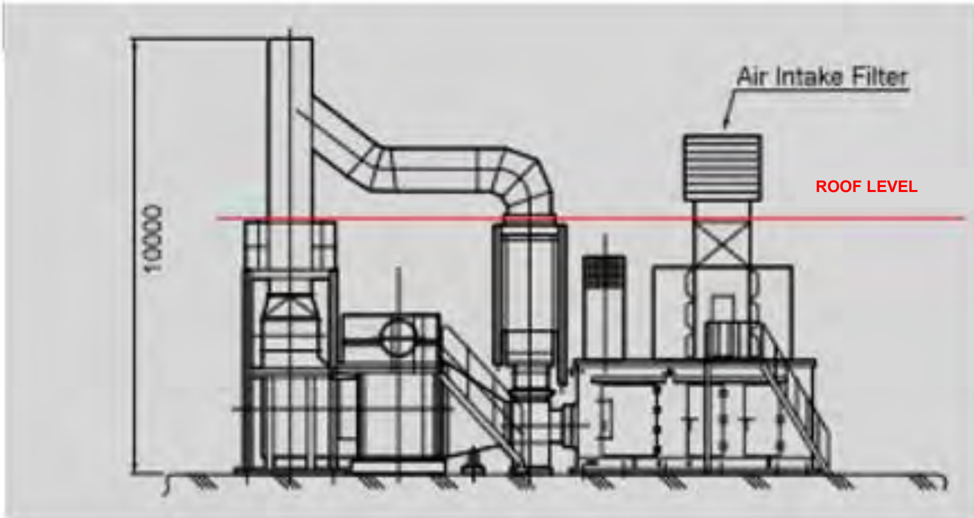


Figure 1.3.5.-3. Side view of the cogeneration plant - standard version

Figure 1.3.5.-3. shows the side view of the cogeneration plant. The height of the chimney must be at least 10 meters. The orientation roof level is indicated in red and located at approximately 6 m. The external dimensions of the power plant, as well as the facility, which will as well as cogeneration be used as storage for other devices and equipment (cooling aggregates, boilers, pumps, etc.) and shall be 25 x 25 x 6 m. The roof of the power plant or an area next to the power plant should provide space for cooling towers with absorption cooling units.

Cooling towers and its work is just temporary and depends on the seasonal modes, can be seen as an occasional source of noise. However, the noise level of cooling towers in this stage is difficult to determine, given that the market offers a number of technical solutions that aim to have noise reduction and can achieve almost all of the required customer requirements (increased diameter fan impeller while reducing speed - Figure 1.3.5.-4, acoustic panelling along with mounting noise absorbers - Figure 1.3.5.-5, etc.). As the most disadvantaged noise level, the cooling towers can take those listed for a cogeneration unit with increased anti-noise encapsulation, or a maximum of 65 dB at a distance of 1 m from the side of the device.

Figure 1.3.5.-4. The counter-flow cooling tower - "Low noise" performance achieved by fitting a large axial fan with speed control

Figure 1.3.5.-5. The counter-flow cooling tower - "Low noise" achieve performance with acoustic encapsulation and installation of noise absorbers on the intake and exhaust of air

Regardless of the level of acoustic attenuation, which will be in the further design phases determined as a reference for the selection of cooling towers, all of them must be in so-called PABCT performance (Engl. "Plume abated cooling tower"). It is a type of cooling tower in which during exploitation there is no appearance of a condensed water vapor cloud in the exhaust air stream, which occasionally occurs during the standard operation of cooling towers. The mentioned cooling towers in PABCT performances are designed to work in the immediate vicinity of airports, highways, etc.
For cooling the new passenger terminal, Zagreb Airport will use absorption cooling aggregates with two degrees (coefficient of usability - 1.2), and 2.4 MW of cooling capacity that uses high-pressure steam supplied by cogeneration and generates water chilled to 6/11 ° C (optionally 7/12 ° C). The absorption aggregates are associated with a cooling tower for cooling water of the condenser with the aid of appropriate installations. Absorption cooling aggregates are characterized by the fact that they have a significantly lower noise level compared to conventional piston or turbine cooling devices. The reason for this is the minimum number of moving masses, and the entire cooling cycle is based on the conversion of the two-phase medium (water and lithium bromide).

Figure 1.3.5.-6. *Two-stage absorption cooling aggregate fired with steam*

The noise levels of the absorption cooling aggregate for characteristic measurement points are given in the chart below. As seen in Figure 1.3.5.-7, the noise level is between 81-82 dB (A) in the standard production of the aggregate.

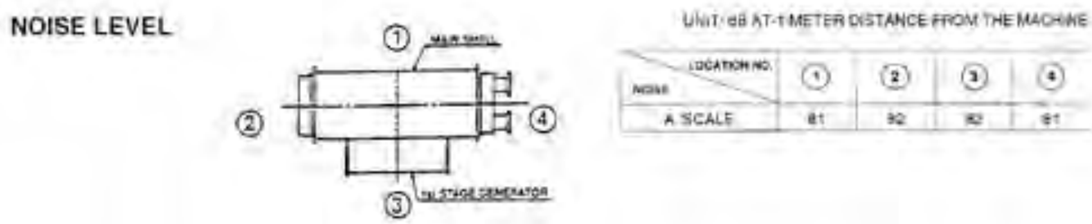


Figure 1.3.5.-7. Noise level of the absorption of the cooling aggregate

It is estimated that it would be enough in Phase I to supply energy to three incorporated absorption coolers while the fourth would be installed if the requirements of energy for cooling exceed 7.2 MW. Here it should be noted that the evaluation of the energy required for cooling, primarily intended to be used for air conditioning systems in the building of the new passenger terminal, heavily depends on the properties of the space and the selection of materials for glass surfaces and their reflective properties.

In Phase I of the power supply, two boilers should be installed to heat the water so that they achieve satisfactory safe operation and to achieve higher efficiency in comparison to the necessary requirements for heating. Boilers will work together with the cogeneration block in case the block is not able to fulfil the requirements for thermal energy (in the case of the so-called "Peak thermal load"), or when it will not be possible to make the supply the power made by cogeneration to the national electricity grid, or when the work of the cogeneration block is not cost-effective. However, the boilers can also be used in emergency situations (lack of or insufficient gas supply), and in this case the fuel that is used is extra light EL heating oil from tanks. It is estimated that in these conditions, the boilers for heating water, with a maximum efficiency of 6 MW of power will be able to successfully respond to the demand of heat until the outdoor air temperature is less than 8 ° C for a time period of one week (depending on the tank).

The number of boilers to heat water will not increase in Phase II of power supply.

In Phase I of energy supply, fitted will be two underground storage tanks for EL fuel oil, with a total volume of 100 m3. These tanks will allow the aforementioned independent work of the boilers to heat water for a week with a maximum rated capacity of 6 MW. The capacity of the tanks can be increased at all stages of construction, depending on customer preferences in terms of the independent work of the energy plant, although in that case it would be important for a timely planned underground space and matching water-tight pool.

The plant for the supply and treatment of water, for the supply of the generator of steam to waste heat (HRSG) and adding cooling water from the condenser in the absorption coolers. The maximum request that provides 120 l / h of softened water is planned for Phase I of the supply of energy.

Natural gas with a lower calorific value ranging Hd 33100-40200 kJ/m3 will be used as the primary fuel for meeting the entire energy needs on the level of the entire year.

In Phase I of the energy supply it is necessary to meet all fuel requirements based on the need in terms of fuel consumption from Phase II. This means that the maximum gas consumption is estimated at 2400 m3 / h at high pressure (14 bar) for cogeneration (2 cogeneration blocks), and 800 m3 / h at low pressure (1 bar) for heating with boiler for heating water.

EL heating oil and diesel fuel will be used as an alternative (backup) fuel source. The capacities of these alternative sources of fuel can vary greatly, depending on the desires of users in terms of independent operation of the energy facility. However, this form of consumption is anticipated only in emergency gas shortages.

Security System
Under the proposed settlement, the Zagreb airport facilities will be supplied with electricity from four independent sources:

1. Power network (HEP) 3.4 MW
2. Tri-generation 7MWt 2.8 MWe, with a combined fuel: natural gas or diesel.
3. Tri-generation 7MWt 2.8 MWe, with natural gas as a fuel
4. Photovoltaic collector with a total capacity of 400 kW

All 4 (four) energy sources are synchronized and work in parallel. In the event of any problem with any certain sources, facilities of Zagreb airport will be supplied with energy from the remaining sources without interruption. In the case that electricity from the HEP grid and both tri-generations is not available (the probability of that happening is less than 0.1125%), Energy is then generated from photovoltaic cells. The capacity of these cells, however, is not sufficient to meet the consumption needs of Zagreb Airport so, in this case, it will be necessary to selectively exclude some less important consumers in order to facilitate the proper functioning of the system (no overload).

Gas supply
Due to the significant role of natural gas in the work of the concerned tri-generational plant, special attention has been given to the technical capabilities and the development plans of companies that appear as potential suppliers of gas, or the operators of transport or the gas distribution systems. We consider that also any eventual solution regarding the local energy supply of the new facility of Zagreb Airport which can be reached during the elaboration in the later stages of the project, must come from natural gas as a primary energy source. The reasons for this are its competitiveness in the energy market, its simple distribution to the final consumer and environmental friendliness in all modes of exploitation. Only in the case that supplying energy to the new Zagreb Airport is resolved through mediation of the heating system of the city of Zagreb, gas supply would then not be considered.
The primary supply of gas is assumed as coming from City Gas Zagreb (GPZ). Local companies for the distribution and supply of gas, such as VG Gas Ltd., were not considered because they are small distributors who do not have their own independent supply, and the original supply of gas continues to be done through GPZ.
Pursuant to valid regulations and in accordance with the regulations of the European Union to liberalize the energy market, or to separate the management of the network from the energy suppliers, "Gradska Plinara Zagreb" Ltd. established a new legal entity - "Gradska Plinara Zagreb - Opskrba" Ltd. In this sense, the regulations of the gas supply terms are the responsibility of the mentioned new legal entity.
In connection with the technical possibilities, GPZ has a main high pressure (HP) gas pipeline DN 250 mm, which was passed along the incoming state road D408 to the access road to Zagreb Airport. On the site of the road junction there is a branch with intersection DN 150 for the needs of a gas reduction station which supplies gas to the power plant of the existing Zagreb Airport. According to information provided by a representative of GPZ, the capacity of the main VT pipeline can meet the needs of the new passenger terminal of Zagreb Airport for gas, which according to the present energy resolution amounts to about 2,400 m3 / h at peak load (heating regime). Any eventual need for changing the dimension of the connecting pipeline will be verified during the preparation of the forthcoming phase of the project documentation.
The concerned magisterial VT pipeline has a maximum operating pressure supply of 6 bars. In the event that the primary mover ("prime mover") of the cogeneration units is using gas engines, the specified pressure is entirely satisfactory, along with a mandatory reduction and stabilization. For the eventual operation of gas turbines as the primary drivers of the cogeneration plant, preferred are the higher pressures (> 10 bars). In this case, the connection to an existing VT gas network of GPZ would imply the attachment of the so-called “booster” gas compressor with the planned cogeneration unit, which would ensure the requested increase in pressure.

Both of these solutions are technically feasible and the final decision will depend on the commercial delivery terms described in the types of cogeneration units.

Estimated annual gas consumption

Estimated annual gas consumption will significantly depend on:

- the chosen power plant (tri-generation, the conventional solution and others)
- the physics of construction (coefficients of U, g and alike.)
- set values of the management system (temperature and relative humidity of the area, ratio of recirculation / fresh air, etc.)
- regimes of ventilating spaces (can save up to 30% in cooling mode)
- percentage of recuperation (recovery) of heat
- and a number of other specific project solutions (such as "free cooling" in the transition periods, controllable blinds on glass facades and alike).

The orientation estimates of annual consumption of natural gas, which is based on a conservative approach, would amount to about 5 million m3 / h ± 10%. The stated amount is assumed with the use of tri-generation and natural gas as an energy source throughout the year, along with the standard solutions of thermo-technical installations in the facility.

Energy supply from heating systems

As an alternative to a full year usage of gas, considered also are other options of supplying energy to the NPT of Zagreb Airport. In regards to this, there was a discussion with representatives of HEP Toplinarstvo Ltd on the possibility of connecting to the thermal network TE-TO.

The conclusion was that despite the great interest in supplying energy to the facility of the NPT of Zagreb Airport by HEP Toplinarstvo, for now there is no possibility of connecting to the thermal network since there are no appropriate hot water pipelines. The possibility of connecting the City of Velika Gorica to the heating system was already considered, but for now it is not realistic to expect that such a significant procedure will start with its realization during a time period which would suit the construction of the NPT.

HEP Obnovljivi izvori energije Ltd for the moment only at the study level consider building a Bio power plant on the volume of wood that would be placed in the wider territory of Velika Gorica.

Although the planned capacity of 35 MWt and 20 MWe is more than sufficient for the energy needs of the NPT, it is estimated that the eventual realization of this project is very uncertain and therefore risky to the concessionaire.

As one of the possible forms of involvement in the project HEP Heating Energy supplying NPT listed the potential possibility that the same phenomenon as concessionaires power plants, based on the process described Tri-generation energy production. The Concessionaire role in the supply of necessary forms of energy for the new Zagreb airport can be done by other legal entities, registered for this type of activity.

1.3.6. Water Supply and Drainage

1.3.6.1. Water supply

Currently, Zagreb Airport is supplied with drinking water by VG Vodoopskrba Ltd., Kolodvorska 64, 10410 Velika Gorica. Zagreb Airport is via two water supply connections Ø200 mm (main and reserve) connected to the water supply pipe of Ø500 mm. In the past ten years Zagreb Airport repaired the internal water network which significantly reduced water consumption, and water consumption in 2001 amounted to 288,851.0 m3 (daily average of 791 m3), while in 2010 it amounted to 81,718 m3 (daily average of 224 m3), which means about 29% of water consumed in 2001.

For NPT Zagreb Airport it is planned to provide drinking water in the quantity of specific consumption per passenger of 100 l / passengers / day. The estimated number of passengers in a peak day is 18000, which is 1800 m3 of water per day at peak.

NPT ZLZ will be supplied with drinking water from two sources (directions):

- the planned location of the water supply pipeline to the existing NPT of Zagreb Airport DN500 water supply pipeline in the existing zone of Zagreb Airport.
- the planned location of the water supply pipeline to the existing NPT of Zagreb Airport DN200 water supply pipeline in the village Selnica Šćitarjevska.

The construction of the water distribution network in both directions will ensure greater security of the supply of drinking water for the NPT of Zagreb Airport. The situational presentation of these water supply pipelines are shown on graphic attachments 1.3.6.-1..

Technological and sanitary water power plants

For the purposes of the NPT of Zagreb Airport, included is the construction of power plants, and its need for technological and drinking water will be provided from the internal water supply system of Zagreb Airport.

Because of the technological process of power plants, drinking water will eventually be necessary to be technologically processed according to the requirements of the technological process (within the power plant facility that will adjust the internal water supply system of Zagreb Airport to the required quality of the technological process). At this level of completion of the project documentation, the required amount of technological water are approximately 120 l / hour (0.03 l / s), and the required amount of drinkable water for the domestic needs of employees is estimated to be about 360 liters / day (4 employees, estimated 90 l / employee / day). Generally speaking, these are relatively small quantities which will be secured from the stated internal water supply system of Zagreb Airport.

Firefighting water of the NPT at Zagreb Airport

For fire protection of the existing building of Zagreb Airport, water from wells at the southwest side of the existing runway is used. The optimal capacity of the wells according to the last measurement (2003) was 70 l / s. The wells were installed with 3 pumps (2 working and 1 reserve), with the capacity of 22.5 l / s and pressure of 6 bar. The water is now collected in backup water tanks with a volume of 4 x 10 m3. The fire protection system of the planned new passenger terminal of Zagreb Airport is based on the fire load, the size of fire sector, the study of fire protection and all in accordance with the Regulations on hydrant network, is defined as a system:

1. External hydrant network (for the space around the building of the planned NPT of Zagreb Airport)
2. For the interior of the building an internal hydrant a network is planned, a sprinkler system and System for extinguishing fires with water mist.

For the outdoor hydrant network we can expect the required amount of water of about 2100 l / min (About 35 l / s) for at least 2 hours. The water demand will still be supplemented with the required amount of water for the indoor hydrant system, the sprinkler system and the system for putting out fires with water mist.

Surface hydrants for fire protection in the area of the complex will be arranged at a statutory distance.
Defining the true necessary amount of water for fire protection will define the source which will also provide the same in quantity and quality (eg, if the existing well meets the requirement, the building of backup water tanks will eventually accumulate rainwater from roofs, etc.).
The existing Zagreb Airport has a concession for the abstraction of water in quantities up to 200 m3/yr at the present well field (data from water permits). Zagreb Airport has already sought permission to increase the abstraction of water from their own wells in an amount up to 10000 m3/year (existing concessions failed). If the construction of the NPT of Zagreb Airport get a higher demand of quantities of water it will be defined after the preparation of the project documentation on a higher level than previously stated.
In any way, Zagreb Airport must comply with current regulations: Regulation conditions of granting concessions for the exploitation of water (OG 89/10 and 46/12) and the Law on Concessions (Official Gazette 125/08).

1.3.6.2. Drainage

Runway and taxiway of Zagreb Airport
The runway and taxiway have solved the rainwater drainage but precipitation spills over the surrounding green areas and infiltrates the underground. Contaminated rainwater from the runway and taxiway will be collected and treated with the polluted rainwater of the standing area of NPT Zagreb Airport. The drainage system will be designed as waterproof.

Apron
The contaminated rainwater of the existing standing area of Zagreb Airport is collected and transported to the system drainage (linear channels, drains and sewers) to the existing internal system of internal traffic areas of Zagreb Airport (roads and parking lots). All contaminated rainwater (from the existing standing area, internal roads and parking areas) are lead and treated with two separator-settlers, and after treatment at the separator-settlers, they are let into the system of rainwater drainage of the city of Velika Gorica.
Contaminated storm water from the apron of the NPT of Zagreb Airport will be collected with the drainage system and will be treated with contaminated rainwater from the runway and taxiway. The contaminated storm water from the existing apron will be redirected to the common system for the collection and treatment of contaminated rainwater.
Prior to discharge to the recipient, the purified rainwater is to meet the criteria of the Codebook on the limitation of emissions of waste water (OG 87/10).

Plateau for de-icing aircrafts
The plateau for de-icing aircrafts and the prevention of ice will be in the apron which will be designed according to the Regulations of the airports (OG 64/10). In order to prevent the mixing of polluted rainwater from other parts of the apron (which are contaminated due to de-icing manoeuvre areas) with means for de-icing aircrafts, or the plateau for de-icing will have its own internal drainage system. The collected means for de-icing will be collected and further recycled and used for the same purpose. The contaminated rainwater will be directed towards the common system of collecting contaminated rainwater.

Plateau for the disposal of snow
In the present situation in the western part of Zagreb Airport a plateau is built (area with a milled final layer of asphalt) that is used for dumping snow. The same system has no plateau drainage, but the melting snow water freely flows to the surrounding terrain, and plunges into the underground.

The construction of the NPT of the Zagreb Airport in the place of the new apron will define the storage area for snow. The plateau for the disposal of snow will solve the drainage system on the same principle as rest of the apron.

Emptied toilets from the aircrafts
In the current situation, the discharge and transportation of contents from toilets from aircrafts is done with a special vehicle and the contents are poured into a control hole of internal drainage of the Zagreb Airport within the building of technical reception I. The same principle of emptying the contents of toilets from aircrafts will be maintained with the construction of the NPT of Zagreb Airport. Ultimately, the content from toilets from aircrafts together with sanitary and Zagreb Airport feacal waste water through an internal drainage system is connected to the drainage system of Velika Gorica and treated at the waste water treatment plant of Velika Gorica.

Drainage and sewage of NPT Zagreb Airport
In the present state, the sanitary sewage and wastewater of Zagreb airport is collected in Two pumping stations that pump to the drainage system of Velika Gorica (settlement Pleso). The capacity of each pump station is declared with a value of QSP = 17.5 l / s. Sanitation and feacal wastewater of Zagreb Airport is ultimately treated on an existing waste waer treatment plant of Velika Gorica.
As stated in Section 1.3.6.2.Vodoopskrba, it is planned to provide drinking water in a quantity of a specific consumption per passenger of 100 l / passenger / day. The estimated number of passengers on a peak day is 18,000, which is 1800 m3 of water per day at peak.
Further elaboration of technical documentation will define all relevant parameters for hydraulic calculation purposes (assuming that the maximum required amount of drinking water 80% goes into the feacal sewage, the daily coefficient of unevenness of the flow will be assumed as K = 1.5, etc).
The drainage of sanitary and feacal water from the area of the new Zagreb Airport will be solved with the construction of a collector K-Zagreb airport (of sanitary and sewage water, approximately 1900 m long with pumping Station CS-Zagreb airport), to a newly designed collector Pleso - Rakarje with a profile DN / ID 400 mm (Construction of the project documentation of sewage and waste water Velika Gorica, September 2010, Hidroprojekt-ing Ltd, Zagreb).
Sanitary sewage and wastewater NPT ZLZ will ultimately be treated in the waste water treatment plant of Velika Gorica.
Situational display of this sanitary sewage collector is shown on the attached graphic 1.3.6.-1.

Drainage of technological and sanitary wastewater of the power plant
The technological waste water of the power plant will be connected to the internal sewerage system of Zagreb Airport over the control measuring shaft (all in accordance to any special requirements of building a competent utility company) to meet the requirements of the Regulations on limit values of waste water (OG 87/10). The sanitary sewage and waste water of the power plant will be connected to the internal drainage system of Zagreb Airport.

Building and parking lots of the NPT of Zagreb Airport
Rainwater (roof) of the building of the NPT of Zagreb Airport are conditionally clean, and do not require treatment and according to the Decision on waste water (Zagreb County Gazette) are not to be poured into the underground through the permeable structure, but it is permitted to discharge it to the surface of the terrain. Accordingly they can possibly be used for watering green surfaces with prior accumulation and utilization during periods of summer months. The final decision shall be made to further develop the technical documentation or an alternative is to connect to the drainage system of parking areas and discharge into the Kosnica Channel.

Contaminated rainwater from the NPT of Zagreb Airport parking areas will be collected through the sewage system and treated before entering the Kosnica Channel. The alternative recipients of treated rainwater from parking lots can be at Bapča Channel or the Sava River.

GRAPHIC ATTACHMENT:
Annex 1.3.6.-1. The situation of the water supply and sewerage of the NPT of Zagreb Airport

1.3.7. Supply and handling of fuel

Today, the supply of jet fuel to aircrafts at the airport in Zagreb is performed by INA Avioservis Zagreb. The fuelling is realized with tanks with capacities of 30t. Jet fuel is produced and transported from INA refineries in Rijeka. Tanks come via the Zagreb - Rijeka highway, go down at the junction of Zagreb Airport, continue through Velikogorička Cesta and cesta Rudolfa Fizera and come to the site of INA aviation service. For the purposes of meeting today's airline fuel consumption, the annual average is between 7 and 8 tanks a day. The peak daily admission in the summer of 2011 amounted to 18 tanks, while the average summer consumption is 10-12 tanks. The consumption and sale of aviation fuel depends largely on the price of fuel in the Republic of Croatia, and these amounts must be adopted in the calculation of future demands and aviation fuel sales at Zagreb Airport.

The location Avioservis INA Zagreb where aviation fuel is picked and stored is not a subject of this study on the impact on the environment. As the technology is still connected to the daily business and traffic of Zagreb Airport, its explanation is given in chapter 3.17. Analysis of the relation of procedures under existing and planned projects, 3.17.2. Storage and supply of airline fuel.

Refuelling and filling air tanks can be activities that potentially create air pollution with volatile hydrocarbons and other volatile organic compounds. With the aim of reducing and preventing pollution, the complete handling of fuel shall be in accordance with the applicable regulations for transport and refuelling aircrafts under the supervision of an authorized person for fire protection within the airport, and in accordance with the Regulation on technical environmental standards for emissions of volatile organic compounds during the storage and distribution of petrol (OG 135/06).

The principle of fuel supply for the new passenger terminal at Zagreb Airport shall be according to the current practice, which is transferred from the air-fuel storage of INA Avioservis up to the airplane with aircraft tanks. The inlet of air fuel from the warehouse to the aircraft with product lines has also been viewed as an option, but the construction of this type of system is functional and economically viable only at airports with a turnover of more than 10 million passengers a year.

The refuelling procedure is strictly regulated and standardized with international regulations as well as the internal rules of service providers, in this case the INA aviation service. The standardized and strictly controlled procedure of refuelling the aircraft has primarily a backup role, but also includes environmental protection as an integral part of the system of quality service.

1.3.8. Artificial lighting

The planned expansion of airport envisages the construction of civil engineering structures (trails for driving, standing areas, access and communication paths, roads and parking lots), and high-rises (Passenger terminal and ancillary facilities).
For the planned expansion of facilities during the expansion of Zagreb Airport, the standards for road lighting HRN EN 13 201 will be used for road lighting and traffic lights. The road lights or the lights of the traffic infrastructure has, according to estimates, up to 50% impact on the total light pollution

which places it as the most important factor. This problem is located in the domain of road lighting designers which were given the task of finding enough effective technical – economical solutions. Lighting Design and luminous calculations will be performed under the applicable standards of respecting local conditions and the use of buildings. Lighting fixtures for the access road from the Kosnica junction to the parking lot in front of the Zagreb Airport is the usual road lighting in terms of HRN 13 201. The length of the route of the concerned road is about 7 km and it partly passes an urbanized area and crosses over local roads. The road lamps should be of a "cut-off" type, designed to emit light above the plane with lamps of 90 ° to the vertical axis of the lamp (pole).

As a light source high-pressure sodium lamps are predicted which are appropriate for the illumination of roads in the wider area of Velika Gorica. In accordance with the expected implementations of standards of road lighting, these sources will be able to be replaced with corresponding metal halide sources in the future without any additional work.

Near or inside the airport it is possible to apply a light source such as a LED or metal halide lamps, and because of adjustments to the colour of light with other light sources of that space.

Parking lot lighting shall be designed and constructed as required by HRN EN 13 201. The central illumination level will be 10 to 20 lx with a general uniformity of 40%.

During the project taken into account will be the requirement for face recognition for the users (Semicylindrical illumination). The selection of the colour of light is to be adjusted with the color of the light source lighting other areas / spaces. Suitable light sources would be with a spectrum of radiation similar to daylight (3000 K - 3600 K), and colour rendering Ra> 60. As suitable sources of lighting, there are LED and metal halide lamps. The selected lamps, other than required efficiency and distribution of luminous flux should have an aesthetic component.

In order to prevent light pollution, construction lamps will prevent emissions of the light flow above the plane at an angle of 90 to the vertical axis of the luminary / source. One should also take into account the reflective properties of the car park to avoid excessive amounts of reflected light to the environment. Brackets / lamp poles will be visually acceptable with a height of 2.5 to 4.5 m. The height of the beams / columns will be aligned with other surrounding buildings or vegetation. The proposed height of the columns is certainly smaller than height dimensions of the building and future plants, and typically located on the land side of the airport, so it should not have an impact on the accessing plane (see Figure 1.3.8.-1).

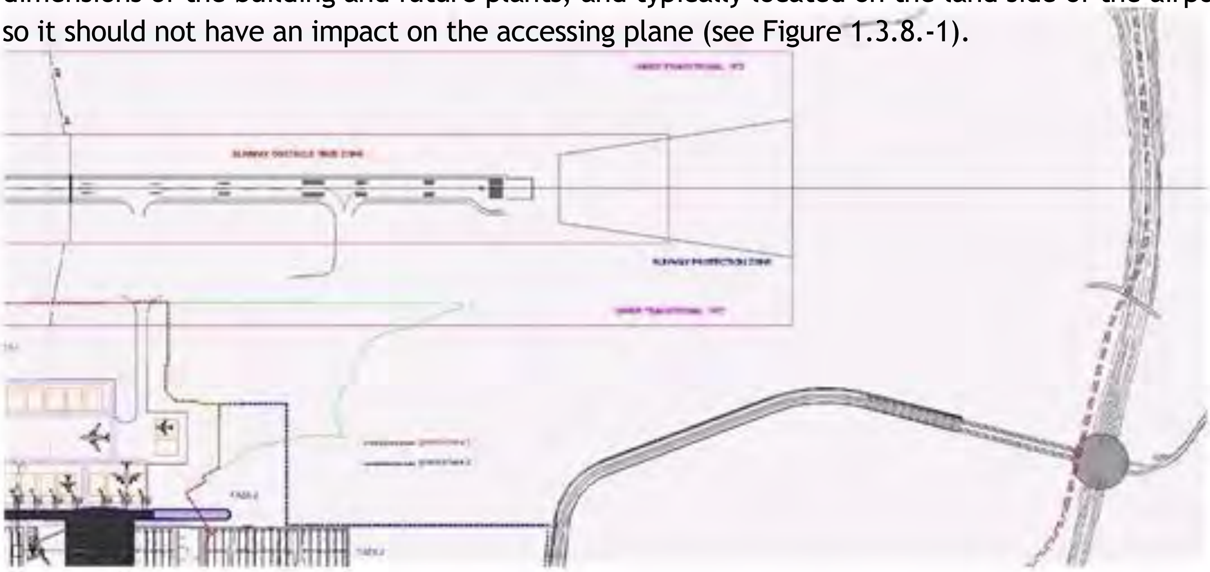


Figure 1.3.8.-1 the ratio of Zagreb Airport planes landing and new access roads to the NPT Zagreb Airport

The required level of illumination can be achieved by the mutual interaction between the horizontal distance of the light source, the mounting height of the light source above the observed surface, the amount of emitted light (power supply) and the distribution of light emission. A good ratio of the previously mentioned will provide adequate lighting, including terms of preventing light pollution.
The light of the aircraft apron will be adapted to the installation of lamps / reflectors, while it should be required to meet the light-conditions for the movement and operation supply and service vehicles and manpower. In doing so, special attention should be given to the Avoidance of a physiological and psychological flare. Basically, there are two possibilities of mounting and locating lamps / reflectors, on the construction of the façade airport terminal building or on poles located along the standing area in front of the building terminals.
The solution of mounted lights / reflectors on the front of the terminal assumes the possibility of installation and maintenance, in the sense of the terminal building, construction, and the materials used. In that case, following the construction of the building, there would be a series of apron lighting lamps / reflectors located along the front of the terminal building.
Applied luminaries shall have no effect on the area within the terminal building, therefore there cannot be any light "breaking" out of the area for which the lighting is predicted. In the case of an installation of a group of lamps / lights on lampposts, it is particularly important to bear in mind the possibility of locations because of the traffic - technical and safety requirements on aircraft aprons.
The disadvantage of this solution is the need for light posts within the premises or in the vicinity of the aircraft standing area, while the advantage is in grouping lamps / reflectors, which allows easier maintenance. The height of the columns will be aligned with the dimensions and appearance of the building.
The terminal should not violate the harmony of the entire architectural design.
Light colour lamps / reflectors will be similar to daylight, so light sources such as LED and metal halide lamps with colour rendering Ra ≥ 60 will come into consideration. The central illumination levels will be 15-30 lx, a general uniformity min. 40%.
The technical characteristics of lamps / reflectors, their mounting and the routing of optical axis prevent the dissipation of light above the axis parallel to the surface of the aircraft standing area. The demands of space presuppose the elimination of unwanted reflects of light to a minimum.
To illuminate the interior lighting of airport buildings, the standard EN 12 464 will be used, which provides the required illumination level for workplaces, while taking into account a possible "light intrusion," or a "light, which will be uncontrollably spilled outside the building."
All public lighting must also meet the requirements for protection against light pollution. It is recommended to use automatic programmable electronic control lighting (ballasts) in all areas where there is a traffic fluctuations during the night, to enable energy saving and reduction of light pollution of the environment.

1.3.9. De-icing aircrafts and manoeuvre areas

Treatment of the runway in winter conditions – de-icing, is done in a way that after removing the snow or slush using snowblowers, if necessary (when pavement temperatures are below 0 ° C) there is an approach for de-icing manoeuvre areas with the help of special airport de-icers, with a width of sprinkling of 24 m.
The following resources are used to de-ice runways:

- UREA 46 - granulate
- SAFEWAY KF HOT - liquid.

In the winter season of 2010/2011, a total of 102.413 kg of urea and 5302 liters (7210kg) of SAFEWAY KF-HOT was used for de-icing operational and transport areas.
Cleaning the manoeuvre area begins immediately after the discharge of road surface precipitation and when it reaches the blanket thickness of 15mm (slush and water), or 20mm if the snow is wet and 50mm if snow is dry, or earlier if there is a change in the braking coefficient of 0.05 units or more.
Cleaning is done in a way that the first ones out on the runway are 7 blowers who push snow up to the edge of the lighting lamps, and behind them if necessary are two snow blowers that throw the snow over the lamps to the green surface. After cleaning, the USS is approached with de-icers which, if necessary, defrost or prevent icing of the road surface. Upon completion of cleaning, a special vehicle comes out which measures the friction coefficient.

UREA 46N
Urea (carbamide) is a compound synthesized from ammonia and carbon dioxide. More than 90% of the world's production of urea is used in agriculture as fertilizer. At airports it is mainly used for de-icing surface gates. Urea is a white crystalline powder. Urea used for de-icing is generally lower in the world (some airports do not use urea at all) due to the fact that it is toxic to fish, increases the concentration of ammonia in the aquatic environment and causes great oxygen consumption in the process of nitrification. It is therefore increasingly replaced with other environmentally friendly, de-icing agents.
Urea is stored in a covered warehouse, packaged in its original packaging or in a bulk condition. At the same time it must be protected from direct moisture from the floor, the elements of sunlight and heat sources. The formation of dust in the warehouse should be prevented, urea should be placed away from possible sources of heat and ignition, and the prolonged contact with metals and organic materials should be avoided. Urea is not toxic (LD50 (rat) = 14 300 mg / kg), it is not carcinogenic, mutagenic and teratogenic. Urea is a biodegradable with enzymatic mineralization.

SAFEWAY KF Hot
55% aqueous solution of potassium formate. Clear, colourless to blue liquid without sediment. Contains about 5% more of the active ingredients than the standard means for de-icing and has the best capacity for melting ice. Easy to apply, and the dosage depends on weather conditions and situation on the dirt surfaces. Stored in steel tanks, plastic resistant alkali or steel tanks coated with a layer of synthetic resin. It does not contain chloride, nitrate, nitrite, and triazole. It is biodegradable. Has a low toxicity for the flora and fauna.

SAFEWAY SF Runway De-icer
Safeway SF is a granulated de-icing agent used to remove snow and ice from airport runways and aprons. It consists of sodium formate (sodium salt formic acid) and corrosion inhibitors. It is in the anhydrous form of white granules of irregular shape that can be easily sprayed on the surface, melting ice and packed snow and their relationship with asphalt or a concrete surface, thus making it easier to remove. It is effective at low temperatures (-17 ° C). Melts snow and ice faster than urea.

It is delivered in bags of 1000 kg or 25 kg (40 pieces per pallet). It should be stored in a dry place to prevent platelet granules in a well ventilated area, inhibit the formation of electrostatic charge. It does not contain chloride, nitrate, nitrite, and triazole. It is biodegradable. Nontoxic (medium lethal dose LD50 (mouse) = 2000 mg / kg).

SAFEWING is used for de-icing aircrafts in quantities of approximately 110,000 liters / year, and the chemical composition of it is propylene glycol - $C_3H_8O_2$. Propylene glycol is used as an antifreeze, in the means of de-icing, for making artificial fog (in theatres and on stage in general), as a solvent, a lubricant and an ingredient in food, cigarettes, drugs, and cosmetics preparations. Propylene glycol exhibits very low toxicity, and there is no data that it is mutagen or carcinogen. Present results in human studies do not confirm its reproductive or developmental toxicity.

SAFEWING MP I 1938 ECO
Low foaming orange odourless liquid in propylene glycol (88% solution) which is used in airports for de-icing aircrafts. Depending on weather conditions and temperature, it is prepared in aqueous solutions of different concentrations. It does not contain triazole. It is biodegradable. It is non-toxic to mammals (LD50 (rat) = 5000 mg / kg). It shows low toxicity to aquatic life.

SAFEWING MP IV Launch
Viscous green liquid in propylene glycol (50% solution) with a low content of surfactants. It is used (usually after de-icing with the means to defrost) as a tool against the formation of ice on the aircraft while the aircraft is on the standing place and during takeoff. It does not contain triazole. It is biodegradable. It is non-toxic to mammals. It shows low toxicity to aquatic life.

1.3.10. Cleaning the runway and waste management

Removing tire tracks and other debris from the surface of the runway is done with a high pressure water pump technology. The Stripe Hog 8000 device cleans only with help of clean water at a pressure of 2757 bar, without chemicals and additives.

With the help of high-pressure water pumps and vacuums, all resulting impurities from the substrate are simultaneously removed and cleaned in one passing. Unlike the mechanical removal of paint, or "milling" where the surface layer of asphalt is mechanically removed and thereby substantially impairing the surface, the water cleaning does not damage such surfaces. The water penetrates to the smallest pores of asphalt and rubber and pulls out tiny particles and other impurities without damaging the structure of the base. Vacuums are on the same head with nozzles that eliminates dirt, also there are vacuums that remove rubber and other impurities from the surface of the water, so that there is a clean surface behind the truck. The device separates waste in a manner that the water is drained and the tank is left with a dry mass that is submitted to an authorized waste collector.

Slika 1.3.10. Cleaning device for cleaning tire marks Stripe Hog 8000

Zagreb Airport today manages waste in a way that the statutory categories are separately collected and then handed over to an authorized collector for disposal. Zagreb Airport also regularly reports the produced and accumulated waste to the system of the Environmental Protection Agency.

In the area of Zagreb Airport waste and hazardous and non-hazardous production waste is produced. In 2010, a total of 158.052 t of production of hazardous and non-hazardous waste was registered. The table below shows the quantities of production waste for 2010 (source: Form PL-PPO).

Table 1.3.10.-1. Waste produced at Zagreb Airport in 2010

Key amount of waste	Name	Produced amount (t)
16 02 11*	Discarded equipment containing Chlorofluorocarbons, HCFC, HFC	0,201
14 06 01*	Chlorofluorocarbons, HCFC, HFC	0,03
15 02 03	Absorbents, filter materials, fabrics and wiping cloths and protective clothing that are not included in 15 02 02	0,16
15 01 10*	Packaging containing residues of hazardous substances or contaminated by dangerous substances	0,372
20 01 21*	Fluorescent tubes and other mercury-containing waste	0,619
16 06 01*	Lead-acid batteries	0,855
16 01 03	Worn tires	3,405
13 02 05*	Lube oil for engines and gears, based on mineral oil	3,415
16 01 07*	Oil filters	0,364
15 02 02*	Absorbents, filter materials (including oil filters not otherwise specified), cloth and wiping cloths and protective clothing contaminated by dangerous substances	0,718
16 04 14*	Antifreeze fluids containing dangerous substances	0,185
15 01 01	Containers of paper and paperboard	53,755
15 01 07	Glass packaging	7,16
19 08 09	Grease and oil mixture from the separator oil / water separation containing only edible oil and fats	8,989
20 01 40	Metals	0,58
13 05 07*	Oily water separator, oil / water	55,369
16 02 13*	Discarded equipment containing hazardous components other than those mentioned in 16 02 09 to 16 02 12	2,779
13 05 02*	Separator sludge from oil / water	19,151
	TOTAL	158,052

According to literature data, the average production of municipal waste per passenger is approximately 0.4 kg over shorter distances. Therefore, based on the number of passengers who used Zagreb Airport (for 2010 2 million passengers) about 800 t of municipal waste was produced.

1.4. ANALYSIS AND FORECAST OF TRAFFIC

1.4.1. Air traffic

In the realization of the project, the Croatian Government has decided to include the private sector in the financing, design, construction, operation and maintenance of the new passenger terminal and related infrastructure in Zagreb Airport, and management and supporting of the existing Zagreb Airport. In order to achieve these goals, the Vocational Commission for the concession of a new passenger terminal at Zagreb airport appointed InterVISTAS Consulting Group, a consulting service provider, for the transaction that will eventually result in a signed contract with a private operator.

The consulting firm conducted the predicted volume of traffic for a period of 30 years: 2010 - 2040. With the basic scenario (which is considered the most likely scenario of development turnover) scenarios were also developed for larger and smaller growth in transport volume to show the range of volume traffic which can be expected. Scenarios for larger and smaller growth in transport volume differ from the base case in terms of the expected economic growth, the development of the domestic carrier Croatia Airlines and the favourable impact of accession to the European Union.

Predictions were prepared for different elements of transport: passenger movements, movements of aircrafts and volume of freight. For the movement of passengers and aircraft, along with annual aggregate values, prepared were also predictions of peak hours. While the annual movement of traffic primarily served as input values for financial analysis, peak forecasts were used as input values for the analysis of capacity. In terms of movement of millions of passengers a year (MAP), the growth in transport was predicted of a volume with 2 mpg to 5.1 mpg under a scenario of lower growth in transport volume, 6.2 mpg under the baseline scenario and by 7.9 MPG according to a scenario of higher growth in transport volume.

Traffic forecasts

Traffic estimates are based on (i) the volume of commercial traffic since 2002, (ii) analysis corresponding to the growth of Croatian GDP, (iii) the result of the Agreement on Common Aviation territory of the European Union Open Skies 2010, and (iv) comparisons with neighbouring European countries, and resulted in the creation of forecasts up to 2040 at the level of the Republic of Croatia. The chapter includes the volume of passenger traffic and aircraft movements and forecasts of air freight traffic by 2040 as well as forecasts of the peak period.

1.4.1.1. Existing condition

The best traffic forecasts include a good understanding of the gravitational field that the airport serves. The socio-economic profile of the region determines the potential market fund of the gravitational field, and is described by parameters like regional GDP, the number of residents who live near the airport and income per household, but also takes into account the socio-economic composition of the key markets that are around the target airport.

Figure 1.4.1.-1. Main airports in Croatia

Figure 1.4.1.-2. Gravitational area of Zagreb Airport with circles of 100, 200 and 500 kilometers

Traffic profile
Through Zagreb Airport in 2009 there has been a total of 2.07 million passengers. Zagreb Airport Ltd recorded a strong combined annual growth rate (CAGR) of 8.0% calculated from 2002 because of the strong growth rates in the period from 2005 to 2008.
Regular commercial traffic covers more than 96% of total traffic at the airport in Zagreb. According to OAG's (Official Airline Guide), Zagreb Airport serves 36 destinations which 19 airlines fly to. Europe is the largest destination region, followed by the domestic market. The rest consists of passengers who fly from Eurasia and Eurasia (Istanbul), Commonwealth of Independent Countries (Moscow) and the Middle East (Tel Aviv). The passenger profiles are made of operational and ethnic reasons and transport is for the purpose of vacation, with incoming and exceeding outgoing.

The domestic market has covered 24.1% of the total regular commercial turnover in 2009, and the majority of the traffic was from and to Dubrovnik (46.0% of total domestic traffic) and Split (41.2%). The rest of the domestic traffic was to Pula (10.9%), Zadar, Brač, Rijeka and Osijek (the remaining 1.9% of the domestic traffic). After Frankfurt, Dubrovnik and Split are the largest markets served through Zagreb Airport, and together make up 21% of the total traffic through the Zagreb Airport.
In addition to handling more than 12% of the total turnover in 2009 (which is equal to the number of 241,000 passengers), Frankfurt is the largest market of Zagreb Airport. German airports together account for more than a quarter of the total passenger traffic, making them the largest market on the country level which is serviced by Zagreb Airport. Together, Germany and domestic destinations cover more than half of the total passenger traffic. Other prominent destinations are the key European hubs of London, Vienna, Paris, Amsterdam and Zurich over which passengers can connect to further flights, towards long-range destinations, such as North America. According to data from OAG, Zagreb Airport Ltd added three new destinations (Barcelona, Madrid and Gothenburg), and lost the services of three airports (Dortmund, Düsseldorf and Hamburg) in comparison with 2008.

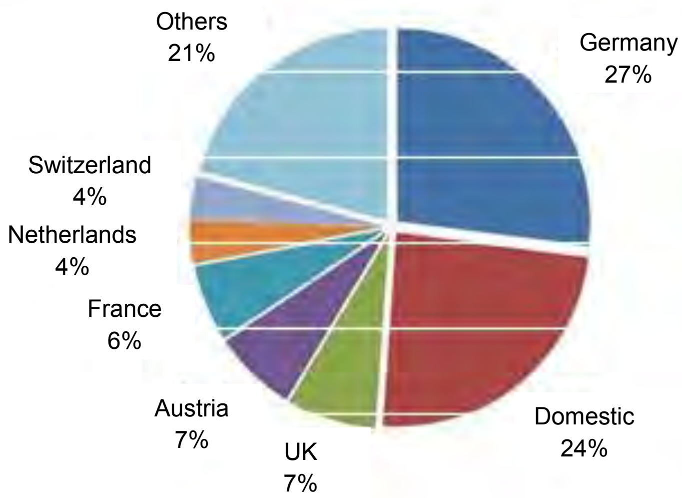


Figure 1.4.1.-3. Destinations of regular commercial traffic at Zagreb Airport in 2009, Source: Zagreb Airport Ltd.

Although most of the traffic at the airport is incoming-outgoing, the importance of Zagreb Airport as a hub is growing. Whereas in 2007, Zagreb Airport shifted 324,576 passengers, the number of passengers using the airport as a hub rose in 2008 by 34% to 434,024. However, half of the passenger traffic is carried on direct lines without stopping to and from the Zagreb Airport. On the way to the final destination, 28% of the total number of passengers had to stop at an intermediate airport, which is a normal level for a regional airport such as Zagreb Airport.

More than a third of passengers who presided at Zagreb Airport arrived from some domestic airport, where 93% of passengers arrived from Split (47%), Dubrovnik (36%) and Zadar (10%). Other airports that offer indirect connecting flights to the airport in Zagreb include neighbouring airports such as Sarajevo and Skopje, and there are large European hubs such as Paris, Amsterdam, Frankfurt and London.

The greatest flow of traffic-related flights accounted for traffic from Croatia to Europe (234.000 passengers), followed by traffic from Europe to Europe (82,000 passengers). An additional 45,052 passengers travelled between Croatian airports and North America through Zagreb Airport, while another 31,486 passengers through Zagreb Airport travelled between Europe and North America. It is not surprising that the majority of the traffic-related domestic flights were conducted by the carrier Croatia Airlines, which carried 93% of all transferred passengers.

The Croatian national air carrier Croatia Airlines (OU) is the dominant airline in Zagreb Airport so in 2009 it covered 69.3% of the total seating capacity for regular flights and 63.5% of the total regular departures (Source: OAG). OU in 2009 transported 1,334,680 passengers from Zagreb Airport and to Zagreb Airport, which is more than two thirds of the total passenger traffic through the airport. The second biggest airline of the seating capacity on regular flights in 2009 was Lufthansa (8.1%), followed by Austrian Airlines (5.5%), Malév (4.7%), Air France (4.7%) and Germanwings (4.4%).

The market of Zagreb Airport was controlled by the traditional airlines. However, after the arrival of low-cost carriers such as Germanwings and Wizz Air, the market share of traditional carriers has fallen to 87% of passenger traffic. The market share of low-cost carriers reached less than 10% of the total number of transported passengers.

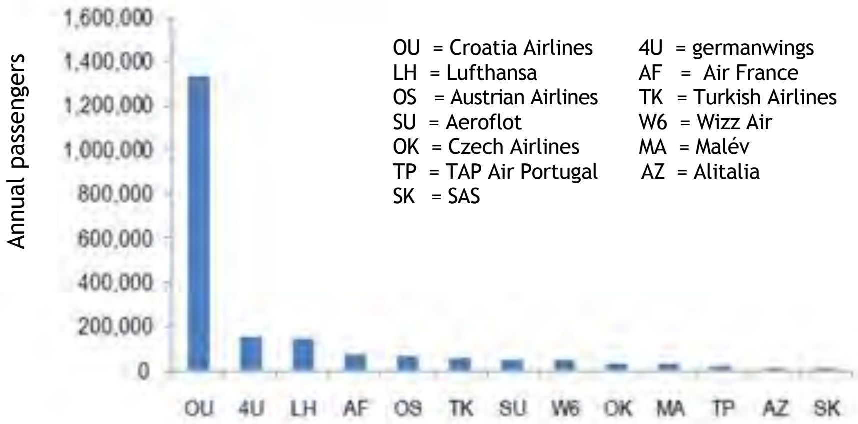


Figure 1.4.1.-4. Structure of passenger flights at Zagreb Airport by operators in 2009, Source: Zagreb Airport Ltd.

Composition of the fleet

The most popular commercial aircraft which operates at the airport in Zagreb in 2009 was a regional turbo aircraft Bombardier de Haviland Canada DHC Dash 8 Q400 (Or abbreviated Q400), with more than a quarter of all commercial operations. Another popular aircraft is the Airbus A318-A321 Family (for short and medium lines), the regional jet Canadair CL-600 RegionalJet CJR-100 and CRJ-700 and Embraer EMB120 turbo. The Boeing 737 and ATR 42 series of aircrafts can also operate at Zagreb Airport. These aircraft types account together for 90% of all movements in 2009. The composition of the fleet this year is similar. Most aircrafts belong to ICAO Category B and C, although you can find anything from aircraft ICAO Category D (Boeing 757) and E (Boeing 747).

Besides commercial aircrafts, Zagreb Airport also performs operations of general aviation and cargo operations. Typical aircrafts for general aviation are the Cessna C172, Cessna Citation, Piper PA31 and Beech.

The cargo is transported mainly through small cargo aircrafts such as the ATR 42, Saab SF34, Fokker F27 and Let L-410. There were also some occasional freight operations with larger aircrafts (such as Ilyushin IL-76), but the load is mainly transported by small regional turbo planes and jets.

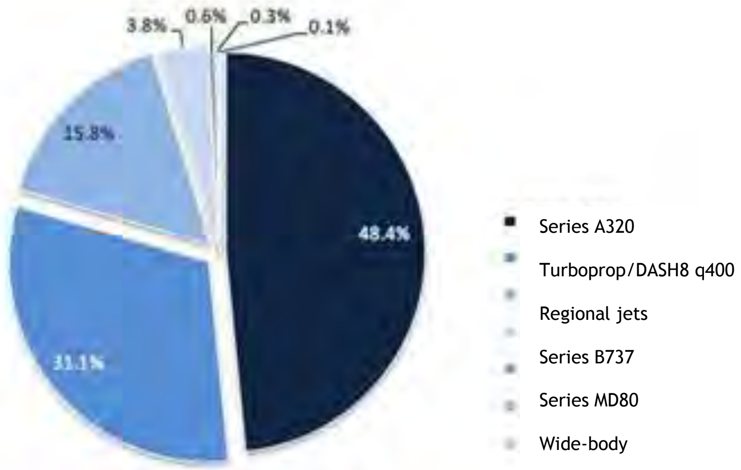


Figure 1.4.1.-5. The composition of the fleet operator Zagreb Airport Source: Zagreb Airport Ltd.

Competitive airports

Vienna International Airport continues to dominate as the largest airport that serves South-eastern Europe and in 2009 it executed the handling of 18 million passengers, mostly due the fact that the company Austrian Airlines, based in Vienna, strengthened its position as an airline preferred by business travellers and tourists in Austria, Central and Eastern Europe. The table on the next page shows a comparison and a classification of Southeast airports according to passenger traffic in 2009. The second International Airport after Vienna Airport is the airport in Budapest, Hungary, which is increasingly competing with Vienna international airport in terms of traffic in Central and Eastern Europe. Except for the airports in Vienna and Budapest, most airports in the Balkan region are regional airports, with less than 3 million passengers annually. After Belgrade (BEG), Zagreb Airport is the largest airport in the Balkan region. Given their relative proximity, the role of regional hubs and the overlapping of gravitational fields, Ljubljana airport (LJU) Belgrade and Sarajevo (SJJ) were identified as competitive airports and Dubrovnik (DBV) and Split (SPU) were added because they are competing with Zagreb Airport for travel traffic. The focal Budapest Airport is also included in the comparison.

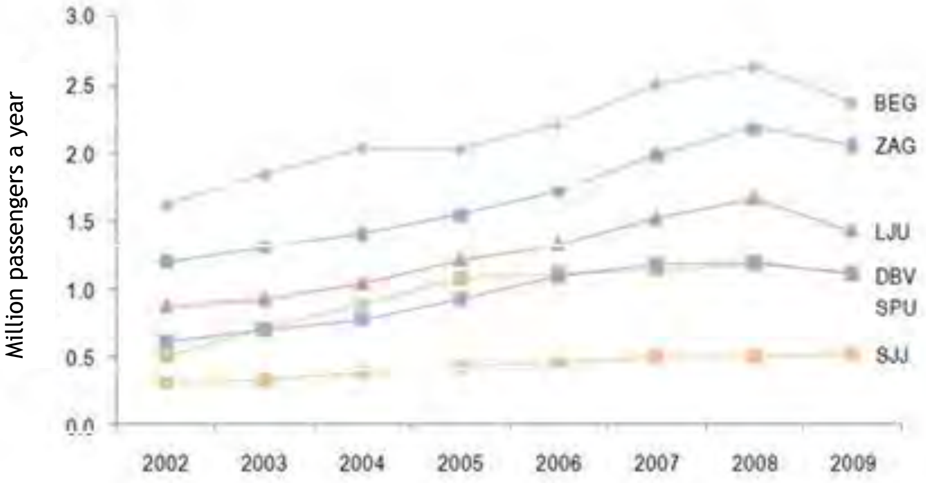


Figure 1.4.1.-6. Display of traffic movements in competitive airports to Zagreb Airport,
Source: Zagreb Airport Ltd.

The share of low-cost companies

According to OAG data for 2010, out of a total of 1.6 million seats in outgoing aircrafts, 172,560 seats will be on flights of low cost companies such as Wizz Air, Germanwings, Norwegian, easyJet and Spanair. This corresponds to the share of market penetration of low-cost carriers (LCC) of 10.4% and can be considered low in comparison with the European average of approximately 31%.

Other domestic airports such as Dubrovnik, Split, and Zadar in particular, have a far greater market penetration of LCC, partly because they are popular tourist destinations.

Although the surrounding airports in Belgrade and Sarajevo have lower market penetration of LCC from the Zagreb Airport, the current liberal policies of the European common air space (ECAA) and the forthcoming accession to the EU should open for Zagreb Airport many opportunities to attract new low-cost traffic. The airport would certainly use the presence of a local LCC, as it happened in Budapest (Wizz Air) and Tirana (Belle Air).

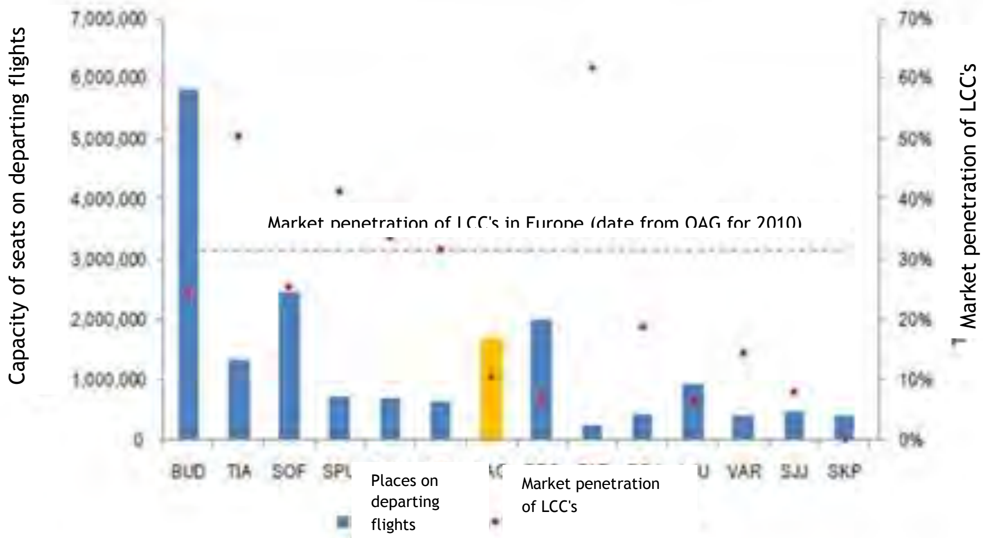


Figure 1.4.1.-7. The market penetration of low-cost carriers (LCCs) in Europe
Source: OAG data for 2010.

Competitive transport modalities

Due to the excellent connections with the continent, many tourists choose to travel to the Adriatic coast by car, especially from the neighboring, but also from distant countries, such as Germany and the Netherlands. Since road links with Europe existed for a long time, it is assumed that the balance between air traffic and road traffic selection is established. However, road networks can play an important role in attracting traffic from the gravitational field of the neighboring airports such as Ljubljana, Sarajevo and Belgrade, but also remote airports such as Budapest, especially when Zagreb Airport attracts other (low-cost) lines. Of course, it vice versa can happen, or traffic from the gravitational Zagreb airport area can turn neighbouring airports (such as Trieste) to take advantage of lower tariffs and a wide network in terms of correlation with air links compared with Zagreb.

Railways urgently need to be modernized. After the breakup of the former Yugoslavia, a minimum was invested in railway infrastructure across the country. Many routes are not electrified, many of them are monorail, and have large slopes and sections with many turns, all of which result in low average speeds. The network has been improved in the last ten years to allow for a higher top speed on the route Zagreb - Novska - Vinkovci. There are parts where the speed limit was increased from 80 km / h to 120 km / h and even 160 km / h. The modernization of railways will be further expanded with the help of the national investment plan for the railroad. Despite the development that is ongoing, the railway is not expected to pose a serious threat in terms of a replacement for air transport.

1.4.1.2. Traffic forecasts

Basis for forecasting domestic traffic

The parameter of paramount importance that dictates the growth of domestic traffic is the development of national economy, which is projected to grow at an average annual growth rate of 2.5% by 2040. Although the local economy is still in bad shape, it is appropriate to prepare air traffic forecasts that predict a different short-term economic recovery. Also, since it is not certain that the global economy has a long-term return to the levels of growth from the time before the crisis, a faster or slower economic growth should also be predicted. Because of this, the higher growth scenario assumes a 20% higher annual economic growth, while in the scenario of a small increase in traffic uses a reduced annual growth rate of 10%.

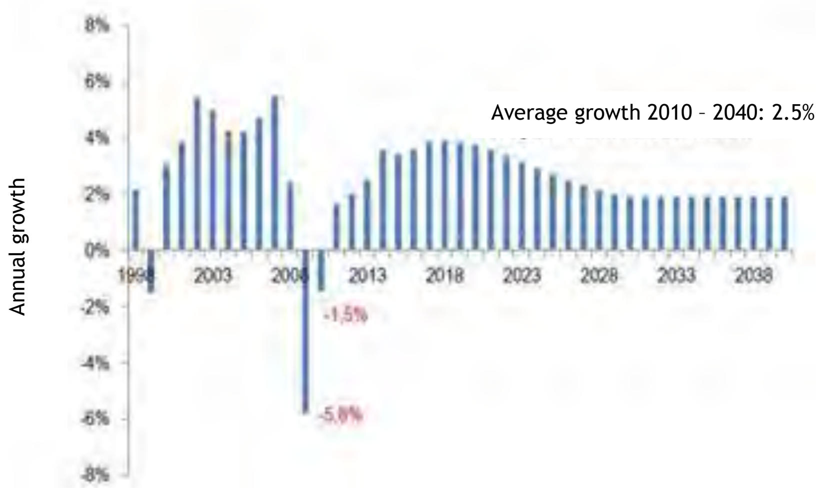


Image 1.4.1.-8. Prognosis of movement of GDP in Croatia until 2040, source: Economist intelligence unit

Basis for forecasting international traffic

Zagreb Airport is still a more incoming (passenger destination is Croatia) than an outward market, although it will develop into a more balanced outgoing and incoming market. As the key incoming markets of Zagreb Airport are in Europe, it is assumed that the economic development of the European Union is representative for the economic growth of key generating markets. While the domestic market has an income elasticity of 1, it is assumed that the incoming market has an income elasticity of 1.5, which will, in line with global trends, gradually fall to 1.2. The output market begins with a little higher income elasticity of 1.8, which will gradually fall to 1.4.

Based on the available data about actual passengers in 2010 as well as the schedule for next year as it was released by OAG, the results in terms of traffic as it provides access to top to bottom are adjusted to reflect the trends of 2010 and data capacity for 2011.

Several airlines, including national carrier, Croatia Airlines, then Germanwings, EasyJet, Turkish Airlines, have indicated that (concrete) plans increased frequency on certain routes and / or added new destinations:

- the global economic downturn has forced Croatia Airlines to significantly reduce capacity in 2009 and 2010. It is expected to increase the capacity by increasing the number of flights in 2011, while not adding new destinations. Croatia Airlines is also expected by 2012 to receive an additional Airbus A319, which will result in an increase of available capacities;

- having recently added Zagreb Airport to its network, easyJet expects to introduce more routes, with the current routes to London and Paris;
- with eight new aircrafts in the fleet, Germanwings is seeking to expand into the Croatian market which will result in increased air services;
- It is anticipated that the other carriers in general will also increase the frequency. Because many people abroad, it is expected that summer charter flights to North America will be reintroduced.

As research has shown, EU accession can be a big boost to the international air travel. Generally speaking, it is possible to identify three general trends when a State becomes the new Member State:

1) through integration into the EU market, the local economy gets a significant boost, which boosts the local preference for flying;
2) after the removal of barriers to enter the market, integration with the aviation market transport in the EU enables LCC's entrance into the relatively uncovered market;
3) taking advantage of the free movement of persons within the EU, migrant workers collectively leave the country and find a job abroad, as in the example of Latvia.

With the Croatian accession to the European Union, it is expected that the country will benefit from economic advantages offered by the EU. For example, EU membership means access to a vast single market and free movement of capital, labor and goods. Thanks to the increase in trade and a visa-free regime, the demand for mobility will increase, as has happened in the case of a few countries that have admitted to membership in the European Union before Croatia, such as Estonia, Lithuania, Latvia, Slovakia and Slovenia, which have become members in May 2004. Upon accession, their air traffic has significantly increased compared with the period prior to membership. The emergence of LCC in these markets is a large part of the initial growth of a catalyst, for example, when easyJet has expanded its network to Tallinn (Estonia) and when Ryanair introduced its services in Riga (Latvia) and Kaunas (Lithuania). Since the greater part of the network of domestic carriers Austrian Airlines focused on Central and Eastern Europe, the International Airport in Vienna also has benefited from rapid growth. Although Croatia has already signed an agreement on a single European airspace transport market, further integration into the European market could map the growth of air traffic from other member states, so its potential effect in this study is quantitative and qualitative.

<u>Developing scenarios of traffic forecasts</u>

Similar to the development of scenarios for domestic transportation, the higher growth scenario assumes the growth of annual economic growth rate of 20% for both Croatia and the EU, while the lower growth scenario applies reduced annual economic growth rate of 10%.
The airport can attract more and more services, and increasing the frequency of all operators, including:

- air lines to one of the Middle Eastern hubs for transportation in long-haul flights to Australia, which also have a large Croatian community, and for Asia;
- LCCs are increasingly recognizing Zagreb Airport as a favourite tourist destination for trips and visits to cities, resulting in a higher growth of LCC;
- In fact, one LCC decided to establish a base at the airport in Zagreb, which considerably increases the available capacity at the airport. Although it currently only has bases in Germany, germanwings can be a viable candidate;
- Along with the growth in passengers, numbers reached a critical mass for a long haul and regular lines for North America have been introduced. Initially it was limited to three per week throughout the summer season, but it gradually increased to a year-round line.

Croatia Airlines is achieving its ambition in becoming the leading carrier in the region, and is adding new aircraft to its fleet. As Zagreb Airport is the hub of this aviation company, it has substantial benefits from the success of the company as partner airlines also increase capacity at the airport to support its role as a regional node. Conversely, at a lower growth scenario, the domestic carrier is still bothered in searching for answers, especially on LCC operations. Similar to today's situation, on routes to which enter into the market and LCC, Croatia Airlines has no choice but to reduce the capacity for reducing losses. Due to the greater frequency and number of destinations, according to the scenario more growth, it is implicitly assumed that Zagreb Airport fails to attract traffic from gravitational fields of neighbouring airports, while at lower growth scenario vice versa applies. In terms of EU accession, the lower growth scenario incorporated a 3% growth in 2013, 3% in 2014 and 2% in 2015. A higher growth scenario is compliant with the relevant project documentation and has been accepted as a reference to this study.

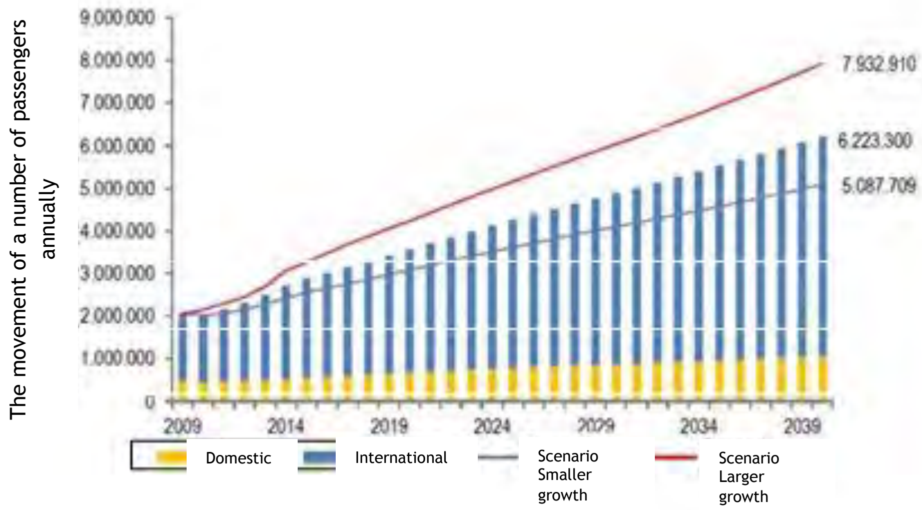
Results of air traffic forecasts

Figure 1.4.1.-1.: Forecast of passenger movements by 2040.

		2009.	2010.	2015.	2020.	2025.	2030.	2035.	2040.
Low-Growth Scenario	Domestic	479,706	423,303	532,378	630,937	726,369	800,839	872,870	951,379
	International	1,582,536	1,593,510	2,024,773	2,453,334	2,891,396	3,297,347	3,703,303	4,136,330
	Total	**2,062,242**	**2,016,813**	**2,557,151**	**3,084,271**	**3,617,765**	**4,098,186**	**4,576,172**	**5,087,709**
	*ann. gr.rate**		*-2.2%*	*3.7%*	*3.7%*	*3.6%*	*3.3%*	*3.1%*	*3.0%*
Base Scenario	Domestic	479,706	434,157	555,022	670,072	783,403	873,037	960,625	1,057,000
	International	1,582,536	1,620,280	2,339,034	2,893,920	3,472,337	4,017,231	4,569,645	5,166,300
	Total	**2,062,242**	**2,054,437**	**2,894,056**	**3,563,993**	**4,255,740**	**4,890,267**	**5,530,270**	**6,223,300**
	*ann. gr.rate**		*-0.4%*	*5.8%*	*5.1%*	*4.6%*	*4.2%*	*3.9%*	*3.6%*
High-Growth Scenario	Domestic	479,706	445,011	580,423	727,041	876,488	997,888	1,118,959	1,254,719
	International	1,582,536	1,698,004	2,681,358	3,508,911	4,287,252	5,040,511	5,822,466	6,678,191
	Total	**2,062,242**	**2,143,015**	**3,261,781**	**4,235,952**	**5,163,740**	**6,038,399**	**6,941,425**	**7,932,910**
	*ann. gr.rate**		*3.9%*	*7.9%*	*6.8%*	*5.9%*	*5.2%*	*4.8%*	*4.4%*

** compound annual growth rate in comparison to 2009 .*

Source: InterVISTASConsulting Group



Basic scenario

Source: InterVISTASConsulting Group

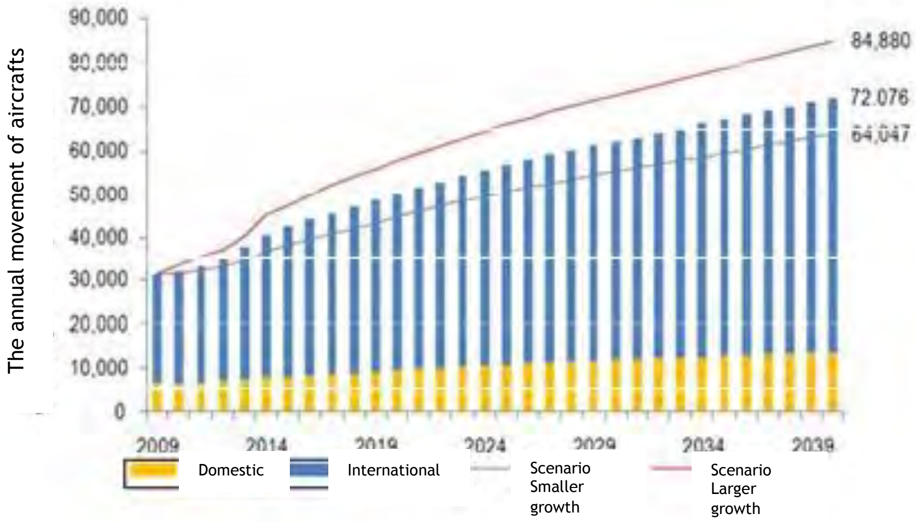
Figure 1.4.1.-9. Graphic of forecasts of passenger movements in 2040

Table 1.4.1.-2.: Prognosis of movements for commercial aircrafts until the year 2040.

		2009.	2010.	2015.	2020.	2025.	2030.	2035.	2040.
Low-Growth scenario	Domestic	6,592	6,041	7,629	8,916	10,123	11,008	11,836	12,727
	International	24,565	25,189	30,674	35,652	40,341	44,205	47,743	51,319
	Total	**31,157**	**31,230**	**38,304**	**44,568**	**50,464**	**55,213**	**59,579**	**64,047**
	*ann. gr.rate**		*0.2%*	*3.5%*	*3.3%*	*3.1%*	*2.8%*	*2.5%*	*2.4%*
Base Scenario	Domestic	6,592	6,196	7,855	9,301	10,669	11,669	12,604	13,617
	International	24,565	25,613	34,829	40,663	46,115	50,506	54,466	58,459
	Total	**31,157**	**31,808**	**42,684**	**49,964**	**56,785**	**62,174**	**67,069**	**72,076**
	*ann. gr.rate**		*0.4%*	*5.6%*	*4.5%*	*4.0%*	*3.5%*	*3.1%*	*2.9%*
High-Growth scenario	Domestic	6,592	6,351	8,115	9,918	11,672	12,979	14,220	15,587
	International	24,565	26,841	39,252	47,708	54,286	59,589	64,416	69,294
	Total	**31,157**	**33,192**	**47,366**	**57,626**	**65,958**	**72,568**	**78,637**	**84,880**
	*ann. gr.rate**		*6.5%*	*7.2%*	*5.7%*	*4.8%*	*4.1%*	*3.6%*	*3.3%*

** Combined annual growth rate in relation to 2009*

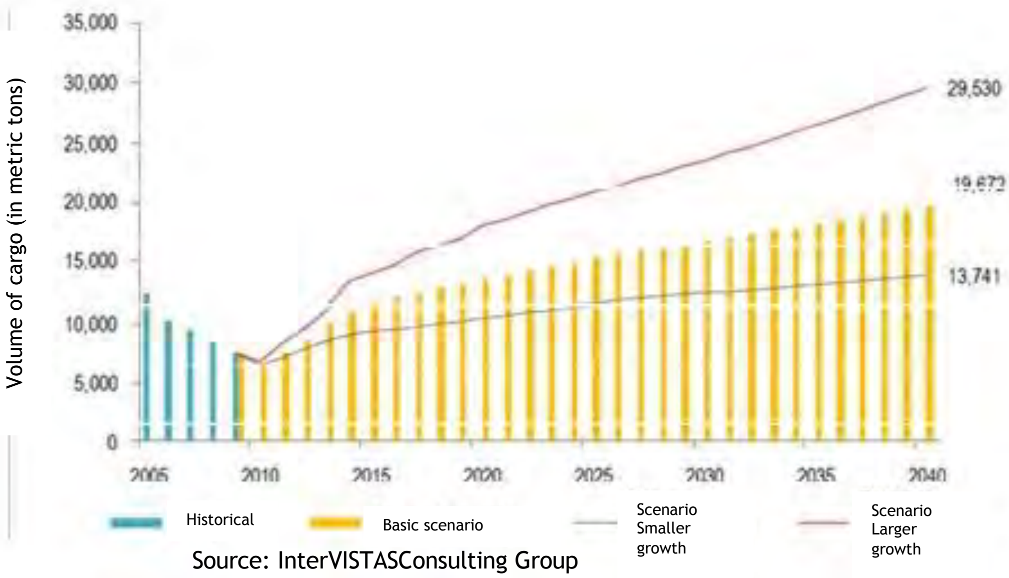
Source: InterVISTASConsulting Group



Basic scenario

Source: InterVISTASConsulting Group

Figure 1.4.1.-10. Chart Forecasts of commercial aircraft movements in 2040



Source: InterVISTASConsulting Group

Figure 1.4.1.-11. Forecast of freight traffic until 2040

1.4.1.3. Calculation of peak hour

Peak hour forecasts were derived from the annual forecast numbers to simplify the process of physically planning the airport. Forecasts of peak hours bring the number of passenger movements and aircrafts that can be expected during peak hours. The following forecasts are derived during peak hours for Zagreb Airport:

1. Forecast of absolute peak hour
2. Forecast of 30 peak hours

Absolute peak hour forecast is made to determine the number of positions for aircrafts that is required to accommodate all aircrafts. As all aircrafts in fact must take a physical position in the airport, one must identify the maximum number of aircrafts that can be expected at the airport at any time, so it is necessary to anticipate absolute peak hours.

Unlike the absolute peak hour used for airline operations, with the process of dimensioning passenger objects attention is focused on the prognosis of 30 peak hours. In order to avoid costly over-dimensioning, airports are usually designed according to 30 peak hours, or so-called peak design, wherein the airport has at a slightly lower level of services during a very short period of time, or 29 hours per year.

As a result of sizing objects to something below the absolute peak demand, a majority of travellers will have an adequate level of service, while only a very small and acceptable ratio of total passengers (in the remaining 29 hours) may have a partial impact of congestion and a lower level of service. However, traffic can still be managed. This impact can be reflected in the range of standing in line longer than usual, the use of less space per passenger, or to maintain a seat near the exit door, etc. However, the demand in the hours after the peak hour is typically much lower, which means that there is excess capacity that can serve as a buffer, thus the airport removes any delays.

1.4.1.4. Results of air traffic forecasts and 30 peak hours

As a reference forecast according to the project design and the basis for all the calculations carried out in this study, a higher-growth forecast scenario was accepted.

Table 1.4.1.-3rd.: Summary of air traffic activity levels - lower growth scenario

Year		2009	2010	2015	2020	2025	2030	2035	2040
Total passengers		2.067.913	2.016.813	2.557.151	3.084.271	3.617.765	4.098.186	4.576.172	5.087.709
Annual growth rate*	(%)		*-2,5%*	*3,6%*	*3,7%*	*3,6%*	*3,3%*	*3,1%*	*2,9%*
Commercial		2.062.242	2.016.813	2.557.151	3.084.271	3.617.765	4.098.186	4.576.172	5.087.709
Domestic		479.706	423.303	532.378	630.937	726.369	800.839	872.870	951.379
International		1.582.536	1.593.510	2.024.773	2.453.334	2.891.396	3.297.347	3.703.303	4.136.330
General airline		5.671	5.546	7.032	8.481	9.949	11.270	12.584	13.991
Total airline operations		37.436	36.786	45.058	52.364	59.314	65.016	70.330	75.810
Annual growth rate*	(%)		*-1,7%*	*3,1%*	*3,1%*	*2,9%*	*2,7%*	*2,5%*	*2,3%*
Commercial		31.157	31.230	38.304	44.568	50.464	55.213	59.579	64.047
Domestic		6.592	6.041	7.629	8.916	10.123	11.008	11.836	12.727
International		24.565	25.189	30.674	35.652	40.341	44.205	47.743	51.319
General airline		3.925	3.839	4.867	5.870	6.886	7.800	8.710	9.683
Solely cargo		2.354	1.814	2.394	2.532	2.674	2.819	2.968	3.120
Total cargo	(metric t)	7.214	6.528	9.296	10.439	11.486	12.295	13.018	13.741
Annual growth rate*	(%)		*-13,5%*	*3,5%*	*3,0%*	*2,7%*	*2,4%*	*2,1%*	*2,0%*
Goods within the luggage area	(metric t)	5.194	4.714	6.902	7.907	8.812	9.476	10.050	10.621
Transport aircrafts	(metric t)	2.020	1.814	2.394	2.532	2.674	2.819	2.968	3.120

* Cumulative annual growth rate compared to 2009

Source: InterVISTASConsulting Group

Table 1.4.1.-4.: Summary of the activity level of air transport - Base Case

Year		2009	2010	2015	2020	2025	2030	2035	2040
Total passengers		2.067.913	2.054.437	2.894.056	3.563.993	4.225.740	4.890.267	5.530.270	6.223.300
Annual growth rate*	(%)		*-0,7%*	*5,6%*	*5,1%*	*4,6%*	*4,2%*	*3,9%*	*3,6%*
Commercial		2.062.422	2.054.437	2.894.056	3.563.993	4.255.740	4.890.267	5.530.270	6.223.300
Domestic		479.706	434.157	555.022	670.072	783.403	873.037	960.625	1.057.000
International		1.582.536	1.620.280	2.339.034	2.893.920	3.472.337	4.017.231	4.569.645	5.166.300
General airline		5.671	5.741	8.731	11.545	14.734	18.020	21.610	25.706
Total of aircraft operations		37.436	37.499	50.442	58.949	66.992	73.480	79.464	85.634
Annual growth rate*	(%)		*0,2%*	*5,1%*	*4,2%*	*3,7%*	*3,3%*	*2,9%*	*2,7%*
Commercial		31.157	31.808	42.684	49.964	56.785	62.174	67.069	72.076
Domestic		6.592	6.196	7.855	9.301	10.669	11.669	12.604	13.617
International		24.565	25.613	34.829	40.663	46.115	50.506	54.466	58.459
General airline		3.925	3.973	5.387	6.426	7.470	8.388	9.298	10.282
Solely cargo		2.354	1.814	3.909	4.660	5.375	6.136	6.945	7.800
Total cargo	(metric t)	7.214	6.616	11.538	13.455	15.215	16.729	18.179	19.672
Annual growth rate*	(%)		*-12,3%*	*7,3%*	*5,4%*	*4,5%*	*3,9%*	*3,4%*	*3,1%*
Goods within the luggage area	(metric t)	5.194	4.803	7.629	8.795	9.841	10.593	11.234	11.872
Transport aircrafts	(metric t)	2.020	1.814	3.909	4.660	5.375	6.136	6.945	7.800

* Cumulative annual growth rate compared to 2009

Source: InterVISTASConsulting Group

Table 1.4.1.-5.: Summary of air traffic activity levels - higher growth scenario

year		2009	2010	2015	2020	2025	2030	2035	2040
Total of passengers		2.067.913	2.143.015	3.261.781	4.235.952	5.163.740	6.038.399	6.941.425	7.932.910
Annual growth rate*	(%)		*3,6%*	*7,9%*	*6,7%*	*5,9%*	*5,2%*	*4,6%*	*4,4%*
Commercial		2.062.422	2.143.015	3.261.781	4.235.952	5.163.740	6.038.399	6.941.425	7.932.910
Domestic		479.706	445.011	580.423	727.041	876.488	997.888	1.118.959	1.254.719
International		1.582.536	1.698.004	2.681.358	3.508.911	4.287.252	5.040.511	5.822.466	6.678.191
General airline		5.671	6.084	10.711	15.797	21.559	27.906	35.179	43.750
Total airline operations		37.436	39.120	55.775	67.628	77.339	85.230	92.614	100.290
Annual growth rate*	(%)		*4,5%*	*6,9%*	*5,5%*	*4,6%*	*4,0%*	*3,5%*	*3,2%*
Commercial		31.157	33.192	47.366	57.626	65.958	72.568	78.637	84.880
Domestic		6.592	6.351	8.115	9.918	11.672	12.979	14.220	15.587
International		24.565	26.841	39.252	47.708	54.286	59.589	64.416	69.294
General airline		3.925	4.211	5.726	6.879	7.919	8.864	9.843	10.938
Solely cargo		2.354	1.814	5.494	7.911	9.505	11.318	13.350	15.600
Total cargo	(metric t)	7.214	6.822	13.902	17.973	20.861	23.614	26.450	29.530
Annual growth rate*	(%)		*-9,6%*	*10,7%*	*8,2%*	*6,6%*	*5,6%*	*4,9%*	*4,5%*
Goods within the luggage area	(metric t)	5.194	5.008	8.408	10.063	11.356	12.295	13.110	13.930
Transport aircrafts	(metric t)	2.020	1.814	5.494	7.911	9.505	11.318	13.350	15.600

* Cumulative annual growth rate compared to 2009

Source: InterVISTASConsulting Group

Table 1.4.1.-6.: The forward movement of 30 peak hours

30 peak hours: the movement of passengers

Year		2010	2015	2020	2025	2030	2035	2040
Lower growth scenario	*Domestic*							
	Incoming	273	329	377	419	447	476	502
	Outgoing	298	354	400	439	461	483	502
	Two-way	372	453	525	592	638	688	736
	International							
	Incoming	712	809	966	1.106	1.234	1.344	1.456
	Outgoing	714	813	972	1.113	1.240	1.349	1.456
	2-way	972	1.123	1.366	1.592	1.809	2.009	2.219
	Total							
	Incoming	719	960	1.136	1.307	1.444	1.581	1.713
	Outgoing	751	997	1.172	1.339	1.467	1.594	1.713
	2-way	968	1.321	1.596	1.874	2.112	2.361	2.610
The basic scenario	*Domestic*							
	Incoming	280	339	392	443	478	505	535
	Outgoing	305	365	416	464	493	513	535
	2-way	381	467	547	626	683	731	784
	International							
	Incoming	724	928	1.115	1.300	1.450	1.600	1.742
	Outgoing	726	932	1.122	1.308	1.457	1.605	1.742
	2-way	988	1.288	1.577	1.871	2.126	2.391	2.654
	Total							
	Incoming	732	1.080	1.297	1.501	1.682	1.843	2.009
	Outgoing	765	1.122	1.338	1.538	1.709	1.858	2.009
	2-way	986	1.486	1.822	2.152	2.461	2.752	3.061
Higher growth scenario	*Domestic*							
	Incoming	284	351	417	477	518	555	598
	Outgoing	310	378	443	500	534	564	598
	2-way	387	484	581	674	740	804	876
	International							
	Incoming	693	1.048	1.314	1.537	1.729	1.910	2.095
	Outgoing	694	1.053	1.322	1.547	1.738	1.917	2.095
	2-way	945	1.455	1.857	2.212	2.536	2.855	3.192
	Total							
	Incoming	820	1.203	1.505	1.768	1.991	2.204	2.426
	Outgoing	858	1.250	1.553	1.810	2.024	2.223	2.426
	2-way	1.106	1.655	2.114	2.534	2.913	3.291	3.697

Source: InterVISTASConsulting Group

Table 1.4.1.-7.: The movement of aircraft in the 30th peak hour

30th peak hour: moving aircraft

Year		2010	2015	2020	2025	2030	2035	2040
Lower growth scenario	*Domestic*							
	1-way	3	4	4	5	5	6	6
	2-way	4	5	6	7	7	8	9
	International							
	1-way	8	9	11	12	14	15	17
	2-way	11	12	15	18	20	23	26
	Total							
	1-way	8	11	13	15	17	19	21
	2-way	10	15	18	21	24	28	31
The basic scenario	*Domestic*							
	1-way	3	4	4	5	5	6	6
	2-way	4	5	6	7	8	8	9
	International							
	1-way	8	10	12	14	16	17	18
	2-way	11	14	17	20	23	25	28
	Total							
	1-way	8	12	15	17	19	21	22
	2-way	11	16	20	24	27	30	34
Higher growth scenario	*Domestic*							
	1-way	3	4	5	5	6	6	7
	2-way	4	5	6	7	8	9	10
	International							
	1-way	8	11	14	16	18	19	20
	2-way	10	16	20	23	26	28	31
	Total							
	1-way	9	13	17	19	21	23	25
	2-way	12	18	23	27	30	34	38

Source: InterVISTASConsulting Group

1.4.2. Road and rail transport

Analysis of the road traffic system in the zone of the airport expansion project and the construction of a new passenger terminal is based on the results of "Spatial traffic studies of road-railway traffic of the wider area of the city of Zagreb", IGH Zagreb 2008./2009. As already indicated, the concerned study was used for the "Conceptual Design of paved areas" from which it is possible to perform stepwise and phase construction solutions as integral parts of future solutions.

1.4.2.1. Existing condition

Access to the Zagreb Airport for public transport is derived from the connecting road D408 direction Velika Gorica road (D30). The connecting road is derived from two pavements and four lanes. The circuit at Zagreb Airport is derived from the southwest side as shown in pictures: 1.4.2.-1. and 1.4.2.-2.

Road traffic within the zone of Zagreb Airport is mainly organized on a one-way roadway, two lanes, except in the cargo terminal, customs and flight school where there is a two-way to two lanes as shown in Figure 1.4.2.-1.

Parking facilities

Zagreb Airport has five public parking lots with charging by the principle of leasing parking places P1 - P5 (Figure 1.4.2.-first). Public parking lots free of charge at Zagreb Airport no. Parking spaces are allocated as follows: P1 + P2 + P3 = 642 sites. P4 car park has the capacity of 140 cars and 3 buses used by employees of Zagreb Airports and the needs may change the ratio of the number of cars and buses. Same parking area is equipped with a system for billing. A paid public parking for cars is used in the case where P1, P2 and P3 are filled. Along parking P4 is the P5 parking. The P5 parking capacity is 190 cars. From the above it can be conclude that the potential capacity of the parking for Zagreb Airport is a total of 972 seats. The staff, in addition to parking P4, uses also open spaces along the roads and in front of boarding facilities, customs, forwarding, the technical base - a total of about 120 spaces. Taxi parking in front of the terminal building and has a capacity of 10 +5. Bus parking is located in the P4parking lot, and as mentioned above has a capacity of 3.

Figure 1.4.2.-1. Organization of road traffic flow and parking resources of Zagreb Airport

As for the other parking lots, within the leased rent-a-car is a space in front of the heating plant and a space along the outgoing road with about 80 places.

Parking duration is from 15 minutes to a month.

Public and private transport

Pleso Transport Ltd. organizes public bus passenger transport between Airport Zagreb - City of Zagreb. According to the current seasonal daily schedule set according to the flight schedule, rush hour traffic is covered with buses departing every half hour, and after this, every hour according to the following timetable:

ZAGREB AIRPORT - ZAGREB (TERMINAL BUS STATION)

MON-SUN	7:00	8:00	8:30	9:00	9:30	10:30	11:30	12:00	12:30	13:00	13:30	14:00
	14:30	15:00	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	20:00

* Every day from Zagreb Airport the last bus departs at 20:00, followed by buses depart by aircraft landings of regular lines of Croatia Airlines.

ZAGREB (Terminal Bus Station) - ZAGREB AIRPORT

MON-SUN	*	5:00	5:30	6:00	6:30	7:00	7:30	8:00	8:30	9:00	10:00
	10:30	11:00	11:30	12:00	12:30	13:00	13:30	14:00	14:30	15:00	
	15:30	16:00	16:30	17:00	17:30	18:00	18:30	19:00	19:30	20:00**	

* Monday, Thursday and Friday, the first bus leaves at 4:30
** On Wednesday, Thursday, Friday and Sunday, the last bus leaves 21:30

From the presented timetables it can be concluded that the buses of Pleso Transport Ltd. perform about 60 passenger transport operations during the day.

In addition to bus transportation, Pleso Ltd. for the transportation of students and staff of the Aviation Technical school of Rudolph Perešin engage ZET buses with 10 operations a day from the City of Zagreb - Zagreb airport.

According to the number of tickets sold it is the operators estimate that about 10% of airline passengers use the service Pleso Transportation Ltd. For coming to work, one hundred employees use bus transportation according to the estimate of the operator.

Private transport (cars) for coming to work, according to the estimated number of occupied parking spaces, are used by about 400 employees at Zagreb Airport and other legal facilities.

Operation of buses and service vehicles at the apron

According to data from the Zagreb airport, bus movement on the platform and other GSE (Ground Equipment service vehicles) are estimated at 140 operations / day with an average mileage of 500 m per operation.

Analysis of traffic load in the network area of Zagreb Airport

In order to create a complete database of the transport system, data was analyzed of regular traffic counting on the road network in the area of the airport. Data on counting and the flow structure were taken from the following publications: Counting the Road in 2010, Croatian Roads, Prometis, Zagreb, 2011 and information on traffic and road accidents on highways under the jurisdiction of HAC in 2010, Croatian Roads, Zagreb, 2011.

The year 2010 was taken as the base year of analysis

In Figure 1.4.2.-2 are the results of the automatic traffic count and AADT (average annual daily traffic) on the automatic counting in AB 2014 (D30) and the occasional automatic counting in PAB 2023 (D408). AADT on the highway A3 was taken from data obtained from the system of counting Croatian Roads Ltd.

Results of flow structures are given according to the type of device that is by category of vehicles or types of devices recognized. At the counting place PAB 2023 a portable meter was used with automatic sorting facility for counting vehicles in classes of length according to the following categories:

I. vehicle up to 5.5 m
II. Vehicle overall length 5.5 m to 9.1 m
III. Vehicle overall length 9.1 m to 12.2 m

IV. Vehicle overall length 12.2 m to 16.5 m
V. Vehicle length over 16.5 m

According to the structure of traffic flow, counting results are as follows:

PAB 2023 - PGDP 9.842

I.	II.	III.	IV.	V.
9.289	355	127	57	14
94,38%	**3,61%**	**1,29%**	**0,58%**	**0,14%**

On the counting place in AB 2014 there is a permanent automatic counter which classifies vehicles by the following groups:
A1 motorcycles,
A2 cars,
A3 cars with trailers,
A4 vans with or without a trailer,
B1 off-road vehicles,
B2 medium duty vehicles,
B3 heavy duty vehicles,
B4 trucks and tractors with trailers and semi-trailers,
C1 buses.

According to the structure of traffic flow counting, the results are as follows:

AB 2014 - PGDP 39.413

A1	A2	A3	A4	B1	B2	B3	B4	C1
257	34.944	646	1.525	118	1.119	142	382	280
0,65%	**88,66%**	**1,64%**	**3,87%**	**0,30%**	**2,84%**	**0,36%**	**0,97%**	**0,71%**

Within the system of supervision, management and control of traffic Croatian Roads Ltd, implemented is a system of continuous traffic counting that detects vehicles using the following categories:

Qnt unrecognized vehicles
Qm motorcycles,
Qov passenger cars,
Qkb van,
Qovp passenger cars with trailer
Qkm trucks
Qkmp rig
Qt tractors,
Qa buses.

According to the structure of traffic flow counting, the results are as follows:

Qm	Qov	Qovp	Qkb	Qkm	Qkmp	Qt	Qa
96	27.661	359	5.409	2.643	1.080	2.503	108
0,24%	**69,40%**	**0,90%**	**13,57%**	**6,63%**	**2,71%**	**6,28%**	**0,27%**

In accordance with the above estimates and the values obtained from automatic counters it is estimated that the AADT in the airport zone ≈ 7000 vehicles, with the structure of the traffic flow was accepted from the temporary automatic timer at PAB 2023.

Figure 1.4.2.-2. AADT positions with automatic traffic counting on the relevant road network in 2010

1.4.2.2. Forecast of road traffic

The future access to the new airport building is ensured with roads. The main access roads of the airport building is the one that connects the eastern bypass of Velika Gorica not far from Velika Kosnica junction on the A3 motorway and the Velika Gorica road itself (1), which is currently under construction.

At this time, 4.2 km of highway has been constructed which connects the existing road terminals. The completion of the remaining part of the motorway (5.3 km), close to the Kosnica node is expected during 2012.

The existing access road to Velika Gorica (southwest) will continue to be used as access to the existing terminal, and in the beginning it will also provide access to the new terminal. The drawing on the side shows the construction of the road.

Roads outside sites are the responsibility of the Croatian Roads, County Road Administration, the City of Zagreb and Velika Gorica. Access to the airport from the north will be realized via a new four-lane road from the crossroads of the bypass to the north of Selnica Ščitarjevska. The realization of this road will be the responsibility of the Croatian Roads (HC).

A connection from the south will be enabled by the existing road to the existing terminal and to the "school" (East of Croatia Airlines parcel, CA), and a new, temporary road (C) with two strips between CA and borders of the military zone A to the internal road in front of the NPZ is to be built by the concessionaire. All roads on the site will be built and maintained by the concessionaire, and all the roads off-site will be built by Croatian Roads (HC).

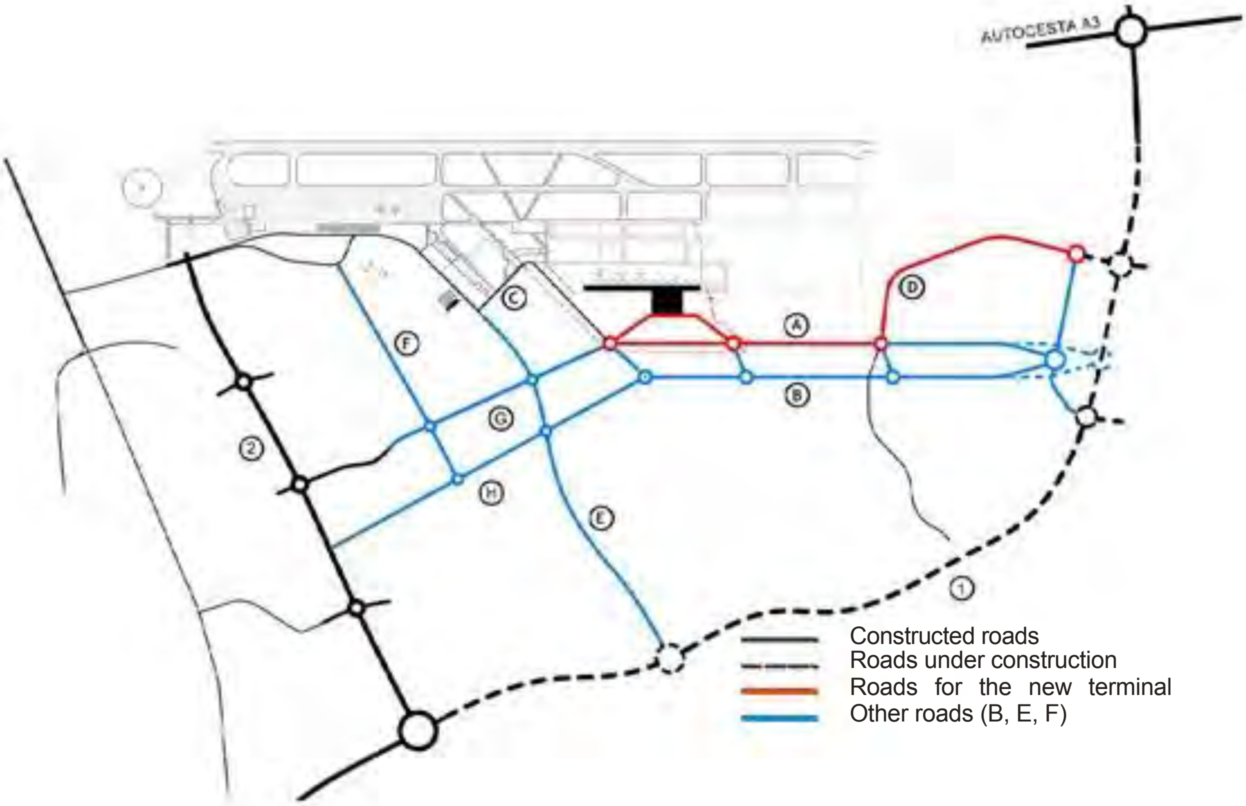


Figure 1.4.2.-3. Schematic representation of a wider network of roads in the area of Zagreb

Public and private transport

The fact is that the buses of Pleso Ltd. perform about 60 operations of passenger during the day and that 10% of airline passengers and 10% of employees come to work using the benefit of this transportation. This means that the average occupation of buses is 10-12 passengers per operation. From this it can be concluded that the expected four-fold increase in the number of passengers will not significantly affect the number of bus transport operations. The estimate is that 70 operations a day would fully meet the needs of this kind of public bus transportation.

It is also expected that the transport of students and employees of the Aviation Technical School Rudolf Perešin is kept at the same level in the future.

Personal transportation (cars) for arriving to work today are today used by about 400 airport employees of Zagreb Airport and other entities that are not expected to increase till the target year 2040.

Operation of buses and service vehicles on the landing area

At 39,120 aircraft operations in 2010, the movement of buses and other platforms GSE (Ground Service Equipment) vehicles are estimated at 140 operations / day with an average traveled 500 yards per operation. Accepting these stated amounts and the fact that in the first phase by the year 2024, 50% of passengers on international flights will use air bridges for boarding aircrafts and 70% of passengers on international flights by 2040 (second phase), so that in 2024 with approximately 75,300 aircraft operations, the movement of buses on the platform and other GSE (Ground Service Equipment) vehicle can be expected at about 160 procedures / day and about 150 operations / day by 2040 when the number of aircraft operations according to the traffic forecast reaches 100,290.

Analysis of the predicted traffic load on the road network in the area of Zagreb Airport

As already stated above, the analysis of road traffic in the project area of airport expansion and the construction of the new passenger terminal is based on the results of "Spatial- traffic Studies of road-rail transport of the wider area of the city of Zagreb".

Traffic analysis systematically analyses the available data on the current traffic network load, along with any additional measurements (counting, surveys). Based on statistic indicators, a forecast of the future traffic loads is given along with determining traffic flows in the planning period in relation to road and rail traffic, remote, local urban and suburban transport, public and private. Constructed is the traffic model in which the first step presents the current state of the road network, and in the second step it verifies the technical solution to the future network of comprehensive transport system.

Traffic analysis includes procedures for the assessment of existing and future trips on networks roads that are characteristic to the envisaged spatial coverage in the appropriate time horizon. The primary purpose of the analysis is to establish a credible picture of future traffic volumes on the elements of the planned road network in addition to an evaluation of the effects of traffic to the overall system of activities of the studied area. These images can be accessed conservatively starting with the image of the existing state of the network of roads and traffic in it.

The future transport network will cover a wider area of the city of Zagreb and the County. Considered are time period sections in which significant changes to the network of 2012, 2013, 2018 and 2030 are identified. In the immediate surroundings of the Zagreb Airport, substantial amendments to the road infrastructure are planned for 2012 with the anticipated completion of the Eastern Bypass Velika Gorica (D31), in 2013 with the anticipated release of the A11 motorway on the section Jakuševac - Velika Gorica South and in 2030 whith the release of the new junction Mlaka on the Zagreb bypass and the Velika Gorica road (D30) is predicted.

The main focuses in the analytical procedures are adapted to the characteristics of the chosen or available IT assets (software) - VISUM in which the gravity model basis is performing analysis.

Predicted traffic flows, regardless of the unit of observation, are formed from the demand of journeys within the observed gravitational field where the total number of the preferred trips to some zones are distributed to all other zones in proportion to the rates of attractiveness. The rates are determined according to the existing laws of distributions that include measurable attributes of productions and attractions of certain zones and attributes of each type of realization (choice of means of travel, length and travel time, the total cost of travel, etc.), and these attributes are directly linked to characteristics of the transport network on which they are realized. Legality is determined by sampling existing trips on the existing road network.

The accepted four-step simulation model was applied with the predefined growth rates of the traffic demand. The average annual growth rate generally follows the development of activities in the area under consideration. The study has adopted growth rates shown in Table 8, and the results are consistent with previous studies and research.

Table 1.4.2.-1.: Average annual rate of traffic demand

Urban area of Zagreb	1%
Suburban ring around Zagreb	4%
The rest of the Zagreb County	3%
The outer area of	6%

1.4.2.3. Results of analysis

The increase in traffic volume within the zone of Zagreb Airport is forecasted conservatively or reciprocally with the growing levels of air traffic. According to the projection of the development of the road network zone of Zagreb Airport and the positions of connections to the remaining road network, the distribution of traffic from the position of access to the airport was estimated. Assumed was the ratio of the total traffic flow at Zagreb Airport, at the existing driveway today from the southwest (D408) goes to 1/3 and 2/3 to the northeast entrance to the motorway junction Kosnica (A3). This estimate was derived from the fact that the northeast compound made it directly on the highway and over the Homeland Bridge and Radnička cesta is a direct connection to the center of the City of Zagreb. The predicted traffic within the zone of Zagreb Airport is presented in the following table.

Table 1.4.2.-2. Forecast of traffic volumes within the Zagreb Airport

Year	Estimated AADT		
	access D408	access A3	Total
2007.	≈ 7.000	-	≈ 7.000
2017.	≈ 3.800	≈ 7.600	≈ 11.400
2024.	≈ 5.400	≈ 10.900	≈ 16.300
2040.	≈ 8.700	≈ 17.400	≈ 26.100

The tables above show that the forecasted traffic loads within the Zagreb Airport are at levels below the capacity of roads proposed with the preliminary traffic solution. The four-lane roads proposed by the project have a capacity of over 40,000 vehicles / day, while the two-lane road as a temporary two-lane road (C) exceeds a capacity of 12,000 vehicles / day. A circular intersection with two lanes in the intersection of two inputs has the capacity to 40,000 vehicles / day. According to the stated criteria, the proposed engineering-technical solutions should be sufficient for the projected traffic. The average structure of the predicted traffic flows within the area of Zagreb Airport is suitable to the structure of the flow recorded at the occasional position of the automatic counting PAB 2023.

The structure of the predicted traffic flows on the D408 and all-pass roads of Velika Gorica, north (D30) and future east (D31 - connection to A3) as in the zone of Zagreb Airport analogous to the structure of the flow recorded at the position of the occasional automatic counting PAB 2023. The structure of the traffic flow on motorways A3 and A11 is analogous to the structure of the flow recorded within the system of supervision, management and control of the Croatian Roads Ltd., while the structure of the Velika Gorica traffic flow on the road (D30) is equal to the structure of the flow recorded at the permanent position of automatic counting AB 2014.

The results of analyzes carried out in the "Spatial- traffic Studies of road-rail transport of the wider area of the city of Zagreb" according to growth rates in Table 1.4.1.-7 and the expected increase in traffic load within the zone of the new Zagreb Airport are shown in the following pictures.

Figure 1.4.2.-4. AADT with the relevant road network in 2017

Figure 1.4.2.-5. AADT with the relevant road network in 2024

Figure 1.4.2.-6. AADT with the relevant road network in 2040

1.4.3. Train traffic

As a potential possibility in connecting Zagreb Airport to public transport, access to the new terminal building was analyzed through connections with a light railway, with direct connections to the center of Zagreb. In the spatial planning documents of the City of Zagreb and Velika Gorica, this link is planned as a two-lane underground line connecting the existing terminal and the new terminal and continues east to the Velika Gorica bypass. The metro then passes the Kosnica junction, Homeland Bridge and goes down Radnička cesta to the very centre of the city (ends at the train station). This railway belongs under the authority of Croatian Railways (HŽ) and is not a subject of this study on the impact on the environment.

The City of Zagreb and the Croatian Railways (HŽ) are responsible for the implementation of transport links including the planning and construction at the site and beyond. The concessionaire will allow Planning and building on the site at the request of the Croatian Railways (HŽ) and coordinate the construction of a garage for parking with Croatian Railways (HŽ).

This project is planned for realization by 2017, which presents quite an ambitious intervention from today's perspective. According to the Master Plan for the Zagreb Airport in 2008, it was emphasized that international experience confirms that building a light city railway is justified in traffic of 10 million passengers a year.

1.5. OPERATIONAL AREA OF ZAGREB AIRPORT

Operativna površina sa pripadajućim objektima u zračnoj luci Zagreb sastoji se od:

- Runways with the corresponding primary path,
- taxiways A, B, C, D and F that connect the apron for aircrafts with the runway, with associated basic trails, and
- ancillary taxiway linking the apron for aircrafts with:
  - hangars: S and T, and
  - the winter maintenance service: R,
- Auxiliary taxiways connecting the taxiway F, parallel to the USS and hangars for aircraft: T and
- apron for aircrafts (new apron is described in chapter 1.3.2. air side of NPT)

The runway with taxiways A, B, C, D, and F make up the manoeuvre area which is intended for the landing and takeoff of aircrafts and the movement after leaving the USS to the entry of the apron for aircrafts and parking or vice versa. The aircraft apron involves the movement areas, parking and aircraft handling.

Figure 1.5.-1. : System of approach lights in the direction of 05 USS and USS lighting system in Zagreb Airport

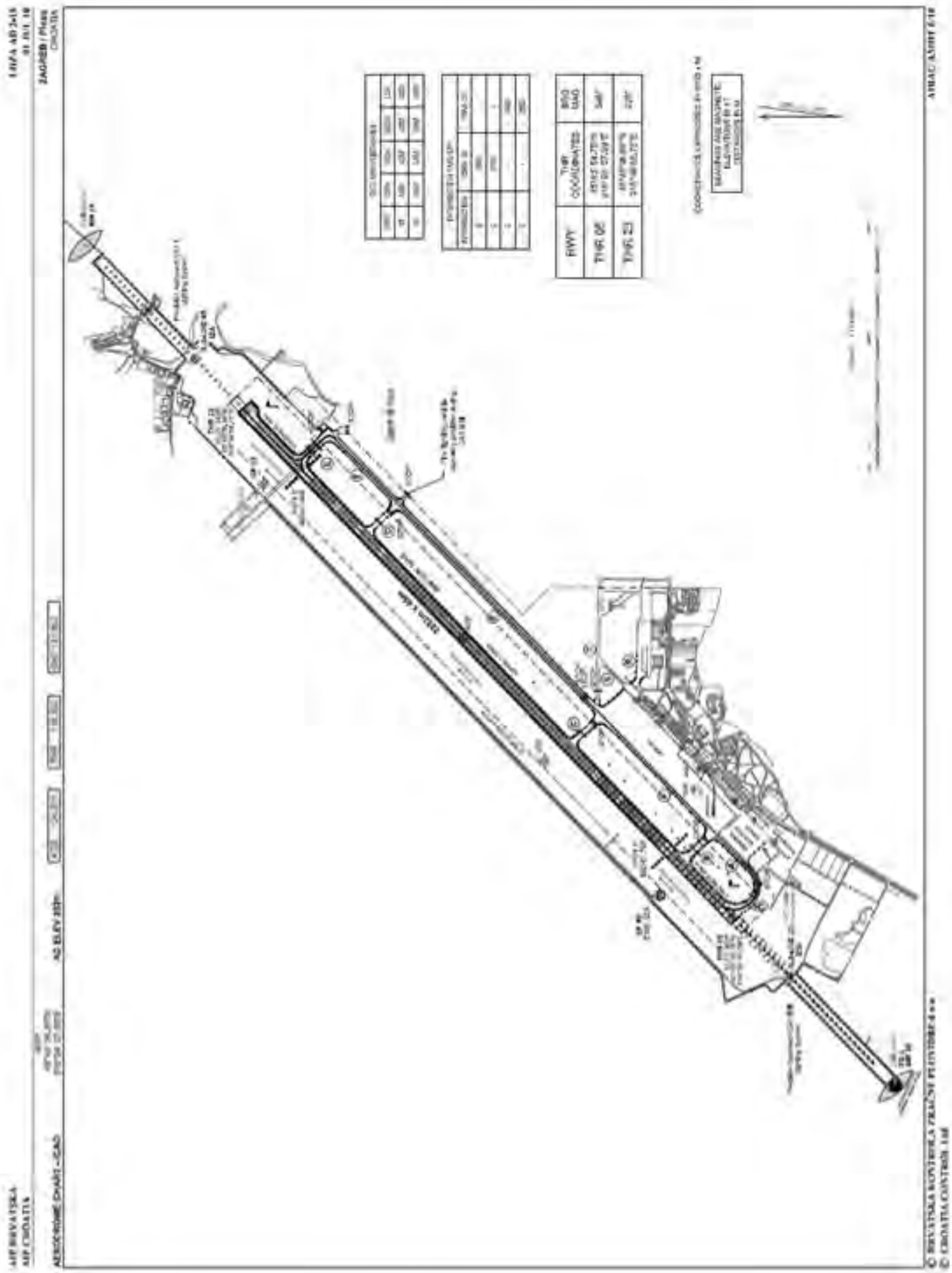
1.5.1. Runway

The length of the runway at the airport Zagreb is 3.252m, and the width is 45m. On both sides of the runway there are constructed shoulders with a width of 15m (2 x 7.5 m). According to the calculated magnetic declination for Zagreb Airport (3 ° in 2011), and because of the geographic and magnetic north, the runway is oriented in directions 05 and 23. The load of the pavement of the runway, expressed as a PCN number (Pavement Classification Number) and published in the Aeronautical Collection: LDZA AD 2-8 (source: http://www.crocontrol.hr/AD) is as follows as seen in the direction of 05: CONC 496m 80/R/C/X/T, ASPH 80/F/C/X/T 2262 m, 494 m CONC 75/R/D/X/T.

In the direction of landing 05, the runway is equipped with a system for instrumental precession approach category 3 (ILS CAT III), which allows a safe approach and landing in conditions where the horizontal visibility is less than 350m. In the direction of landing 23, the runway at Zagreb Airport is equipped with a system of instrumental precision approach category 1 (ILS CAT I).

The system of approach lighting in the direction of 05 of the runway is adapted to the system of instrumental precision approach category 3 (ILS CAT III), and in direction 23, the system of instrumental precision approach category 1 (ILS CAT I ILS). The system boundary lights and the lighting system of centerline of the runway and threshold lights and points of contact and system marks are drawn on the pavement of the runway and signs are placed along the edge of the runway path and are fully compliant with the requirements of Annex 14 ICAO and the Codebook of airports.

Based on the physical dimensions and capacity of the pavement and the shoulders of the constructed runway landing paths, as well as the set system for the state of the specific aircraft and visual orientation of pilots in terms of day and night, it can be concluded that the landing runway trail systems and associated navigation and visual orientation are aligned with the requirements of ICAO Annex 14 and Rules of the airports, and it is designed for safe landings and takeoffs of aircrafts with code letters E (B747-100, 200, ... 400, A300, A330).



Slika 1.5.-2: Airport map of the Zagreb Airport, published in the Collection of Aeronotical information, Source:http://www.crocontrol.hr/AD

1.5.2. The basic runway

The basic runway is a rectangular area that surrounds the airstrip, and is intended for the case when:

- the aircraft when landing misses the runway or
- the aircraft during landing or liftoff flies off the runway.

In accordance with the purpose, the surface of the basic path of the runway must be made in such a way that the structural damage to the aircraft that misses the runways or flies off the runway are minimal. In Annex 14 ICAO, the main path of the runway is defined in Chapter 3.4 (Runway strips), and the Regulations of airports in Article 34: The main trail runway sprawling threshold and beyond the end of the runway or path to stop for a length of at least 60m.

Table 1.5.-1. The length of the basic runway

	1	2	3	4
Smallest distance in front of the Threshhold and behind the Runway	30 m[a] **or** 60 m[b]	60 m	60 m	60 m
[a] - *non-instrumental runway with code number 1.* [b] - *instrumental runway with code number 1.*				

Source: Codebook on Airports

The basic runway track width is provided on both sides of the runway, symmetrically from the center line and its extended axis, with its minimum width on each side of the runway individually defined according to the code number of the USS.

Table 1.5.-second: Width of basic runway paths

	Code number of the runway			
The smallest width of the basic runway On each side from the extented central Axis of the runway are equipped with A system for:				
Instrumental precision access	75 m	75 m	150 m	150 m
Instrumental -non-precision access	75 m	75 m	150 m	150 m
Non-instrumental access	30 m	40 m	75 m	75 m

In Article 34, paragraphs 4 and 5 of the Codebook on airports the following was stated: (4) "... Except for the vertical signaling in a way to meet relevant requirements of fragility defined in Section 5... of the Codebook, there are no immovable objects allowed on the surface of the runway whose width is measured from the central line of the runway in the following way:

Table 1.5.-3: Arranged belt of the basic runway strip

	Code number of the runway strip			
Smallest width of half of the Basic strip without immobile objects	**1**	**2**	**3**	**4**
Instrumental precision access to categories (CAT) I, II or III for the runway strip with code letter F	**-**	**-**	**-**	**77,5 m**
Instrumental-precision access categories (CAT) I, II and III	45 m	45 m	60 m	60 m

(5) ... During the landing or takeoff of an aircraft, no movable objects are allowed on the runway path of which the width is measured from the centre line of the runway in the following way ... ":

Table 1.5.-4th: Arranged belt of the basic runway path

	Code number of the runway strip			
The least width of half of the basic trail without mobile objects during landings or takeoffs of aircrafts	1	2	3	4
Instrumental precision access to categories (CAT) I, II or III for the runway strip with code letter F	-	-	-	7,5 m
Instrumental-precision access categories (CAT) I, II and III	45 m	45 m	60 m	60 m

Pursuant to the provisions of Article 34 paragraphs 4 and 5, except for the navigation system, within the space of a regulated basic paths belt that stretches over a distance of 60m, measured from the centre line of the e-USS, Zagreb Airport there must not be any moving or stationary objects.
Information: LDZA AD 2-12 (source: *http://www.crocontrol.hr/AD*) amount 3.372m (length) x 300 m (Width), and that the entire surface of the basic tracks, except for navigational aids, are not placed on other fixed devices, it can be concluded that the main path of the runway at the airport in Zagreb is in full compliance with the provisions of Annex 14 ICAO and with Article 34 of the Codebook on airports.

Figure 1.5.-3: Photography of the runway and the corresponding basic trail with a landscaped strip at the Zagreb Airport

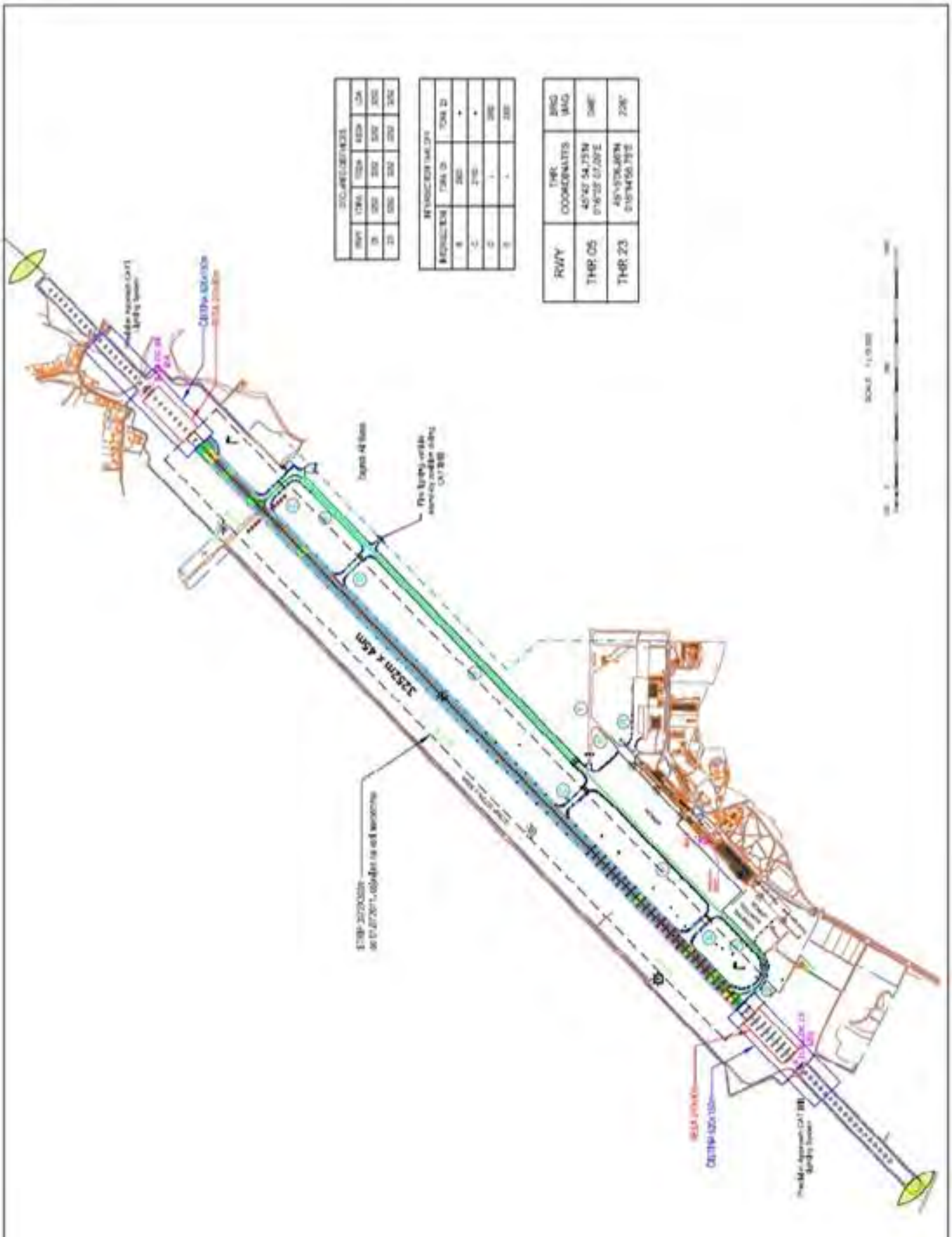


Figure 1.5.-4: Basic runway at the airport in Zagreb (Strip), featured with black dotted line, Source: Technical documentation of Zagreb Airport

1.5.3. Safety surface next to the runway (RESA)

Based on the requirements of Chapter 3.5 of Annex 14 of ICAO, as well as Article 35 Paragraphs 1 to 8 of the airports operator, Zagreb Airport is obligated to define and provide safety surface at the runway (Runway End Safety Area) with a length of 240m and width of 90m (2 x 45m), which continues to the base path of the runway, taxiways.
The safety surface at the USS-e (RESA) is designed to prevent damage to the aircraft when landing at the threshold next to the strip, or that it does not stop till the end of the strip. Safety surface at the strip must be freed of constructed immovable objects that may affect the structural damage to the aircraft with a maximum degree of longitudinal and transverse slope of 5. The payload of the safety surface next to the strip must be such that:

- it does not cause additional damage to the aircraft that switches to the strip,
- enables faster halt for the aircraft,
- allows undisturbed movement of vehicles and means of the fire-rescue service of the airport.

In Figure 14 the safety surface next to the runway (RESA) is presented by a rectangular solid line highlighted in red.

The Zagreb Airport operator has not defined and secured a safety area next to the runway, which makes it necessary to assess the risks of possible other consequences and additional structural damage to an aircraft that lands on the surface in front of the threshold of the runway, or does not stop at the end of the runway, and since Zagreb Airport has not defined and secured a safety surface at the runway.

1.5.4. The Clearway

Under the provisions of the Codebook on airports in Article 36, Paragraphs 1 to 6, the operator Zagreb Airport operator shall define and provide a clearway with a length of 1.626m (TORA) and the minimum allowable width of 150m (2 x 75m). The clearway is a surface which continues from the USS at the take-off direction with a slope of 1.25% upwards. This is actually a surface in space, which must be free of obstructions to prevent damage to aircrafts during takeoff, which for example has a:

- completely failed engine,
- a significantly reduced available power of the engine,
- a partially or completely cancelled other, essential to flight safety system,
- total weight of the aircraft is greater than the maximum take-off weight of the aircraft (MTOM) for which aircraft cannot achieve satisfactory acceleration and an appropriate flight level.

The land of that surface should not be higher than the plane that has an upward slope of 1.25%, and in addition it must be free of natural and man-made obstacles that rise above the surface. Accordingly, each object set in a clearing which may endanger the safety of aircraft in flight must be removed.

In Figure 1.5.-4. the clearing is represented by a rectangle solid line highlighted in blue.

The Zagreb Airport operator has not defined and secured the clearway, therefore it is necessary to assess the risk of other possible consequences and additional structural damage to the aircraft during takeoff when they cannot achieve satisfactory acceleration and the required height, and considering that the Zagreb Airport has not defined and secured a clearway.

1.5.5. TAXIWAYS

Based on the requirements of Chapter 3.9 and 3.10 of Annex 14 of ICAO, as well as Article 39, Paragraphs 1 to 12 and Article 42 of the Codebook on airports, the taxiway is defined. In Zagreb Airport the taxiways built are A, B, C, D, E and F.

Table 1.5.-5: The width of pavement and shoulders of the taxiway at the Zagreb Airport

Taxiway	Reference code of the taxiway	The least width of the driveway constr.of the taxiway and belt
A	26 m	26 m
B	37 m	37 m
C	23 m	23 m
D	23 m	23 m
E	37 m	37 m
F	22,5 m	30 m

Source: Collection of Aeronautical Information: LDZA AD 2-8

The required width of the taxiway is standardized with respect to the distance between the outer edges of the main landing gear wheel for each aircraft type.

Table 1.5.-6: The required pavement width of the taxiway for certain types of aircrafts

Type of aircraft	Code letter	Distance of wheels from front chassis to the wheels of the main chassis (m)	Distance between the outer edges of the wheels of the main chassis (m)	Necessary runway width for riding regarding the minimum allowed distance of the wheels of the main chassis to the edge of the driveway (m)
A 340 - 500,600	E	24,50	10,684	10,68 + (4,5 x 2) = 19,68
A 340 - 200,300	E	24,50	10,684	10,68 + (4,5 x 2) = 19,68
A 330	E	24,50	10,684	10,68 + (4,5 x 2) = 19,68
B 747- 400	E	25,60	11,00	11,00 + (4,5 x 2) = 19,00
B 747- 100,200,300	E	25,59	11,00	11,00 + (4,5 x 2) = 19,00
B 787	E	25,89	9,80	9,80 + (4,5 x 2) = 18,80
B 777 - 200,300	E	25,88	10,97	10,97 + (4,5 x 2) = 19,97
A 300	D	18,60	9,60	9,60 + (4,5 x 2) = 18,60
A 300 - 600	D	18,60	9,60	9,60 + (4,5 x 2) = 18,60
A 310	D	15,21	9,60	9,60 + (4,5 x 2) = 18,60
B 767 - 200,300,400	D	22,80	9,30	9,30 + (4,5 x 2) = 18,30
B 757 . 200,300	D	18,29	7,32	7,32 + (4,5 x 2) = 16,32
B 707	D	17,96	6,73	6,73 + (4,5 x 2) = 15,73
DC 10	D	22,05	10,67	10,67 + (4,5 x 2) = 19,67
MD 11	D	24,61	10,70	10,70 + (4,5 x 2) = 19,70
A 319	C	11,04	7,59	7,59 + (3,0 x 2) = 13,59
A 320	C	12,63	7,59	7,59 + (3,0 x 2) = 13,59
DC 9	C	18,57	5,0	5,00 + (4,5 x 2) = 14,00
MD 90	C	23,52	5,08	5,08 + (4,5 x 2) = 14,08

Source: http://www.airbus.com/support/maintenance-engineering/technical-data/aircraft-characteristics/ and http://www.boeing.com/commercial/737family/specs.html

In Chapter 3.10 of Annex 14 ICAO, as well as Article 42 of the Codebook on airports, standardized is the minimum pavement width of the taxiway with shoulders for the taxiway (Table 1.5.-7.)

Table 1.5.-7. The minimum allowed width of pavement of the taxiway shoulders

	Code letter of the taxiway					
	A	B	C	D	E	F
The least width of the driveway construction of the taxiway and belt	-	-	25 m	38 m	44 m	60 m

Source: Codebook on airports

It is evident that the reference track for a ride at Zagreb Airport (table 1.5.-8th) is lower than the required reference code E of taxiways. Therefore, it is necessary to assess the risk of potential damage to the reference aircrafts with code letters D and E, which use the taxiways of a lower reference code.

Table 1.5.-8: Reference code for taxiways at Zagreb Airport

Taxiway	Width of the driveway together with the (un)constructed belts	Reference code of the taxiway
A	26 m	C
B	37 m	C
C	23 m	B
D	23 m	B
E	37 m	C
F	30 m	C

1.5.6. The main driving track

Under the provisions of section 3.11 of ICAO Annex 14 and Article 43 of the Codebook on airports, standardized was the obligation to establish a basic taxiway. The surface of the primary routes for driving must be freed of objects that may endanger the safety of aircraft movements.

Zagreb airport has not defined, nor established a basic taxiway for A, B, C, D, E and F.

Therefore, it is necessary to assess the risk of potential damage to the aircraft, since Zagreb airport has not secured basic strips for taxiways.

1.5.7. Apron for aircrafts

According to the requirements of Chapter 3.13 of Annex 14 ICAO and Article 45, Paragraph 2 of the Codebook on airports, the apron area shall be designed for safe transport, aircraft handling, loading and unloading of passengers, loading and unloading cargo and mail, parking for loading and unloading, planned during the busiest traffic hour flight schedules approved by the airport operator. The minimum allowed distance is 7.5 m between the furthest parts of the aircraft code letters C, D and E, with the power of its own engines to enter and exit a position. Accordingly, a new apron will be defined with the new passenger terminal at Zagreb Airport.

1.5.8. Surfaces with limited obsticles

Based on the technical documentation of Zagreb Airport and aeronautical data published in the Collection of Aeronautical Information, we can conclude that the operator of the airport Zagreb has:

- defined surfaces with limited obstacles is entirely in accordance with Article 60 of the Codebook on airports and the values defined in Table 4-1 of the Codebook, which regard the runway system equipped with instrumental precision approach of CAT III,
- has drawn up an Airport Obstacle Chart type A in accordance with the request under item 3.1 of Annex 14 of ICAO, intended for the takeoff of aircrafts, and has published it in the Collection of Aeronautical Information (LDZA AD 2-21),
- has organized the work of the service for planning and development by continuously monitoring changes in spatial planning as well as in real, concrete changes in the area where there is a complete or partial ban of construction.

The Zagreb Airport operator has not:

- created a special map of the area surrounding the airport in Zagreb, and above which there are areas with a limit of surface barriers, with special emphasis on locations which:
  - have a complete ban of the construction of facilities that represent an obstacle in the area,
  - have a partial ban on constructing objects up to a particular height, for these objects do not penetrate the surface which must be freed of obstacles, and has delivered the same to the authorized office for spatial planning of the Zagreb County with a request that the County and City urban plans of development be supplemented with the attached map, in order to protect to a maximum the surfaces in the surroundings of Airport Zagreb which based on regulations in part 4 of the Codebook on Airports must be freed of obstacles.

- prepaired airport chart of B type obstacles and airport field and obstacle chart i (Aerodrome Terrain and Obstacle Chart - ICAO Electronic) according to the requests from chapters 4.1 and 5.1 Annex 4 ICAO-a, intended for aircrafts on the runway,
- particularly distinguished deviation from the regulations of the Codebook on airports in the part that is related to certain surfaces with limited obstacles and according to that:
  - noted the Agency for civil air-force
  - issued special information in the treasury of air-force information.

As the operator of the Zagreb Airport drew up and in the Collection of Aeronautical Information published in the Airport Obstacle Chart Type A, which is in full compliance with the regulations of Chapter 3.1 of Annex 4 of ICAO and intended for aircrafts that liftoff the runway in Zagreb Airport in directions 05 and 23, and was not drawn up and published in the Collection of Aeronautical Information maps with obstacle type B and airport map terrain and obstructions (Airport Terrain and Obstacle Chart - ICAO Electronic), which are defined in chapters 4.1 and 5.1 of Annex 4 of ICAO, it is necessary to assess the risk to the aircrafts:

- in the takeoffs and landings on the runway in Zagreb Airport,
- in failed approaches and take-offs from landing on the runway of the Zagreb Airport,
- while circling the airport,
- in the case of any irregularity which regards one or more of the previously stated aircraft operations.

Assessments of these risks were made in chapter of this Study 4.2.14. Assessment of risk of aircraft accidents.

2. VARIATIONS TO THE SOLUTION OF THE WORK

Given that the case of the study is on the impact on the environment, or the minimum technical requirements of the new passenger terminal at Zagreb airport, the defined technical scope document (Croatia, Zagreb Airport, 2011), has not considered special project alternatives regarding the choice of the location of a new passenger terminal or the design of the building

Resolving the problem of drainage water from paved areas is of great importance for the acceptability of existing and planned activity and the environment. Details of the means used and their amounts indicate potential adverse effects on ground water, which is necessary to prevent with the construction of an adequate drainage and purification system. This chapter analyzes the world's experiences in addressing these issues and provides an overview of the technical and technological capabilities that would later be further developed by comparing the benefits and costs and making technical and economic analyzes reviewed in more detail, and will choose one of the two offered variations.

2.1. INTRODUCTION

In principle it is possible to define the flow of wastewater of Zagreb Airport depending on the place of origin and their properties:

- Sanitary, feacal wastewater,
- Contaminated rainwater that does not contain means for de-icing,
- highly burdened rainwater (technological) wastewater containing funds for de-icing,
- Medium burdened rainwater containing agents for de-icing.

In accordance with the above stated division, discussed will also be the possible ways of treatment. This division, of course, does not exclude the possibility of joint processing of individual courses, or even a unique wastewater treatment. Finally, the definition of wastewater treatment technologies requires design studies that will include reviews and compare several variants of Zagreb Airport and enable the selection of optimal solutions. Below are examples of treatment for several airports in Europe and the U.S.A.

2.2. CHARACTERISTICS OF CERTAIN FLOWS

<u>Sanitary-sewage wastewater</u>
Sanitary sewage is a result of human habitation in Zagreb Airport (employees, passengers). This is wastewater from sanitation, food service facilities, washing of the interior spaces, etc. These waste waters are in its composition identical or very similar to municipal wastewater and are collected by a separate drainage system.

<u>Polluted wastewater which does not contain de-icing agents</u>
Polutted wastewater which does not contain agents for de-icing cover the drainage of:

- the roof water from objects,
- parking spaces,
- roads and other surfaces (plateaus) in the airport which are not treated by special de-icing agents.

The above mentioned rainwater can be discharged into the recipient with prior purification in hydrocarbon separators and sand. After defining the size and potential flows, identified can then be the need to build retention which will reduce the hydrolic shock to the recipient or the drainage system.

Highly burdened rainwater (technological) wastewater which contains agents for de-icing

Highly polluted contaminated storm (technological) waste water is generated in the process of de-icing aircrafts or preventive treatment for the prevention of icing. During the process, the aircraft is "showered" in solution of the corresponding agent. In doing so, some of the agents leak to the plateau and into the collection system. The waste is highly concentrated, with its actual characteristics depending on the current weather conditions (possible precipitation). The agents for de-icing are products based on glycols (ethylene glycol, propylene glycol) with the addition of functional additives (surfactants, corrosion inhibitors, etc.). The problem of highly burdened contaminated rainwater (technological) waste water requires special attention. The usual treatments (purification) are recycling or biological treatment (anaerobic or aerobic).

Medium burdened rainwater containing de-icing agents
The problem of medium burdened contaminated rainwater includes surfaces which prevent freezing during the winter months and their immediate surroundings. The problem, then, is of seasonal character and results from the specific composition of agents for de-icing. Namely, the use of common agents (sodium chloride, calcium chloride) is not allowed due to the potential impact on the material of the aircraft. Chlorides can cause the process of crevice corrosion of aluminum alloy and stainless steels, which results in a breakdown of materials (called stress corrosion cracking). Therefore, the airport is required to apply different, corrosive neutral means.
The most frequently administered agents are based on urea and sodium and potassium salts of formic and acetic acids. The administered agents are highly water soluble and therefore rapidly migrate into the environment with melted snow, ice and precipitation. Medium burdened rainwater contaminated by de-icing agents is treated through the aerobic biological process.

2.3. CHEMICAL AGENTS FOR DE-ICING

Chemical agents which Zagreb Airport uses can be grouped depending on their intent:
- use on manipulative surfaces (runways, taxiways),
- use for de-icing aircrafts.

Since the agents differ significantly (chemically and by application) they will be processed in accordance with the division.

2.3.1. Agents which are used on manipulative surfaces

Basic information on the chemical agents which are used in the process of de-icing in Zagreb Airport:

UREA	Producer	n/a
	Active substance	urea
	Chemical formula	$CO(NH_2)_2$
	Concentration	> 99%
	Annual consumation	100.000 kg
	Aggregate condition	solid
	Additions	no

Urea	Contents of nitrogen	46%
	Solution in water	545 g/l
	biogradibility	yes
	Rijeka,decomposition,8 °C	14 days
	Rijeka,decomposition,20	4 - 6 days
	°C	2,13 g O_2/g, 1,8 g O_2/g
	Burdening, KPK, BPK_5	CO_2, H_2O, NH_3 → NO_{2-} → NO_{3-}
	Products of decomposition	great (exeptionally water soluble)
	Mobility in the system Possible influences - Surface water	yes (anoxia, toxic effects of decomposition products on aquatic organisms, eutrophication)
	Producer Active substance	Yes (contamination of underground water with urea, amoniac and nitrates)
Safeway KF HOT	Manufacturer	Clariant
	Active substance	potassium form
	Chemical formula	COOK
	Concentration	55%
	Aggregate condition	fluids
	Annual consumption	30.000 l
	Additions	Yes, inhibito of corrosion
	Water solubility	yes, in all ratios
	Biorazgradljivost	da, vrlo ovisna o temperaturi
	Opterećenje, KPK, BPK_5	0,12 g O_2/g, 0,085 g O_2/g
	Produkti razgradnje	CO_2, H_2O
	Mobilnost u sustavu	velika (izrazito vodotopljiv)
	Mogući utjecaj - površinske vode	da, moguća anoksija
	Mogući utjecaj - podzemne vode	da, moguća anoksija
Safeway SF	Proizvođač	Clariant
	Djelatna tvar	kalij formijat
	Kem. formula	COOK
	Koncentracija	≥ 98%
	Agregatno stanje	krutina
	Godišnja potrošnja	25.000 kg
	Dodaci	da, inhibitor korozije
	Topljivost u vodi	da
	Biorazgradljivost	da, vrlo ovisna o temperaturi
	Opterećenje, KPK, BPK_5	0,211 g O_2/g, 0,154 g O_2/g
	Produkti razgradnje	CO_2, H_2O
	Mobilnost u sustavu	velika (izrazito vodotopljiv)
	Mogući utjecaj - površinske vode	da, moguća anoksija
	Mogući utjecaj - podzemne vode	da, moguća anoksija

2.3.2. Means for aircraft treatment

Osnovni podaci o kemijskim sredstvima koja se primjenjuju u procesu odleđivanja/zaštite zrakoplova u ZLZ:

Safewing MP I 1938 ECO (80)	Proizvođač	Clariant
	Djelatna tvar	propilen glikol
	Kem. formula	$C_3H_8O_2$
	Koncentracija	80%
	Agregatno stanje	tekućina
	Godišnja potrošnja	51.000 l
	Dodaci	da, paket aditiva
	Topljivost u vodi (mješljivost)	da, u primjenskim omjerima
	Biorazgradljivost	da
	Opterećenje, KPK, BPK_5	1,30 g O_2/g, 0,44 g O_2/g
	Produkti razgradnje	CO_2, H_2O
	Mobilnost u sustavu	velika (izrazito vodotopljiv)
	Mogući utjecaj - površinske vode	da, moguća anoksija
	Mogući utjecaj - podzemne vode	da, moguća anoksija i pojava neugodnih mirisa
Safewing MP IV LAUNCH	Proizvođač	Clariant
	Djelatna tvar	propilen glikol
	Kem. formula	$C_3H_8O_2$
	Koncentracija	50%
	Agregatno stanje	tekućina
	Godišnja potrošnja	51.000 l
	Dodaci	da, paket aditiva
	Topljivost u vodi	da, u primjenskim omjerima
	Biorazgradljivost	da
	Opterećenje, KPK, BPK_5	0,81 g O_2/g, 0,28 g O_2/g
	Produkti razgradnje	CO_2, H_2O
	Mobilnost u sustavu	velika (izrazito vodotopljiv)
	Mogući utjecaj - površinske vode	da, moguća anoksija
	Mogući utjecaj - podzemne vode	da, moguća anoksija i pojava neugodnih mirisa

2.3.3. World practice and comparisons to the Zagreb Airport

The comments here solely regard the characteristics which could have effect on the environment and they do not look at the efficiency of a certain agent. In accordance with the available information from Safeway and Safewing, the products belong to the very top of world quality:

- toxicity for people is very low or does not exist, of course with following the regulated measures for handling and the application of regular measures of protection,
- the products are biodegradable,
- KPK i BPK5 products for de-icing manipulative surfaces are very low (in relation to other possible products),
- agents for treating aircrafts (Safewing) are possible to be collected and recycled.

NOTE: the term recycling is not to be taken literally. The product of recycling is not as such suitable for re-use. It is necessary to additionally process it with an addition of an adequate package of additives. More information regarding the procedure is available on the web site of the producer:
http://www.aviation.clariant.com/bu/ics/internet.nsf/vwWebPagesByID/BEB0FEEA8C0AC445C125770500282108?OpenDocument

Contrary to the above products, the possible effect of urea on the environment is significantly unfavorable. The reason for the use of urea is economic. However, since Zagreb Airport will have to build a collection system and wastewater collection and treatment plant, the use of urea will probably become unprofitable. Specifically, the removal of nitrogen from wastewater (denitrification) would significantly be a more expensive treatment regarding investments and operations. Of course, it is possible that during the technical and economic analyzes of treatment to find a solution that would justify the retention of urea in use. Below you'll see ways of treating wastewater in several airports and it is important to note that no one uses urea, except Zurich airport (very small amounts).

As an illustration, we will give details on the consumption of resources to defrost maneuvering areas in the U.S. (U.S. EPA, Environmental Impact and Benefit Assessment for Proposed effluent Limitation Guidelines and Standards for the Airport deicing Category, 2009th, EPA-821-R-09-003):

Asset	Assessed consumption., t/god
Potassium acetate	22.538
Urea	4.127
Propylene glycol products	3.883
Sodium acetate	3.100
Sodium formate	1.117
Ethylene glycol products	774

The same document lists the data on the use of liquid funds for de-icing aircrafts (types I and IV). The products based on propylene glycol, which are used in Zagreb Airport, make up 88.5% of the total consumption:

Asset	Estim. Consumption., mil. l/year	share in total cons. %
Tip I - propylene glycol	73,077	77,1
Tip IV – propylene glycol	10,811	11,4
Tip I – ethylene glycol	9,747	10,3
Tip IV - ethylene glycol	1,16	1,2

2.4. WORLD EXAMPLES OF PURIFYING WASTEWATER IN AIRPORTS

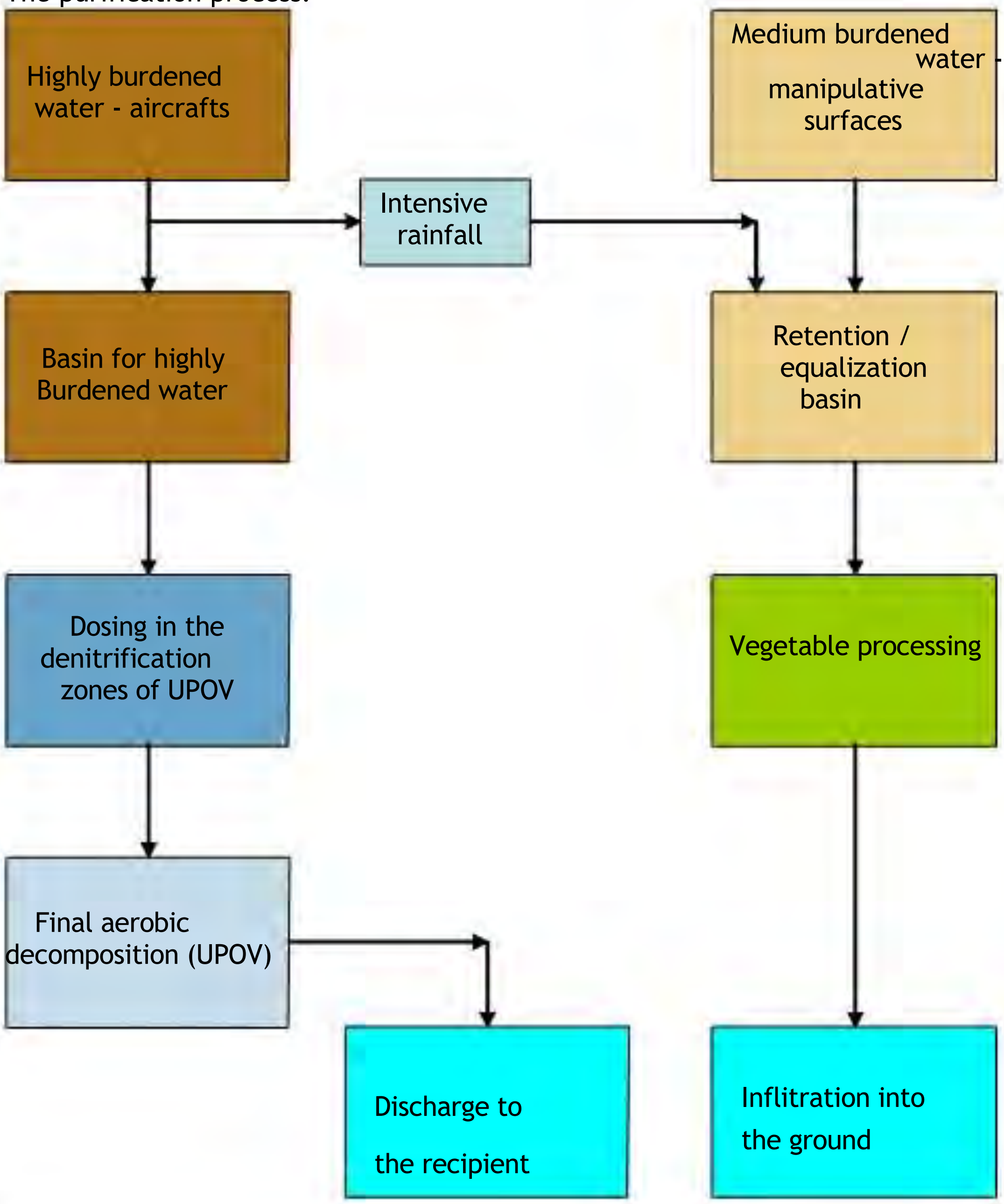
Based on the available data we will show a few concrete solutions to the problems of wastewater generated during the de-icing of aircrafts and manipulative surfaces. The procedures are shown as the basic operations of the purification process without processing the details and the sizing of the facilities and equipment.

2.4.1. Airport Zürich

The device for purifying waste water in Airport Zurich has been in effect since the season of 2000/2001. The drainage systems are entirely separate. The agents for de-icing surfaces are a combination of ethylene glycol (41%) and isopropanol (59%) and a small amount of urea. The purification process consists of the following:

- a system for the collection of highly burdened water (waste) generated in the process of aircraft treatment. This water (waste) is disposed of on the local device and serves as a source of fast-metabolical source of carbon in the process of denitrification,
- Rainwater contaminated with de-icing agents for manoeuvre surfaces is stored in the retention / equalization basin and purified on plant fields. The control efficiency of the process is carried out by sampling and analysis of groundwater. Stated is an example of the winter in 2003/2004 when only 5 of 834 samples exceeded the legal maximum size (DOC max. 20 mg / l),
- rainwater in which the DOC less than 20 mg / l is discharged directly into the recipient.

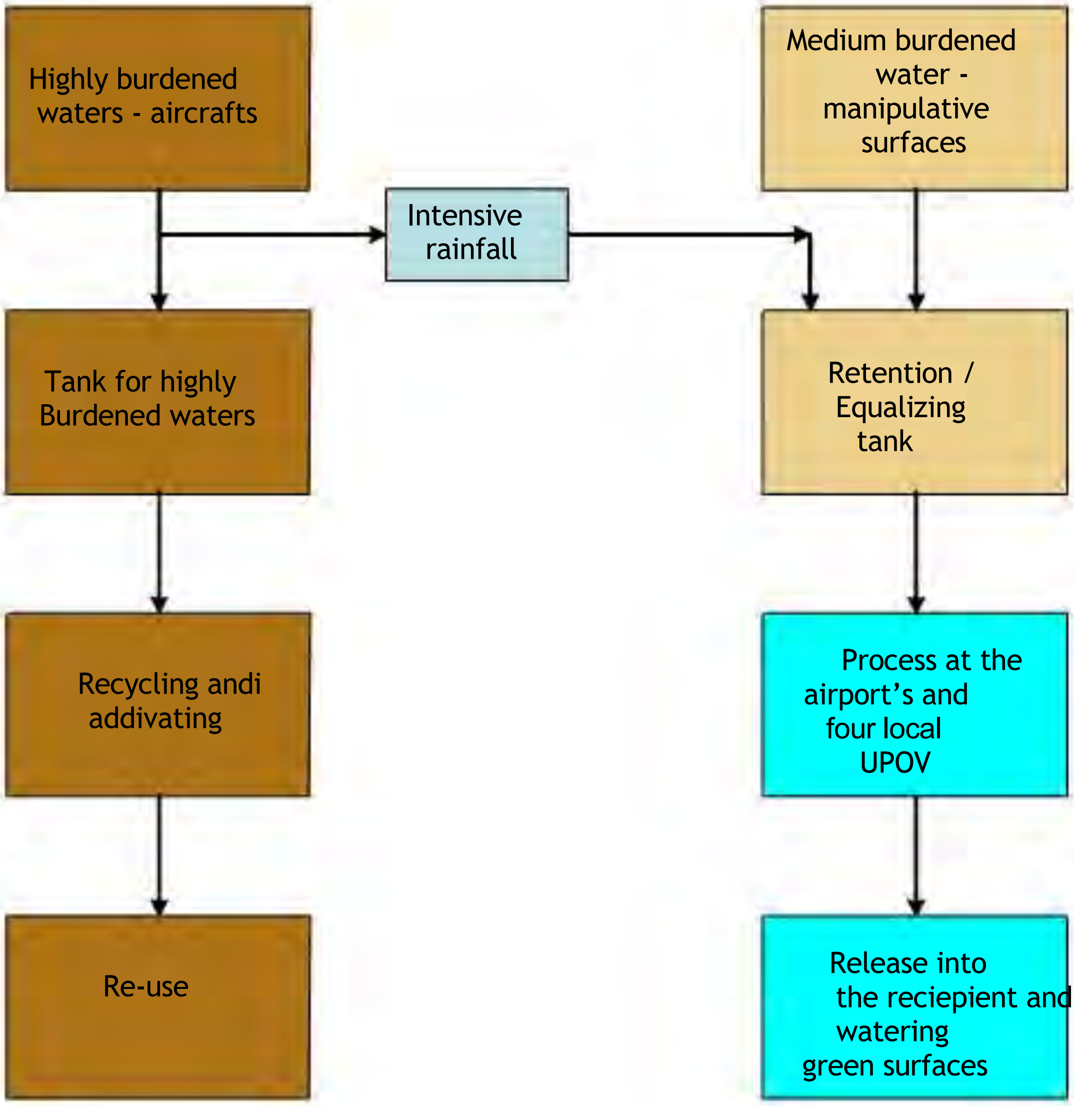
The purification process:



2.4.2. Airport Frankfurt

A comprehensive solution to the problem of waste water of Airport Zurich commenced in 1990. They gave up on the application of urea due to high pollution of the groundwater and began reconstruction of the drainage system and the separation of individual flows. The Zurich Airport has a device for purifying wastewater of a smaller (11,000 ES). Therefore, a good portion of wastewater is treated in the surrounding urban devices. Currently a much larger device for wastewater treatment is being built (100,000 ES), which will reduce the burden on local devices, especially during the winter months (season of de-icing).
In 1999 the underground repairs began. The unit started operating at a capacity of 300 m3 / h which was designed exclusively for treating groundwater. At the time of commissioning, the concentration of nitrate in groundwater was approximately 280 mg / l. After 12 years of treatment the nitrate concentration was reduced to 56 mg / l.

Purifying procedure:

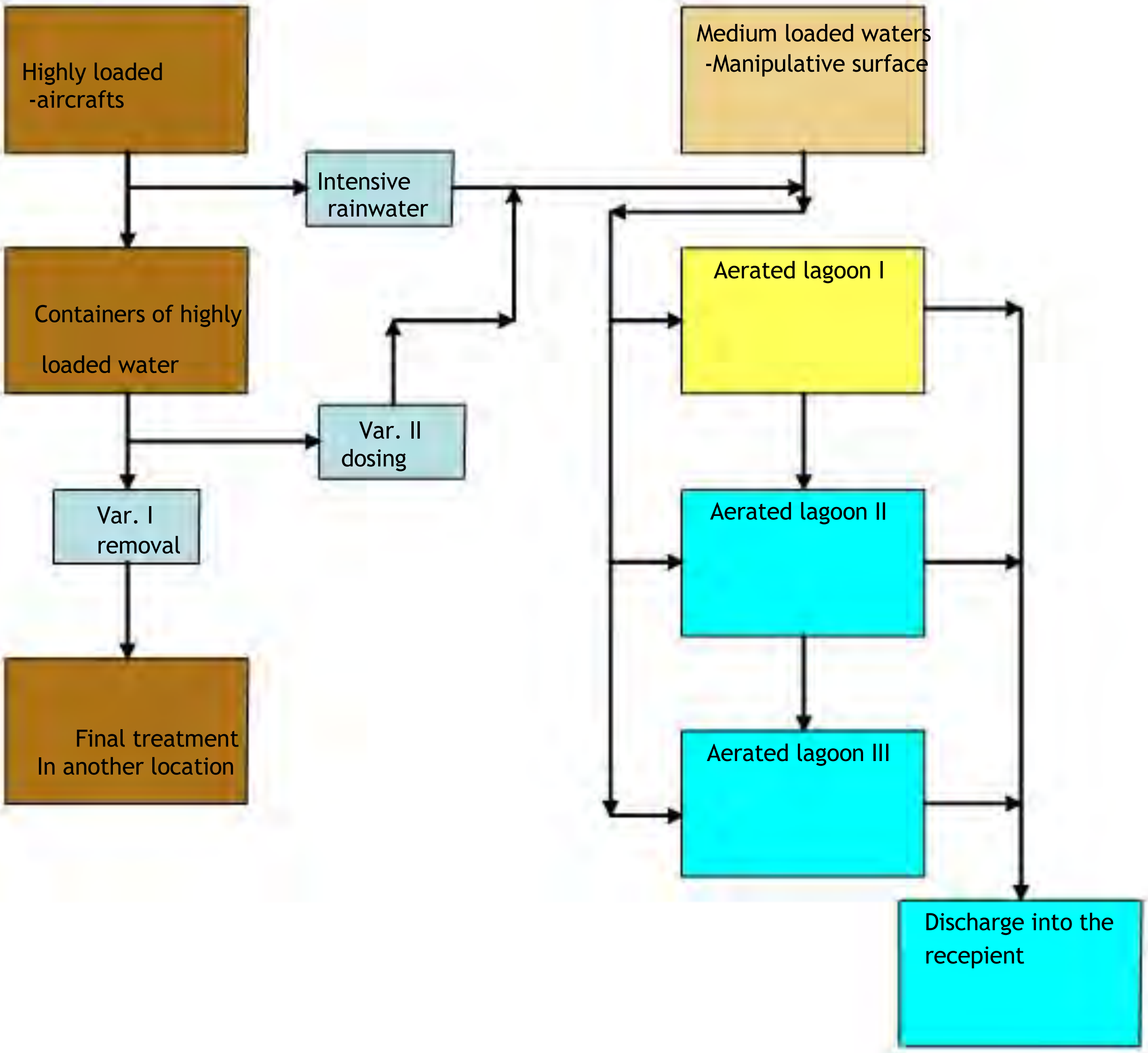


2.4.3. ZL Syracuse Hancock International

Syracuse Hancock International Airport is a regional airport with an annual revenue of 2,000.00 passengers. The processing of wastewater from the process of de-icing started in 1996. The system consists of:

- separated surfaces for treating aircrafts and a system for collecting and storing high burdened wastewater (waste),
- separated surfaces for storing waste snow polluted with agents for de-icing,
- system for drainage of manipulative surfaces,
- retention/equalization areas (three basins) where biological waste is processed. When the BPK_5 value in the basin falls under 20 mg O_2/l the process of aeration is stopped, the active sludge is set and the clean (purified) water is drained into the recipient. Biological sludge is transported to be processed and handled at a local device.

Procedure of purification:



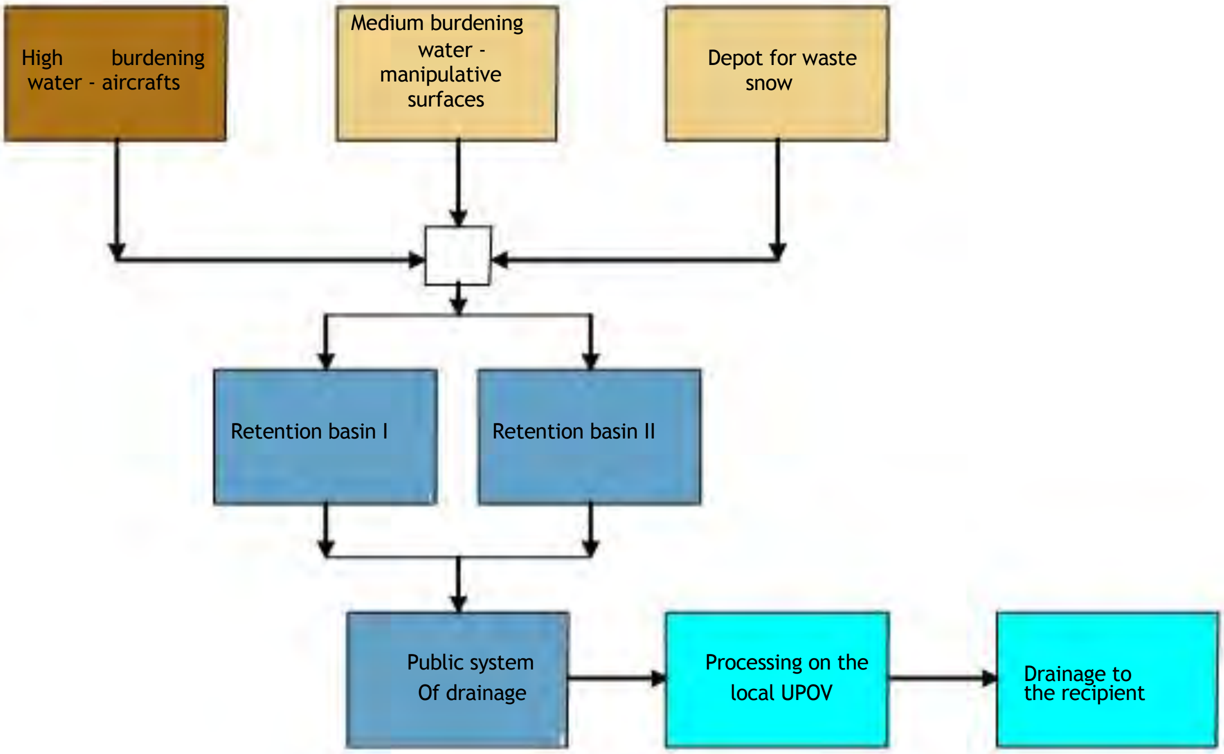
2.4.4. Albany airport

The Albany International New York Airport is a regional airport with an annual revenue of 1,000.000 passengers. It is stated that Airport Albany was the prototype for purification which was later used on numerous other airports. The system was put into effect in 1989/1990 to prevent the pollution of the local river (Shaker Creek) with glycol.
The system was not concepted for purification, but only serves for collecting wastewater and consists of:

- a drainage system (collecting) for wastewater,
- retention / equalization of the system.

The wastewater is re-pumped from the retention system and processed on the local device (Albany County North Treatment Facility) with conventional technology.

Procedure of purification:



2.5. PRINCIPLE CONCEPT OF THE DEVICES

On the basis of the previously stated, it is possible to roughly draw up the basic conception of the device for purifying water from de-icing. It is necessary to mention that the real concept of the device will be able to be defined only after the draw up of several variants and their technical and economic comparison. The future device will be made up of two entities:

- drainage system (collecting) wastewater,
- system of purifying waste water.

<u>Drainage system</u>
Drainage system (collecting) for wastewater of the Zagreb Airport covers four separate entities:

- sub-system of drainage od highly burdened polluted rainwater which also includes the basin for their storage,
- subsystem of drainage of medium burdened rainwater polluted with special agents for de-icing water which includes an appropriate retention / equalization volume,
- subsystem for the drainage of sanitary-fecal wastewater,
- subsystem for the drainage of rainwater wastewater which was not polluted with agents for de-icing.

The system of drainage and retention should satisfy the following demands:

- it should completely be water-resistant to protect underground waters
- land surfaces between the collector and manipulative surfaces should be made water-resistant to prevent infiltration to the underground.

2.5.1. Manner of purification

Since certain flows of wastewater significantly differ, the purification of certain flows will be described separately.

<u>Sanitary-fecal wastwater</u>
Sanitary-fecal wastewater is purified through a biological procedure. The device for purifying can be within the Zagreb Airport or the wastewater will be possible to purify in Velika Gorica.

<u>Rainwater polluted with special agents for de-icing</u>
As it has been shown, there are various technologies which can give satisfactory results. What can be defined with security is that biological purification is necessary. Furthermore, most of the observed devices separate highly burdened water and treat them seperately. Basically, two types of technoligies for purifying rainfall are possible for water polluted with special de-icing agents:

o plant processing by spraying polluted water on grassy and similar surfaces,purification is based on the plant and microbiological decomposition of the pollution,
o process with active sludge, the pollution is decomposed with microbiological actions in the device for purification (aerobic procedure).

Since the Zagreb Airport is located in the immediate vicinit of drinking water, it can be concluded that the variant of plant purification cannot be taken into account. Namely, the control of the process is made more difficult (large surface), and the influence of the user regarding the efficiency of the process is minimum. Therefore the plant device should be made water-resistant, and a drainage system should be build to pump the purified water into the recipient.

The optimal technology for purifying rainwater that is polluted with agents for de-icing is the so-called process of active sludge. The decision on choosing the sub-type technology of purification and the location of the process should be brought based on executed technical and economic analysis. The chosen technology should satisfy positive legal regulations and legal terms.

The basic variants of processing regarding the location can be:

- local processing – processing to a satisfactory criteria for drainage to a natural recipient is performed on the location of the Zagreb Airport,
- exterior processing - retentioning/equalization on the location of Zagreb Airport, and further processing in Velika Gorica.

The surface for depositing dirty snow that is polluted with agents for de-icing is attached to the drainage system, and the contaminated water is stored in retention and purified through a biological process.
Since this is a seasonal problem, it is necessary to envisage the possibility of discharging directly into the recipient out of the season of de-icing. Before discharge, treatment is required in the hydrocarbon / sand separator. It is, of course, necessary to ensure adequate monitoring of water quality prior to discharge (measuring TOC, total organic carbon).

<u>Polluted rainwater which does not contain agents for de-icing</u>
Contaminated rainwater that does not contain agents for de-icing (parking lots, roads, etc.) are treated in the sand and hydrocarbon separator and are discharged into the recipient. The surface for depositing snow that is not contaminated by de-icing agents is included in the drainage system, and the contaminated water is treated in the hydrocarbon separator / sand separator.

<u>Highly burdened rainwater (technological) wastewater</u>
Highly polluted rainwater (technological) wastewater is collected in tanks and processed or treated in one of the following ways:

- Recycling and reuse,
- The use of sewage water as a source of carbon in the denitrification process,
- Anaerobic digestion and biogas production,
- Aerobic degradation in biological device for wastewater treatment.

The recycling process would be built on the site of Zagreb Airport. Other options listed may not be related to the location of Zagreb Airport or with its surroundings. Specifically, the amount of highly loaded waste water is relatively small (roughly 100-200 m3/yr) and the possible treatment is at one of the closer treatment plants (V. Gorica, Zagreb, Karlovac), but even beyond the country's borders.

2.5.2. Quality of purification

It should be noted that any of the anticipated variants will meet the required quality of the demanded effluent (Codebook on the limitation of emissions of waste water, RH OG 87/10), and thus eliminate the possibility of negative impacts on the environment. The proposed actions are consistent with international practice and, in its entirety, enforceable also in Croatia.

2.6. POSSIBLE VARIATIONS OF PROCESSING POLLUTED RAINWATER

2.6.1. Introduction

A necessary degree of purification (effluent quality) is given by the positive regulations of The Republic of Croatia that are in compliance with EU regulations. Essential documents that determine the degree of treatment and the required effluent quality are:

- *Decision on the determination of sensitive areas (NN 81/2010),*
- *Ordinance on the limit values of emissions of waste water (RH NN 87/10)..*

Decision on designation of sensitive areas (Article IV) water area of the Danube River in whole a catchment of sensitive areas. Accordingly, the Regulations on limit values of waste water is defines treatment stage III, that is, the required effluent quality:

Indicator	Borderline value	Least percentage of the decreased load
Suspended substance	35 mg/l	90
BPK_5	25 mg/l	70 - 90
KPK	125	75
Total nitrogen	15	70 - 80
Total phosphor	2	80

In order to facilitate the monitoring of the further text, the meaning of certain terms will be clarified and the basic features of certain technological processes, ie the total work will be described.

Retention
Retention is a structure (container) that is installed before the treatment plant.
Retention functions are:
- Acceptance of the increased flow of waste water in a short time,
- Equalization of the composition of wastewater.

Installation of previous retention allows the construction of the treatment plant of optimal size and provides a significantly better effect of treatment (balanced composition of waste water), and which is particularly important for biological treatment. Specifically, biological processes are sensitive to rapid load changes.

Pretreatment
Pretreatment includes mechanical and physical treatment of wastewater which reduces the potential adverse impacts to other stages of purification.

Sand Separators / hydrocarbon
Purification of polluted storm water (roads, parking lots, etc.) includes the removal of sand and similar particles and hydrocarbons. Typically applying separators of sand / hydrocarbons, after which the effluent is discharged into the recipient.

Biological treatment (aerobic)
Wastewater treatment is the result of biological activity of microorganisms that are mostly located on the surface of the so-called. Floccules of activated sludge. Floccules are an agglomeration of insoluble inorganic salts, hardly degradable suspend and insoluble residues from dead biomass. Present microorganisms use organic matter (dirt) as a source of energy for maintenance, growth, and development. Since the process is aerobic, decomposition products are carbon (IV) oxide and water and, of course, a certain amount of newly formed biomass that depends on the quantity of available food in relation to the amount of active biomass.

Limiting growth factors may be a concentration of so called *nutrients*, compounds of nitrogen and phosphorus.
Depending on technological variations, the biological sewage treatment plant can be classified as:

- A conventional devices composed from a bioreactor (treatment) and secondary settling tank (separation of water / sludge),
- Batch devices (SBR) - the so-called batch purification in so-called cycles, the bioreactor simultaneously functions as a secondary settling tank,
- Membrane devices (MBR) - consisting of a bioreactors and the separation of water / sludge is performed by filtration through membrane filters (the current standard of 40 nm pores)
- Devices with biomass support - biomass in a bioreactor grows on bearing elements (fixed or moveable), excess sludge is allocated in the subsequent settling tank.

Depending on the required effluent quality, the biological wastewater treatment plant may II or III stage of treatment.

<u>II level of treatment</u>
II level of treatment predicts reduction of the basic indicators of pollution (COD, BOD5, suspended solids). Reduction of nitrogen and phosphorus is not predicted. The bioreactor is fully aerobic.

<u>III degree of purification</u>
III level of treatment while reducing the basic indicators of pollution (COD, BOD5, suspended matter) provides for the reduction of nitrogen and phosphorus, which results in a significant increase of the bioreactor part of the wastewater treatment plants.
The bioreactor is divided into two sub-units:

- Nitrification subunits (aerobic conditions) which oxidize organic compounds and nitrificates the present ammonia,
- Denitrification subunits (anoxic conditions) in which the denitrification process takes place (reduction of nitrate).

Phosphorus is possible, in part, to be biologically removed in the so-called anaerobic selector. The remaining amount of phosphorus is removed by precipitation with the addition of iron or aluminum salts.

<u>Anaerobic digestion</u>

Anaerobic digestion is the biological degradation of organic matter in the absence of oxygen. By-product of anaerobic digestion is biogas, which contains approximately 60 - 65% of methane. The resulting methane can be used to produce electricity and heat. The anaerobic process is very rarely used as a primary wastewater treatment. It is commonly applied in the treatment of sludge (primary and secondary) of larger treatment devices (> 50,000 PE), and in this case is used for the disposal of liquid waste with a high content of organic matter, such as waste grease traps and similar.

2.6.2. Treatment of sanitary sewage feacal wastewater

Sanitary-feacal waste water is treated by biological activated sludge process.
The process usually requires a certain mechanical pretreatment. There are two variations of purification.

Variation Ia - treatment WWTP Velika Gorica

There is an agreement in principle related to the treatment of sanitary sewage waste water on the WWTP in Velika Gorica.

Variation IIa - treatment WWTP ZAGREB AIRPORT

The alternative treatment of fecal waste water in the waste water treatment device of ZAGREB AIRPORT is possible. Specifically, if there is no possible treatment of polluted storm water polluted with means for defrosting at the outdoor location of ZAGREB AIRPORT will need to build its own device for biological treatment. Since the problem is seasonal, and the establishment of biological process takes 3 - 5 weeks, ZAGREB AIRPORT will need a Wastewater Treatment Plant in operation the entire year. Thus, maintaining the biological treatment process will condition the treatment of sanitary feacal waste water at ZAGREB AIRPORT.

2.6.3. Treatment of highly loaded polluted rainwater

Pursuant to contemplated characteristics of wastewater, using the chemicals and experiences from practice it is possible to define the possible variations of purification. It should be noted that certain parts of the treatment process is actually do not have an alternative:

- Separation of highly loaded water (waste) is necessary because of the impact on the further stages of purification. Uncontrollable flows of highly loaded water would certainly marred the process of purification. In addition, a separate collection of highly loaded wastewater allows multiple ways of processing, which will ultimately have a lower investment cost and lower operating costs.

The collected effluent (waste) contains a high concentration of propylene glycol (according to literature data 10 - 40%) and certain impurities, such as dust, remnants of tires and similar). Possible variations of processing:

Variant Ib - Recycling

According to data from the manufacturer and specific examples of airports, highly loaded waste recyclable and, with adequate treatment, reusable. There are two subtypes of recycling:

- *Reuse at the airport* which includes the following operations:
  - collection and storage,
  - mechanical treatment (filtration)
  - chemical treatment
  - steaming up to the required concentration (usually Type I)
  - adding additives and mixing

The resulting product can be used for the treatment of aircrafts. Normally the recycling product corresponds to the type I.

- *Re-use for other purposes*, which includes the following operations:
  - collection and storage,
  - mechanical treatment (filtration)
  - evaporation to the desired concentration (60 - 85%)
  - transport to the user and use for other purposes

Variant IIb - anaerobic digestion

The high content of propylene glycol makes this a favourable substrate for waste processing in the biogas plant (anaerobic digestion). Possible locations of processing are utility devices for waste water treatment in the area of ZA - Velika Gorica, Zagreb, Karlovac. A relatively small volume of highly loaded waste (roughly 100-200 m3/yr) allows processing (use) even beyond the borders of Croatia.

Variation IIIb - an aid in the process of denitrification

Propylene glycol is a very good addition to the denitrification process (extensive metabolizing source of carbon). It is dosed in the denitrogenation zone of the purification device. Currently in the area there is no larger utility device that is capable of denitrification (UPOV and V. Gorica and Zagreb Devices are devices of the II treatment level, there is no reduction of nutrients).
The situation will change relatively quickly because RC is required to raise the level of purification of large agglomerations on the III level of treatment (removal / reduction of nutrients). According to the available information, projects for V. Gorica and Zagreb are in preparation.
Therefore, this concept of treatment should not be rejected in advance. The relatively small volume of high loaded waste water (roughly 100-200 m3/yr) enables to treat (use) even beyond the borders of Croatia.

Variant IVb - aerobic treatment

The variation of aerobic treatment includes conventional biological degradation or a similar procedure. Highly loaded waste water (waste) is dosed gradually (controlled volume) in the aerobic bioreactor and decomposes. The location of processing depends on the adopted concept of treating wastewater ZAGREB AIRPORT, and may be local (device ZAGREB AIRPORT) or external (public device). This method of treatment is probably the most expensive biological treatment due to costs of aeration.

2.6.4. Processing medium-loaded storm water contaminated by means of de-icing

Pursuant to contemplated characteristics of wastewater, the chemical used resources and experience of practice it is possible to define the possible variations of purification.
It should be noted that certain parts of the treatment process is actually not alternative:

- Retention / equalizing tank is necessary due to periodic large inflows (Precipitation). The primary function of the tank is, therefore, retention. The absence of retention would dramatically increase the device and cause big problems in the work of the later phase of treatment (biological treatment). Equalization of wastewater is a secondary effect which is very conducive to the biological treatment (biological processes are very sensitive to load changes). The authors of the EIS are not familiar to the example of purification of wastewater with any retention system.

Processing medium-loaded wastewater mandatorily require adequate biological purification.
Certain variations, in principle, can be defined as:

- *Local treatment*, the overall process of purification takes place within ZAGREB AIRPORT, effluents meet the criteria for discharge,
- *External purification,* waste water drains to the municipal treatment device, only collection and retention is performed at the area of ZAGREB AIRPORT.

Variation Ic - local treatment
Local treatment in ZAGREB AIRPORT involves building a complete wastewater treatment plant for contaminated storm water. The result of the treatment process must be the effluent that will meet all the requirements for discharge into the watercourse of category II and conditions from (water- permit) management permit.
During the technology selection, particular attention should be paid to the seasonal nature of processing.
Possible technologies are:

- Plant *purification* soaking lawns contaminated with polluted storm water. Application of this method is questionable because ZAGREB AIRPORT located near a drinking water

pumping station, and it is necessary to disable the impact on groundwater.
The area, which is necessary to make watertight is significant,

- *Aerated lagoons* where the water is purified saržno, lagoon I is filled and aerated. After reaching the maximum level, other lagoons are filled and aerated etc. By achieving necessary effects the aeration is stopped, activated sludge settles, and the clear part of treated water is discharged into the recipient. Establishment of the purification process is made difficult by seasonality, it is possibly necessary to connect sludge for a faster launch of the process
- *Conventional or similar device (the process for activated sludge) aggravating circumstances and problems as with aerated lagoons, but is more acceptable for the surface.*

In the case of local processing using urea should be minimized, but not completely abolished. So, in the case of a complete elimination of the use of urea, it should be added in the purification process (wastewater with a low level of nutrients). The use of urea should be very carefully controlled (effluent quality). Adding phosphorus is likely to be inevitable.

Variant IIc - external purification

Waste water is treated at a municipal unit. The facilities located in the ZAGREB AIRPORT area are drainage system, retention and controlled shipment to the municipal unit. Relatively near ZA the wastewater treatment plant in Velika Gorica is located. The reality of this variation can be judged only after a detailed analysis of available capacities of the devices and the possible impact on their work and the costs (investment and operational) of delivery of wastewater to the devices.
In the event that this variation appears feasible and affordable, the use of urea will need to be abolished.

2.6.5. Summary of variations

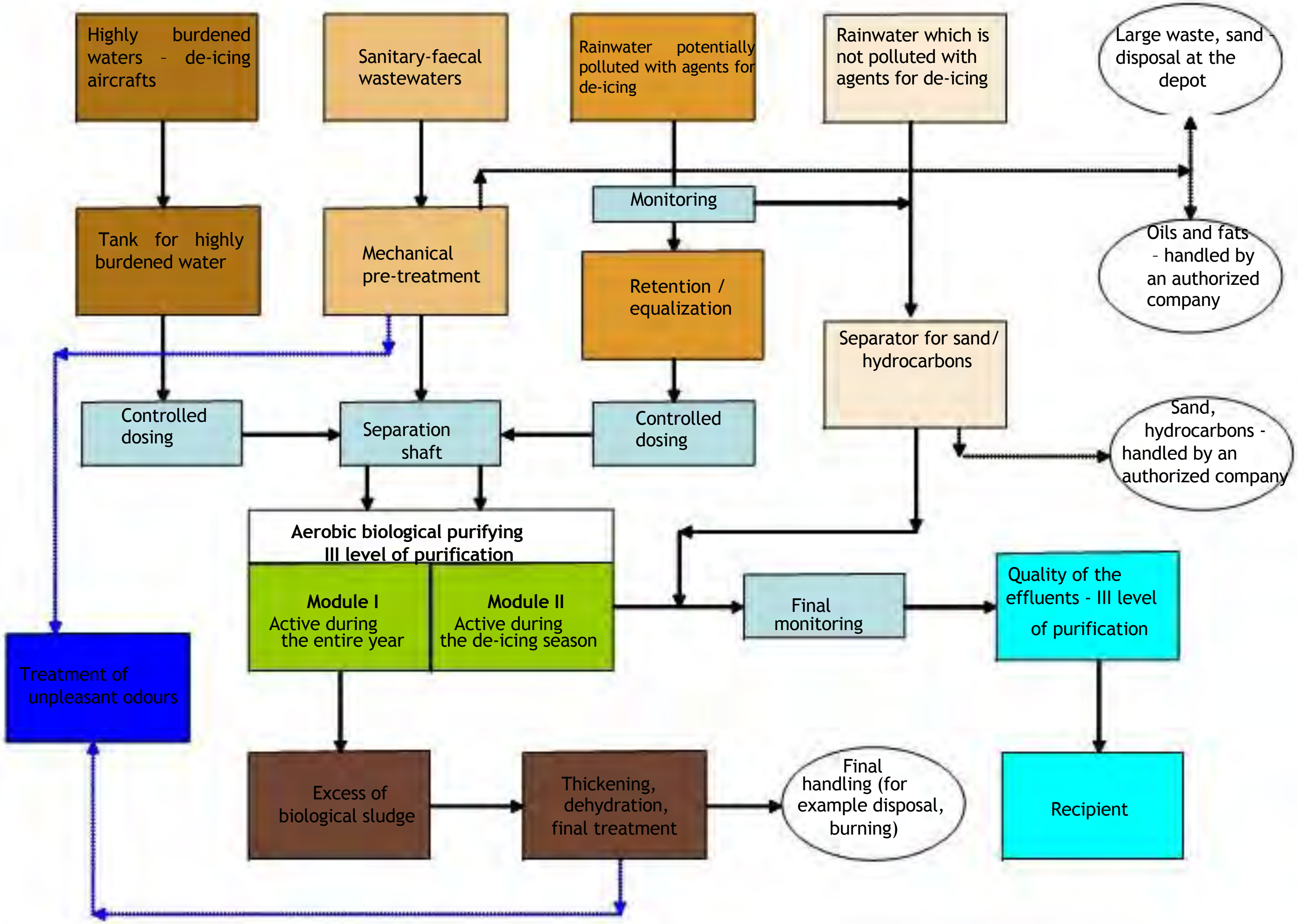
In accordance with the above, the possible variations of wastewater treatment Zagreb airport will be shown.

Variation A - the processing at the location of ZAGREB AIRPORT

Waste water treatment at the ZA site includes:

- Collection and treatment of sanitary sewage wastewater, which includes pretreatment and biological treatment of stage III throughout the year,
- Collecting, retention and stage III biological purification of rainwater contaminated with means for deicing during the deicing season. Out of season deicing stormwater is treated in a hydrocarbon / sand separator
- The collection and treatment of highly loaded wastewater containing means for de-icing. Waste water is gradually dosed into the biological level of treatment throughout the year. This wastewater can be disposed of at other ways - through recycling or use in anaerobic digestion or denitrification, if there are interests and capacities for that on some of the larger treatment facilities,
- The collection and treatment of storm water that is not polluted by special means for deicing are purified in the hydrocarbon / sand separator.

Variation A - scheme of treatment at the WWTP in Velika Gorica

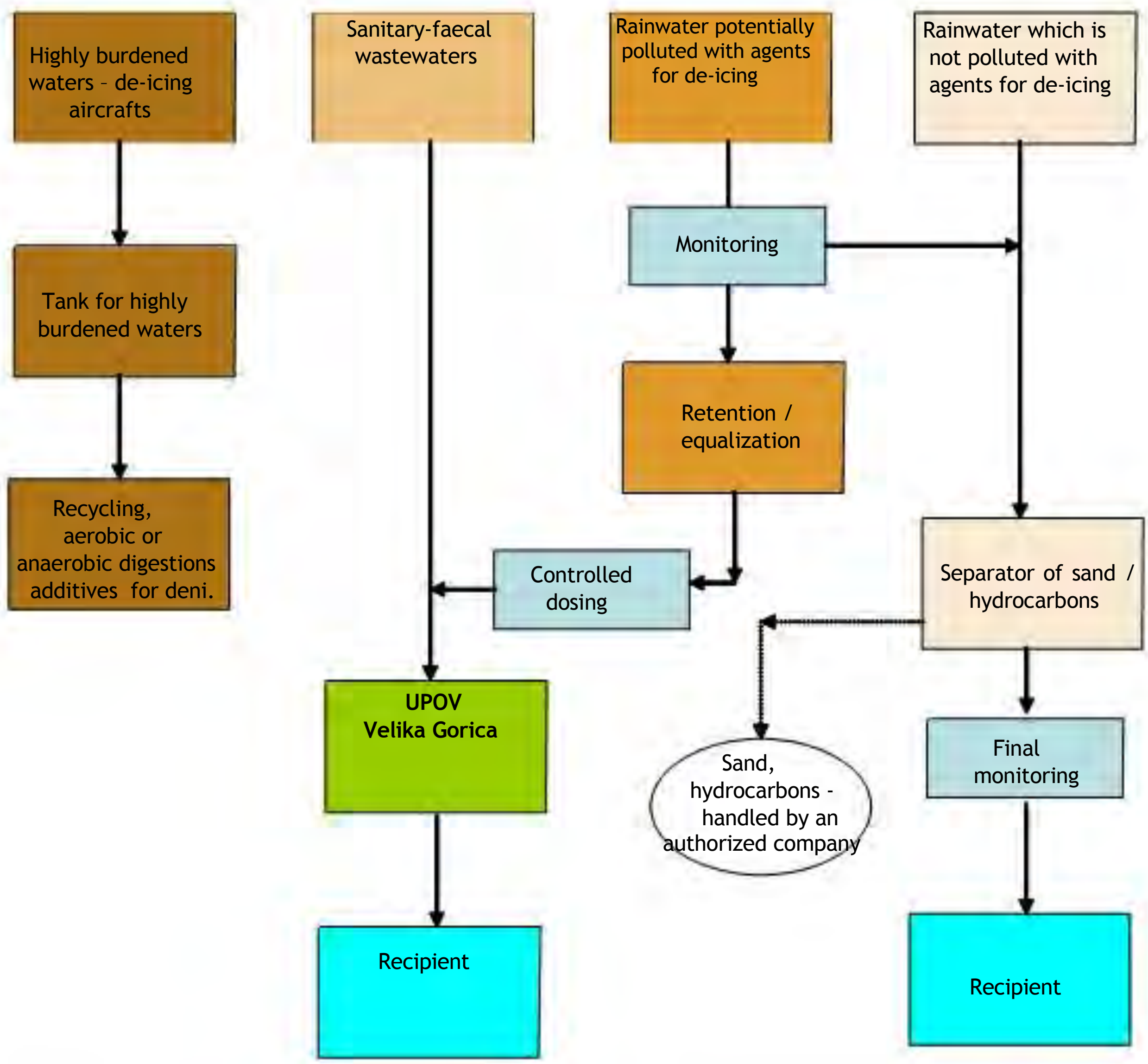


Variation B -scheme of treatment at the WWTP in Velika Gorica

Wastewater treatment on site WWTP Velika Gorica includes:

- Collecting sanitary sewage waste water, treatment in the WWTP Velika Gorica all year round,
- Collection and retention of storm water contaminated with means for deicing during the season and the treatment at the WWTP in United Gorica. Out of deicing season deicing stormwater is treated in the separator hydrocarbon / sand.
- Collection of highly loaded wastewater containing means for deicing. These waste water shall be disposed of by recycling or using the anaerobic digestion and denitrification, if there are interests and capacities on some of the larger plants,
- The collection and treatment of storm water that is not polluted by special means for deicing are purified hydrocarbon / sand separator.

Variation B - Scheme of wastewater treatment - WWTP Velika Gorica



2.7. DIFFERENCES BETWEEN VARIATIONS ACCORDING TO THE POSSIBLE ENVIRONMENTAL IMPACT

2.7.1. Impact on air quality

Variation A - local treatment

A properly designed and constructed drainage and treatment system will have no impact on air quality. The purification process must be aerobic and thereby disables the appearance of unpleasant odors (products of aerobic decomposition are carbon (IV) oxide and water).

In some parts of the machine (mechanical pretreatment, treatment of excess biological sludge) may cause odor emissions that are removed by biological or chemical treatment of air. These cases are common and apply routinely to the treatment plant.

Variation B - WWTP Velika Gorica

Properly designed and constructed drainage system will have no impact on the quality of air.

2.7.2. Impact on groundwater

Variation A - local treatment

All facilities of the system must be made watertight (drainage, grass area between the manipulative surfaces and the collector, retention, purification device, drainage to the recipient). This will prevent the penetration of waste water in the subsoil, and the impact on groundwater will be virtually negligible.

After the establishment of the purification process of treated wastewater, stormwater will also be discharged into the recipient. Permanent monitoring of groundwater quality will be continuously carried out, and any change in quality will be a possible signal of mechanical damage. Periodic visual inspections of the pipeline (camera) will be required. Visual inspection and any repairs will be simple and will be carried out during the dry season.

Variation B - WWTP Velika Gorica

All facilities of the system must be made watertight (drainage, grass area between the manipulative surfaces and the collector, retention, purification device, drainage to the recipient). This will prevent the penetration of waste water in the subsoil, and the impact on groundwater will be virtually negligible.

After the establishment of the purification process of treated wastewater, stormwater will also be discharged into the recipient. Permanent monitoring of groundwater quality will be continuously carried out, and any change in quality will be a possible signal of mechanical damage. Periodic visual inspections of the pipeline (camera) will be required. Visual inspection.

2.7.3. Impact on surface water

Variation A - local treatment

The purification process will result in effluent within the legal limits and conditions laid down from the Water permit, which is considered acceptable impact. Waste water has a low level of nutrients (minimal use of urea), which means that the effluent will meet the III degree of purification. The effluent will not cause the process of eutrophication.

Variation B - WWTP Velika Gorica

Since the waste water will be finally treated at another location, impact on recipient should be assessed for the treatment plant. However, since for such facilities the EIS are also prepared on the basis of the maximum capacity, it can be considered it will not have an impact on the aquifer. However, in order to purify wastewater from Zagreb Airport in WWTP in Velika Gorica, they must have sufficient capacity for processing. This means that even with wastewater ZA it should not exceed the maximum design capacity.

2.7.4. Waste products of the purification process

Highly loaded wastewater

Highly loaded waste water (treatment of planes) is collected and stored in containers. Occasionally, it is recycled or drained for disposal to other locations.
Impact on the environment is only possible in case of an accident (breaking pipeline tanks, etc.). Accuracy of the equipment should be checked regularly. Possible environmental impact, except in the event of a major accident is negligible.

Hydrocarbon / sand separators

Collected hydrocarbons (parking zones, workshops, etc.) shall be disposed of by certified companies. Sand and similar extracted substances are collected and dispose of by a utility company or another authorized firm. The waste should be removed periodically, equipment should be controlled and environmental impact will not be significant.

Excess sludge - Variation A - local treatment

A certain amount of excess sludge is an inevitable consequence of aerobic biological purification. There is not enough data available that would allow an estimate of the amount. Pursuant to experiences it will require special treatment (Thickening, dehydration), and finishing would be performed on one of the surrounding treatment devices (anaerobic digestion). The excess sludge treatment process, done properly and controlled, will not have a significant impact on the environment.

Excess sludge - Variation B - WWTP Velika Gorica

As noted before, the processing at another location certainly does not affect the environment in the ZA area. Since the condition of this treatment is sufficient processing capacity of treatment devices, the impact on the environment will not go beyond that covered by the EIS of the device.

2.8. DIFFERENCES IN QUALITY OF TREATMENT AND ENVIRONMENTAL IMPACT BETWEEN VARIATIONS

There are no differences in the quality of treatment between the two processed versions. Both variations are based on the biological wastewater treatment process with activated sludge and therefore effluent quality differences are not expected. The primary difference is the location of the biological treatment (ZA or WWTP Velika Gorica). Since the same technological process of wastewater treatment in both variations is predicted, the possible environmental impact will be the same.

2.9. Use of urea

Therefore, the EIS orders the reducing use of urea with an obligation to end the use of it the latest January 1st 2016. EIS preparers do not have the power to order the reduction / ban to use urea in the surrounding agricultural areas, which would certainly be necessary. After the construction of drainage systems, defining variations of treatment and construction of the treatment system, it is possible to allow the use of certain quantities of urea as a nitrogen sources for the biological process (nutrients). This option applies only to the variation of local purification.

2.10. CONCLUSION

The possibility of external processing depends on a number of conditions:

- Readiness of the appliance owner to accept and process certain waste water from ZA,
- Actual (current) load of existing devices and available capacity (Current and future),
- The fee for processing the subject wastewater
- Investment and operating costs of pumping water to external devices.

Defining the factors mentioned above, at this point, is not possible. Therefore, for the purposes of EIS both variations are assessed as equivalent.

In order to protect the environment, the basic assumptions of future drainage and wastewater treatment systems for ZA are defined:

The drainage system, which consists of four independent subsystems:

- Drainage of highly loaded wastewater (deicing / treatment of Aircraft with means for deicing)
- Drainage medium loaded wastewater (stormwater polluted with means for deicing)
- Drainage sanitary sewage wastewater
- Drainage of contaminated waste water that does not contain means for deicing (Roads, parking lots, etc.)

The purification of certain wastewater streams:

- Highly loaded waste water is collected and stored in a tank and treated at the ZA site (aerobic degradation or recycling) or on the outer location (anaerobic digestion, use in the process of denitrification or aerobic degradation),
- Storm water contaminated by special means for deicing collected and stored in the retention / equalization basin and purified by an aerobic and biological process. Purification is possible on the device for the purification of Within ZA or WWTP (Velika Gorica)
- Faecal waste water is collected and treated at the treatment device within ZAGREB AIRPORT or in the WWTP (Velika Gorica)
- Stormwater not contaminated with de-icing agents are collected and prior to discharge into the recipient purified in a sand and hydrocarbons separator.

In accordance with the above variations, measures to protect the environment have been discussed. Based on above, it is possible to conclude that both variations with their impacts on the environment can be reduced to acceptable and legally permissible frames. Since the variation of treating polluted storm water from ZA at the city WWTP depends on the construction of a new wastewater treatment plant (Does existing does not meet the existing capacity), the chosen variation is purifying contaminated storm water at the airport site.

3. LOCATION DESCRIPTION AND ENVIRONMENTAL DATA

3.1. DATA FROM SPATIAL PLANNING DOCUMENTS

In the excerpts from the relevant regional planning documents for the project of a NEW PASSENGER TERMINAL ZA shows the location of the project and compliance with the provisions of applicable spatial plans.
For the subject area, the following planning documents are in force:

- Spatial Plan of County of Zagreb *(˝Zagreb County Gazette ˝ "no. 3/02, 8/05, 8/07, 4/10 and 10/11)*
- *Spatial Plan of the City of Velika Gorica ("Official Gazette of the City of Velika Gorica "no. 10/06 and 6/08)*

In the subject area under construction:

- Spatial plan of special features Črnkovec - Zagreb Airport (A public debate has been performed on the Draft Spatial Plan for the period from 1th to 30th December 2011. And a public exposure has been held on December 9th, 2011. The processing of complaints is in progress.)

In Book III, we offer a verified excerpt from physical planning documents, and following is the analysis of the relevant planning documents with the findings of compliance with the planned works.

3.1.1. Spatial Plan of Zagreb County
(˝Zagreb County Gazette "no. 3/02, 8/05, 8/07, 4/10 and 10/11)

Spatial Plan of the County of Zagreb, at the level of planning and guiding meanings, determines the basic position of transport systems in the County in relation to the transport role, arrangements of settlements, values, and protection of the area.

Development of air transport is based on securing the possibility of further expansion of Zagreb airport (the expansion and renovation of existing capacity) within the area that is

designated as a space for the development of the Zagreb airport by this plan. Inside of the area for the development of Zagreb Airport, there is an area for special purposes - military complex Pleso.

In this area it is possible to plan for all services in the function of air traffic, including the second runway.

The spatial range of expansion and reconstruction of Zagreb airport should be further elaborated through the Spatial plan's area of special features and the Spatial Plan of the City of Velika Gorica.

By the spatial plans area of special features Črnkovec - ZA and Spatial Plan of planning the development of Velika Gorica, the development of Zagreb airport is possible in the area that is in the Plan set for the development of the airport.

Zagreb County Regional Plan determines Zagreb airport in Velika Gorica as one of the buildings of importance to the State determined and Zagreb Airport in Velika Gorica town for international and domestic traffic for accepting and dispatching aircrafts, 4E classes and groups and a permanent international border air crossing the first category: Zagreb.

Part of the project that includes a new road corridor for access to the airport only partially coincides with the planned Corridor Regional Plan. This road enters the archaeological area.

3.1.1.1. Excerpt from the Spatial Plan of the County of Zagreb (“Zagreb County Gazette ˝ no. 3/02, 8/05, 8/07, 4/10 and 10/11)

I. ESSENTIAL PART OF THE PLAN
I.1. TEXTUAL PART
I.1.2. PROVISIONS FOR IMPLEMENTATION

1. Terms of demarcation of space according to characteristics, function and purpose
1.2. Terms of demarcation of space according to use
1.2.6. Areas and parts of the endangered environment

(11) Article 16.

Space is according to sensitivity, based on the indicators in Table 1, divided into 4 categories of protection:
I Category - the area of banned construction
II. category - the area of strict restriction of construction
III. categories – the area of restrictions of construction
IV. category - an area without restrictions

Table 1: Criteria of demarcation of space sensitivity

SENSETIVITY (category of limitations)	*Criteria*
I. category (area of construction prohibition)	*Areas of sanitary protection of drinking water sources: - I. zone -area of source (zone of strict protection regime)* *Area for special purposes intended for spreading for the development of the Zagreb airport* *Contact area next to the space for the development of Zagreb airport* *Forests*

2. Terms of determining areas of buildings of importance to the State and County
2.1. Buildings of significance to the State

(32) Article 37.

The plan shall specify the following buildings of importance to the State:
1. Traffic buildings:
c) Aviation buildings:
- *Zagreb Airport in Velika Gorica for international and internal traffic for eccepting and dispatching aircrafts of 4E classes and groups,*
- *a permanent international border air crossing of the I category: Zagreb.*

3. Conditions of storage facilities in the area
3.4. Exploitation of mineral resources

(61) Article 66.

It is not allowed to plan new locations for exploration and exploitation of mineral raw materials in the following areas:
- *within I., II. and III. zones of protection of water sources, as well as potential water protection area Črnkovec,*
- *within Space for development of the Zagreb airport,*
- *within the contact area with Space for the development of the Zagreb airport,*
-

5. *Terms of determining construction areas and use of developed and undeveloped parts of the area*

5.1. *General terms and conditions*

(74) Article 79.

The Plan sets forth the requirements for determining the area under construction according to categories for protection of spaces from section 1 Table 1 of the following provisions:

• Category I is the area of protection prohibiting construction and land operations, in which new construction areas cannot be formed and expanded and existing ones cannot be reconstructed. Inside the area for the development of Zagreb Airport, marked on the cartographic figure 1 "The use and purpose of space", which includes the existing settlements Mala Kosnica and Petina, establishes a regime of renovation of existing settlements until relocation. The above regime is introduced due to the proximity of the runway-landing trails and other facilities at Zagreb airport to the mentioned settlements, and the permanent and immediate danger and the many negative impacts that these facilities have on the inhabitants of these settlements, as well as for ensuring the possibility of further Zagreb airport expansion within this region. The renovation regime of settlements until relocation allows the planning of the necessary transport and utility infrastructure and reconstruction of existing buildings, and all according to the terms and conditions determined in the Spatial Plan of Velika Gorica, in accordance with provisions of this Plan.

Within the contact area with Area for the development of Zagreb Airport, also marked the first cartographic representation "Use and intention of space", which includes existing settlements Selnica Ščitarjevska and Bapča, exceptionally allowing formation of the construction zone of the settlement, but only in the spatial measurements of the existing structure, which is defined in the Final regulations of the Decision on IV.

Amendments to the Decision on the adoption of the Spatial Plan Zagreb County;

•...

(76) Article 81.

According to the requirements of the Strategy and Program of Physical Planning of the Republic of Croatia ("Official Gazette" No. 50/99) and on the basis of the analysis on the construction of construction areas from existing spatial planning documents, construction areas in the total surface on the level of local government (large cities, cities and municipalities) cannot be raised in relation to the size of the current spatial planning of cities and municipalities on the date of this Plan.

Exceptionally, construction areas from the previous paragraph may be increased due to:

•...

- *forming construction zone within the Contact area with the Space for the development of Zagreb Airport, under the terms of Article 79 Paragraph 1 Item 1of this Plan;*

6. *Determining conditions of traffic and other infrastructure systems in space*

6.1. *Transport Systems*

(90) Article 95.

This plan, on the level planning and guiding significance, determines the basic position of the traffic system in the County in relation to the transport role arrangement of settlements, and the protection of space for:

- *major road transport routes,*
- *road border crossings,*
- *rail transport routes,*
- *airports and airstrips,*
-

(97) Article 102.

The development of air transport refers to the expansion and renovation of the existing capacity of Zagreb airport. The development of Zagreb Airport is possible in the area that is designated by the Spatial Plan for the development of airport. In the area of the paragraph 2 of this article it is possible to plan all services in operating air traffic, including the second runway.

Inside of the area for the development of Zagreb Airport is located the area of special Purpose - Pleso military complex.

Spatial range of expansion and reconstruction of Zagreb Airport should be developed to detail through the Spatial plans area of special features and spatial plan of the development of the city Velika Gorica.

Until the creation of the Spatial Plan of Special Features and Spatial Plan of Planning the development of Velika Gorica Zagreb airport is possible in the area that this Plan determines for the development of Zagreb airport. The cartographic display of 3.2. "Terms of use and protecting space II" marked the

controlled airspace (CTR) as follows: CTR Zagreb airport and airport CTR Airport Lučko. Terms of use within the specified area are defined by special regulations.

The cartographic display map 1 " Use and purpose of space" determined the location for: airport for international and domestic air traffic - Zagreb Airport, location for a smaller airport in the survey reference code 2B and locations of airfields. ...

Due to the need for consideration of air services throughout the county, hereby The plan specifies the obligations of the Study of The development of air traffic of Zagreb County. The study should include existing and valid documents of Spatial Planning a planned air traffic infrastructure in the county, consider the needs and opportunities of the future development of air transport and to establish the ability to plan for new airports and runways of different classes, groups and categories.

Spatial plans of major cities, towns and municipalities on whose spaces are existing or planned airports or airfields it is necessary, in cooperation with authorities and legal persons in accordance with relevant regulations of the Republic of Croatia as well as international regulations in civil aviation, to determine Runway and transitional surfaces (areas of limiting obstacles) and conditions for the use of this area, particularly the part that refers to the possibility and conditions for construction.

Areas for heliports are possible to be predicted as one of the buildings of importance to the state and in spatial plans of major towns, cities and municipalities.

11. Implementing measures

11.1. Obligation to prepare documents of spatial planning

(157) Article 162.

Spatial plans of areas of special marks should be made for:

- *...,*
- *Area of well-field "Črnkovec" and Zagreb airport.*

(159) Article 164.

For the purposes of preparing regional planning documents under the jurisdiction of the County and local governments, as well as any amendments to these documents, it is necessary to create:

- *Study of interaction of services in the area of Zagreb airport and well-field "Črnkovec" that are predicted in the plan,*
- *...*
- *Study of the development of air transport in Zagreb County.*

3.1.1.2. Review of compliance of the Project with the Spatial Plan covers the Zagreb County

the Subject project predicts the construction of the new passenger terminal of airport Zagreb in two phases. Phase I includes the implementation of a new terminal with the capacity of 5 million passengers a year, and the phase II. Includes the capacity expansion in the next 15 years in which Zagreb Airport will ultimately be able to accommodate 8 million passengers per year.

The procedure includes the construction of access to the airport from the northeast side to be implemented through a new road (D) with four lanes from the bypass to the intersection of Velika Gorica to the north of Selnica Ščitarjevska. The realization of this road will be the responsibility of “Hrvatske Ceste"(HC).

The subject decision of the new passenger terminal of Zagreb airport is consistent with the Regional Plan for Zagreb County (“Zagreb County Gazette” no. 3/02, 8/05, 8/07, 4/10 and 10/11) in the segment of a new passenger terminal at the airport and associated services but not aligned with respect to the planned route for a new road to access the airport. The route

planned for the access road to the new terminal at Zagreb airport, in order to achieve optimal Physical and technical solutions and the solutions of this road junction in connection with planned eastern bypass of Velika Gorica, partially deviate from the planned route determined by the Spatial Plan of the county, but it is generally consistent.

3.1.2. Spatial Plan of the City of Velika Gorica
(˝ Official Gazette of Velika Gorica ˝ no. 10/06 and 6/08)

Spatial Plan of Velika Gorica provides the spatial conditions for the organization of air traffic, through the booking room of the airport for international and domestic air traffic "Zagreb Airport."

The project is located in the area of infrastructure systems (infrastructure buildings of national importance) and the area of special purpose (MORH), and areas for possible expansion of the airport.

Within the area planned for the eventual development of Zagreb Airport besides the construction of buildings, equipment and facilities for the airport and the Ministry of defense, allows only the construction and reconstruction of urban infrastructure and buildings, except transmission lines.

Part of the project that includes a new road corridor for access to the airport only partially coincides with the planned Corridor Regional Plan.¸

The roads partially enter the archaeological area Ščitarjevo - wider protection zone (B). The developer agrees that during the preparation of research works that precede the assessment

ensure environmental archaeological investigation, the result which must be carefully positioning of archaeological finds in the area and their evaluation, and that the investor

to such construction in the area has an obligation to do archaeological research or probing as directed by the Conservation Department and in the case of very important archaeological findings can lead to project changes or adjustments to the presentation of his findings).

The procedure is subject to the mandatory implementation of environmental impact assessment and preparation of the spatial plan of the area with special characteristics "Well-field area Črnkovec and Zagreb airport "as defined in the Spatial Plan for the County.

3.1.2.1. Excerpt from the Spatial Plan of Velika Gorica (˝Official Gazette Velika Gorica ˝ no. 10/06 and 6/08)

A TEXTUAL PART

II. PROVISIONS FOR IMPLEMENTATION

1. Conditions for the determination of land use in the City

1.2. Areas for development and improvement of space outside the settlement

1.2.2. AREAS FOR DEVELOPMENT AND SPATIAL PLANNING OUTSIDE THE CONSTRUCTION AREAS

Article 17

(1) **The surfaces of infrastructure**, as well as the surface intended for eventual further development of the Zagreb airport is intended to accommodate the infrastructure traffic and utility surface buildings, and the Map image, no. 1 "Use and purpose of surfaces" the major areas of state and County importance are shown '(airport for international and domestic air traffic "Airport Zagreb and "air port" Buševec "landfill for municipal and inert waste, transformer facilities 220/110 kV and 110/10 [20, 30, or 35 kV], I. zone of sanitary protection of water wells, the existing wastewater treatment plant of the settlement V. Gorica). 2) Within the area planned for the eventual development of Zagreb Airport is allowed besides the construction of buildings, equipment and facilities for the purposes of the Zagreb Airport Ministry of Defense, only the construction and reconstruction of urban and infrastructure buildings, except for transmission lines.

2. Conditions for the development of space

2.2. Buildings of importance to the State and County

2.2.1. PROCEDURES IN PLACE OF SIGNIFICANCE FOR THE STATE

Article 43.

Interventions in space of concern for the state:

- Traffic buildings with associated facilities and equipment:
  - Zagreb Airport for international and domestic air traffic,
  - Skyway for international and domestic traffic,
  - a permanent international border air crossing of the I category in Zagreb airport,
  - ...,

5. Conditions for establishing corridors / routes and areas for traffic, utilities and infrastructure systems

Article 128.

(2) Due to the use of infrastructure facilities, corridors, routes and surfaces are designed for:

- transport infrastructure for the following:
  - road traffic,
  - rail transport,
  - river traffic,
  - aviation and ...

5.1. Transport Infrastructure

5.1.1. ROAD TRAFFIC

5.1.1.1. Network of public and unclassified roads

Article 132

(1) Areas to accommodate planned roads, and their alternative routes outside constructed parts of construction areas and those areas for which the plan is not prepared for the narrower area or the conceptual design of traffic facilities, make the corridors of the following width:

-
- 100 m for other state roads,
-

(2) Until enforcing the relevant regional plans for smaller areas or approval of projects in the area according to the law (location license) for road constructions, it is not possible to construct facilities of other functions within the Corridors in the preceding paragraph, except the infrastructure and utility facilities.

Article 133.

(1) For the road corridor in the research, it is necessary to make additional professional and Planning that would be used to determine the possibility of its routing within the corridor.
(2) In the case of choosing alternative solutions for the road, the alignment with the regional plans of local governments should be done. (City of Zagreb, Orle).

Article 134

(1) Areas to accommodate existing road corridors are routes whose widths designated pursuant to special regulations, generally associated to road land, but generally not less than the width:

-
- 15 m for local roads and
-

(2) The width specified in the preceding paragraph may be less in the already constructed parts of the construction areas in accordance with relevant regulations.

5.1.4. AIR TRAFFIC

Article 146

(1) The plan shall provide for the organization of the physical conditions of air traffic through reservation:

- space for the airport for international and domestic air traffic "Airport Zagreb
- space for the air port "Buševec"
- location of heliports and
- Corridors of the airways for international and domestic air traffic.

(2) In addition to the heliport locations that are indicated on the Map figure, no. I allows the placement of the heliport and the building or buildings of importance to the state from Article 43 paragraphs 4 and item 3 of paragraph 2.

(3) Space arrangement of the airport, runway and heliport are conducted in accordance with the conditions and norms prescribed by special regulations.

Article 147

(1) Within the area of restriction barriers that have been identified in the area around the Zagreb Airport, and marked on the Map figure, no. 3, prohibits the construction of buildings that are too high and represent a threat to the safety of the air traffic.

(2) Approval of the competent government authority is required for:

- construction of buildings below the surface of obstacles limitations and
- construction of buildings taller than 150 m outside the obstacle limitation surfaces.

5.2. Infrastructure and utility systems

5.2.2. Water Management

5.2.2.3. Waste water discharge

Article 167

(4) The construction and reconstruction of infrastructure facilities of importance to the State and County (roads, railways, airport Zagreb), and military facilities, which may adversely affect the quality of groundwater is not allowed without adequate storm water drainage solutions and implementing other measures to protect groundwater from contamination, but the same applies to the given possible negative impact on the quality of groundwater and the inadequate solution for the storage of hazardous substances and / or hazardous waste, inadequate solution for waste water discharge, failure to maintain a system of internal waste water discharge and rainwater, etc.

6. Measures to protect the landscape and natural values and cultural - historical entities

6.1. Areas of special conditions of use

6.1.2. CULTURAL HERITAGE

6.1.2.1. Arheološka Heritage

Article 179

(1) For wider areas of Ščitarjevo and Želin certain archaeological areas with special conditions of use are determined. Archaeological areas are divided into the narrower and wider archaeological zones of protection. Archaeological protection zones are shown on the map figure no. 3, exactly the appropriate pages of the map figure no. 4 "construction areas".

(3) In the wider protection zone of the archaeological area, measures that are prescribed for archeological sites are implemented.

Article 180

Archaeological sites are indicated by approximate location on the map figure no. 3. Most of the site is indicated on the basis of random findings, but A number consists of a group of potential sites, based on the assumed indicative toponyms, geomorphological position, historical data, continuity of settlement, and numerous areas of the material remains. Because of the degree of exploration and research, they are classified as endangered and least protected cultural goods and the following steps to protect them are prescribed:

- On previously unexplored archaeological sites and areas of archaeological subject, experimental archaeological probing should be carried out , to allow the define the borders of the protection of the site
- Priority research carried out in the areas that are used for the intensive development of infrastructure systems
- For their identification is necessary to perform detailed mapping and documentation, on the basis of research and excavations. In all recognized areas, before the construction work for building the infrastructure or other buildings, archaeological investigations and probing should be carried out, to determine the further proceedings. If during handworks objects of rare archaeological significance should be found, the works should be stopped immediately, the nearest museum or the competent authority for the protection of cultural heritage should be notified.

Article 181

(1) For archaeological sites, which are recorded on the basis of occasional findings or assumed to have findings and, and there are no determined boundary of protection, no directive measures of safety are prescribed. If, during the performance of land works, objects of archaeological significance are encountered, the works need to stop and the Museum or the Institute for Protection of Cultural Heritage must be notified. Competent Archaeologist conservator will, depending on the degree of findings define further research.

(2) In areas that this Plan predicts for the construction of buildings and the space is not built and brought to purpose, based on current regional plans, the developer agrees that during the development of research works that precede

Environmental Impact Assessment to ensure archaeological investigation, which must result to detailed positioning of archaeological findings in the area and their evaluation, or the investor to construction in the area has an obligation to do archaeological research or probing according to the instructions of the Conservation Department and in the case of very important archaeological findings may change the project or its adjustments because of the presentation of findings), if explored areas required presentations in situ, and the projects of conservation and presentation of findings must be adjusted and plans and construction projects of buildings and facilities and arranging land.

8. Measures to prevent adverse impacts on the environment

8.4. Reducing excessive noise

Article 231

Reducing excessive noise predict:

- prescribing special construction requirements in the areas affected by the noise (The area around Zagreb airport) under a special regulation,

9. Measures of Implementation of the Plan

9.1. Obligation to prepare spatial plans

9.1.1. WIDER AREA SPATIAL PLAN

Article 234

Commitment of preparation, and the area of required spatial planning of the wider area - Spatial plans of areas of special features it "Area of well-field Črnkovec and Zagreb airport "established by the Spatial Plan for the County, and as shown in Map figure, no. 3.

3.1.2.2. Review of compliance of the project with the Spatial Plan of Velika Gorica

The solution of a new passenger terminal at Zagreb airport, scheduled for execution in two phases, is within the area of infrastructure systems (infrastructure buildings of national importance), the special purpose area (MORH), and areas for possible planned expansion of the airpot determined in the Spatial Plan of Velika Gorica. Therefore we conclude that the present procedure complies with the Regional Plan of the City Velika Gorica (˝ Official Gazette of Velika Gorica ˝ no. 10/06 and 6/08) in the segment of the new Airport terminal and supporting facilities. The route of the planned access road to the new terminal at Zagreb airport, in order to achieve optimal spatial and technical solutions and the solutions of this road junction at conjunction with the planned eastern bypass of Velika Gorica, partly deviates from the planned route specified in the Spatial Plan of Velika Gorica (˝ Official Gazette of the City Velika Gorica ˝ no. 10/06 and 6/08), but it is generally consistent.

3.1.3. Spatial plan of special features Črnkovec - Zagreb Airport (Final draft spatial plan)

The spatial plans for the area Črnkovec - Zagreb Airport (draft of the final proposal of the regional plan), provided the conditions for the organization of spatial air traffic through the reservation of space for the development of the airport for international and domestic air traffic - Zagreb airport and reserving sites for heliports and corridors for airways for international and domestic air traffic.

The concerned work is located in the area of infrastructure systems (infrastructure building of national importance) and an area of specific purposes – a military complex, in the zone of prohibited construction of special purpose buildings and its north-eastern side within the restricted zone construction.

Within the prohibited zone construction allowed is the possibility of building a new passenger Zagreb airport terminal with access roads, other alternative runways and other facilities in the function flow of air traffic and transport, technical, service and other facilities in the function of the development of Zagreb Airport, and government roads - eastern bypass of Velika Gorica, under special conditions and with the approval of the authorised ministry.

Within the limited zone of construction, prohibited is the construction of buildings, installations and other objects that protrude norms established by a special regulation, as well as the construction of facilities can be a source of disruption to navigation devices and devices for instrumental rating, sources of interference for visual flying, as well as other objects which in some way may endanger the safety of flight in the airport zone.
Part of the work that includes a new road corridor for access to the airport only partially coincides with the corridor of the planned Spatial Plan.
Corridor access road enters his part in an archaeological area of Andautonia – a wider zone of protection.
In the wider area of protection of the archaeological there are measures that have been prescribed for archaeological sites. For archaeological sites, which are recorded on the basis of occasional sites or are presumed sites, and there are no exact determined boundary protection, the directive does not lay down protective measures. For the determination of accurate data and dating certain localities, where there are no exact boundaries of protection, it is desirable to implement archaeological excavations. During the execution of land and construction works, it is necessary to alert the client of possible sites, in which case more care and archaeological surveillance will be necessary. In the case there is a site which demands an in site presentation, the planned construction of the construction work should be adapted to the demands of the archaeological profession.

The mentioned work is located in an area for which a recommendation for defining the obligations of the draw up of the Spatial Plan for work in Zagreb Airport was given.

3.1.3.1. Excerpt from the Spatial Plan of areas with special features Črnkovec - Airport Zagreb

III. PROVISIONS FOR IMPLEMENTATION

1. Terms of division of space according to use and purpose

1.1. Terms of division of space according to use

1.1.7. AREAS OF SPECIAL LIMITATIONS IN RELATION TO AIRPORT ZAGREB

Article 14

Space covered by the plan where there are special limitations
in relation Zagreb Airport is divided into:
- Space for the development of Zagreb Airport
- The contact area with space for the development of Zagreb Airport
- Controlled airspace (CTR) Zagreb Airport
- Obstacle limitation surfaces Zagreb Airport
- Area of propagation of noise around the runway.

1.1.8. CATEGORIES OF PROTECTION OF AREAS

Article 15

The coverage plan is divided by sensitivity, and based on the criteria specified in this article, the three categories of protection are:
- I. category for space protection - an area prohibiting construction
- II. category for space protection - an area of strict construction restrictions
- III. category for space protection category - construction restrictions.

The criteria for determining the first category of the protection of the coverage of the plan are:
- Forest areas,
- Area of Zone 1 of the source of protection,
- Space for the development of Zagreb Airport and
- The contact area with space for the development of Zagreb Airport.

1.2. Terms of division of space by application

1.2.2. AREAS FOR DEVELOPMENT AND PLANNING OUTSIDE OF THE SETTLEMENT

Article 33.

Surface infrastructure systems are designed for the accommodation of transport and infrastructure utility lines and surface constructions. The cartographic display 1 shows, other than linear transport facilities, the following areas of infrastructural systems:
- Area for the development of Zagreb Airport (code IS1)
- Area of Zone 1 of sanitary protection of the water reservoirs Kosnica Phase I (mark IS2)
- A device for purifying waste water Velika Gorica (mark IS3).

2. Terms of determining the area of constructions of importance to the state and county

2.1. Buildings of importance to the State

Article 36

The plan shall specify the following buildings of importance for the State:

1. Traffic constructions:
a) Road constructions with associated facilities and equipment:
- ...
- Other national roads:
- ...
- Velika Gorica - Zagreb Airport, D408
- ...
c) Aviation constructions:
- Zagreb Airport for international and domestic traffic for handling aircrafts, 4E grade and group
- A permanent 1st category international border air crossing: Zagreb

5. Terms for determining construction areas and the use of constructed and unconstructed parts of the area

5.1. General terms

Article 78

The Plan defines the requirements for determining the construction area by categories of space protection from Chapter 1.1.8. of these regulations for implementation:

- I. category space protection is an area of prohibition of construction and land operations, in which new construction areas cannot be formed and existing ones cannot be expanded This category in the coverage of the Plan covers: forest areas, areas of Zone 1 of source protection, an Area for the development of Zagreb Airport and the Contact area along the Area for the development of Zagreb Airport. Within category 1 of protection, it is allowed to plan necessary infrastructures and to reconstruct existing constructions. Within the Area for the development of Zagreb Airport, marked on cartographic displays 1 and 3 of this Plan, which covers the existing settlements Mala Kosnica and Petina, defined is the regime of recovery of the existing settlements until movement. The state regime is introduced because of the immediate vicinity of the runway strip and other objects of Zagreb Airport with the stated settlements, or because of the constant and immediate danger and numerous negative impacts that these objects have on the inhabitants of these settlements, as well as because of securing the possibility of further expansion of Zagreb Airport within this area. In the regime of recovers of the settlement until movement, allowed is the planning of necessary traffic and communal infrastructures and the reconstruction of existing constructions, and all in accordance with the regulations of this Plan. Within the contact area along the Area for the development of Zagreb Airport, marked also on the cartographic displays 1 and 3 of this Plan, allowed exceptionally is the forming of a construction area in the settlements, but only within the special volume of the existing constructions and according to terms from this Plan;

5.2. Criteria for the formation of construction areas and of the settlements for construction

5.2.1. CRITERIA FOR FORMING CONSTRUCTION SETTLEMENTS WITHIN THE CONTACT AREA ALONG THE SPACE FOR THE DEVELOPMENT OF ZAGREB AIRPORT AND GUIDELINES FOR CONSTRUCTION

Article 79.

Within the Contact area along the Space for the development of Zagreb Airport, defined by the Spatial Plan of the Zagreb County and marked on cartographic displays 1 and 3 of this Plan which covers the existing settlements Selnica Ščitarjevska and Bapča, allowed exceptionally is the forming an a construction are of the settlement, within the spatial volume of the existing constructions. Existing constructions refer to the constructions according to official digital orthophoto bases of DOF 5 in the scale of 1:5000 which was drawn up by the State Geodetic Department, recorded until the period to 2010. Further construction and expansion of the settlement is limited within the Contact area along the Area for the development of Zagreb Airport and is directed to the reconstruction of existing constructions, with the preservation of historical marks in centres of the settlements and traditional architectures. Planned also is to supply the settlement with basic traffic and communal infrastructures, and specially defined are the obligations of constructing a system of draining of wastewater due to the prevention of further pollution of underground water resources.

6. Terms of determining traffic and other infrastructural systems in the area

6.1. Transport System

6.1.1. ROAD TRAFFIC

Article 96.

Road traffic within the scope of the Plan is made up of the road network of public roads (highways, state, county and local roads.) In addition to the existing road network, this Plan provides for the extension of the road network with new roads, and on the plan-direction definitions, shown is the proposal of division (categorization) of public roads. Until the re-categorization of the existing public roads to a higher or lower category proposed by this Plan, kept is the category in which it is divided in based on the Decision on dividing public roads, and it is considered a public road in that category.

In relation to the proposed categorization of public road networks, possible are changes in the functional terms (change category), pursuant to the Decision on the classification of public roads, which is brought by the relevant ministry and with no special amendments to the Plan. The rehabilitation of roads through corrections or the mitigation of poor technical elements on the roads as well as partial movement of roads is not considered a change of the road.

Article 97

The area to accommodate the existing road corridors are routes whose widths are determined in accordance with special regulations, generally not less than the width:

- ...
- 18 m for other state roads,
- ...
- 15 m for local roads.

The width specified in the preceding paragraph may be smaller within the building in accordance with specific specifications and these regulations.

Along public corridors of publically classified roads within and outside the construction area, it is possible to build facilities for the provision of road users (petrol stations, catering-supply facilities and motels). Locations and conditions for these facilities should be determined in the spatial plans of more narrow areas.

6.1.4. AIR TRAFFIC

Article 99

This Plan provides the spatial conditions for the organization of air traffic through reservations:

- An area for the development of the airport for international and domestic air traffic – Zagreb Airport
- Location of heliports and
- Corridors of the airways for international and domestic air traffic. The development of Zagreb Airport is possible in the area that is designated as the plan for the development of Zagreb Airport. The size and shape of the Area for the development of Zagreb Airport, as well as the proposed solution to his division with an area for special purposes, are set at cartographic display number 1: "Land Use and Planning," in scale of 1:25,000 as well as on the thematic maps in the scale of 1:50,000. When determining the boundaries of these areas in the immediate areas of spatial plans, possible are minor deviations from the established surfaces in this Plan which arrise from different scale representations or data sources, however, such discrepancies need to be discussed and coordinated with the relevant authorities. Within the Area for development of the Zagreb Airport, it is possible to plan only the contents regarding the execution of air traffic, or traffic, services, technical and other contents in the function of the development of the Zagreb Airport. Within the area stated in the previous paragraph of this plan, defined was as follows:
- The position of the existing runway,
- The position of the taxiway with physical characteristics of the runway,
- The principle position of rural strips for their connection.

This Plan generally marked locations of heliport on the cartographic display number 1. Other than on the marked locations, spaces for heliports are possible to be predicted also along the construction or on a construction of importance to the country.

7. Measures to protect the landscape and natural values, cultural – landscape wholes and other areas with special features

7. 1. Areas of special conditions of use

7.1.2. CULTURAL HERITAGE

7.1.2.1. Archaeological Heritage

Article 133

Within the coverage of the plan there are two significant archaeological areas: archaeological site Andautonija and the archaeological site Želin. Archaeological areas are divided into narrower and wider zone of archaeological protection, which are shown in the cartographic Figure 3 "Terms and protection of space.

In the wider area of protection of the archaeological areas implemented are measures that have been prescribed for archaeological sites.

Article 134

In accordance with guidelines from the Conservation base for the draw up of this Plan, on the entire area of the Archeologically site Andautonija, which includes the narrow and wider zone of protection, planned is the area of the Eco-museum Ščitarjevo Posavina. The area of the Eco-museum covers, other than the settlements Ščitarjevo in which the narrow zone of the protection of archaeological areas is located, are also the settlements or parts of settlements Drenje Ščitarjesko, Novaki Ščitarjevski, Sasi, Obrezina, Trnje, Lekneno, Črkovec, Selnica Ščitarjevska, Velika Kosnica and Mala Kosnica, with the possibility of further expansion.
The eco-museum Ščitarjevačke Posavina is planned as an outdoor museum, which includes all construction structures, water, landscapes, plants, animals, as well as all activities of people who testify on life in this region. On the entire area of the eco-museum, other then archaeological, there are also a series of cultural-historical values, of which we specially emphasise the traditional Posavina wood architecture.
The guidelines for regulation of this area is provided in the text of the Plan.

Article 135

Individual archaeological sites are indicated with an approximate location on the cartographic display 3, and listed in a table in the text of the Plan.
There are no prescribed directive measures of protection regarding archaeological sites which are registered on the basis of occasional findings or findings are assumed and possible, and where there are no precisely defined boundaries of protection. In order to determine more precise information and dates of certain sites where there are no defined borders of protection, it is preferable to conduct archeological research. While executing the land and construction work, it is necessary to warn the client of possible findings, for which increased care and archeological monitoring will be necessary. In case it is a site which requires a presentation on site, the planned construction or the construction work will be necessary to adapt to the demands of the archeological profession.

7. 2. Areas of special restrictions in use

7.2.3. WATER

7.2.3.2. Water-protection areas

Article 149

The potentially water-protected area of Črnkovec is defined with a spatial plan as an unexplored or an insufficiently explored area and a specially sensitive area on which work is limited in the area before the implemented hydro-geological research, and all with the goal of the efficient protection of future pumps. The areas from Paragraph 1 of the Article are divided to narrower and wider zones of protection. The narrower zone of protection is formed in the vicinity of the planned water pumps, on the basis of previous experiences when defining the zones of sanitary protection for the pumps in the area of the County and the City of Zagreb. It covers two areas covered by the plan which consists of:
- Narrow protection zone 1 (Kosnica), an area of approximately 7.5 km2 - within this zone are planned future water pumps Kosnica (I, II, III phase), Kosnica Mičevec and Kosnica - East;
- Narrow protection zone 2 (Črnkovec), an area of approximately 8.7 km2 - within this zone are planned works of the future water pump Črnkovec.

The broader protection zone covers the remaining space of the Potential water conservation area Črnkovec.

Article 150

Defined within the protection zones in the previous article are, with the approval of the competent authority, specific conditions of use and protection. On the wider protection zone the following is not allowed:
- Discharge of untreated wastewater
- Storage, treatment and disposal of waste,
- Construction of facilities for use, treatment and disposal of hazardous waste
- Construction of plant for the production and storage of hazardous and radioactive substances or other plants that can compromise the quality or yield of groundwater,

- Construction of industrial chemical plants of hazardous pollutants to waters and the water environment
- Construction of industrial plants and business activities in which hazardous substances or those that arise as waste are used, without connecting to the public sewerage system,
- Construction of petrol stations without double-walled tanks, devices for automatic detection and leak detection and a defence construction (bundwall)
- Construction of roads, airports, parking lots and other transportation and handling areas without controlled drainage and adequate purification of polluted rainwater before discharge into a natural receiver,
- Underground and surface mining of minerals other than geothermal and mineral water,
- Execution of exploration and exploitation wells, except those related to water research papers for the public water supply and renewable energy
- Removal and disposal of the outer layer of land except on places for the construction of buildings,
- Transport of dangerous goods by road and railways outside the approved corridor or without implementation of appropriate measures of protection,
- The use of the herbicide atrazine on the base.

7.2.4. SAFETY ZONE WITH RESPECT TO THE AIRPORT ZAGREB

Article 153

In order to protect the area near Zagreb Airport from the possible adverse impact of buildings and facilities in the function of air traffic, as well as for providing space intended for the development of Zagreb Airport for its further expansion, determined area the following areas of special restrictions in use:
- Space for the development of Zagreb Airport
- The contact area with space for the development of Zagreb Airport
- Controlled airspace (CTR) Zagreb Airport
- Areas of limited obstacles of Zagreb Airport
- Borders of noise dispersion around the runway.

7.2.4.1. Space for the development of Zagreb Airport

Article 154

Within the area for the development of Zagreb Airport, it is possible to plan contents solely in the operational flow of air traffic and transport, service, technical and other facilities in the function of Zagreb Airport. The formation of a construction area is not allowed, and for existing settlements a regime is established of rehabilitation until the relocation.

7.2.4.2. Contact area along the Area for the development of Zagreb Airport

Article 155

Within the Contact Area along the Area for the development of Zagreb Airport allowed is the limited formation of the construction zone of the settlement, solely in the spatial measurements of existing constructions and under the terms of this Plan.

7.2.4.3. Controlled airspace (CTR) Zagreb Airport

Article 156

The controlled airspace (CTR) of Zagreb Airport is determined according to data from Croatian Air Traffic Control. Terms within this area are determined by special regulations

7.2.4.4. Areas of limited obstacles of Zagreb Airport

Article 157

Areas of limited obstacles of Zagreb Airport were established in accordance with the Development Plan of Zagreb Airport, and it is on the following areas:
- Surfaces for limited obstacles for the existing runway,
- Surfaces for limited obstacles for the planned alternative runway,
- Surfaces for limited obstacles for the heliport.

Within this area, the construction of buildings that would pierce the surface with their height and impede air traffic safety is not allowed. More detailed conditions us use within the area from Paragraph 1 of this Article should be defined with the spatial plans of development, in accordance with this plan and with the consent of the Agency for Civil Aviation.

7.2.4.5. Limits propagation of noise around the runway

Article 158

Limits of noise propagation around the runway at Zagreb airport were established in accordance with the Development Plan of Zagreb airport, and it regards five zones of the propagation of noise:
1. zone of 65-70 dB,
2. zone of 70-75 dB,
3. zone of 75-80 dB,
4. zone of 80-85 dB,
5. zone > 85 dB.

Outside the noise contours of 65 dB there are no limits for the development of residential areas, but with the planning of the construction of buildings of public facilities (hospitals, schools, kindergartens, etc.) near the contour noise of 65 dB it is recommended that prior noise analysis be conducted followed by the identification and implementation of protection measures. Within the first, and especially the second zone of propagation of noise, between 65 and 75 dB, established is strict control regarding the further expansion of residential construction. For the existing residential construction within these zones, for which there is no defined regime for recover until movement, but rather the same is used within the existing construction area of the settlement (part of settlement Obrezina), it is necessary to define the measures of protection from noise. Within the third, fourth and fifth zone it is possible to solely plan the contents in the function of executing aviation traffic, of the contents in the function of the development of Zagreb Airport and the contents of special intent.

7.2.5. SAFETY AND SECURITY ZONES FOR CONSTRUCTIONS OF SPECIAL INTENTION

Article 159

In accordance with the Codebook on safety and security zones for military facilities, this Plan has established safety and security zones for military facilities in the area covered by the Plan. Under the safety and security zones of military facilities included are the areas with a special regime of use, to protect the interests of defence in a particular area and the functional maintenance of the military facility and increasing its security as well as the safety of people and property. Determined are the following areas of restriction in usage, depending on the facility of special intent:
- Forbidden construction zone (ZZG)
- Zone of limited construction (ZOG)
- Zone of controlled construction (ZKG)
- Protective corridor for the network system.

Within the zones from the previous paragraph, this Plan will regulate special limitations of use.

7.2.5.1. Prohibited construction zone

Article 160

The zones of prohibited construction (drawn and marked with ZZG on the cartographic display number 3) prohibit any constructions, except buildings, facilities and equipment for defence needs. An exception from Paragraph 1 of this Article is that within the prohibited construction allowed is the possibility of building a new passenger terminal at Zagreb airport with access roads, alternative other runways strips and other contents in the function of aviation or road, technical, service and other contents in the function of the development of Zagreb Airport and state roads – eastern bypasses of Velika Gorica, with special terms and with the consent of the authorized ministry. More detailed terms of use within the zones of prohibited construction will be defined with the Spatial Plan of development for the City of Velika Gorica.

7.2.5.2. Zones of limited construction

Article 161

The zones of limited construction (delineated and marked with signs ZOG, ZOG ZOG 1 and 2 on cartographic representation No. 3), prohibit the construction of buildings, installations and other objects that protrude norms established by a special regulation, as well as the construction of facilities that can be a source of disruption of the navigation device and instrument rating , so source for the interference of visual flying, as well as other objects which in some way may be endanger the safety of flight in the airport zone. Detailed conditions of use within the zones of limited construction will be determined by the Spatial Plan of Velika Gorica.

9. Measures of preventing unfavourable impact on the environment

Article 169

The fundamental principle of an integrated approach to the planning and development of an area includes the protection of the environment as a continued and present component in all segments. Preventing unfavourable impact to the environment is present in all components of this Plan, and should be present in all plans of the narrower area as well. With the goal of preventing unfavourable impact on the environment, in the previous Items of the regulation for implementing this Plan, most of the measures of protecting the environment are applied which will be implemented in accordance with special regulations, and these are: measures for protecting the soil, water, air, forests, climate, health of people, the plant and animal world, landscape, cultural and spatial values, measures of protection against noise and fire and measures for handling waste. Along with the measures for protecting the environment from the previous paragraph, defined also are the following special measures for environmental protection:
- To preserve and improve water quality,
- To preserve and protect the quality of soil,
- To preserve of air quality,
- To reduction excessive noise,
- To establish operations in the area that requires the implementation of environmental impact evaluation.
- To establish operations in the area that requires an evaluation of acceptability for the ecological network.

9.3. Preserving air quality

Article 172

Preserving air quality covers the following:
- ...
- Regular monitoring of air quality at the Zagreb Airport and applying appropriate protection measures - using a new generation of aircrafts with reduced exhaust gas emissions, the introduction of new technologies and alternative energy sources, etc.
- ...
- And other measures, in accordance with the Air Protection Act and other subordinate regulations.

9.4. Reducing excessive noise

Article 173

Reducing excessive noise predicts the following:
- Dividing areas for different purposes by the rule that the permitted levels of noise differ with neighbouring areas by 5 dB at the most, according to a separate preliminary regulation, which is confirmed by measuring the current situation,

- The application of acoustic protective measures in areas of emissions, and on the paths its spreads,
- ...
- Prescribing special construction requirements in areas affected by noise (the area around Zagreb airport) based on a special regulation,
- The preparation of noise maps and
- Continuous noise measurement.

10. Measures of implementation

10.1. Obligation to prepare documents of spatial development

Article 175

The obligation to prepare spatial plans of development for all cities and municipalities in the Republic of Croatia was determined by the Physical Planning and Construction Act. The area covered with this Plan has in effect the Spatial Plan of development of the City of Velika Gorica, and the Spatial Plan of development for the Municipality of Orle.
The obligation of creating implementing spatial planning documents in the scope of this Plan will be determined by the spatial plans of the previous paragraph, in accordance with the obligations of the Spatial Planning and Construction Act, special provisions and the Spatial Plan of the Zagreb County.

Article 176

This plan provides recommendations of determining the liability of making the next urban plans of development:

12. UPU Zagreb Airport.

10.2. Area for the application of special developmental and other measures

10.2.2. PROTECTION OF SPECIAL VALUES AND FEATURES

Article 178

In order to protect special values and characteristics, the following endangered areas for which special restoration are defined:
- ...
- Restoration of areas affected by noise (the area along the highway, the main road Zagreb-Large Gorica, railway, hydropower plant Drenje, heliports and Zagreb Airport) with the construction for protective sound barriers and the implementation of measures with the goal of decreasing the level of noise at the source of this noise itself
- …

3.1.3.2. Review of compliance of the Work with the Regional Plan of the area of special features (PPPPO) Črnkovec - Zagreb Airport (final draft of the proposal of the Spatial Plan)

The solution of a new passenger terminal at Zagreb Airport regulated with Regional Plan of the area of special features (PPPPO) Črnkovec - Zagreb Airport (final draft of the proposal of the Spatial Plan) is scheduled for implementation in two phases.
The subject procedure is within the area of infrastructure systems (infrastructure buildings of national importance) and areas of specific intent - military complex within the zone of prohibited construction (ZZG) special purpose buildings and its north-eastern wing within the zone of limited construction (ZOG 1).
Within the prohibited zone construction allowed is the possibility of constructing a new passenger Zagreb airport terminal with access roads, other alternative runway strips and other facilities in the function of the flow of air traffic and transport, technical, service and other facilities in the function of the Zagreb airport, government roads – the eastern bypass of Velika Gorica, all under special conditions and with the approval of the authorized ministry.
Within the restricted zone construction prohibited is the construction of buildings, installations and other objects that protrude norms established by a special regulation, as well as the construction of facilities which be a source of disruption of navigation devices and instrument ratings and the source of interference for visual flying, as well as other objects which in some way may be endanger the safety of flight in the airport zone.

Therefore, we can conclude that the subjected procedure is in accordance with the Regional Plan areas Special Features (PPPPO) Črnkovec - Zagreb Airport (final draft of the proposal of the Spatial Plan) in the segment of the new airport passenger terminal of Zagreb Airport and associated facilities.

The route of the planned access road to the new terminal at Zagreb airport, in order to achieve optimal spatial and technical solutions of this road and a solution to the road junction at the connection with the planned eastern bypass of Velika Gorica, partly deviates from the planned certain routes defined by PPPPO Črnkovec - Zagreb Airport, (draft of the final proposal of the Spatial Plan), but it is generally consistent.

3.1.4. Conclusion

The subjected decision of the new passenger terminal at Zagreb airport is consistent with the Regional Plan for the County of Zagreb *Zagreb County Herald No. 3/02, 8/05, 8/07, 4/10 and 10/11)*, The Spatial Plan for the City of Velika Gorica *(˝Official Gazette Velika Gorica No. 10/06 and 6/08)* and the Regional Plan areas with special features Črnkovec - Zagreb Airport *((the final draft of the plan)* in the new segment passenger terminal of Zagreb Airport and supporting facilities.

The route of the planned access road to the new terminal at Zagreb airport, in order to achieve optimal spatial and technical solutions of this road and a solution to the road junction at the connection with the planned eastern bypass of Velika Gorica, partly deviates from the planned certain routes of the County Regional Plan, Regional Plan of the City of Greater Gorica and the final draft of the Spatial Plan areas with special features Črnkovec - Zagreb Airport, but it is generally consistent.

GRAPHIC ATTACHMENT:
Excerpt from cartographic display IV. Alterations and annexes to the Spatial Plan of Zagreb County *(˝Zagreb County Gazette No. 10/11) with a drawn coverage of the work*

3.1.1.-1. Excerpt from the cartographic display Land use and intent showing with a drawn coverage of the work
3.1.1.-2. Excerpt from the cartographic display 2.1. Infrastructure Systems: Energy and Telecommunications with a drawn coverage of the work
3.1.1.-3. Excerpt from the cartographic display 2.2. Infrastructure systems: water management system with a drawn coverage of the work
3.1.1.-4. Excerpt from the cartographic display 3.1. Terms and use and protection of space with a drawn coverage of the work

Excerpt from the cartographic display of Alterations and Annexes of the Spatial Plan for the development of the City of Velika Gorica *(˝Official Gazette of Velika Gorica No. 6/08) with a drawn coverage of the work*

3.1.2.-1. Excerpt from the cartographic display of 1a Use and purpose of areas with a drawn coverage of the work
3.1.2.-2. Excerpt from the cartographic display of 2a Infrastructure systems with a drawn coverage of the work
3.1.2.-3. Excerpt from the cartographic display of 3a. Terms of use, planning and Environmental space with a drawn coverage of the work

Excerpt from the cartographic display of the Spatial Plan of special features Črnkovec - Zagreb Airport *(draft of the final proposal of the spatial plan) with a drawn coverage of the work*

3.1.3.-1. Excerpt from the cartographic display 1. Land use and planning with a drawn coverage of the work
3.1.3.-2. Excerpt from the cartographic display 1. Infrastructure systems with a drawn coverage of the work
3.1.3.-3. with a drawn coverage of the work 3. Terms of use and protection of the area with a drawn coverage of the work

Graphic figure 3.1.1.-1. Excerpt from the cartographic display of the IV. Alterations and annexes to the Spatial Plan of the Zagreb County (Zagreb County Herald No. 10/11): 1 Land use and planning with a drawn coverage of the work

Graphic figure 3.1.1.-2. Excerpt from the cartographic display of the IV. Alterations and annexes to the Spatial Plan of the Zagreb County (Zagreb County Herald No. 10/11): 2.1. Infrastructure Systems: Energy and Telecommunications with a drawn coverage of the work

KEY:

- ZONE OF THE NEW TERMINAL – PHASE I
- ZONE OF FURTHER EXPANSION – PHASE I.a
- ZONE OF FURTHER EXPANSION – PHASE II
- ZONE OF NEW ACCESS ROADS

Key for plan marks

TERRITORIAL AND STATISTICAL BORDERS:

- **STATE BORER**
- **COUNTY BORDER**
- **MUNICIPALITY / CITY BORDER**

POSTAL SERVICES AND TELECOMMUNICATION
POSTAL SERVICES

- **MAIN POSTAL CENTER**
- **POSTAL CENTER**
- **UNIT OF THE POSTAL NETWORK**

PUBLIC TELECOMMUNICATION
TELEPHONE NETWORK – COMMUNICATION JOINTS IN THE IMOBILE NETWORK

- **LOCAL TELEPHONE HEADQUARTERS**
- **REMOTE SUBSCRIBERS LEVEL**

CABLES AND CHANNELS

- **INTERNATIONAL CONNECTIONS**
- **MAIN CONNECTIONS**
- **USER'S CONNECTIONS**

ELECTRONIC COMMUNICATION INFRASTRUCTURE AND CONNECTIVE EQUIPMENT

- **RADIO STATION**
- **MINI LINK**
- **EXISTING SELF-STANDING ANTENA POLES ELECTRONIC COMMUNICATION**
- **ELECRONIC COMMUNICATION ZONE FOR THE LOCATION OF SELF-STANDING ANTENA POLES**

RADIO AND TV SYSTEM CONNECTION

- **LARGER STATION FOR RADIO AND TV**
- **RADIO TRANSMISSION CENTRE**
- **RADIO CORRIDOR**
- **TV TRANSMITOR**
- **TV TRANSFORMER**
- **RADIO-NAVIGATIONAL DEVICE**

ENERGY SYSTEM – PRODUCTION OF PIPE TRANSPORT FOR PETROLEUM AND GAS

- **FORWARDING STATION**
- **MAIN PIPELINE FOR INTERNATIONAL TRANSPORT**
- **MAIN PIPELINE**
- **PRODUCT-LINE**
- **MAIN GASLINE**
- **LOCAL GASLINE**
- **MEASURING REDUCTION STATION**
- **REDUCTION STATION**

ELECTRO-ENERGY
PRODUCTION DEVICES

- **HYDRO-ELECTRICITY PLANT**
- **THERMO PLANT**
- **THERMO ELECTRIC HEATING PLANT**

ELECTRICITY TRANSMITTING DEVICES

- **TRANSMISSION LINE 400 KV**
- **POSSIBLE OR ALTERNATIVE TRANSMISSION LINE TRACK 400 (220) KV**
- **TRANSMISSION LINE 220 KV**
- **TRANSMISSION LINE 110 KV**
- **CABEL 110 KV (UNDERGROUND)**

TRANSFORMER AND DISJOINTED PLANTS

- **DISJOINTED PLANTS**
- **TS 400/200/110 KV**
- **TS 400/110 KV**
- **TS 220/119 KV**
- **TS 110/10 (20, 30 OR 35) KV**

Graphic figure 3.1.1.-3. Excerpt from the cartographic display of the IV. Alterations and annexes to the Spatial Plan of the Zagreb County (Zagreb County Herald No. 10/11): 2.2. Infrastructure Systems: Water management system with a drawn coverage of the work

Graphic figure 3.1.1.-4. Excerpt from the cartographic display of the IV. Alterations and annexes to the Spatial Plan of the Zagreb County (Zagreb County Herald No. 10/11): 3.1. Terms of use and protection of area 1 with a drawn coverage of the work

Key for plan marks

TERRITORIAL AND STATISTICAL BORDERS

- **STATE BORER**
- **COUNTY BORDER**
- **MUNICIPALITY / CITY BORDER**

HISTORICAL SETTLEMENTS AND PARTS OF HISTORICAL SETTLEMENTS OF NATIONAL AND REGIONAL IMPORTANCE

- **CITY SETTLEMENTS**
- **CITY RURAL SETTLEMENTS**
- **RURAL SETTLEMENTS**

CONSTRUCTION, SCOPE OR PART OF THE CONSTRUCTION WITH AN ENVIRONMENT

- **SACRAL CONSTRUCTIONS (convents, churches, chapels)**
- **OLD CITIES**
- **RESIDENTIAL CONSTRUCTIONS (castles, curias, villas)**
- **CONSTRUCTIONS OF PUBLIC PURPOSE (city halls, hotels, schools, resorts and alike)**
- **MILITARY CONSTRUCTIONS**
- **ECONOMIC AND INDUSTRIAL CONSTRUCTIONS**
- **CEMETARIES AND BURIAL CONSTRUCTIONS**
- **TECHNICAL CONSTRUCTIONS AND LOW-LEVEL CONSTRUCTIONS WITH DEVICES**
- **AREA, PLACE, MONUMENT AND FEATURE CONNECTED TO HISTORICAL EVENTS AND PEOPLE**
- **ARCHEOLOGICAL SITES**
- **PARK MONUMENTS**
- **ARCHEOLOGICAL AREAS**

CULTURAL LANDSCAPE

- AREA OF STRICT PROTECTION
- AREA OF MODERATE PROTECTION

PROTECTED NATURAL VALUES

Protected Registered

- **NATURE PARK**
- **SPECIAL RESERVE**
  B – botanical, O – ornithological, Z – zoo, ŠV – forest vegetation
- **PARK FOREST**
- **SIGNIFICANT LANDSCAPE**
- **NATURAL MONUMENT**
- **MONUMENT OF PARK ARHITECTURE**

LANDSCAPE

- ESPECIALLY VALUABLE SECTION – NATURAL LANDSCAPE
- ESPECIALLY VALUABLE SECTION – CULTIVATED LANDSCAPE

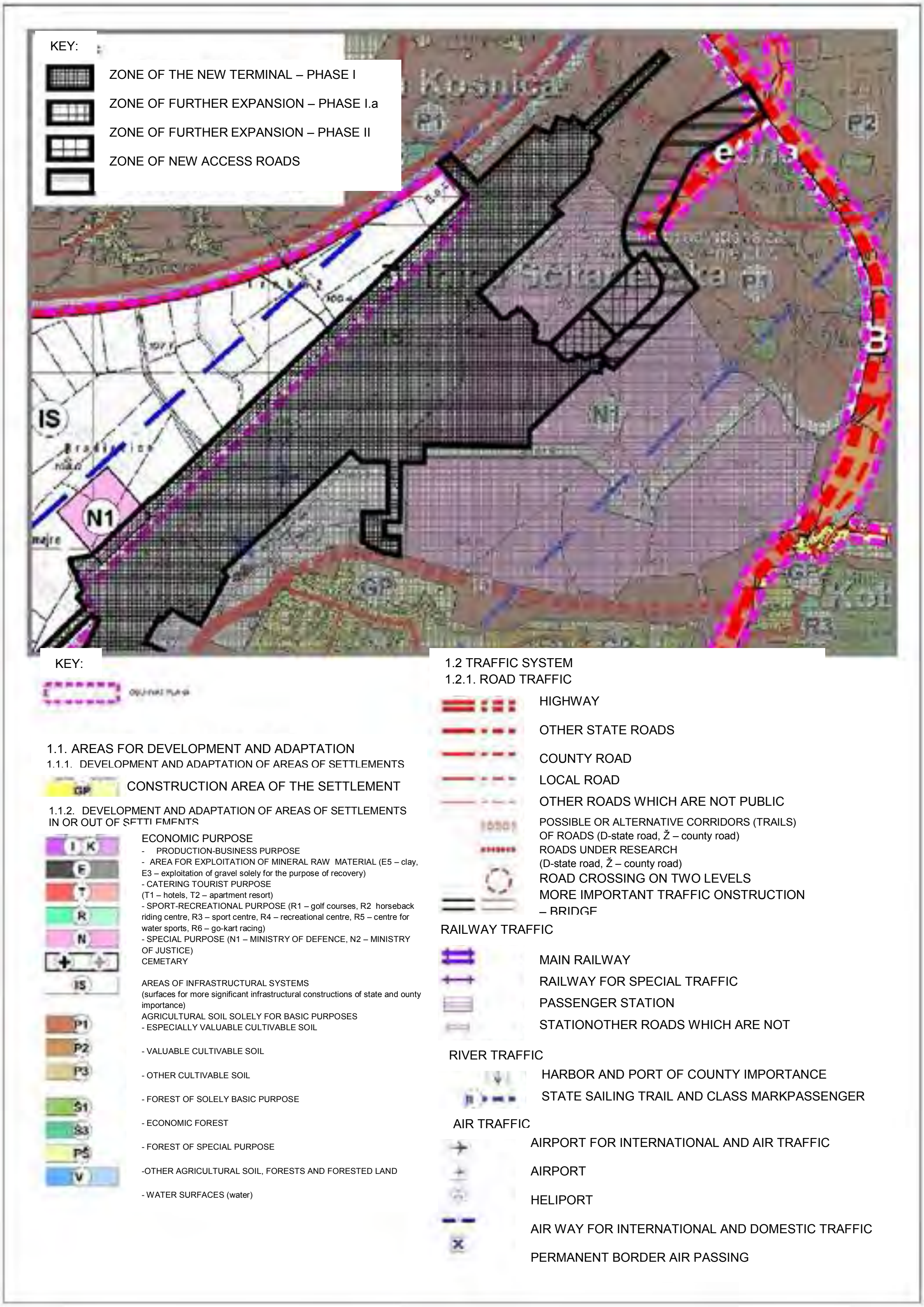
AREA OF APPLICATION OF PLAN MEASUREMENTS OF PROTECTION

- COVERAGE OF OBLIGATORY DRAW-UPS OF THE SPATIAL PLAN FOR THE AREA OF SPECIAL FEATURES
- WORK NECESSARY FOR THE IMPLEMENTATION OF THE EVALUATION OF INTER-IMPACTS TO THE ENVIRONMENT

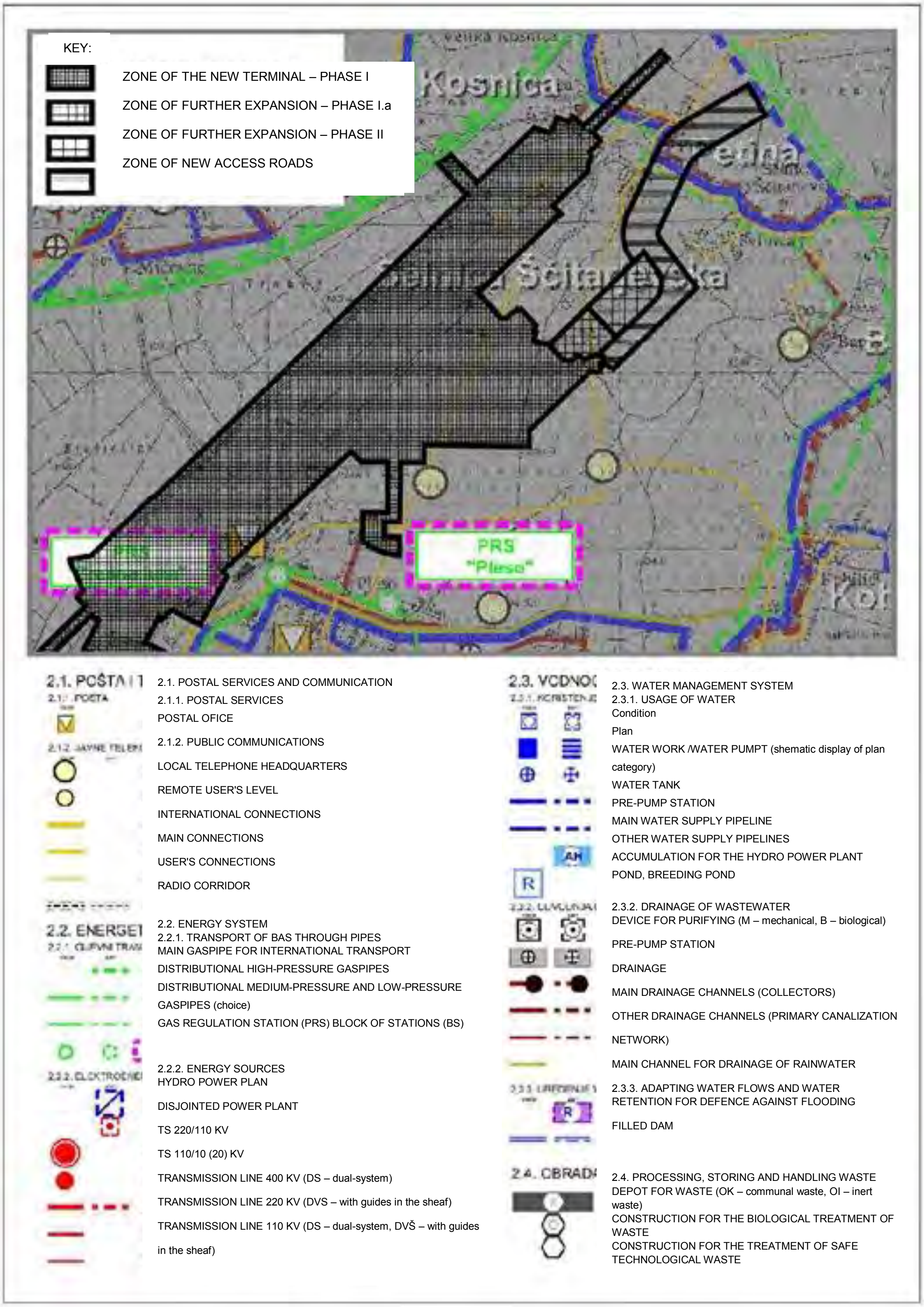
ECOLOGICAL NETWORK

- INTENATIONALLY IMPORTANT AREAS FOR BIRDS
- IMPORTANT AREAS FOR WILD SPECIES AND HABITATS
- IMPORTANT AREAS FOR WILD SPECIES AND HABITATS

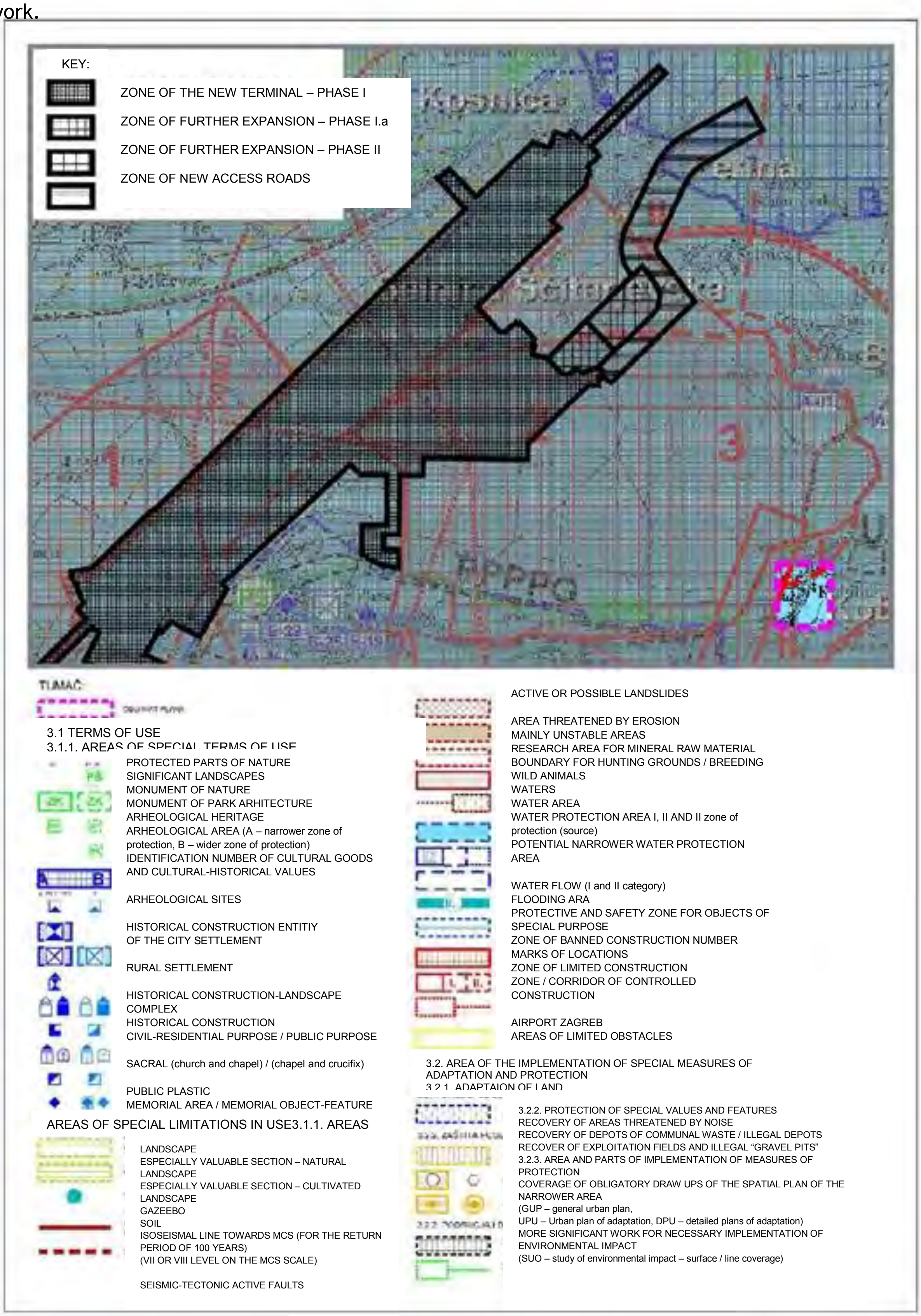
Graphic figure 3.1.2.-1. Excerpt from the cartographic display of the Alterations and annexes to the Spatial Plan of development for the City of Velika Gorica (Official Gazette of Velika Gorica" No. 6/08): 1a use and purpose areas with a drawn coverage of the work



Graphic figure of 3.1.2.-2. Excerpt from the cartographic display of the Alterations and annexes to the Spatial Plan of development for the City of Velika Gorica (Official Gazette of Velika Gorica" No. 6/08): 2a infrastructure systems with a drawn coverage of the work

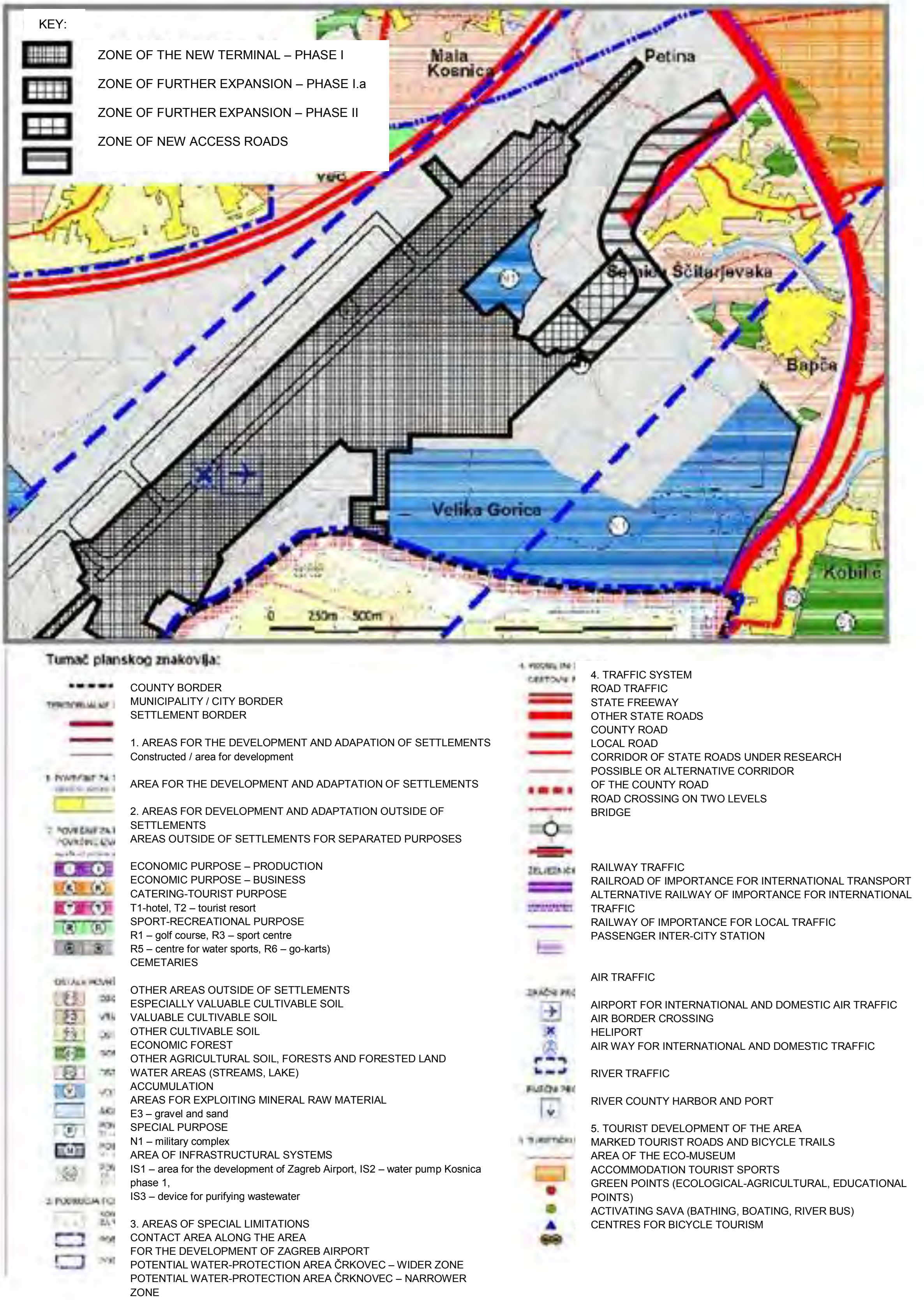


Graphic figure of 3.1.2.-3. Excerpt from the cartographic display of the Alterations and annexes to the Spatial Plan of development for the City of Velika Gorica (Official Gazette of Velika Gorica" No. 6/08): 3a. Terms of use, planning and protection of the area showed with a drawn coverage of the work.



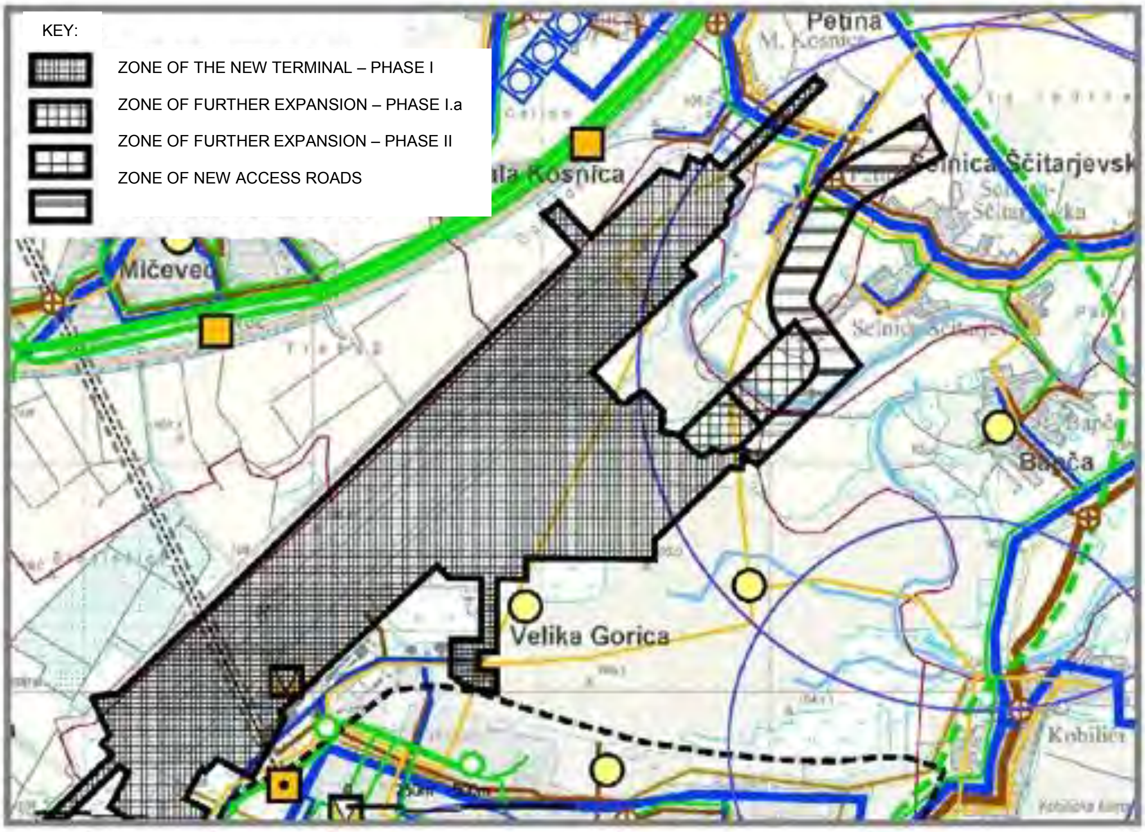
Graphic figure 3.1.3.-1. Excerpt from the cartographic figure of the Spatial Plan of Special characteristics Črnkovec - Zagreb Airport (draft of the final spatial plan):

1. Land use and planning of the area shown with the drawn coverage of the work



Graphic figure 3.1.3.-2. Excerpt from the cartographic figure of the Spatial Plan of Special characteristics Črnkovec - Zagreb Airport (draft of the final spatial plan):

2. Infrastructure systems with drawn coverage of the work



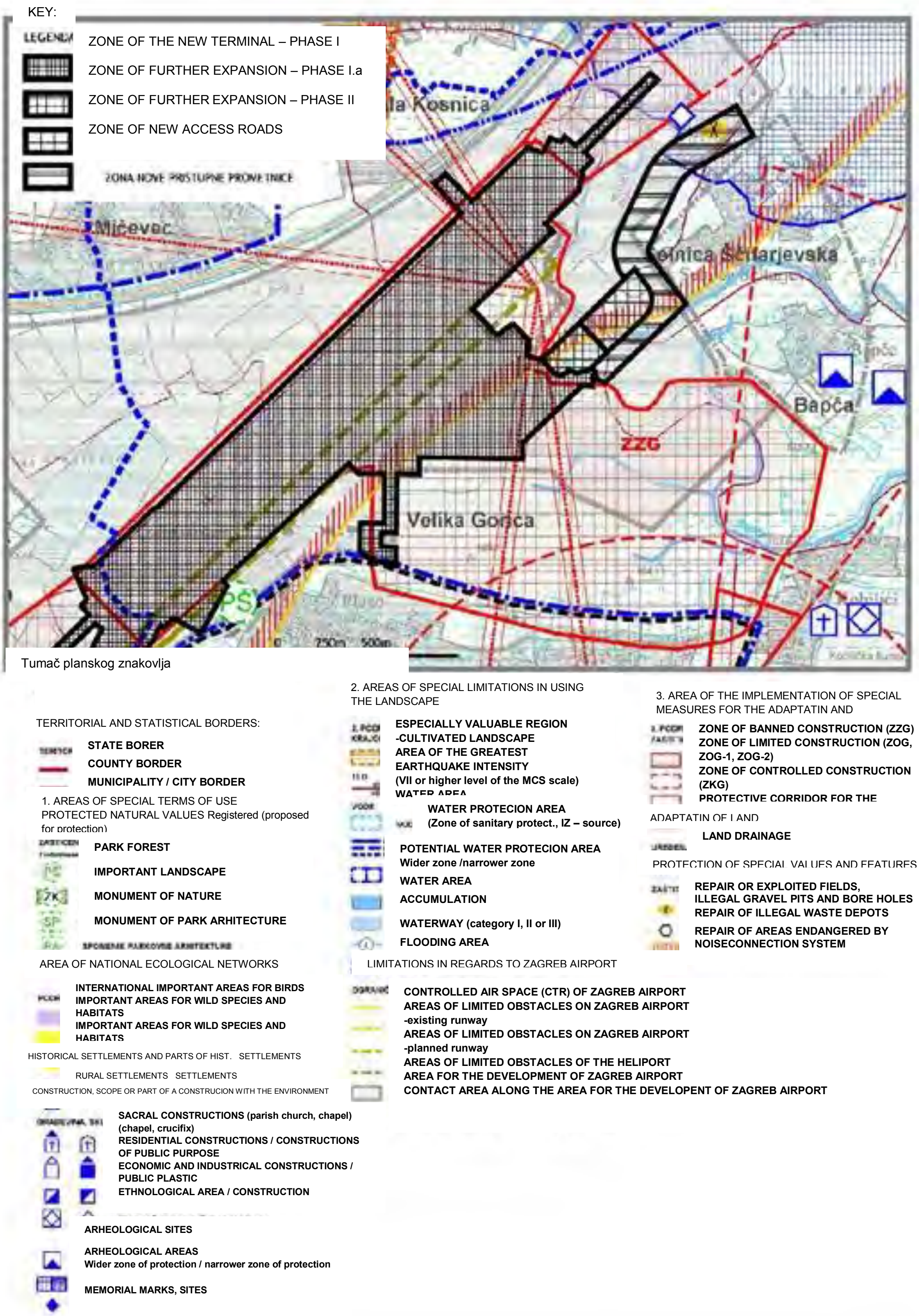
Tuma Key for plan marks:

BORDER OF THE PLAN COVERAGE
TERRITORIAL AND STATISTICAL BORDERS
COUNTY BORDER
MUNICIPALITY / CITY BORDER
SETTLEMENT BORDER
1. POSTAL SERVICES AND TELECOMMUNICATION
POSTAL SERVICES
POSTAL CENTER
UNIT OF THE POSTAL NETWORK
PUBLIC TELECOMMUNICATION
TELEPHONE NETWORK – COMMUNICATION JOINTS IN THE IMMOBILE NETWORK
LOCAL TELEPHONE HEADQUARTERS
REMOTE SUBSCRIBERS LEVEL
CABLES AND CHANNELS
INTERNATIONAL CONNECTIONS
MAIN CONNECTIONS
USER'S CONNECTIONS
RADIO AND TV SYSTEM CONNECTION
RADIO CORRIDOR
ELECTRONIC COMMUNICATION INFRASTRUCTURE AND CONNECTIVE EQUIPMENT
MINI LINK
EXISTING SELF-STANDING ANTENA POLES
ELECTRONIC COMMUNICATION
ELECRONIC COMMUNICATION ZONE FOR THE LOCATION OF SELF-STANDING ANTENA POLES
2. ENERGY SYSTEM – PRODUCTION OF PIPE TRANSPORT FOR PETROLEUM AND GAS
FORWARDING STATION
MAIN PIPELINE FOR INTERNATIONAL TRANSPORT
MAIN PIPELINE / TRAIL UNDER RESEARCH

LOCAL GASLINE
REDUCTION STATION
ELECTRO-ENERGY
PRODUCTION DEVICES
HYDRO-ELECTRICITY PLANT
DISJOINTED PLANTS
TS 110/10 (20, 30 or 35) KV
ELECTRICITY TRANSFERRING DEVICES
TRANSMISSION LINE 400 KV
POSSIBLE OR ALTERNATIVE TRANSMISSION LINE 400 (220) KV
TRANSMISSION LINE 220 KV
TRANSMISSION LINE 110 KV

3. WATER-ECONOMIC SYSTEM
USAGE OF WATER
Water supply
WATER WORKS / WATER PUMPS
WATER TANKS
MAIN SUPPLYING PIPELINE
OTHER WATER SUPPLYING PIPELINES
Usage of water
ACCUMULATION – AH for hydro-electric plants
POND
DRAINAGE OF WASTEWATER
DEVICE FOR PURIFYING WASTEWATER
DRAINAGE OF WASTEWATER
PUMPING STATION
MAIN SUPPLY CHANNEL (COLLECTER)
OTHER SUPPLYING CHANNELS
CHANNEL OF RAINWATER
ADAPTING WATERFLOWS AND WATER
Regulation and protection system
EMBANKMENT
CHANNEL (RELIEF, LATERAL)
LAND DRAINAGE
DETAILED CHANNEL NETWORK
WATERS
WATER AREAS
WATERFLOW (I, II or III category)

Graphic representation 3.1.3.-3 Excerpt from the cartographic representation of the Spatial Plan of Special characteristics Črnkovec - Zagreb Airport (final draft spatial plan):
3. Terms of use and protection of space with delineated scope of the project



3.2. METEOROLOGICAL AND CLIMATIC FEATURES

3.2.1. General climate characteristics of Zagreb Airport

This chapter presents the analysis of meteorological parameters. The temperature and precipitation regime and the relative humidity and wind conditions in this area were analyzed by observational data on the main meteorological station Zagreb-Pleso airport
($\phi = 45°43'46''$, $\lambda = 16°3'14''$, $h = 106\ m$ The analyzes were performed according to the data in the period 1981-2010.

Zagreb Airport Area is located in continental Croatia, where the climate is moderate continental. It is the year in circulation in the midlatitude belt where the state of the atmosphere is highly volatile with frequent and intense weather changes during the year. Causing them are traveling systems of low or high pressure often similar vortices of several hundred thousand milesin diameter. In the cold season, stationary anticyclonic weather types prevail with foggy weather and low clouds with very weak currents. Summers are dominated by barička fields with low pressure gradient in which low wind also prevails, but with labile stratification of the atmosphere. Turbulent mixing of the air is strong, convective clouds develop with the possibility of rain showers.

For spring rapidly moving cyclonic weather types (cyclone and valleys) are characteristics as leading to frequent and sudden changes in the weather, rainy and rainless periods alternate.

3.2.2. Air temperature

Temperature expresses the thermal state of the atmosphere and depends on the amount of heat that the surface of the earth receives from the sun directly. As the atmosphere heats up by absorbing long-wave radiation on Earth's surface, the air temperature depends on the type of foundation and the distance from the sea or large bodies of water. On land, the heat is rapidly transferred from the substrate into the air and extremes in coastal areas of temperate latitudes occur in the months after the solstice, that is July and January. In addition to the type of foundation, the temperature depends on the form of relief and transport of heat by air currents.

Temperature conditions at the airport in Zagreb are presented in the analysis of secondary monthly and absolute maximum and minimum temperatures.

Moderate monthly and annual air temperature changes in air temperature during the year are shown in a series of 12 moderate monthly air temperature values obtained from measurements in terms of measuring in climatological measuring terms 7, 14 and 21 hours.

The medium annual air temperature (Table 3.2.-1 and Figure 3.2.-1) has a maximum in July (21.6 ° C) and a minimum in January (0.0 ° C). In the analyzed 30-year period, July and August were the warmest in the year in 73% and 23% of the cases, and once the highest monthly medium temperature was measured in June. In July, average temperatures ranged between 18.8 ° C and 23.4 ° C. January was the coldest month in most cases (57%), followed by December (23%) and February (20% of cases). The lowest meddium temperature in January was -6.0 ° C and maximum 5.6 ° C. The medium annual air temperature ranges between 9.5 ° C and 12.4 ° C, and the medium value for the 30-year period is 11.0 ° C.

The values of standard deviation, which provide assessment of variability of temperature within 30 years show a greater variation in air temperature in the cold season, from November to March. The largest variations are expected in February (sd = 3.1 ° C), while in the sense of temperature the most stable is (sd = 1.2 ° C).

Table 3.2.-1. Medium monthly and annual temperature (middle), the corresponding standard deviation (sd), maximum (max) and minimum (min), the medium monthly and annual air temperature and absolute maximum and minimum air temperature (Tmin and tmaks) and absolute amplitude (the difference between the absolute maximum and minimum temperatures - ampl).

Zagreb-Pleso airport, period: 1981-2010.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	god
cent. (°C)	0.0	1.7	6.6	11.3	16.4	19.6	21.6	20.8	16.2	11.0	5.5	1.1	11.0
sd (°C)	2.4	3.1	2.1	1.5	1.5	1.5	1.2	1.4	1.3	1.4	2.2	1.9	0.8
max (°C)	5.6	6.6	10.3	14.4	19.4	24.0	23.4	24.5	18.9	14.0	9.7	4.4	12.4
min (°C)	-6.0	-4.4	1.6	8.1	12.4	17.0	18.8	18.7	13.4	8.9	0.7	-3.8	9.5
t_{maks} (°C)	20.2	23.1	26.5	28.8	33.5	35.8	38.4	38.5	33.7	28.3	23.9	22.5	38.5
t_{min} (°C)	-24.1	-22.3	-17.3	-4.4	0.0	3.2	6.5	5.2	1.1	-5.5	-15.8	-21.0	-24.1
ampl. (°C)	44.3	45.4	43.8	33.2	33.5	32.6	31.9	33.3	32.6	33.8	39.7	43.5	62.6

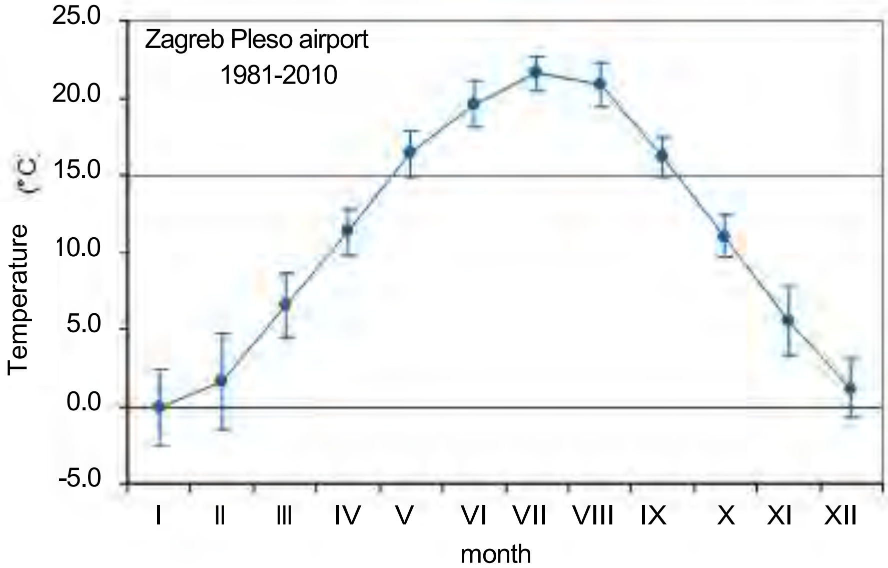


Figure 3.2.-1. . Annual range of monthly medium air temperature and the average deviation from the medium (Vertical bars: medium + sd, medium-sd). Zagreb-Pleso airport, period: 1981-2010

Absolute maximum and minimum air temperature

Absolute extremes are the highest and lowest temperatures measured in a particular month or year (Table 3.2.-1).

The absolute maximum temperature was recorded in August 2000 and was 38.5 ° C. The annual maximum temperature usually occurs in July and August and in 47% and 40% of cases, while in June it was recorded in 13% of cases.

The absolute minimum temperature recorded in January 1985. (-24.1 ° C). The annual minimum temperature occurred from November to February, and usually in January (40%). In 30% of cases it was measured in December, 27% in February, and one also has been reported in November.

Absolute amplitudes are the difference between the absolute maximum and minimum air temperatures. The greatest temperature range that is 45.4 ° C can be expected in February. General amplitudes are higher in the winter months and the lowest amplitude is in July (31.9°C, Tab. 3.2.-1).

Estimate of the expected maximum and minimum air temperature

Estimates of the expected maximum temperatures were performed using general distributions of

Extreme values accordin to Jenkinson whose theoretical curve of extremes has a shape (B.Makjanić, 1977.):

for maximum values: $x_{maks} = x_0 + \alpha \cdot (1 - e^{-ky}) / k$

for minimum values: $x_{\min} = x_0 - \alpha \cdot (1 - e^{-ky}) / k$

where, x_0, α and k parameters of the distribution of extremes derived from empirical data, and have the following meanings:

x_0 - - the value of x in the point y = 0, which can be expected once annually

k - - curvature parameter

α - - inclination x, y curve at the point $x = 0, y = 0$

Reduced variate y is a function of return period T (B. Makjanić, 1977.):

$$y = -\ln \ln(T/(T-1))$$

The return period is the medium interval in years that flows between two overshootings of a certain extremes.

On the basis of the measured annual absolute maximum and minimum air temperature in analyzed period the extreme theoretical curves were obtatinedfor the Zagreb-Pleso Airport:

$$t_{max} = 34.2 + 1.65\ (1\text{-e}^{-0.19y})/0.19$$

$$t_{max} = -14.8 - 3.98\ (1\text{-e}^{-0.33y})/0.33$$

According to the calculated parameters of the distribution of maximum and minimum air temperature, taking into account the ratio of reduced variate and return period T (years), can calculate the estimates of extreme temperatures and for other return periods, ie. values that are likely to be exceeded in one of these T years.

Parameter values t0, α and k are shown in Table 3.2.-2. and the value of the estimated extreme temperatures that can be expected in the response period 10, 20, 50 and 100 years, respectively, which are assumed to be exceeded with a small probability of 10, 5, 2 or 1%. According to the corresponding values of standard deviation, also listed in Table 3.2.-2, can be determined with confidence intervals in which estimated extremes range with a given error. Depending on the degree of precision with which they want to estimate temperature extremes and include them in the project technological budgets, confidence intervals t ± sd at approximately 68% confidence level can be used, t ± 1.28sd on approximately 80% level of confidence it 1.65sd to about ± 90% confidence level.

According to calculations by the Zagreb-Pleso airport, value of the parameter k is positive in both cases, which means that the maximum temperature curve bounded by the upper limit, in the case of minimum temperatures of lower limit, ie, temperature extremes weigh towards the final value.

The absolute maximum recorded temperature at 38.5 ° C belongs to the return period of 37 years, while the absolute minimum of -24.1 ° C can be expected once in 88 years (Fig. 3.2.-2. and 3.2.-3).

Table 3.2.-2. Distribution parameters (t0, α k) extreme values of air temperature, estimated annual extreme temperatures (TT - ° C) according to Jenkinson's distribution for return periods (T) 10, 20, 50 and 100 years, and corresponding standard deviation (SDT). Zagreb-Pleso airport, period: 1981-2010.

t_0	α	k	t_{10}	sd_{10}	t_{20}	sd_{20}	t_{50}	sd_{50}	t_{100}	sd_{100}
Absolute max. air temperature										
34.2	1.65	0.19	37.2	0.5	37.9	0.6	38.7	0.7	39.2	0.8
Absolute min.air temperature										
-14.8	3.98	0.33	-21.2	1.1	-22.4	1.2	-23.6	1.2	-24.3	1.3

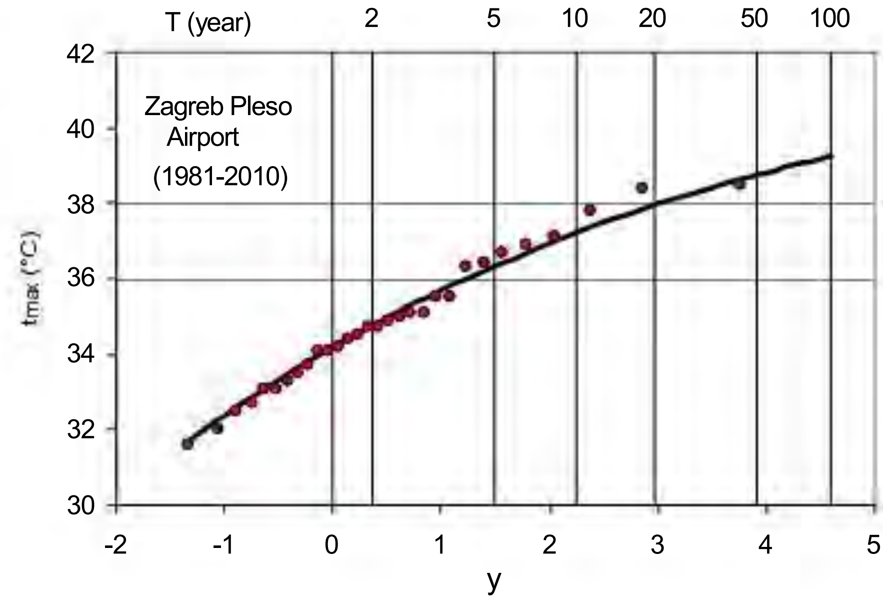


Figure **3.2.-2**. The measured absolute maximum temperature (points) and estimates of expected maximum (curve) calculated using the general distribution of the extreme values according to Jenkinson. Zagreb-Pleso airport, period: 1981-2010.

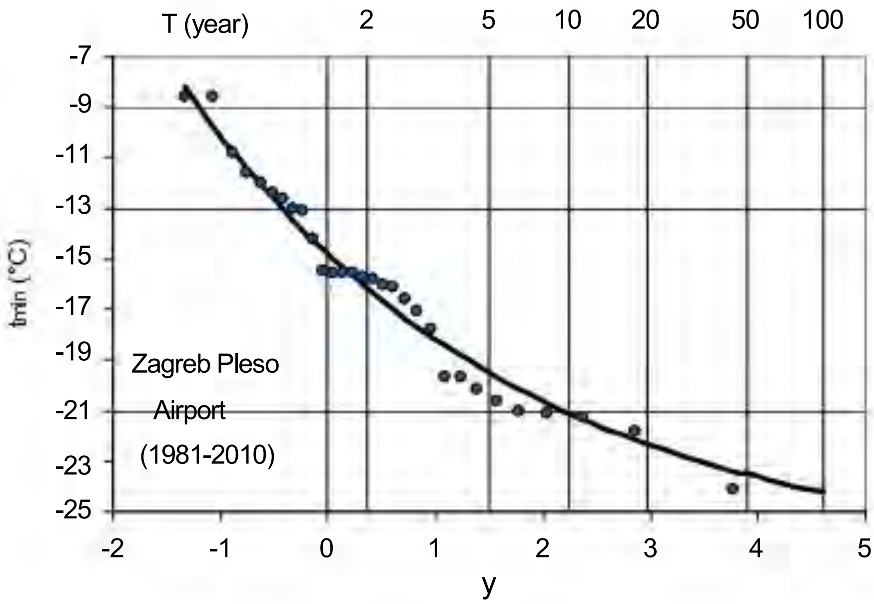


Figure 3.2.-3. The measured absolute minimum air temperature (points) and estimates of expected minimum (curve) calculated using the general extreme value distribution to Jenkinson. Zagreb-Pleso airport, period: 1981-2010.

3.2.3. Precipitation

Precipitation regime is among the most variable climatic elements, both spatially and timely. Precipitation regime is dependent on the location and the general circulation of the atmosphere, and local conditions such as the relief, and the distance from the sea. In this study, storm climate shows monthly and maximum daily precipitation.

Annual course of monthly precipitation

At the Zagreb-Pleso airport-yearly there was a an average of 934 mm of precipitation. In the warm season (April - September, 512 mm) more precipitation falls than in the cold part of the year (October - March, 422 mm). Of the total annual precipitation 55% falls in the summer.
Most precipitation falls in June with a monthly volume of about 99 mm. Minimum precipitation occurs in the cold part of the year (in February) and is 52 mm. Slightly visible secondary maximum performances in September, when it falls an average 94 mm of precipitation. These characteristics suggest continental type rainfall regime (Table 3.2.-3 and Figure 3.2. - 4).
The highest measured monthly precipitation in some months can significantly deviate from the expected average monthly values. Thus, the monthly maximum is generally greater two to three times the average monthly quantity. To assess the interannual variability of monthly and annual precipitation using the coefficient of variation (CV), which in the percentage describes how rainfall varies from year to year. According to the CV values table 3.2.-3 shows that the greatest variability belong to January (67%) and the lowest to June (38%). Annual precipitation is more stable and varies around 13%.

Table 3.2.-3. Average monthly and annual amounts of rainwater (R), belong to the standard deviation (sd) coefficient, variation (cv), maximum (Rmaks) and minimum (Rmin)monthly and annual amounts of rainwater and maximum amounts of rainwatr Rdmaks, Zagreb-Pleso-Airport, period: 1981-2010

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	god
R(mm)	54.8	52.4	64.8	64.7	79.6	99.3	80.9	92.7	94.4	83.4	88.2	78.4	933.5
sd (mm)	36.9	30.8	29.9	38.7	37.1	37.6	35.4	54.9	47.8	49.7	45.5	42.0	116.5
Cv (%)	67.4	58.9	46.2	59.7	46.6	37.8	43.8	59.3	50.7	59.6	51.6	53.6	12.5
R_{maks}(mm)	179.0	111.5	127.4	175.3	156.8	180.1	201.9	252.0	211.6	221.8	188.3	166.5	1147.5
R_{min}(mm)	4.7	1.8	8.1	4.0	10.4	29.9	38.1	2.9	24.8	4.6	13.6	13.6	681.6
Rd_{maks} (mm)	33.7	38.3	50.4	37.2	48.0	58.8	73.8	81.0	72.2	64.4	58.5	43.6	81.0

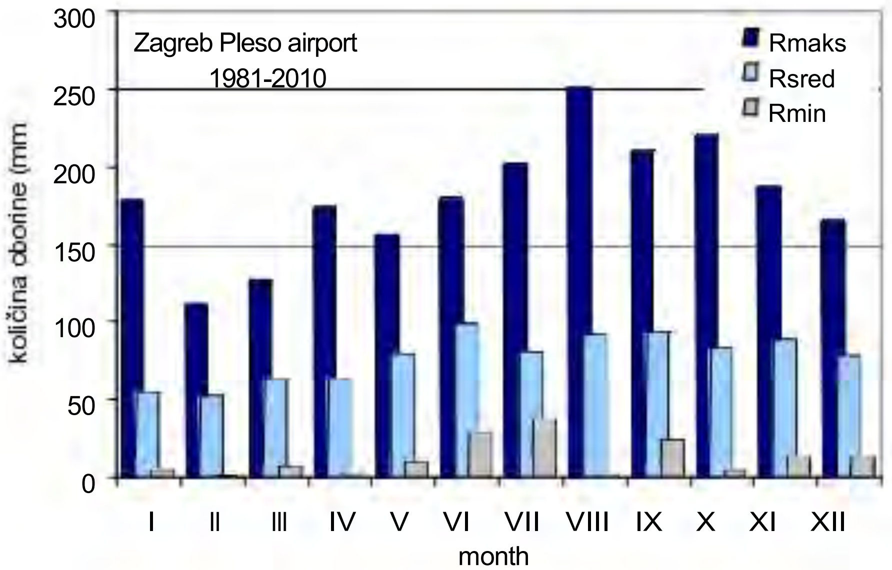


Figure 3.2.-4. Annual course of medium, maximum and minimum monthly precipitation amounts. Zagreb-Pleso airport, period: 1981-2010.

Maximum daily precipitation

Daily precipitation is measured in the morning at 7 h and concerns the amount that has fallen in the past 24 hours. In the cold season, the highest daily amount of precipitation caused by prolonged rainfall, and in the warm part of the year are usually a result of short but strong showers.

The annual maximum daily precipitation amount represents the maximum amount of precipitation measured during a particular year.

In the 30-year period, annual maximum daily precipitation was measured in all months except February and April, and are usually measured in the summer and autumn.

The probability of occurrence of the annual maximum daily maximum is in August, June and October.

The highest daily precipitation in the period 1981-2010 is 81.0 mm and was measured in August 1989.(Table 3.2.-3).

Evaluation of the expected maximum daily precipitation

Estimates of annual maximum daily precipitation were performed using general extreme value distribution (GEV) by Jenkinson described in section 3.2.2. On the basis of the measured annual maximum daily precipitation in the period of 1981-2010.

The theoretical curve was obtained for the extreme-Zagreb-Pleso Airport:

$$Rd_{maks} = 41\ 8 + 9\ 36(1 - e^{0\ 08\ y})/(-0\ 08)$$

From this equation it is possible, taking into account the ratio of reduced Vari y of the return period T
calculate the maximum daily precipitation amounts which are likely to be exceeded once in T years.

Parameter values Rd0, α k are shown in Table 3.2.-4 as the value of the estimated maximum daily precipitation that can be expected once in 10, 20, 50 and 100 years, respectively, which are assumed to be of low probability to be exceeded by 10, 5, 2 or 1%. According to the corresponding values of standard deviation, also
listed in Table 3.2.-4, one can determine the confidence intervals in which these estimated maximums range with a given error. Depending on the degree of safety with which estimated precipitation extremes could be included in the design and technology budgets, we can use confidence intervals Rd ± sd for approximately 68% level of confidence, Rd ± 1.28sd on Approximately 80% level of confidence and ± 1.65sd Rd at approximately 90% confidence level.

According to the associated distribution, the maximum daily rainfall of 81.0 mm can be expected once in 38 years (Figure 3.2.-5).

The value of the parameter k, which determines the slope of the curve, which is negative because the curve is not bounded from above. Therefore it is not recommended to use it to estimate the maximum daily precipitation for return periods longer than 100 years, because the values obtained can not be overestimated.

Table 3.2.-4. Parameter distribution (*Rd_0, a* i *k*) and the estimated annual maximum daily amount of precipitation (Rd_T) were calculated using the general extreme value distribution (GEV distribution) to Jenkinson for return periods T 10, 20, 50 and 100 years, and corresponding standard deviation (sd_T). Zagreb-Pleso airport, the period 1981-2010.

Rd_0	α	k	Rd_{10}	sd_{10}	Rd_{20}	sd_{20}	Rd_{50}	sd_{50}	Rd_{100}	sd_{100}
41.8	9.36	-0.08	64.7	4.9	72.9	6.1	84.2	7.7	93.2	9.0

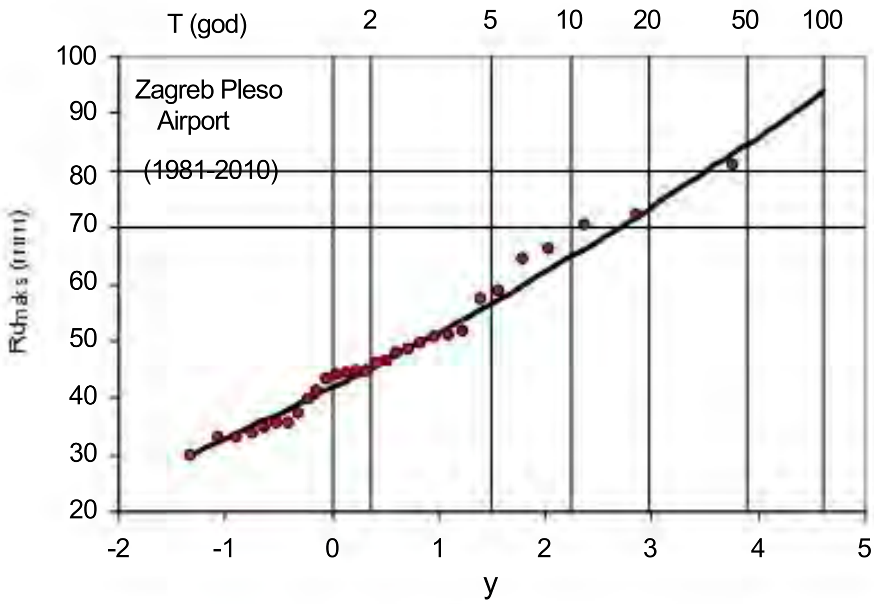


Figure 3.2.-5. The measured maximum daily precipitation Rdmaks (points) and estimates of expected maximum (curve) calculated using the general distribution of the extreme values according to Jenkinson. Zagreb-Pleso airport, period: 1981-2010.

3.2.4. Relative humidity

Knowing the water vapor content of the air, and the degree of saturation of the air with water vapor it can be concluded that it is condensation of water vapor, or the formation of clouds and precipitation. The air saturated with water vapor leads to condensation and formation of water droplets or ice crystals.
One of the best known and most accepted measure of moisture in the air is the relative humidity,which shows the degree of saturation of air with water vapor. The amount of water vapor in the air depends on air temperature, flow and position of location.

Central and term minimum monthly and annual relative humidity

Average monthly relative humidity at the Zagreb-Pleso airport has high values throughout the year, on average, greater than or equal to 69% and do not change much from month to month (Table 3.2.-5 and Figure 3.2.-6), and the medium annual value is 77%. The highest values of relative humidity in the cold part of the year with the maximum in December (87%), October (86%) and January (85%), while the lowest values are in April May (69% and 70%). Very small values of standard deviation indicate to small variability of monthly medium relative humidity from year to year.
Absolute minimum relative humidity refers to the lowest time values, without matter which climatological terms of observations it is measured (7, 14 or 21 hours). Minimal values range from 17% in March to 33% in December.

Table 3.2.-5. Medium monthly and annual values of relative humidity (middle-%) and associated standard deviation (SD%) and minimum time values (% min). Zagreb-Pleso airport, period: 1981-2010.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	god
sred	85	78	71	69	70	72	71	74	79	83	86	87	77
sd	4	4	5	4	4	4	4	6	4	3	3	3	2
min	29	21	17	19	22	25	24	20	28	25	31	33	17

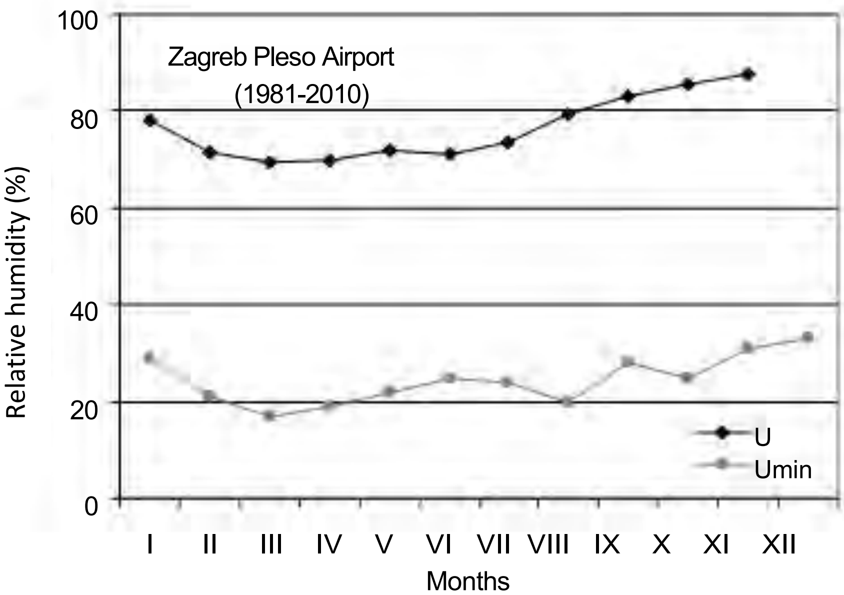


Figure 3.2.-6. The annual course of medium monthly relative humidity and minimum forward values. Zagreb-Pleso airport, period: 1981-2010.

3.2.5. Airflow

Wind is the horizontal component of the air flow and is determined by the direction and speed.An air current caused by the horizontal difference in pressure and density of air are the consequence of unequal temperature of the atmosphere. The bigger the difference in pressure on smaller area,the higher the wind speed is, and this usually occurs in Croatia in cyclones and edges of anticyclones. In contrast, calm weather situation with weak winds occur in the centers of anticyclones, ridges and bezgradijentnim pressure fields, when spatial pressure differences over a large area is very small. The change in wind direction often means a change in the weather, and in some areas the wind from a certain direction indicates the type of weather. Speed affects evaporation, soil erosion, human sense of heat, and also operates on vegetation, road, air, river and sea transport. Here are analyzed distributions of strength and direction of the wind and the emergence of strong and stormy winds.

The distribution of intensity and direction

Instrumentally the wind direction and speed are determined on a small number of stations. If not,there is an instrument for measuring wind speed, its strength is determined according to Beaufort scale (Table 3.2.-6). The wind is estimated by the effect of wind on objects in nature in three climatological monitoring periods (7, 14 and 21 hours). Beaufort scale contains 13 levels which are associated with the corresponding medium wind speed. In the analyzed period, his is how the data on the wind was determined at the meteorological station of Zagreb-Pleso airport. Wind direction means the side of the world from which the wind is blowing, and is also determined visually by pinwheel that has marked only four directions, and the observer evaluates the wind direction in 16 directions.

Results of the analysis of flow on the Zagreb-Pleso airport according to seasons and the year are shown in Figures 3.2.-7. and 3.2.-8, and numerical values are given in Table 3.2.-7th.

Table 3.2.-6. Beaufort scale of wind strength and associated medium wind speed in m/s.

Beauforti (Bf)	Name	Class speed (m/s)
0	Silence	0.0-0.2
1	Light breeze	0.3-1.5
2	Wind	1.6-3.3
3	Light wind	3.4-5.4
4	Medium wind	5.5-7.9
5	Medium to strong wind	8.0-10.7
6	Strong wind	10.8-13.8
7	Very strong wind	13.9-17.1
8	Storm wind	17.2-20.7
9	Storm	20.8-24.4
10	Strong storm	24.5-28.4
11	Hurricane wind	28.5-32.6
12	Hurricane	32.7-36.9

During the year , the area of the airport Zagreb wind usually blows from the north and southwest quadrants - NE, NW, SW and NE currents are present in approximately 9% of cases. Following is the wind from the western direction (8% of cases), E, NE, NW and N flow (5 - 6% of cases). Other routes are present in approximately 1-4%. Silence was monitored in 18% cases. If the wind is observed regardless of direction, the perennial observations show that the strength of the wind that usually blows is Bf 1-3 in 75% of cases. Moderately strong winds (4-5 Bf) occur in 6% of cases. Strong and very strong wind (6-7 Bf) blow extremely rare (0.3% of cases).

In terms of observations a tornado was recorded (magnitude ≥ 8 Bf).

During the winter the flow is dominated by NE direction (11% of cases), and the wind from the southwest quadrant (W, SW and SW blow in approximately 8% of cases). The next is a representation of the wind from NNE direction (7% of the cases) and the NE and E flow (6%). Other directions are represented with 1 - 4%. Silence occurs in 23% of cases. Light to moderate winds (1-3 Bf) was observed in winter in 71% cases, a moderately strong wind in 6% of cases. Strong and very strong wind (6-7 Bf) are very rare and blow in 0.3% of cases. Wind strength Bf ≥ 8 have been reported in terms of monitoring.

In the spring, the most common wind blows from the NE and SW direction (11% of cases) and NE and SW directions (10% of cases). Following is the flow of W (9%), E and NE direction (6%). N and NE flow reported in approximately 5% of cases. Other routes are present in 1-4%. Silence is monitored in 12% of cases. Light to moderate winds (1-3 Bf) in spring occurs in 78% cases, a moderately strong wind is the most common in this season, with an incidence of 9%. Strong and highly strong wind (6-7 Bf) blow in 0.6% of cases. Wind measuring 8 Bf is recorded in one analyzed period.

During the summer, prevailing SW stream with an incidence of 10%. Following is the wind from the SW and NE and W direction (8%), No flow (7%), E, NE and N direction with the frequency of 6%. Other directions are present in 2-5% of cases. Frequency of silence is at 17%. Light to moderate winds (1-3 Bf) in the summer occurs in approximately 79% of cases, and moderately strong wind in 4% of cases. Strong and highly strong wind (6-7 Bf) blow rarely (0.2% of cases). Wind measuring 8 Bf recorded two times in terms of monitoring the 30-year period.

In the fall, as in other seasons, the most frequent is the flow from the north
(NO, N - 9%) and Southwest (SW, SW - 8%) quadrants. Following is the west wind (7%), SW flow (6%), and the wind from the direction E, and NE (5%). Other directions are present in 1-4% of cases. Silence was observed in 23% of cases. Light to moderate wind (1-3 Bf) in autumn occurs in 72% of cases, and moderately strong wind in 5% of cases. Strong and very strong winds (6-7 Bf) blow extremely rare (0.1% of cases). Wind measuring 8 Bf was monitored only once in the analyzed period.

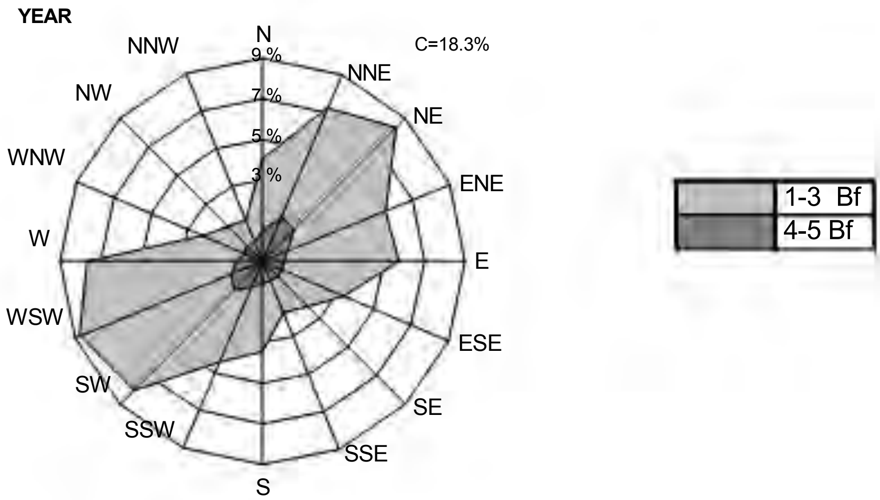


Figure 3.2.-7. Annual wind rose for the Zagreb-Pleso airport-for the period 1981-2010.

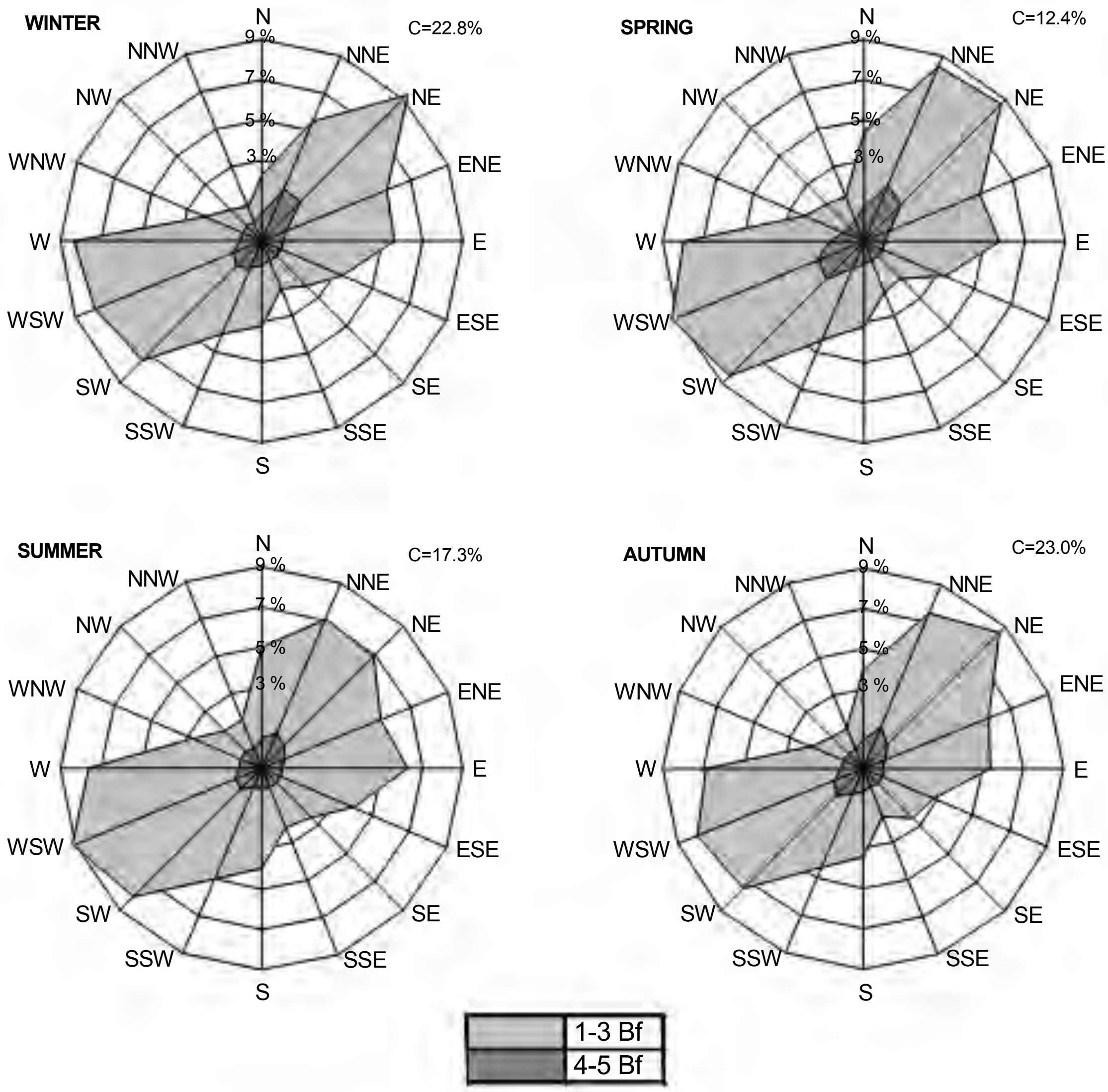


Figure 3.2.-8. Seasonal wind roses for-Zagreb-Pleso airport for the period 1981-2010.

Table 3.2.-7. The probability of simultaneous occurrence of different wind directions (‰) by classwind force for Zagreb-Pleso airport-period 1981-2010.

ZAGREB-PLESO-AIRPORT, YEARS 1981-2010

Strength(Bf)	0	1	2	3	4	5	6	7	8	9	10	11	12	TOTAL
N		21.5	12.2	6.6	3.4	1.5	0.4	0.1	0.0	0.0	0.0	0.0	0.0	45.7
NNE		25.2	30.8	16.2	10.4	4.4	0.5	0.2	0.0	0.0	0.0	0.0	0.0	87.7
NE		20.3	39.4	23.8	9.5	2.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	95.5
ENE		20.2	26.1	9.1	2.0	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	57.8
E		28.7	24.2	4.7	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.0
ESE		17.4	14.7	1.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.8
SE		12.8	8.3	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.8
SSE		10.5	6.4	0.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.8
S		19.7	12.1	3.0	1.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.0
SSW		21.4	15.8	6.6	2.6	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	47.1
SW		33.1	30.7	15.5	6.9	2.8	0.4	0.1	0.0	0.0	0.0	0.0	0.0	89.4
WSW		37.9	37.8	12.1	5.1	2.0	0.3	0.1	0.1	0.0	0.0	0.0	0.0	95.3
W		38.6	30.9	7.4	1.9	0.9	0.1	0.0	0.0	0.0	0.0	0.0	0.0	79.8
WNW		12.9	6.9	2.5	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.9
NW		9.3	3.7	1.5	0.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.1
NNW		7.7	3.6	1.4	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	13.1
C	183.1													183.1
TOTAL	183.1	337.1	303.6	113.4	44.7	15.1	2.4	0.6	0.1	0.0	0.0	0.0	0.0	1000.0

ZAGREB-PLESO-AIRPORT, WINTER 1981-2010.

Strength(Bf)	0	1	2	3	4	5	6	7	8	9	10	11	12	ZBROJ
N		13.0	7.1	2.6	1.8	1.5	0.6	0.6	0.0	0.0	0.0	0.0	0.0	27.3
NNE		19.5	20.9	14.1	12.5	5.5	0.5	0.2	0.0	0.0	0.0	0.0	0.0	73.2
NE		24.8	41.1	26.6	14.6	2.8	0.6	0.0	0.0	0.0	0.0	0.0	0.0	110.6
ENE		24.0	24.4	8.9	2.3	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	60.1
E		34.8	18.2	2.8	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	56.7
ESE		23.7	8.9	0.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.5
SE		15.9	5.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.9
SSE		11.9	3.6	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.8
S		20.3	8.3	3.4	1.8	0.3	0.2	0.0	0.0	0.0	0.0	0.0	0.0	34.3
SSW		21.6	12.5	5.4	3.4	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	44.0
SW		31.7	29.6	12.8	5.0	2.9	0.2	0.2	0.0	0.0	0.0	0.0	0.0	82.3
WSW		32.8	35.2	11.9	3.1	1.5	0.3	0.0	0.0	0.0	0.0	0.0	0.0	84.8
W		42.2	34.1	7.3	0.6	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	84.9
WNW		12.5	6.7	2.1	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.6
NW		8.0	2.9	1.6	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.8
NNW		6.3	2.1	0.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	8.8
C	227.5													227.5
TOTAL	227.5	343.0	260.6	101.8	46.8	16.9	2.4	1.0	0.0	0.0	0.0	0.0	0.0	1000.0

ZAGREB-PLESO-AIRPORT, SPRING 1981-2010

Strength(Bf	0	1	2	3	4	5	6	7	8	9	10	11	12	ZBROJ
N		22.0	13.3	9.1	5.6	1.8	0.6	0.0	0.0	0.0	0.0	0.0	0.0	52.3
NNE		26.7	38.3	19.2	12.2	7.2	1.2	0.1	0.1	0.0	0.0	0.0	0.0	105.1
NE		17.9	42.8	25.6	12.7	3.9	1.0	0.1	0.0	0.0	0.0	0.0	0.0	103.9
ENE		12.8	26.3	13.0	2.8	0.7	0.1	0.0	0.0	0.0	0.0	0.0	0.0	55.8
E		23.7	26.8	7.2	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	58.3
ESE		12.9	19.4	2.2	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.7
SE		7.5	8.5	0.6	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.7
SSE		8.9	7.1	1.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.6
S		17.2	12.2	3.0	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.5
SSW		18.5	15.1	9.7	3.4	1.2	0.2	0.0	0.0	0.0	0.0	0.0	0.0	48.1
SW		28.4	32.7	23.2	10.9	5.1	1.0	0.1	0.0	0.0	0.0	0.0	0.0	101.3
WSW		34.5	41.1	17.2	9.8	4.5	0.5	0.4	0.0	0.0	0.0	0.0	0.0	107.9
W		32.3	36.0	11.2	4.5	2.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	86.8
WNW		9.8	8.9	2.8	0.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	22.5
NW		9.1	5.3	1.8	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.8
NNW		8.1	3.5	1.9	0.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	14.5
C	124.3													124.3
TOTAL	124.3	290.1	337.4	149.2	65.8	27.5	4.8	0.7	0.1	0.0	0.0	0.0	0.0	1000.0

ZAGREB-PLESO-AIRPORT, SUMMER 1981-2010

Strength(Bf)	0	1	2	3	4	5	6	7	8	9	10	11	12	ZBROJ
N		24.5	17.4	8.1	3.4	1.4	0.2	0.0	0.0	0.0	0.0	0.0	0.0	55.1
NNE		24.8	30.3	15.5	6.9	2.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	80.2
NE		17.4	33.0	18.2	4.8	0.7	0.0	0.0	0.1	0.0	0.0	0.0	0.0	74.3
ENE		18.8	26.4	8.5	1.6	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	55.6
E		26.8	30.2	5.9	0.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	63.3
ESE		17.5	19.3	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	39.9
SE		12.8	11.4	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	24.6
SSE		11.6	8.9	1.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	21.6
S		18.6	18.2	2.7	0.5	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	40.2
SSW		22.5	20.9	5.9	0.7	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0	50.2
SW		36.7	31.9	11.7	4.1	0.7	0.2	0.0	0.0	0.0	0.0	0.0	0.0	85.4
WSW		42.5	40.3	8.8	3.6	0.5	0.2	0.0	0.1	0.0	0.0	0.0	0.0	96.1
W		41.2	28.4	6.2	1.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	77.2
WNW		14.4	9.2	3.5	0.8	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	28.1
NW		11.1	3.9	1.9	0.6	0.5	0.1	0.1	0.0	0.0	0.0	0.0	0.0	18.2
NNW		8.7	5.7	1.9	0.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.0
C	172.9													172.9
TOTAL	172.9	349.9	335.4	103.4	29.3	7.0	1.3	0.5	0.2	0.0	0.0	0.0	0.0	1000.0

ZAGREB-PLESO-AIRPORT, AUTUMN 1981-2010

Strength(Bf	0	1	2	3	4	5	6	7	8	9	10	11	12	ZBROJ
N		22.8	10.5	5.8	3.0	1.3	0.3	0.0	0.0	0.0	0.0	0.0	0.0	43.6
NNE		27.9	31.7	14.9	9.7	2.4	0.3	0.3	0.0	0.0	0.0	0.0	0.0	87.3
NE		22.6	40.1	23.0	6.2	0.5	0.1	0.0	0.0	0.0	0.0	0.0	0.0	92.6
ENE		25.5	26.8	5.4	1.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	59.4
E		29.6	21.1	2.9	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	53.7
ESE		16.6	11.0	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	27.9
SE		15.8	8.7	0.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	25.2
SSE		9.7	5.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16.3
S		21.6	9.2	3.0	0.9	0.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.4
SSW		23.0	14.9	5.9	2.9	0.3	0.1	0.0	0.0	0.0	0.0	0.0	0.0	47.2
SW		33.1	28.2	13.0	6.7	2.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	83.3
WSW		40.1	30.9	8.9	4.0	1.4	0.0	0.1	0.1	0.0	0.0	0.0	0.0	85.5
W		38.1	25.9	4.0	1.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	69.2
WNW		13.7	3.4	1.4	0.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	18.7
NW		9.0	2.8	0.8	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	12.6
NNW		7.6	2.7	1.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	11.8
C	230.3													230.3
TOTAL	230.3	356.7	273.9	91.8	36.8	9.0	1.0	0.4	0.1	0.0	0.0	0.0	0.0	1000.0

Number of days with strong and stormy winds

Because the wind is not a discrete but continuous size, it may be that strong or stormy winds blow outside monitoring periods. That's why observers recorde time of performance and termination of wind that is ≥ 6 Bf (strong wind) and ≥ 8 Bf (tornado) during the day. Force 6 Bf wind corresponds with the speed in range 10.8 - 13.8 m / s, while wind measuring 8 Bf corresponds with a speed range 17.2 - 20.7 m / s. A day with a strong / stormy is the day when there is at least one recorded wind with the intensity of ≥ 6 Bf / Bf ≥ 8.

A strong wind can blow in all months, but with the highest frequency it appears in spring - March and April have nearly 9, and May 7 such days (Table 8). Then followed with June and July with approximately 6, and February with five days with strong wind. In other months, a strong wind can be expected about 4 times a month. Strong wind was recorded in all years with an average of 64 days a year.

At the Zagreb airport stormy wind blows rarely. It is most common in the summer months (June to August), and in April, when there was an average of 7 times in 10 years (Table 3.2.-8). Stormy wind is also monitored in each year of the analyzed period, ina n average it can blow about 6 times a year.

Table 3.2.-8. Medium monthly and annual number of days with severe (≥ 6 Bf) and windstorm (≥ 8 Bf). Zagreb-Pleso airport, the period 1981-2010.

	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	year
STRONG WIND													
med.	3.6	4.9	8.8	8.5	6.7	5.6	5.8	4.4	3.6	3.8	4.0	4.2	63.9
STORM WIND													
med.	0.4	0.3	0.5	0.7	0.4	0.7	0.7	0.7	0.3	0.2	0.2	0.3	5.6

3.3. AIR QUALITY

According to the Law on Air Protection (Official Gazette 178/04, 60/08), Zagreb County has adopted a Program for the protection and improvement of air quality in the County (Bulletin No. ZZ. 33/07), in 2010. Administrative Department of Urban Planning, Construction and Environment Department - Environmental Protection, made the first report on the implementation of protection and improvement of air quality for the period since 2008 to 2010. When the data were used collected from municipalities and cities in the county, utility companies, State Protection and Rescue, the data from the protection and improvement of air quality in ZZ, Environmental Emission, Environmental Pollution Register, the Central Bureau of Statistics and data on air quality from the automatic monitoring station in Velika Gorica. They also used data from recent studies, documents and projects..

According to Table 4.2 of the Report, in Velika Gorica, the key problem lies in state road D-30, Zagreb Airport, gravel and concrete factory in the the area of Novo Čiće, municipal wastewater treatment plant (sludge drying beds), HEP thermal stations on fuel oil, light metal factory „Žura“ in Čićka Poljana, wood industry „Solidum – Zuzic“ in Kušanec and landfill in Mraclinska Dubrava. It is said that the citizens mostly complain to the above sources about pollution, but they are generally satisfied with the air quality.

The center of Velika Gorica has an established automatic measuring station (AMP) for the monitoring of air quality (NO2, SO2, H2S, benzene, PM10, O3, CO). Obtained results of measurements in 2009 and 2010 indicate that concentrations were low and did not exceed GV (limit values) according to the Regulation on Limit Values of pollutants in the air (OG 133/05) and the Regulation on the ozone in the air (OG 133/05), and the surrounding air was I. category of air (C <GV), according to the Air Protection Act (Official Gazette 178/04, 60/08).

At the end of the report it was concluded that "the air quality in the area of Zagreb County is in good condition, but it is needed to continue to monitoring of air quality due to the increase in road traffic, emissions of air pollutants from process and industrial plants and boiler rooms. " It is stated that the current state of monitoring potential air pollutant does not meet all the necessary legal measures to
prevent uncontrolled and illegal discharge of pollutants into the air and continuously implement systematic protection of air, in cooperation with all public authorities, associations and citizens.

ZERO STATUS IN ZAGREB AIRPORT

In the area of Zagreb Airport there is metric data on concentration parameters of air pollution. Therefore, the estimate of the impact of Zagreb airport and main roads on the air quality, according to data on air and road traffic in 2009 and 2010. The simulations were performed using the ISC-AERMOD View software for 3-D modeling of dispersion of air (U.S. Environmental Protection Agency), as described in Section 4.2.1 (Impact on air quality).

Below are just basic input parameters and the results of performed simulations.

1 Report on Air Quality Monitoring at AMP Velika Gorica (Dvokut ECRO, 2010)
Report on Air Quality Monitoring at AMP Velika Gorica (Dvokut ECRO, 2011))

Characteristics of sources of pollution[2]:

- The total number of aircraft operations: 37,435
- *Given that, according to current practice, the largest number of air operations are performed in July and an average 20% higher than the medium annual traffic, the analysis NOx and PM10 was conducted for that month, as it considers the time of averaging from 1 to 24 h. The analysis of BaP was made for average annual traffic according to the higher-growth scenario, since the averaging time of averaging is 1 year.*
- structure of aircraft types: B (4.043 - 10.8%), C (33.018 - 88.2 %), D (374 - 1%)
- *Based on the types of aircraft that operate in Zagreb Airport, parameters are used in simulations of air pollution that correspond to Airbus 320-200 aircrafts.*
- The assumed the average time of the landing and taking off cycle (LTO - Landind - Takeoff Cycle) for the aircraft type C for 45 min (approach 4 min., Landing: 1 min., Taxi in: 3 min., Idle - on arrival: 2 min., Idle - off gl.engine, the APU is running: 18 min., idle - at departure: 7 min., taxi out: 5 min.,takeoff and climbing: 5 min.
- Road traffic within Zagreb Airport - access over D408 - AADT ≈ 7000th.
- Road traffic on the main roads around Zagreb Airport - according to figure 1.3-14. ADT with positions of automatic traffic count on the relevant road network in 2010.

The wind blowing from all directions is assumed, in order to obtain a **potential zone of contamination** around the site area. Emission of parameters on contaminated air are elaborated in section 4.2.1.

Given the recorded pollution sources, as reference parameters for pollution for the assessment of the impact on air quality were selected NO2, PM10 and benzo (a) pyrene (BaP). Prescribed concentration limits with respect to human health are given in Table 4.2.1.-5.

Figure 3.3.-1 shows the spatial domain oft he numerical model, measuring 14 x 14 km, with defined sources of pollution. They are tagged as sources of contamination within the operation, especially the main roads in the area of impact, in order to make the analysis of relations of procedures according to the existing and planned roadways.

2 Source: InterVISTAS (2010) Traffic Forecast - public-private partnerships - - Zagreb Airport
3 http://www.zagreb-airport.hr/hr/iz_statistike
4 Polluted air- - air whose quality is such that it may harm the health, quality of life and / or adversely affect any component of the environment - difinicija from the Air Protection Act (Official Gazette 130/11).

Figure 3.3.-1. Spatial domain of the numerical model with marked sources of pollution

SOURCES OF POLLUTION:

a) Zagreb Airport - Zagreb Airport
PR / TO - approach / takeoff
ST - the apron on the terminal – waiting of aircrafts
SL - landing
UZ - takeoff / climbing of aircraft
P - Parking
Zagreb Airport - the main roads in the area of ZA

b) the main roads in the impact zone of ZA (GP)
D408 - Western approach ZA (existing)
D30 - Northern bypass of Velika Gorica
A3 - motorway

PGDP values are taken from section 1.4 Analysis and forecast of traffic.

Figure 3.3.-2. . Scheme of control points in the impact zone of Zagreb Airport (K1 - K6: nearest residential buildings int he surroundings of ZA)

THE PERFORMED EXPIREMENTS AND RESULTS

Experiments were conducted for the following scenarios:

Experiment	Phase	Parameter of pollution	Sources of pollution*
P0-NOx_A	Zero state (2010.)	NOx	ZLZ
P0-NOx_B	Zero state (2010.)	NOx	GP
P0-NOx_C	Zero state (2010.)	NOx	ZLZ+GP
P0-PM10_A	Zero state (2010.)	PM_{10}	ZLZ
P0-PM10_B	Zero state (2010.)	PM_{10}	GP
P0-PM10_C	Zero state (2010.)	PM_{10}	ZLZ+GP
P0-BaP_A	Zero state (2010.)	BaP	ZLZ

* ZA - Parts oft he project; GP - the main roads in the area of impact

Determining NOx emissions - the zero state (2010)

Table 3.3.-1. Emission concentrations NOx at control points (μg/m^3) for experiments P0-NOx_A, P0-NOx_B i P0-NOx_C

Control point	**P0-NOx_A** Sources: ZLZ VU* = 1 h	**P0_NOx_B** Sources: GP VU = 1 h	**P0-NOx_C** Sources: ZLZ + GP VU = 1 h
K1	52,45	27,38	62,88
K2	54,96	13,13	61,80
K3	73,82	31,88	77,07
K4	132,87	50,44	135,82
K5	39,89	41,20	76,68
K6	32,94	26,28	42,94

* VU - averaging time

In order to compare the results obtained with the Regulation of prescribed values (GV), an estimate was made of NO_2 concentrations based on hypothetical ratios: : NO_2 / NO_X ≈ 0,4 ((Šega and Beslić, 2008; Beslić and others, 2005a).

Table 3.3.-2. . Estimation of the emission concentration of NO_2 in checkpoints (μg/m^3) for experiments NOx_A, P0-NOx_B i P0-NOx_C

Control point	**P0-NOx_A** Sources: ZLZ VU* = 1 h	**P0_NOx_B** Sources: GP VU = 1 h	**P0-NOx_C** Sources: ZLZ + GP VU = 1 h
K1	20,98	10,95	25,15
K2	21,98	5,25	24,72
K3	29,53	12,75	30,83
K4	53,15	20,18	54,33
K5	15,96	16,48	30,67
K6	13,18	10,51	17,18

Determining emissions of PM_{10} - - the zero state (2010)

Table 3.3.-3. . emission concentration of PM_{10} at control points (μg/m^3) for experiments P0-PM10_A, P0-PM10_B i P0-PM10_C

Control point	**P0-PM10_A** Sources: ZLZ VU* = 24 h	**P0_PM10_B** Sources: GP VU = 24 h	**P0-PM10_C** Sources: ZLZ + GP VU = 24 h
K1	5,25	7,37	7,38
K2	5,94	3,38	8,40
K3	2,66	8,17	8,49
K4	3,56	13,45	13,45
K5	2,69	11,49	13,07
K6	3,05	6,56	6,63

Determining emissions of benzo(a pyrene – the zero state (2010)

Tablica 3.3.-4. emission concentration of BaP at control points (ng/m^3) for experiments P0-BaP_A

Control point	**P1-BaP_A** Sources: ZLZ VU = 1 god.
K1	0,206
K2	0,451
K3	0,087
K4	0,041
K5	0,086
K6	0,121

Note:
Since the airport is a dominant source of benzo(a)pyrene emissions, the analysis results show only the results for Zagreb Airport, and not the main roads in the zone of impact from the work (GP).

CONCLUSION

The conducted analysis of the impact on air quality at Zagreb airport had the goal of determining the baseline condition of pollution. As reference parameters, considered were concentrations of NOx, PM_{10} and BaPThese results are comparable with results of impact on air quality because of the construction of the new passenger terminal at Zagreb Airport (Chapter 4.2.1).

In the performed simulations it was taken into consideration that all aircrafts are type Airbus A-320, which gives us a somewhat greater load than in the real situation. However, the impact of ancillary devices and vehicles (GSE) was not taken into account, so it was assumed that these impacts counterbalance each other.

Analysis of emission concentrations of NOx for the zero state (figures 3.3-1a/b/c) showed the following:

- The largest concentrations were registered on the takeoff part of the runway, since the largest emissions of NOx from the aircraft engines are during takeoff. The loss of contact of the aircraft with the surface of the Earth decreases the immediate impact on the surface's concentration increase of NOx with the fact that the pollutions stays in the lower layer of the atmosphere until the height of mixing (seasonal and daily differ – on an average from 200 to 900 m) and participates in the creation on the lower ozone.
- Elements of procedures (Runway, terminal and associated roads) form a potential zone of pollution on the following radii:
  - about 300 m with NOx concentration values greater than 200 µg/m3, about 450 m with values greater than 100 g/m3, about 700 ms values greater than 50 µg/m3 ... (figure 3.3-1a)
- Roads in the area of impact (A3, D30, D408) form a potential zone of pollution dependent on the PGDP and the structure of the vehicle. The concentration of nitrogen oxides from roads has a key impact regarding the ratio of large cargo vehicles.

[5] runway

As is evident from figure 3.3-2b, the most significant pollution is around roads A3.

- With regard to the position Zagreb Airport and roads in the area of impact, the cumulative impact is felt in the radius of 2 km around Zagreb Airport. According to the position of surrounding settlements, the strongest negative impact on settlements Mala Kosnica and Petina, in the immediate vicinity of the northeastern edge of the runway. In narrow round of the impact of Zagreb Airport include Pleso, Selnica Šćitarjevska, Bašča and Velika Kosnica. In the area of the settlement Pleso, impact on the concentration of emissions has the road D408, while the road D30 is dominant regarding impact in the area of Velika Gorica.
- Data in checkpoints indicate the prevailing influence of Zagreb Airport, except in item K5. Roads, which are significant in the context of the cumulative impact are D408 and D30 in K1 and K2, highways A3 K3, K4 and K5, and A3 and D30 in K6.
- Given the measured values of the wind and the nearest impact zones (settlement Pleso, Mala Kosina and Petina), the least favorable winds are from the direction of N, NNW, with an annual frequency of 6% and wind from the direction of the southeast which blows with an annual frequency of approximately 8%.

Based on the assumed ratio: $NO_2/NO_X \approx 0.4$, an estimate was made of NO_2 concentrations and the derived values are compared with the prescribed values (GV) with respect to human health. Since the Regulation on Limit values of pollutants in the air (OG 133/05) of GV for NO2 is 200 µg/for an averaging time of 1 h, it can be concluded that in the case of peak **load exceeds the GV next to the runway. In the nearby area, the proportion of pollution under influence of Zagreb Airport is under limits prescribed by the Regulation.**

Analysis of PM_{10} emission concentrations for the zero state (figures 3.3-2a/b/c) has shown the following:

- The highest concentrations are recorded on the runway and on parts of the future highway A11.
- Elements of the work (runway, terminal and associated roads) form a potential zone of contamination of the following radii:
    - about 200 m with values of PM_{10} concentrations greater than 15 g/m^3, about 300 ms values greater than 10 g/m^3, greater than 5 µg/m^3, about 500 m with values greater than 5 µg/m^3... (figure 3.3-2a)
- Roads in the area of impact (A3, D30, D408) form a potential zone of pollution dependant on PGDP and the structure of the vehicles (figure 3.3-2b). The most significant impact has road A3.
- With regard to the position of Zagreb Airport and roads in the area of impact, the cumulative impact is felt in the zone of 1.2 km radius around Zagreb Airport. Considering the position of the nearby villages, the strongest negative impact is on the settlement Pleso, Mala Kosnica and Petina, although much lower than in the case of parameter NOx.
- Data in checkpoints indicate prevailing impact of roads (D30, D408, A3) in K1, K3, K4, K5 and K6, and the Zagreb Airport in K2.
- Given the measured values of the wind and the nearest impact zones (settlement Pleso, Mala Kosina and Petina), the least favorable winds are from the direction of N, NNW, with an annual frequency of 6% and wind from the direction of the southeast which blows with an annual frequency of approximately 8%.

Since according to the Regulation on Limit Values of Air Pollutants (OG 133/05), the GV for PM10 is 50 µg/m^3 for an averaging time of 24 h, it can be concluded that there is no exceeding of GV, even in the case of peak load.

Analysis of emissions of concentrations of benzo (a) pyrene in the zero state (figure 3.3-3a) revealed the following:

- The highest concentrations were registered at the runway and the terminal, since aircrafts during LTO cycles represent the most significant source of pollution.
- Elements of the work form potential contamination zone with the following radius:
  - about 250 m with BaP concentration values greater than 1 ng/m^3, about 350 m with values greater than 0.5 ng/m^3 ... (Figure 3.3-3a)
- Roads in the zone of work impact have little influence in relation to the airport.
- With regard to the position of the surrounding settlements, the most pronounced negative impact is on the area of settlement Pleso (K2). A twice smaller impact is on the outskirts of the city Velika Gorica (K1), while the impact on other settlements in the region: Petina (K3), Mala Kosnica (K4), Mičevec (K5) and the Velika Mlaka (K6), is 4 - 10 times smaller.
- With regard to the annual frequency of wind blowing from a given direction, a cloud of pollution in the direction of nearby settlements is formed by the following winds:
  - for the settlement Pleso and Velika Gorica: The wind is from the NW, N and NE (blow an annual frequency of 2%, 4% and 7%, as a reference)
  - for the area of the settlement Petina: wind is from the direction of North (9%)
  - for the area of the settlement Mala Kosnica: wind is from the SW (8%) and West (5%)
  - for the area of the settlement Mičevac: wind is from the SE (2%) and SE (2%)
  - for the area of the settlement Velika Mlaka: The wind is from the E (6%) and NE (6%)

Since according to the Regulation on Limit Values of Air Pollutants (OG 133/05), GV for benzo(a)pyrene is 1 ng/m^3 during the averaging period of 1 year, it can be concluded that in the case of peak loads there is an **exceeded GV in the immediate vicinity of the runway and the terminal. In the nearby area**, the proportion of pollution under the influence of Zagreb Airport Regulation does not exceed the prescribed limits.

If we compare the emission concentration for the examined parameters in relation to Regulation limit values, we conclude that NO2 emissions and benzo (a) pyrene are relevant indicators of risk to human health. Critical situation represents the case of peak load that occurs due to exceeding the GV directly And the USS terminal. As far as the surrounding areas, the proportion affected by air pollution Zagreb Airport Regulation **does not exceed the prescribed limit values for the observed parameters**.

GRAPHIC ATTACHMENTS

3.4. . NOISE LEVEL

3.4.1. General information about airport noise

European airports have a long history of environmental noise management. The first monitoring of the noise of the environment, which was executed in the system of environmental noise management, had their beginnings starting 30 years ago. The Frankfurt Airport in 1964, the Amsterdam airport Schiphol in 1976.
In the Republic of Croatia in force is the Codebook on managing rules and procedures regarding the implementation of operative limitations connected to airport noise in airports on the territory of the Republic of Croatia (OG 120/11). This Codebook has all the regulations which are in accordance with the Directive of the European Parliament and the Council 2002/30/EZ since March 26, 2002 on the implementation of rules and procedures regarding the implementation of operative limitations connected to noise in airports of the Community (SL L 85, 28.3.2002).
An airport in flight, especially when landing and during takeoff, represents a significant source of noise. This problems is especially emphasized at airports which are located close to city settlements. Many factors define the influence of noise which aircrafts make on people. The engine of the aircraft is the only significant factor where noise can be minimized. Because of this, the American National Organization FAA (Federal Aviation Administration) in 1969 brought regulations which forced commercial airlines to adopt noise standards. The FAA in its national standard FAR (Federal Acquisition Regulation), Part 36 established three categories for jet planes. The first category covers the oldest and noisiest aircrafts such as the first series of Boeing and McDonnell-Douglas DC-8. The second category is made up of noise aircrafts such as the Boeing 727, 737-200, Tupolev 134 and 154, DC-9, and later series DC-8 and Boeing 707 and Fokker 28. The third category of aircrafts is the current aircrafts such as Boeing 737-300, 757, Airbus 319, MD-80 and Fokker 70 and 100.
The problematic of aircraft noise was defined by the international standards of ICAO (International Civil Aviation Organisation) in Annex 16, Volume 1, Aircraft Noise. This came to be from the American standard of FAR, Part 36. ICAO Annex 16, Volume 1, other than defining the terms connected to noise made by aircrafts, also defines the maximum level of noise during the landings and takeoffs of all category aircrafts, depending on their mass and number of engines. Furthermore, they define the methodology of measuring noise which defines the procedure of measurements and processing the obtained information, as well as conditions for measuring.

The European Parliament issued a series of directives that regulate the area of noise management and established measures and procedures of operative restrictions regarding noise in airports. In April, 2002, a directive entered into force which regards the noise that aircrafts cause, according to which in airports of member countries of EU it is prohibited for so-called “noisy” aircrafts classified in chapter 2 of ICAO Annex 16 to land. Aircrafts which in a smaller measure fulfill the demands of chapter 2 of the Annex can travel within the EU with a special permit. Jet planes without a noise certificate cannot travel unless it is a government aircraft of an emergency airplane and historical flights. Airports close contracts with airlines on aircrafts landing basically during the day, the working hours of airports during the night are limited and alike. All member countries of the EU have a developed national Program for decreasing noise which is made up of the following:

- the prescribed methods of landing and takeoff of aircrafts in order to minimize the impact of noise caused by aircrafts,
- Air traffic control procedures which allows aircrafts to go directly to a certain height and keeping the aircraft until arrival at a certain height while not close the airport,
- publications of the results of measurements of noise and noise maps.

Since 1970, Europe ratified approximately twenty various directives in the field of noise, which cover the construction of equipment, motor vehicles and aircrafts. In June 2004, The EU Commission adopted a "European Action Plan for the protection of the environment and health from 2004 to 2010." which all Member States are required to implement and to obligate themselves to researching, monitoring and measuring harmful effects on the environment.

At the national level of the Republic of Croatia, noise caused by aircrafts is regulated by the law, which was limited to the obligation of measurement noise by the airport operator. With this was an obligation of defining areas of protection from noise which are caused by aircrafts according to the results of the measurements, where the equivalent level of noise exceeds 67 dB (A) or 75 dB (A). The category of aircrafts that can land at airports in Croatia were established with the Codebook on the flight of airplanes (OG 75/06) and they must have appropriate certificates of noise for all civilian jet aircrafts using Croatian airport. Civilian jet aircraft classified in Chapter 2 of the ICAO Annex 16 can operate on airports in Croatia if they meet the noise requirements. Airline pilots as well are required to follow the procedures prescribed by the Regulations to reduce noise during takeoff and landing. The Protection from Noise Act determines the noise protection measures on land, water and air, and monitors the implementation of these measures for preventing or reducing noise and eliminating threats to human health. The provisions of the Act do not apply to noise protection measures that are required under international conventions, treaties and regulations in air transport. In Croatia there is no consistent and rational transport policy related to environmental protection. There is also a series of regulations missing that would further elaborate the provisions of the Act. According to the European model, developing a program of lowering the noise level at the national level should be approached.

3.4.2. The results of previous noise level monitoring

By the start of production to estimate the effect of noise on the environment of the new passenger terminal at Zagreb Airport, in the town of Velika Gorica, the following measures and programs have been implemented which relate to the protection of the environment from noise pollution.

- "A study on the impact of noise on the environment at Zagreb Airport," creator: Inženjering za naftu i plin Ltd., Zagreb, Savska street 88a, in July 2000
- "Strategic railway noise map of the city of Velika Gorica," creator: Brodarski institut Ltd., report label YF13-01-003, in January 2008
- "Strategic noise maps for road transport of Velika Gorica", creator: DARH 2 Ltd., 2008-report label KB-07, in March 2009
- "Annual Report on the level of noise in 2009", creator: Zagreb Airport.

Zagreb Airport has implemented a system for measuring aircraft noise in order to meet two objectives. The first is to get an introduction to the value of noise with measurements and to define the area of impact on the population that lives in the vicinity of the airport. The second objective is related to the international and national legal requirements, where it is required that all airport adapt to EU regulations.

The system of permanent noise monitoring which was introduced in Zagreb Airport consists of three fixed and one portable measuring device. The positions of the fixed noise measuring device in Zagreb Airport (NMT - Noise Monitoring Terminal):

- Stations NMT 1 and NMT 2 measure the noise on the edges of runways 05 and 23.ž
    - Distance of station NMT 1 from the edge of runway 05 about 306 meters
    - Distance of station NMT 2 from the edge of runway 23 about 307 meters
- Station NMT 3 Tower 3 is set at the administration building (next to the control tower) – it executes noise measurements on the apron
- Station NMT 4 Mobile – is set on locations depending on the need for noise measurements of aircrafts - the current location is at settlement Donja Lomnica (firehouse)

Two fixed measuring devices are close to the edges of runway 05 and 23, the third is a fixed device placed near the apron, and the place of the fourth portable device is determined on the need for data collection. The portable device has its own power supply, which can be transferred to any location around the airport. In order to monitor the accuracy of the measurement of noise at Zagreb Airport, regardless of the measured data, each year a computerized noise map is created. To create the map, the following data is used; coordinates of the edge of the runway, altitude, temperature and humidity. It also uses a database with all the aircrafts divided into groups (commercial, cargo, general aviation and military) and the average of daily operations with a division of the day to day, evening, night (Lden) in accordance with the Noise Protection Act (OG 30/09).

Table 3.4.2.-1. Data from measurement stations according to months for 2009

L_{den} (dB)		Month											
Mark	**Location**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**
NMT 1	Runway 05	65,7	66,7	67,2	66,3	6 ,6	67,6	69,6	70,0	68,8	🖰	🖰	🖰
NMT 2	Runway 23	59,6	60,3	59,8	59,8	62,3	61,8	64,1	63,2	60,8	62,5	63,5	62,3
NMT 3	Tower	75,7	76,3	76,3	76,8	77,2	77,4	77,7	77,6	77,3	77,3	75,6	75,4
NMT 4	D.Lomnica	57,5	57,3	60,3	61,4	62,5	62,1	64,1	64,6	64,0	63,5	58,4	57,6

*stations not working

During 2009 and 2010, measurements of noise levels were executed at 4 locations. Two fixed measuring devices NMT1 and NMT2 were set near the edges of runways 05 and 23, the third is a fixed device NMT3 set on the administration building (apron) and the fourth mobile measurement device was set at the location of the settlement of Donja Lomnica (near the fire station). The positions of the fixed measuring device noise are in the airport area are due to the availability of the necessary infrastructure and many out of which the most important is the area most exposed to noise, the proximity of the edge of the runway, smooth sound propagation from the aircraft to the microphone without obstacles and supporting infrastructures and networks for the proper functioning of the measuring device. The measured noise level is expressed as an equivalent noise L_{eq} and based on the obtained values the indicator of noise Lden is then calculated.

L_{den} (Level day-evening-night) is an indicator of noise, and it refers to the overall irritation caused by noise. Lden is the calculation of equivalent noise levels over a period of 24 hours. To measure noise through L_{den}, the basic indicator is noise which is calculated according to the standard time division with a daily ratio of 12 hours (7:00 to 19:00), evening 4 hours (19:00 to 23:00) and night 8 hours (23.00 to 7.00), in accordance with the Noise Protection Act (OG 30/09). The time period for Lden in which measurements are carried out is one year. Based on L_{den}, a noise map has been created as a basis for the start of noise action plans in order to reduce noise, further spatial planning, and zoning the areas in a circle around the airport.

Location of edge 05

The measured noise levels at the site of edge 05 where the measuring stations NMT 1 was placed were shown as an equivalent noise level Leq per months for the year 2009 which varied from 62.8 dB(A) to 66.5 dB(A). The higher level of noise more than permitted (65 dB(A)) was shown as equivalent noise Leq measured during the month of May, June, July, August and September. The highest level of noise was measured in July. Increased noise is the result of an increased number of operations due to the impact of seasonality and a varying schedule (IATA Winter and summer flight schedule). Values calculated for Lden by month for the year 2009 ranged from 65.7 dB (A) to 70.0 dB (A). The noise level expressed as Lden was higher than 65 dB (A) during all 9 months when measurements are carried out. The measured level of Leq during days in 2009 ranged from 57.1 dB (A) to 76.2 dB (A). Daytime noise levels expressed as Lden ranged from 60.0 dB (A) to 84.3 dB (A) and a significant number of days were above the permitted level. During all of 2010, no measurements were performed at the location of edge 05 due to a malfunction of measuring station NMT1.

Location of edge 23
At the location of edge 23 (measuring station NMT2), the measured L_{eq} and L_{den} levels were lower than 65 dB. The measured levels of L_{eq} and L_{den} shown by days in 2009, only in a few days exceed the value of more than 65 dB (A). Due to the failure of the measuring station, measurements during 2010 were carried out only at the end, and the measured value did not differ with respect to values obtained in 2009, which means that they were less than 65 dB (A). Setting the measuring station on that location and determining the level of noise was important because near airport and the runway for takeoff are the settlements Selnica, Petrina, Mala Kosnica and Velika Kosnica which can be endangered with the flight departures at Zagreb Airport.

The third fixed station (NMT 3) controls the exposure of staff and passengers to noise. The measurement results show that the highest levels of L_{eq} and L_{den} noise measurements were highest in that location. Values for L_{eq} was 70 dB (A) Leq and ranged from 72.3 dB (A) to 73.9 dB (A). Values for L_{den} were higher, ranging from 75.4 dB (A) to 77.7 dB (A) as well as the value of daytime noise levels by days. The noise level is increased due to the continuous operational processes related to machinery (vehicles) engaged in handling aircraft and aircraft systems for power supply (own APU system installed on the aircraft or GPU (Ground Power Supply).

Donja Lomnica
From the data obtained by measuring on the mobile measuring station NMT4 set on the site of the settlement Donja Lomnica, it can be said that the measured levels of equivalent noise level L_{eq} (dB) and L_{den} during 2009 were lower than 65 dB (A). The measured values for L_{eq} ranged from 54.8 dB (A) to 60.2 dB (A), and for L_{den} 57.3 dB (A) to 64.5 dB (A).
Also, during the month of July 2009 and 2010 the noise level in the Donja Lomnica was compared. After being banned from landing for generating high levels of noise category 2 aircrafts (example Tupolev 154) 2010, the daily average L_{eq} levels, L_{den} and Leback background noise were reduced, but for all the days L_{den} value was ≥ 55 dB (A) while the measured L_{eq} values were slightly lower.

3.4.3. The methodology of noise mapping for Zagreb Airport

The noise mapping methodology was prescribed by the "Codebook on the shape and content of noise maps and action plans, and the manner of calculating permitted noise indicators" (OG 75/2009), and directly from Directive 2002/49/EC - "relating to the assessment and management of environmental noise", as well as the guidelines of the European Commission 2003/613/EC of 08.06.2003 "Guidelines on the revised interim computation methods for industrial noise, aircraft noise, road traffic noise and railway noise, and related emission data. ". The noise map is made using computer programs and calculation methods for the propagation of sound (noise) emitted from known sources of noise in the geographical area of known characteristics.

Data on the subject area of the noise mapping include: digital elevation model (elevation, contours, and turning points), data on buildings (buildings, viaducts, walls, etc.) ground coverings (grass, concrete, etc.), information on air and road traffic, and meteorological data. Data for the creation of noise maps imply of the knowledge of sound power, expressed in dB (A) for individual noise sources, or in dB (A) / m for line noise sources or dB/m2 for surface noise sources with knowledge of the octave spectrum. In addition to these acoustic characteristics, it is necessary to know the time of the operation of these sources of noise (day, evening or night). For the creation of the noise map, a validated software package was used designed for making acoustic models of propagation and noise maps Bruel & Kjaer LimA 5.5.0 (June 2011), which fully meets the

requirements of Article 13 of the Codebook on the methoand content of noise maps and action plans and the manner of calculating the permissible noise indicators (OG 75/2009). After the completion of entry and verification of all data in the specified software package, a calculation is carried out based on the noise level based on a series of equations describing the terms of expansion of sound waves in the atmosphere from the source of the noise. Essential acoustic phenomena which are taken into the calculation includes the direction of the sources, geometric divergence, absorption of sound waves in the atmosphere, the spreading of sound waves close to the surface of the ground, the appearance of reflection and the diffraction of sound waves off various surfaces, the protective effects of the relief elements and objects that make a barrier from the sound waves.
The noise map is a presentation of existing and / or predicted state of noise emissions on the observed area, expressed with harmonized noise indicators. The creating of noise maps for Zagreb Airport is in accordance with Croatian legislation, the requirements of the EU 2002/49 and best professional practice of creating noise maps. The results of the noise maps represent a starting point in the management of environmental noise, or they give us a picture of environmental levels of noise coming from the air and road traffic of Zagreb Airport. The noise map for 2009 year was aimed to determine the "zero state" or show the level of noise indicators for air traffic in the settlements around the airport. The results are shown with a noise map for air traffic noise and numerically for periods L_{day}, $_{evening}$, L_{night} and L_{den}.
The noise map for air traffic for 2009 was made on the basis of an average number of 103 daily operations according to data gathered by the InterVISTASConsulting Group and on the basis of the referenced types of aircrafts (Bombardier de Haviland Canada DHC Dash 8 Q400, Airbus A318-A321 Family, the Canadair CL-600 RegionalJet CJR-100 and CRJ-700, Embraer EMB120, Boeing 737, ATR 42).
The validation of the digital model itself was made in 3 checkpoints where Zagreb Airport performs continuous monitoring.

Zagreb Airport			Acoustic model - noise map - LimA			DEVIATIONS	
NMT1	68,00	dB(A)	RECEIVER 1	63,50	dB(A)	4,50	dB(A)
NMT2	62,00	dB(A)	RECEIVER 2	63,00	dB(A)	-1,00	dB(A)
NMT3	76,50	dB(A)	RECEIVER 3		dB(A)		
NMT4	62,00	dB(A)	RECEIVER 4	61,40	dB(A)	0,60	dB(A)
Noise indicator for L den for 2009							

Variations in control points of digital model emission receivers, compared to the Noise Monitoring Terminal Zagreb Airport shows us that such a modeled acoustic model represents an accurate model of the real situation. The reason for differences in emission control points, and the increased value of the measuring stations at Zagreb airport compared to the values obtained using the acoustic model are operations of military aircrafts type MIG 21. These aircrafts, because of the confidentiality of their time of operation are not included in the noise map, but the metering station registered their level of noise emissions, and their values were added to the total value of the NMT's (Noise Monitoring Terminal).
In making the noise maps for the modeling of existing and planned conditions, the input data of military aircrafts (for security reasons - military MIG 21, the status of confidentiality) were not available. Helicopters are very rare (insignificant number) at Zagreb airport, and most of them come in during the day while their impact on the increase in the noise level is minimal.
The noise indicators was made on a grid of 10x10 meters, 4 meters above the ground, with the software package designed to create models of acoustic propagation and noise maps Bruel & Kjaer Lima 5.5.0.

3.4.4. Model results for the noise map of air traffic in 2009

The evaluated noise emissions in open space was given with regard to the Codebook on maximum permissible noise levels in the environment in which people work and live (OG 145/04), and the Spatial Plan of the City of Velika Gorica – alterations and annexes 200. Analyzed was a total of 30 settlements: Bapče, Buševec, Črnkovec, Donja Lomnica, Drenje Ščitarjevsko, Gornja Lomnica, Gornje Podotočje, Gradići, Kobilići, Lazi Turopoljski, Lukavec, Mala Kosnica, Mićevec, Mraclin, Novaki Ščitarjevski, Obrezina, Ogulinec, Okuje, Petina, Petrovina Turopoljska, Rakitovec, Sasi, Selnica Ščitarjevska, Staro Čiče, Ščitarjevo, Turopolje, Velika Gorica, Velika Kosnica, Velika Mlaka and Vukovina.

The results of the current noise levels determined that these settlements, due to noise exposure of Zagreb Airport, correspond to the fourth noise zone – zone of mixed, predominantly commercial purposes with housing, according to Article 5 of the Codebook of the highest permissible noise levels in the environment in which people work and live (OG 145/04), where maximum allowable noise levels for the day is 65dB (A) or for the night 50 dB (A). In accordance with this criterion is the assessment on noise emission in the open.
A detailed presentation of the results for 2009 is given on figures 3.4.-1, 3.4.-2, 3.4.-3. On the noise maps is directly related data where the surface which is shown is affected by noise indicators as well as an analysis of the exposure of the population that is exposed to exceeding levels of noise, as shown in Table 3.4.4.-1 for $L_{day,evening}$ and Table 3.4.4.-2 L_{night}.

According to the analysis of the current situation there are no recorded exceedings for the daytime noise, while for night noise exceedings were observed for Donja Lomnica, Mala Kosnica and Petina.

GRAPHIC ATTACHMENTS

Appendix 3.4.-1. Karta buke zračnog prometa za doba dana i večeri za 2009 godinu
Appendix 3.4.-2. Karta buke zračnog prometa za doba noći za 2009 godinu
Appendix 3.4.-3. Karta buke zračnog prometa za L_{den} za 2009 godinu

Table 3.4.4.-1. Settlement surface areas and estimated number of inhabitants exposed to excessive air traffic $L_{day,evening}$ noise indicator levels for 2009

Ord. No.	Name of the settlement	Settlement data	Total	$L_{day,evening}$ noise indicator class for 2009											Total excess
				<35 dB(A)	35 - 39 dB(A)	40- 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
1	Bapče	Settlement surface area (km²)	1,68				0,53	0,03							0,00
		Number of buildings	105												0
		Number of inhabitants	130												0
2	Buševec	Settlement surface area (km²)	4,17												0,00
		Number of buildings	464												0
		Number of inhabitants	889												0
3	Crnkovec	Settlement surface area (km²)	4,62				0,47								0,00
		Number of buildings	147												0
		Number of inhabitants	413												0
4	Donja Lomnica	Settlement surface area (km²)	14,93				1,62	1,44	1,46	0,83	0,04				0,04
		Number of buildings	778						212	205					0
		Number of inhabitants	1416						386	373					0
5	Drenje Šćitarjevsko	Settlement surface area (km²)	2,23				1,66	2,86	1,21						0,00
		Number of buildings	147						126						0
		Number of inhabitants	202						173						0
6	Gornja Lomnica	Settlement surface area (km²)	2,49				0,45	0,27	0,04						0,00
		Number of buildings	162												0
		Number of inhabitants	582												0
7	Gornje Podotočje	Settlement surface area (km²)	2,93												0,00
		Number of buildings	153												0
		Number of inhabitants	492												0
8	Gradići	Settlement surface area (km²)	1,90				0,21								0,00
		Number of buildings	622												0
		Number of inhabitants	1808												0
9	Kobilići	Settlement surface area (km²)	1,56												0,00
		Number of buildings	248												0
		Number of inhabitants	520												0
10	Lazi Turopoljski	Settlement surface area (km²)	3,40												0,00
		Number of buildings	43												0
		Number of inhabitants	58												0
11	Lukavec	Settlement surface area (km²)	11,34				0,12	0,05							0,00
		Number of buildings	535												0
		Number of inhabitants	1136												0
12	Mala Kosnica	Settlement surface area (km²)	1,01				0,01	0,27	0,36	0,30	0,07				0,07
		Number of buildings	44						9	28					
		Number of inhabitants	49						10	31					
13	Mićevec	Settlement surface area (km²)	6,54				1,44	0,55	0,24	0,12	0,09				0,09
		Number of buildings	648												0
		Number of inhabitants	1281												0
14	Mraclin	Settlement surface area (km²)	12,93												0,00
		Number of buildings	607												0
		Number of inhabitants	1068												0
15	Novaki Šćitarjevski	Settlement surface area (km²)	2,65				1,00	0,57							0,00
		Number of buildings	112												0
		Number of inhabitants	165												0
16	Obrezina	Settlement surface area (km²)	1,79					0,37	1,42						0,00
		Number of buildings	274						242						0
		Number of inhabitants	577						510						0
17	Ogulinec	Settlement surface area (km²)	3,76												0,00
		Number of buildings	337												0
		Number of inhabitants	296												0

Ord. No.	Name of the settlement	Settlement data	Total	$L_{day/evening}$ noise indicator class for 2040											Total excess
				<35 dB(A)	35 - 39 dB(A)	40 - 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
18	Okuje	Settlement surface area (km²)	4,71												0,00
		Number of buildings	226												0
		Number of inhabitants	467												0
19	Petina	Settlement surface area (km²)	1,84						0,75	1,07	0,01				0,01
		Number of buildings	150						3	147					0
		Number of inhabitants	211						4	207					0
20	Petrovina Turopoljska	Settlement surface area (km²)	2,63												0,00
		Number of buildings	275												0
		Number of inhabitants	702												0
21	Rakitovec	Settlement surface area (km²)	10,37												0,00
		Number of buildings	247												0
		Number of inhabitants	573												0
22	Sasi	Settlement surface area (km²)	1,67				0,56	0,77	0,04						0,00
		Number of buildings	62												0
		Number of inhabitants	164												0
23	Selnica Sčitarjevska	Settlement surface area (km²)	1,96				0,53	1,03	0,37						0,00
		Number of buildings	241						29						0
		Number of inhabitants	537						65						0
24	Staro Čiče	Settlement surface area (km²)	3,02												0,00
		Number of buildings	418												0
		Number of inhabitants	783												0
25	Sčitarjevo	Settlement surface area (km²)	3,79				1,28	1,06	0,34						0,00
		Number of buildings	243						127						0
		Number of inhabitants	440						230						0
26	Turopolje	Settlement surface area (km²)	4,64												0,00
		Number of buildings	468												0
		Number of inhabitants	951												0
27	Velika Gorica	Settlement surface area (km²)	31,47				1,15	1,04	0,73	0,61	0,78	0,51	0,39		1,68
		Number of buildings	5968												0
		Number of inhabitants	31341												0
28	Velika Kosnica	Settlement surface area (km²)	2,13				0,74	0,57	0,27						0,00
		Number of buildings	233						62						0
		Number of inhabitants	799						213						0
29	Velika Mlaka	Settlement surface area (km²)	6,07				0,59	0,51	0,42	0,35	0,27				0,27
		Number of buildings	1102												0
		Number of inhabitants	3326												0
30	Vukovina	Settlement surface area (km²)	5,84												0,00
		Number of buildings	453												0
		Number of inhabitants	945												0
	Σ	Settlement surface area (km²)	160,07						7,65	3,28	1,26	0,51	0,39		2,16
		Number of buildings	15512						810	380					
		Number of inhabitants	52321						1592	611					

YES		Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO		Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
*	**Maximum permitted $L_{day,evening}$ noise immission evaluation levels according to the purpose of the area**	
	Purpose of the area : zone of mixed, mostly residential purpose, $L_{day/evening}$=65 dB	

Table 3.4.4.-2. Settlement surface areas and estimated number of inhabitants exposed to excessive air traffic Lden noise indicator levels for 2009

Ord. No.	Name of the settlement	Settlement data	Total	L_{night} noise indicator class for 2009											Total excess
				<35 dB(A)	35 - 39 dB(A)	40- 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
1	Bapče	Settlement surface area (km²)	1,68			0,01									0,00
		Number of buildings	105												0
		Number of inhabitants	130												0
2	Buševec	Settlement surface area (km²)	4,17												0,00
		Number of buildings	464												0
		Number of inhabitants	889												0
3	Crnkovec	Settlement surface area (km²)	4,62												0,00
		Number of buildings	147												0
		Number of inhabitants	413												0
4	Donja Lomnica	Settlement surface area (km²)	14,93			1,37	1,28	0,31							0,31
		Number of buildings	778				345	12							12
		Number of inhabitants	1416				628	22							22
5	Drenje Ščitarjevsko	Settlement surface area (km²)	2,23			3,30	0,40								0,00
		Number of buildings	147				78								0
		Number of inhabitants	202				107								0
6	Gornja Lomnica	Settlement surface area (km²)	2,49												0,00
		Number of buildings	162												0
		Number of inhabitants	582												0
7	Gornje Podotočje	Settlement surface area (km²)	2,93												0,00
		Number of buildings	153												0
		Number of inhabitants	492												0
8	Gradići	Settlement surface area (km²)	1,90			0,15									0,00
		Number of buildings	622												0
		Number of inhabitants	1808												0
9	Kobilići	Settlement surface area (km²)	1,56												0,00
		Number of buildings	248												0
		Number of inhabitants	520												0
10	Lazi Turopoljski	Settlement surface area (km²)	3,40												0,00
		Number of buildings	43												0
		Number of inhabitants	58												0
11	Lukavec	Settlement surface area (km²)	11,34			0,01									0,00
		Number of buildings	535												0
		Number of inhabitants	1136												0
12	Mala Kosnica	Settlement surface area (km²)	1,01			0,30	0,35	0,29	0,06						0,35
		Number of buildings	44				7	28							28
		Number of inhabitants	49				8	31							31
13	Mićevec	Settlement surface area (km²)	6,54			0,45	0,21	0,11	0,08						0,19
		Number of buildings	648												0
		Number of inhabitants	1281												0
14	Mraclin	Settlement surface area (km²)	12,93												0,00
		Number of buildings	607												0
		Number of inhabitants	1068												0
15	Novaki Ščitarjevski	Settlement surface area (km²)	2,65			0,45									0,00
		Number of buildings	112												0
		Number of inhabitants	165												0
16	Obrezina	Settlement surface area (km²)	1,79			0,61	1,18								0,00
		Number of buildings	274				223								0
		Number of inhabitants	577				470								0
17	Ogulinec	Settlement surface area (km²)	3,76												0,00
		Number of buildings	337												0
		Number of inhabitants	296												0

Ord. No.	Name of the settlement	Settlement data	Total	$L_{day/evening}$ noise indicator class for 2040 <35 dB(A)	35 - 39 dB(A)	40 - 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	Total excess
18	Okuje	Settlement surface area (km²)	4,71												0,00
		Number of buildings	226												0
		Number of inhabitants	467												0
19	Petina	Settlement surface area (km²)	1,84			0,04	0,89	0,91							0,91
		Number of buildings	150				3	147							150
		Number of inhabitants	211				4	207							211
20	Petrovina Turopoljska	Settlement surface area (km²)	2,63												0,00
		Number of buildings	275												0
		Number of inhabitants	702												0
21	Rakitovec	Settlement surface area (km²)	10,37												0,00
		Number of buildings	247												0
		Number of inhabitants	573												0
22	Sasi	Settlement surface area (km²)	1,67			0,7									0,00
		Number of buildings	62												0
		Number of inhabitants	164												0
23	Selnica Sčitarjevska	Settlement surface area (km²)	1,96												0,00
		Number of buildings	241			0,96	0,32								0
		Number of inhabitants	537				26								0
24	Staro Čiče	Settlement surface area (km²)	3,02				58								0,00
		Number of buildings	418												0
		Number of inhabitants	783												0
25	Sčitarjevo	Settlement surface area (km²)	3,79			1,00	0,22								0,00
		Number of buildings	243				104								0
		Number of inhabitants	440				188								0
26	Turopolje	Settlement surface area (km²)	4,64												0,00
		Number of buildings	468												0
		Number of inhabitants	951												0
27	Velika Gorica	Settlement surface area (km²)	31,47			0,95	0,67	0,67	0,68	0,49	0,34				2,18
		Number of buildings	5968												0
		Number of inhabitants	31341												0
28	Velika Kosnica	Settlement surface area (km²)	2,13			0,53	0,24								0,00
		Number of buildings	233				52								0
		Number of inhabitants	799				178								0
29	Velika Mlaka	Settlement surface area (km²)	6,07			0,46	0,38	0,36							0,36
		Number of buildings	1102												0
		Number of inhabitants	3326												0
30	Vukovina	Settlement surface area (km²)	5,84												0,00
		Number of buildings	453												0
		Number of inhabitants	945												0
	Σ	Settlement surface area (km²)	160,07			11,29	6,14	2,65	0,82	0,49	0,34				5,81
		Number of buildings	15512				838	187							190
		Number of inhabitants	52321				1641	260							264

YES	(green)	Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO	(pink)	Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
*	**Maximum permitted Lnight noise immission evaluation levels according to the purpose of the area**	
	Purpose of the area : zone of mixed, mostly residential purpose, L_{night}=50 dB	

3.5. GEOLOGICAL FEATURES

Geological structure of the wider area
Zagreb Airport is located southeast of Zagreb, 17 km from the city center. On the north side it is bounded with the detour highway Lučko-Ivanja Reka and the Sava River, and the south side with the state road Zagreb-Sisak, settlement Pleso and the city of Velika Gorica. It extends over approximately 300 ha of land that houses all infrastructure and traffic objects. Therefore, the location of Zagreb Airport is situated in the Sava valley that extends between mountainous parts, made up of Medvednica, and hilly areas of Vukomeričke Gorica.
Tectonically speaking (according to the geological map with a scale of 1:100000 sheet Zagreb) this area belongs to the structural unit Zagreb depression, which is part of the tectonic units of the Sava Tertiary basins. The Zagreb depression is fenced by faults with a significant edge marginal terrace cropping sequences along the Stupničke and Zagreb terrace, and it is filled with sediments from the Plio-Quaternary and Quaternary age. Specifically, the tectonic activity in the Upper Pliocene was the final stage in the formation of complex tectonic and geomorphological relief formations in this and on the Pannonian wider space. With the further upsurge of the Medvednica mountain ranges and the Samoborske hills, they became source areas of clastic material deposition fluvial-lacustrine and proluvial sediments of the molasno pre-mountain type. These deposits are found on the surface of the Stupnička terrace and in the narrow space of Rakitje to Obreža. They consist of unsorted gravel, sands of various grain size and clay of mutual improper modification. Less frequently, these deposits are layers contain sandstone and conglomerate. In some parts of the column sediments, there are strong limonitizations with interbeds of limonite crust, sandstone with a centimeter thick binder limonite and limonite concretions. Clays are found in the form of thin layers and lenses, and sometimes they are carboniferous. The remaining part of the area is covered with younger, predominantly alluvial sediments of Quaternary age. Because of this, the course in the general vicinity of Zagreb Airport is built of clastic sediments of Quaternary age which differ in origin, which cause the differences in mineralogical and granulometric composition (Figure 3.5.-1).
According to these features, the following types of deposits were extracted: ***no-carbonate land loess (l), alluvium of the other (secondary) Sava terrace (a2), alluvium of the first Sava terraces (a1), alluvial silt of the Sava River (a), flood sediments (ap), marsh sediments (b) and sediments of stagnation (am) (Basch, 1983)***.

No-carbonate land loess (l) occupies most of the area south of the line Goli Breg - Obrež - G. Lukavec - D. Lukavec-Petrovina. These are poorly-connected dusty rocks of yellowish-brown color, irregularly streaked with gray, clayed parts. They usually consist of about 73% of the particles with silt dimensions, 17% particles sized of clay and about 13% of the particles is sand. In the mineral composition, quartz is predominant, which usually exists in about 65%, followed with about feldspat 27%, the rest being other minerals. The thickness of these layers is about thirty meters.

The alluvium of the second (middle) Sava terrace **(a_2)** is spread across the area between the lines Goli Breg-Obrež-G. Lukavec-D. Lukavec-Petrovina and roads Klara-Velika Gorica. It consists of gravels, sands and, to a lesser extent, on sandy and silted clay. The deposits are unsorted, mostly un-layered or cross-layered. The pebble gravel were formed by mechanical weathering and formation of different rock fragments of petrographic composition so that the gravel consists of limestone, dolomites, sandstones, cherts, eruptive, metamorphic rocks and quartz. The gravels are almost always mixed with middle-grain to coarse sand. The diameter of the pebble gravel varies greatly. As a rule, it decreases going from west to east. The size of the pebbles generally ranges between 1 and 4 inches, but also rarely has a diameter of ten inches. The sands are also variously granulated. In the western part of the observed areas they are mostly coarse and gravel-like. Moving eastwards the gravel content decreases, and the size of sand grains decreases as well. In some places within the sand lenses are embedded layers of silted sandy-clay. The average thickness of the alluvial sediments of the second terrace of the Sava ranges between 30 and

40 meters. It increases from west to east, and decreases going from the Sava River to the north and south, that is going towards the edges of the Sava valley.

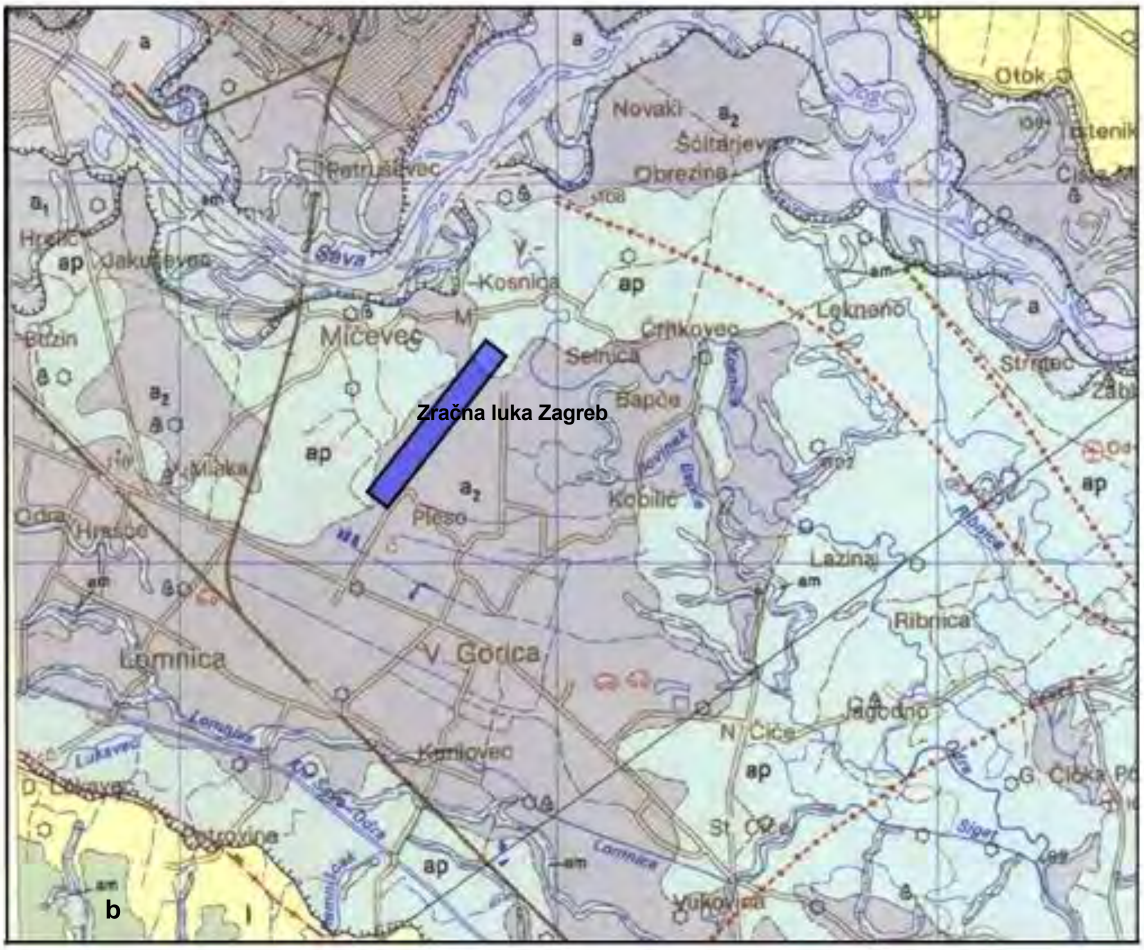


Figure 3.5.-1. Excerpt from a basic geological map with a scale of 1:100000 - Ivanic Grad paper (Basch, 1983)
(l)- *no-carbonate loess land*; **(a_2) -** *alluvium of the second (middle) Sava terrace*;
(a_1) - *alluvium of the first Sava terraces*; **(a) -** *alluvial deposit of the Sava River*; **(ap) -** *flood sediments*; **(am)** *sediments still wate*; **(b)-** *swamp sediments*

The alluvium of the first Sava terrace **(a_1)** is developed along the Sava River. The terrace is narrower than the previous one. After deposition of the first terrace deposits, the stage of erosion and denudation occurred so the Sava River cut into its own sediments. In several places the old river beds are visible. The height of the terrace section varies from 0.5 ÷ 2 meters. In the lithological composition it is dominated by coarse-grained gravel mixed with sand. In the eastern and southeastern parts of the composition clay appears, more or less mixed with sand and silt. The thickness of the sediments of the first terrace is variable.
The alluvial deposits of the Sava River **(a)** is made up of deposits which belong to the sediments along the Sava, in parts of the area that it makes blue for higher water levels and flooding. From the first terrace they are separated with a terrace section with a height of 1 ÷ 1.5 m. The terrace section south and southeast of Rugvica is no longer expressed. In recent deposits, sand predominates, while gravel is present in a subordinated amount.
The flood sediments **(ap)** cover an elongated area with a width of 1-3 km between Gornji Lukavac and Mraclin. It lies like a blanket on the other alluvium of the second Sava terraces. They are made up of fine-grained unbound sediments which consist of sandy-clay-like and clay-like silt with the transition to silty clay. On the surface, due to external influences, they form humus-contaminated pedological blanket - farmland. The contents of these layers of silt usually have about 57% clay, 23% of powder, and

18% sand. The mineralogical composition is dominated by quartz in the proportion of about 80%, and the rest are feldspars, carbonates and other minerals. The largest thickness of flood sediments of 14 m has been registered in the area between Strmec Bukevskog and Zablatja, and on the rest of the region it reaches several meters.

Sediments of stagnation **(am)** are deposited in narrow elongated zones of irregular shape. They are located in the areas of Odra, Hrašća, Lomnica and Kurilovec. These spaces represent the remaining parts of old flows of Lomnica, the streams Lukavec and Ramnišćak and smaller, mostly temporary streams coming from the south. Some are still constantly filled with water and there is intensive sediment. Others are swamped and organic material is deposited in them, others only during the rainy season are sometimes filled with water, and the recent sedimentation is insignificant. Something similar also happens in the basin of the Sava-Odra. In all cases the sediment stagnation consists of mud, clay-like silt and silted clay with many undecayed organic (plant) remains. Those that were originally associated with the old meanders of the Sava River have thin interbeds of fine grained sands. Since they are generally thin (thinner than 1 m) and their expansion is small, they do not have greater importance in the hydro-geological, engineering-geological and pedological sense.

Pond sediments **(b)** were selected on the OGK-sheet Ivanic-Grad in the area south of Donji Lukavac, Petrovina and Okuja. According to the author of OGK (Basch, 1983) they occurred in morphological dents with impermeable surfaces and they represent areas of recent swamps. The lithological composition is dominated by greenish and bluish clay and clay powder. In the surface part, due to the admixture of decay products of plants, they contain a significant amount of humic components. The thickness of pond sediments rarely exceeds 1 m and that is why they have a negligible impact on the hydro-geological characteristics of the area where they are located.

In the area of the Sava valley Zagreb, established was a series of significant radial and probably tangential faults. Most of the fractures are located along the edges of the Zagreb hills and Vukomerička gorica. With recent deep and morphometric methods, it has been established that there is an increasing number of fractures in the inner part of the Sava valley. Block movements until the Quaternary period caused the emergence of space for sedimentation and erosion and also it being filled with mainly coarse-grained material which was carried by the Sava. Significant thickening of clastic sediments is from west to east and southeast.

Geotechnical characteristics of the site

During the period from 05 - 14 October 2011, at the future location of the new passenger terminal of Zagreb Airport, preliminary geotechnical investigations were executed with the goal of ensuring preliminary data on soil characteristics and layering on a location that will used to evaluate the conditions and methods of foundation of future facilities.

Within the preliminary geotechnical investigation work in the area of future facilities, executed was a total of five bore holes, with individual depths of 10, 15 and 20 meters. During the drilling, it was continued by the depth of stored cores in boxes. During the execution of field investigations, every borehole was implemented with standard penetration tests (SPT), a total of 35 tests, and the disordered soil samples were taken from each detected layer.

After the field geo-mechanical classification of layers and conducted field investigations, a program was developed of laboratory tests and the samples were shipped to a certified laboratory for further testing of geotechnical properties of the material. Testing was executed in the Institute IGH Plc, and the manager of the testing was Snježana Sesar, BSc.

The geotechnical investigations conducted as a part of the research for the new passenger terminal of Zagreb Airport gave insight into the expected stratification and evaluation of physical-mechanical characteristics of the soil layers at the site.

On the basis of the research, it is expected that the site is built with predominantly uniformly layered soil. In the investigated area of the site, the soil consists of several characteristic geotechnical environments, which is evident from the displayed profiles of the explored boreholes.

LAYER 0

Humus

LAYER 1

Below the topsoil on all the boreholes is a registered low plasticity clay layer and a rigid consistency. This layer generally extends to a depth of about 1 to 1.5 m, except borehole B-1, where there is a depth of 2.5 m measured from the surface.

The results of the standard dynamic penetration test (SPT) for this zone are as follows:

BOREHOLE	DEPTH OF TESTING (m)	NUMBER OF HITS $(N_1)_{60}$
B1	1,50 - 1,95	26
B3	1,50 - 1,95	19

The average value of the number of hits obtained on the basis of standard penetration tests in this area amounts to 22.5 strokes.

The results of laboratory tests for this zone are as follows:

FEATURES OF THE LAYER	VALUE
Limit of Liquidity (%)	27,1 - 78,6
Limit of plasticity (%)	20,6 - 30,3
Index of plasticity (%)	6,1 - 48,3

Ratio of certain granulations in this zone are as follows:

GRANULATION	VALUE
gravel G (%)	0 - 7
Sand S (%)	5 - 49
Powder M (%)	29 - 45
Clay C (%)	13 - 49

LAYER 2

Under the layer of low-plastic clay, in some wells silty sand layer, well compacted is registered. Although it does not appear in all wells, in all the wells in the transition from clay to gravel surface, recorded was an increased proportion of sand and components in some way it can be considered that this layer as well appears throughout the area, but in a small, insignificant thickness up to max. 1 m.

LAYER 3

The last, and in geotechnical terms the most important, geotechnical environment registered a layer well-compacted gravel. The depth at which the pebbles appear ranges from 1.2 to 2.5 m measured from the ground surface.

The results of experiments of standard dynamic penetration (SPT) for this zone are as follows:

BOREHOLE	DEPTH OF TESTING (m)	NUMBER OF HITS $(N_1)_{60}$
B1	3,60 - 4,05	24
B1	5,50 - 5,95	28
B1	7,10 - 7,55	19
B1	8,50 - 8,95	30
B1	9,70 - 10,15	30
B2	3,00 - 3,45	27
B2	4,70 - 5,15	37
B2	6,10 - 6,55	37
B2	8,00 - 8,45	27
B2	9,50 - 9,95	28
B2	11,50 - 11,95	27
B2	13,20 - 13,65	25
B2	15,10 - 15,55	30
B2	17,00 - 17,45	30
B2	19,50 - 19,95	24
B3	3,00 - 3,45	25
B3	5,20 - 5,65	31
B3	7,50 - 7,95	30
B3	9,50 - 9,95	28
B4	3,00 - 3,45	30
B4	4,70 - 5,15	45
B4	7,50 - 7,95	24
B4	9,20 - 9,65	24
B5	1,50 - 1,95	45
B5	3,50 - 3,95	24
B5	5,50 - 5,95	29
B5	7,50 - 7,95	23
B5	9,20 - 9,65	22
B5	11,00 - 11,45	24
B5	12,90 - 13,35	22
B5	14,50 - 14,95	24

The average value of the number of hits obtained on the basis of standard penetration tests in this area amounts to **28 strokes** with a standard deviation of 6.

The ratio of certain granulations in this zone are as follows:

GRANULATION	VALUE
gravel G (%)	53 - 85
Sand S (%)	20 - 40
Powder M (%)	3 - 11
Clay C (%)	0 - 3

Given the recorded and expected stratification and physical-mechanical characteristics of soil layers and the anticipated contact stress on the soil under the foundation of future facilities, as well as the sensitivity of future buildings on the total and differential subsidence, it is assumed that there is a need for a good foundation in the layer of founding and compacted gravel. Because of possible unequal thickness of the surface layers of the foundation, work will be carried out in a layer of gravel where it is not possible to substitute materials or apply deep foundation. This will depend on the load of certain parts of the building.

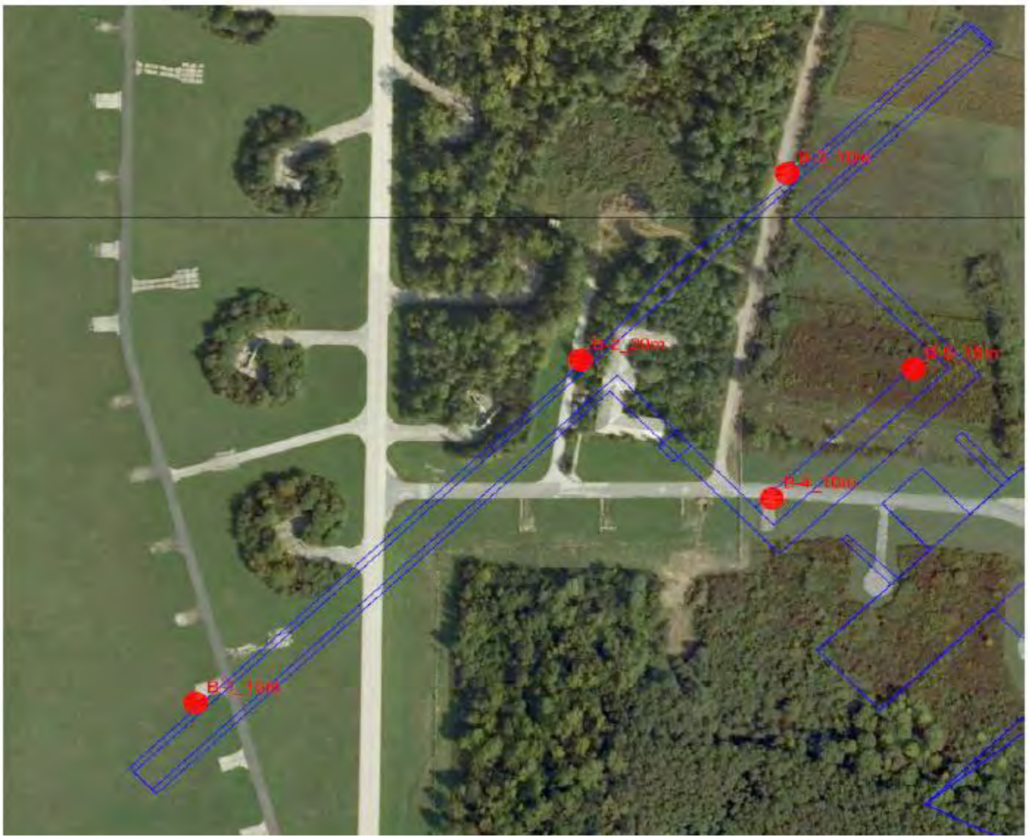


Figure 3.5.-2. Situation of the position of exploratory bore holes

Tectonic relationships and seismicity

Tectonic relationships and seismicity of the wider area anticipated for the work is defined by structural relations which marks Medvednica and its neighboring areas, or blocks, which are interactive. First of all, it is important to emphasize that Medvednica is a transpressive zone dominated with sequences of faults laid sideways from the main axis of the mountain. With these faults are significant left movements and the mutual collisions of blocks. In accordance with this, a series of structures were deployed and oriented that are maximally developed tectogenic processes in the Pliocene and Quaternary period. During this period of strong regional compression mechanisms comes a contraction and uplift of Medvednica, where the wider belt slopes with the area became a single tectonic block with the neighboring Posavina area. The Medvednica uplift occurred along the fault towards northeast-southwest, which in more mature periods of evolution became reverse in some places.

The area predicted for the project are marked by fault systems parallel to the main structure, however, here is a series of developed normal faults that range from north to south. These faults predispose ridges running north-south, perpendicular to the axis of Medvednica, which make up the morphological element of a larger belt including the immediate area. Displacements along these faults are up to ten meters in scale. These are the major fault systems, which have not significantly disrupted morphological relations in the wider project. On the other hand, in the project area, all of these movements are masked with the youngest sediments, however, a more direct reflection of the tectonic processes, reflects in numerous morphological notches and terraces, gently cut falls, discrete morphological stairs and series of small depressions in which there has been a marshification or creating stagnation, especially in the area close to the Sava river basin. In accordance with the tectonics and seismicity, the site area has distinctive features. An important factor in this kind of structural construction presents the presence of the bulk material, mainly Quaternary. These materials are encountered in the underlying of the project, so that the stress that is developed during the powerful movement and collision of stone complexes underlying this part of Posavina on the surface may have different reflections.

As you can see from the map of seismicity, in the immediate area of the project, here is an extending broad band with several earthquake epicenters with a magnitude of 3-40° according to Richter. This means that in the immediate surface and on the surface of the area of the project we can expect the effects of the earthquake from 7 to 80 MCS (MERCALLI - CANCANI - SIEBERG) of the modified scale (Figure 3.5-3). However, the data from the larger neighboring areas are warning for caution, since much higher concentration of foci of earthquakes occur in the neighboring northeastern part, especially in the area and on the southwestern slopes of Medvednica. This is particularly emphasizes the zone in the immediate area of Čučerje near where maximum reaches up to 9o MCS. Otherwise, the wider area of the project is marked by earthquakes that are very rare, that reach up to a maximum of 3o, and rarely 3 to 4o according to Richter. Having in mind the fact that in the neighboring areas there are epicenters of very strong earthquakes, a favorable circumstance is the fact that the quakes had relatively shallow focus, so their action in the field of the project is significantly weakened.

During the construction of buildings, one should bear in mind the fact that, as in most of Posavina, on the surface and underground are besides alluvial valleys are present thicker klastitarastresitih materials, which in situations of high saturation with water, more effectively accelerate seismic waves, which means that on the surface they may have greater effects than in areas where the surface is made of solid rock, especially in situations where the saturation of sediment with water is smaller.

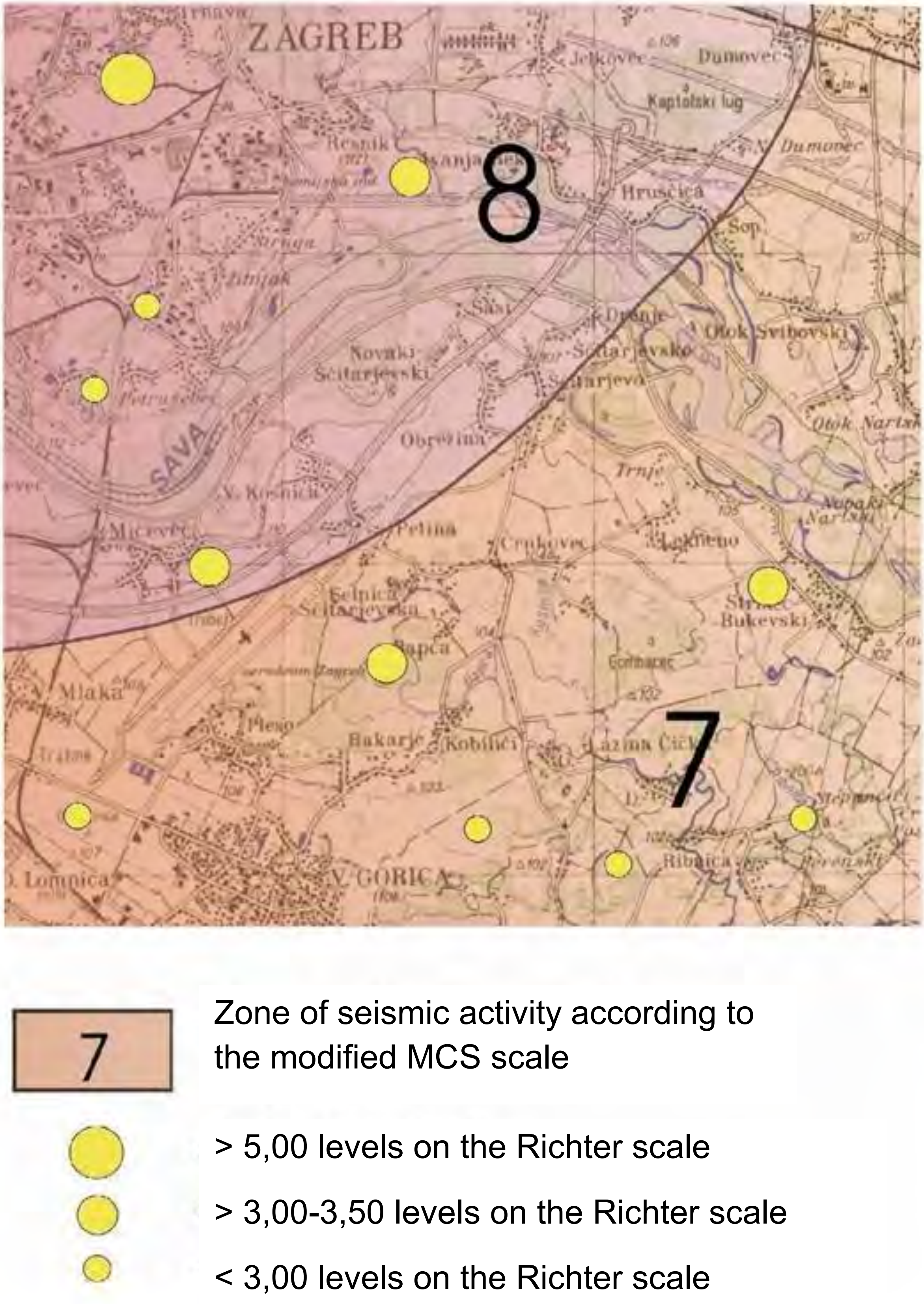


Figure 3.5.-3. Mp of seismicity and earthquake epicenters in the broad areas of the project

3.6. Hydrogeological characteristics

Hydrogeological characteristics are the result of, on the one hand, geological factors, ie lithological composition, propagation, thickness, and the interaction of different lithological members that build the terrain, and on the other side of hydrological conditions, ie the impact of Sava and its tributaries.

Genesis, lithological structure and geometry of the aquifer system

The paleogeographic features of sedimental space, tectonic and sedimentary processes and tectonic movements during the youngest geological periods have caused a spatial arrangement and geometric sedimentary bodies built of clastic sediments of different granulometriskog composition. As the spatial distribution and geometry of sedimentary bodies constructed of coarse grained sediments, they have a major influence on today's hydrogeological characteristics of the area, and they should be analyzed in detail. Based on the correlation analysis of the sedimentary area of Zagreb three main lithofaciesare separated (Blaskovic I. & Dragicevic, I., 1988). These are: a) proluvial lithofacies, b) aluvial sedimentary complex and c) lacustrine-swamp lithofacies.

a) Proluvial lithofacies is genetically linked to the occasional local waterways from the southern slopes of Medvednica. It lithologically consists of lenses of poorly sorted gravel with a large content of clay layers. The main features are its considerable thickness with rapid and repeated lateral and vertical changes in rough and fine grain lithologic members. The schedule of thickness of this sequence is associated with morphologically expressed valleys carved into the older rocks in hinterland of sedimentary bodies of proluvijal lithofacies, comprising from source material for their formation.

b) Alluvial sedimentary complex is widespread clastic sequence of sediments in the Sava valley between Podsused and Rugvica, which laterally builds on the sediments of proluvial lithofacies. The genesis of the alluvial sedimentary complex is associated with meandering along the Sava and its tributaries and sedimentation processes that followed them during the youngest geological periods. This complex was isolated as a complete sedimentary body but in many places alongside it, different lithological members can be clearly distenquished that, going from top to bottom, line up in the following sequence:

(1) pure gravel or gravel mixed with sand,
(2) gravel with sand and dust often turned into clay,
(3) gravel with sand of different grain sizes,
(4) dust sand or sandy dust with gravel more or less turned into clay,
(5) fine to medium grained gravel and
(6) clean coarse gravel.

The amount and maximum thickness of alluvial sedimentary complexes are predisposed by synsedimentary tectonic, mainly radial motions. In the area between Podsused and Rugvica the northern border of the aluvial sedimentary complex stretches through Podsused-Stenjevec-Borongaj-Ivanja-Reka. The south and southwestern boundary is not precisely defined, and it extends around the foot of the northernmost slopes of Vukomeričke gorice. Moving from Podsused eastward the obvious trend is increasing the thickness of the aluvial sedimentary complex with the extension of its spreading. The increasing thickness is not even, but it emphasizes areas with significant abrupt, but spatially limited thickenings. Thus, the relatively rapid thickening of the aluvial sedimentary complexes from ten to over twenty feet registered southeast of the line Zagreb-Botinec-Odranski Obrež. The area of thickness of the alluvial deposits that are significantly bigger than 20 meters is situated between that line and the line that connects the localities Ferenčica-Lomnica-Strmec Bukevski-Gornja Čička Poljana- Mraclin. Within this area there are zones of thicknesses of 30, 40, even over 50 meters. Maximum thicknesses are found in zones Toplana- Jakuševec, Petruševec-Mičevec-Velika Gorica, Ščitarjevo-Črnkovec, and Lekneno-Črnkovec and Strmec Bukevski-Ribnica.

c) The lacustrine-swamp lithofacies is widely distributed in the basement of sedimentary bodies of proluvial lithofacies and alluvial sedimentary complex or can be located as a lateral equivalent of the lower proluvial facies. It is made from clay-dust sediments with layers of peat, especially in the area of greater thickness, with thick pads and / or lenses of gravels, sandy gravels and gravelly sands with additions of powder and clay. Numerous research papers (geophysical measurements and research drillings) found that the east from the line-Maksimir Jakuševec-Velika Gorica and on to Sesvete-Strmec Bukevski-Ribnica the thickness of lacustrine-swamp lithofacies ranges from the 20 to more than 50 meters. Within these areas it is quite more possible to isolate regions of greater thickness than those of small thickness. They typically continue from areas of larger thickness to those of smaller thickness of sedimentary proluvial lithofacies of the Dubrava-Sesvete zone.Thus, the maximum thickness is established in two cases: in the area of Stara Loza- Mičevec-Pleso as an extension of the thickening of proluvial equivalents from areas Štefanovec-Borongajski Lug-Vukomerec, and in the wider region of Kosnica-Črnkovec-Ščitarjevo, as an extension of proluvial gravels in the Brestje Sesvete zone. From the descriptions of geological factors, it is evident that the structure of the ground in the wider area in which Zagreb Airport is located may, with respect to litological features, offer three types of sediments. Sediments of the three described lithofacies cross each other in either the vertical either laterally so that they hydrogeologically represent a whole - so called ***Zagreb quaternary aquifer system***.

This aquifer system consists of gravel, sand, dust and clay, and subordinated conglomerates. Each of these has its lithofacies hydrogeological function. Sand, dust sand, dust and clay in the surface of the ground are presenting the aquifer roof, gravel and sandy gravel, regardless of the genesis, ie, whether it is a alluvial, proluvial or lacustrine sediment, it represents an aquifer, and clay deposits on deeper levels create an aquifer. Overlying sediments have a protective function, or they protect the aquifer from sudden intrusion of any contaminants from the surface. The degree of protection depends on the share of fine fractions in the content of that roof cover and its thickness. Looking at the wider area of the largest roof thickness in the Zagreb area, north from the Sava River, it is larger in the east (17 m),than in the west. The minimum thickness is closer to Sava and south from Sava (Figure 3.6.-1).

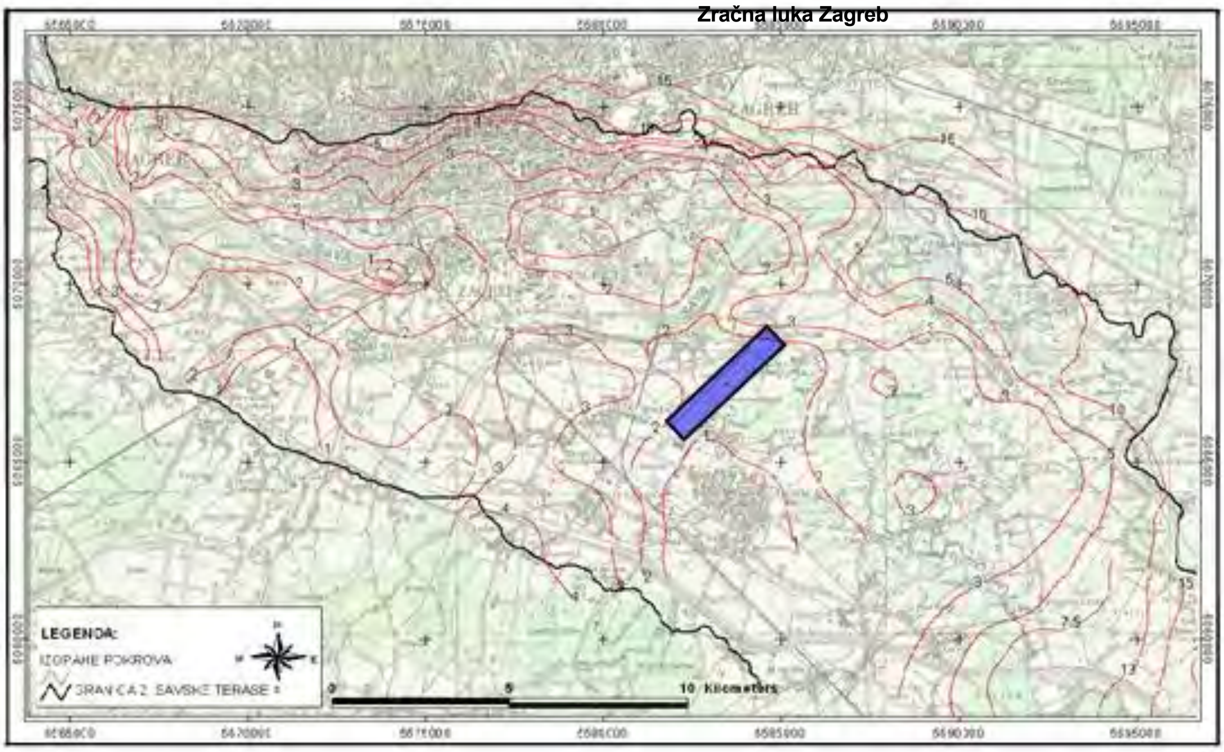


Figure 3.6-1. Izopahe cover (according to the Study of protective wellfield zones in the City of Zagreb – Phase I Bačani etc. 2005)

The aquifer in the western part of the area has a thickness of 5 - 10 m. On the line Sašnjak – Mala Mlaka the thickness rapidly increases to 20 - 40 m and continues to grow, so that in the area Obrezina - Črnkovec, where the aquifier includes which includes lake sediments, the thickness has grown to more than 100 m.(Figure 3.6.-2).

Figure 3.6-2. Izopahe aquifer (according to the Study of the wellfield protection zones in the City Zagreb – I Phase Bačani etc. 2005)

Vertical and lateral changes of granulations of coarse clastic sediments into fine-grained sediments are frequent. Thus, in the wider area of Črnkovci and Petruševca at depths between 40 and 70 meters is a layer / dirt band of dusty clay that is thick from tens of centimeters to a few meters, which is more or less locally divided by the aquifer vertically in two aquifer layers. Continuity of the clay layer / bands is not defined either by stretchment or by depth, so its hydraulic roles are still questionable. In the western areas of the aquifer, hydraulic conductivity is very high and exceeds 3000 m / day, while further to the east decreases and at Črnkovci it is about 2000 m / day, and a little on the east it's less than 1000 m / day (Urumović and Mihelcic, 2000). Existing data on Zagreb aquifer hydraulic conductivity are very unevenly spreaded among the observed area, and show very different values at small distances. But Study authors of protective wellfield zones of the Zagreb area - Phase I (Bačani ect. 2005) separated the zones with approximately equal values. The results of this zoning for the upper part of the aquifer system (1.aquifer layer) are shown in Figure 3.6.-3.

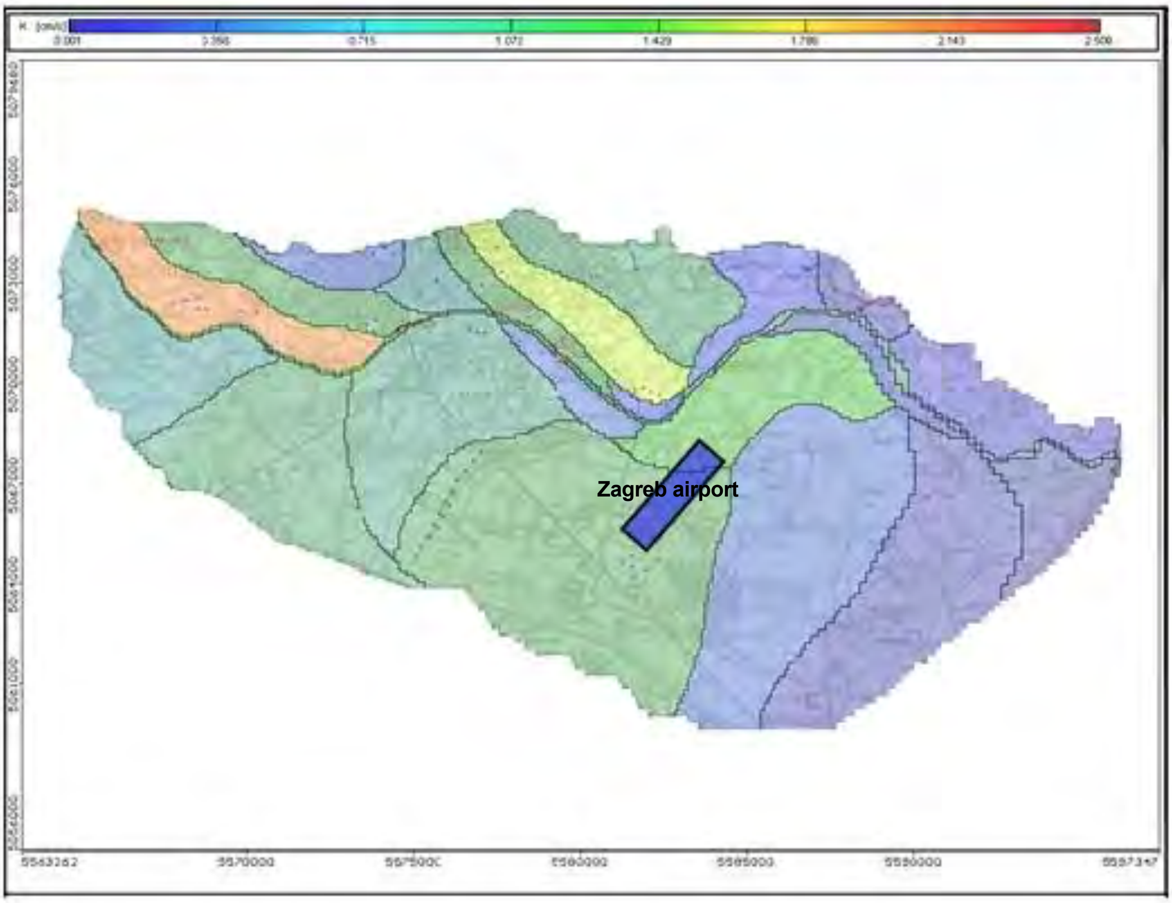


Figure 3.6.-3. The spatial distribution of hydraulic conductivity K (cm / s) for the 1. aquifer layer (according to the Study of the protective zones of wellfields in the City of Zagreb – Phase I Bačani etc. 2005)

Aquifer transmissivity culminates in the area of Črnkovci (50000 m2/day) due to the high amount of hydraulic conductivity and thickness of the aquifer layer (Brkic Biondić, 2000). The aquifer basemen, according to data from a wide area, consists of gray-blue and gray-green clay whose thickness is not defined.

Dynamics of groundwater

Comparing the level-grams of Sava with level-grams of groundwater levels measured with piezometers near Sava along the flow on the studied area a very good connection of the Sava water level and ground water level has been observed. On the basis of water balance for 1998, it was concluded that the contribution of Sava to the renewal amount of ground water is around 73% (Miletic and Bačani 1999). Analysis of the movement of the groundwater level in the period since 1950, orwhen the measurements last until today, showed that groundwater levels since 1950 until the mid 1993 decreased in the whole aquifer, an average of 1 ÷ 2 m every 10 years.

In the early nineties declining levels briefly stopped due to the construction of water columns on the river Sava near thermal power plant (TE-TO) Zagreb in the area upstream of the water column, but soon after the construction of a declining trend has continued with similar intensity. Reasons for declining groundwater levels are mostly in the construction dikes for flood protection along the Sava River which prevent occasional flooding of coastal areas, and thus the potential infiltration of water from flooded areas into the aquifer.

As the aquifer is in hydraulic connection with Sava, lowering the groundwater level is also the result of the process of deepening the Sava river bed, which was mostly caused by erosion of the riverbed and the simultaneous absence of bringing of a new coat from the upstream part of the flow due to construction of reservoirs on Sava upstream of Zagreb in the Republic of Slovenia, and the regulation of tributaries and removing gravel from the Sava riverbeds (Bonacci Trninić, 1986), and results in lowering the water level of the river Sava. The deterioration level of groundwater is undoubtedly influenced by the increasing exploitation of groundwater for the water supply of the city of Zagreb. Specifically, the total amount of pumping at Zagreb wellfields since 1983, when it amounted to about 3300 l / s, increased to 4000 l /s in 1993, and today it is about 4700 l /s, which means that it continuously increased to approximately 700 l / s every 10 years.

The spatial distribution of groundwater levels and their relationship with the Sava level conditions the directions of the flow of groundwater.
Generally it can be said that in the area covered by Quaternary aquifer Zagreb system during high water basin, the groundwater flow north of Save takes place from the west to the northeast, and south from Sava from west-northwest towards east-southeast. Only in the area north of Mala Mlaka, due to the effects of the pumping station, groundwater flows from north to south. In any case, during the high water level Sava supplies the aquifer throughout the Zagreb area (Figure 3.6-4).

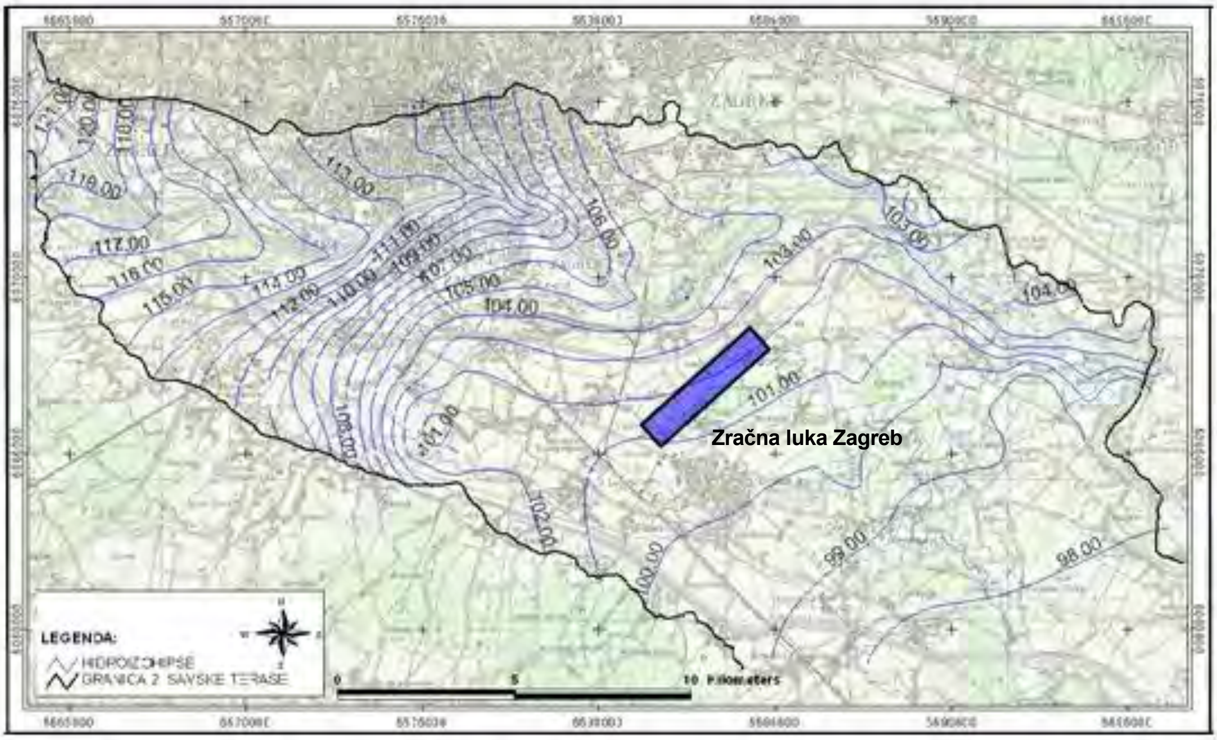


Figure 3.6.-4. Hidroizohipse at high water (23/11/2000) (according to the Study of wellfield protection zones in the City of Zagreb - Stage Bačani etc. 2005)

During low tide Sava drains south of the coastal area in the west part of the area on the part of the flow between Podsused and Jarun, and the eastern part between Mičevac and Rugvica (Figure 3.6.-fifth).

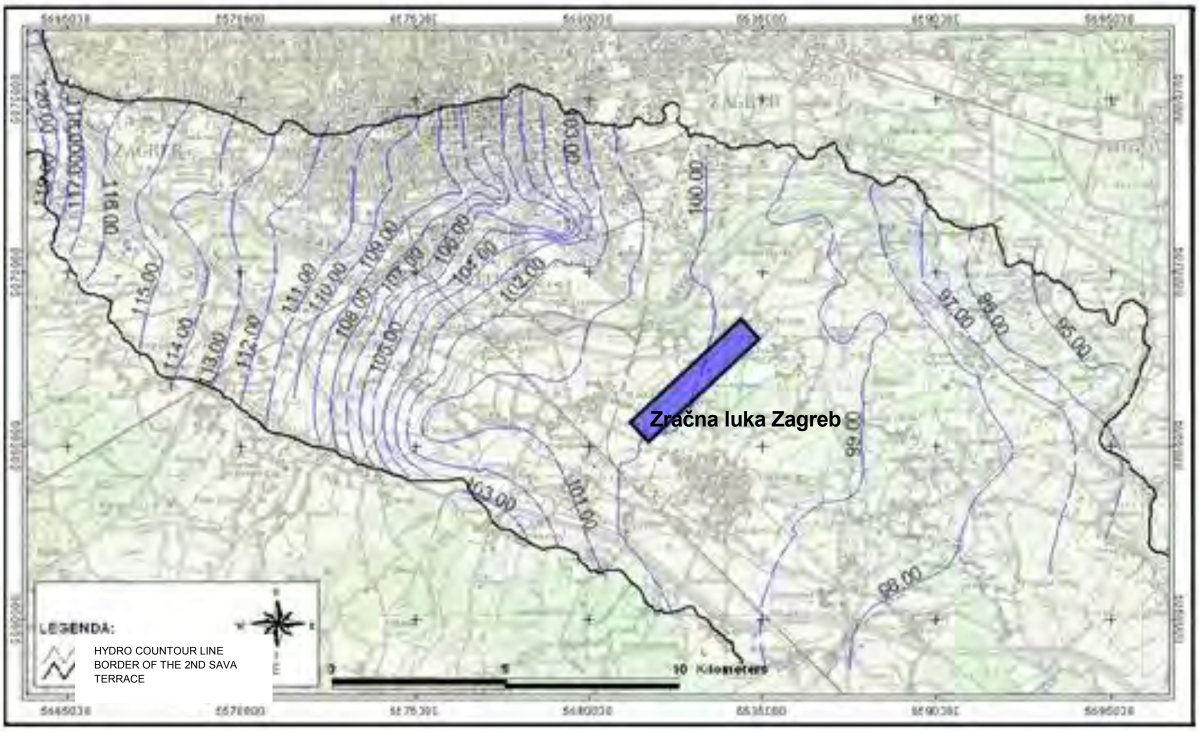


Figure 3.6.-5. Hidroizohipse at low water (07/09/2000) (according to the Study of protection of wellfield zones in the City of Zagreb - I Phase Bačani etc 2005)

The difference between the groundwater levels during high and low water level is, depending on the area, between 2 and 3 meters.

The direction and intensity of groundwater flow, except Sava level, is significantly influenced by pumping the water wells south of Sava. Given the task of this study, particularly interesting is the effect of the pumping station of Velika Gorica.

Very interesting data on the impact of the well field on the dynamics of the groundwater in the project area were obtained by the particle tracking model, which was created with the aim of determining and delineation of protection zones of the Velika Gorica wellfield (Bačani etc 2009). For simulations of particle tracking is used MODPATH program is used for simulations of particle tracking. As stated in "The study of water well protection zones Velika Gorica" as a surface model of particle tracking, which is used for the sizing of the second and third water well protection zones, as defined by the Ordinance on the establishment of the sanitary protection zone ("Official Gazette" No. 55/02), the results of the previouse models of groundwater flow were made. Equations of particle tracking used by MODPATH were performed under the assumption that all solution particles move in the effective speed of the flowing groundwater. To calculate the effective flow rate of groundwater flow in the domain model, MODPATH uses the effective porosity parameter. Based on the results of the model flow and spatial distribution of effective porosity, distribution of effective flow rate of groundwater for each time (stress) period in the domain model of the flow was created. Given that protection zones for water wells are determined for periods of high and low water, the distribution of effective speeds of groundwater flow at high (Figure 3.6.-6th) and at low (Figure 3.6.-7th) water was used with the simulation particle tracking.

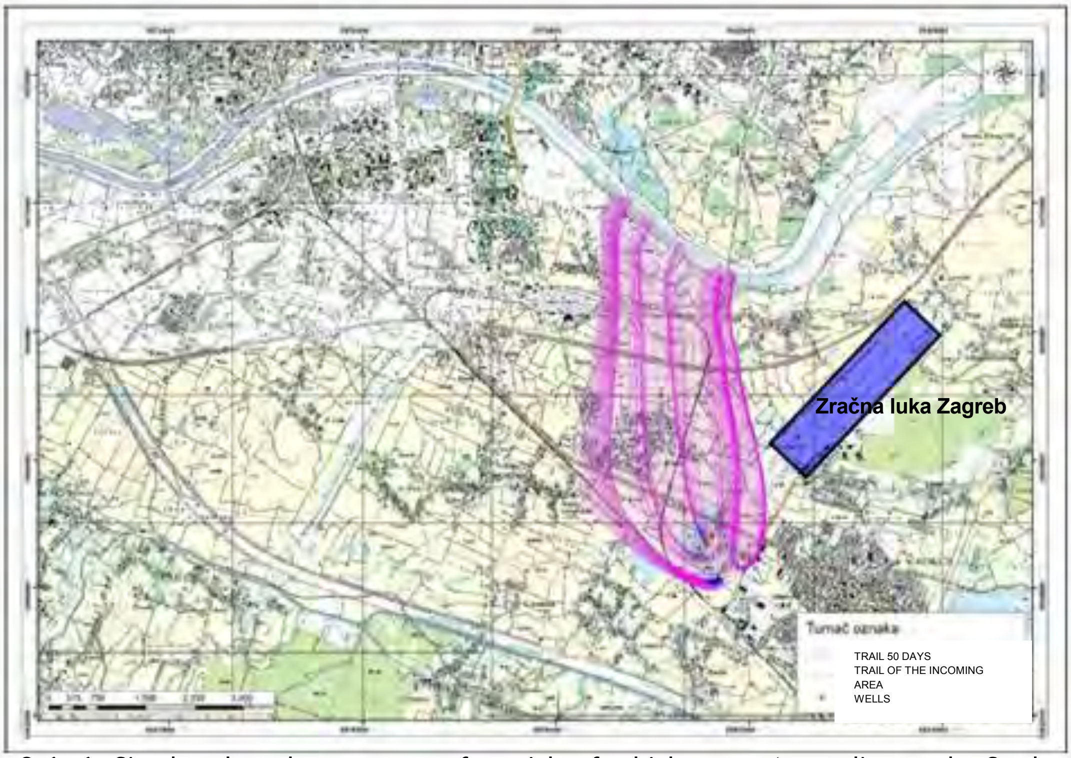


Figure 3.6.-6. Simulated track movement of particles for high water (according to the Study of wellfield protection zones in Velika Gorica, Bačanii and Posavec, 2009)

Figure 3.6.-7. Simulated track movements of particle for low water (according to the Study of wellfield protection zones in Velika Gorica, Bačani and Posavec, 2009)

The model results show that at high water the dominant flow of groundwater towards the wellfield Velika Gorica is taking place west of Zagreb Airport, from Sava towards the south (below Jakuševac!), And at low water from the slopes of Vukomeričke gorice from the south, and from the Save through a narrow track (probably due to the spatial distribution of hydrogeological parameters) in the direction northwest-southeast, also west of the Zagreb airport.

Groundwater supplies

Due to the described situation, groundwater supplies in the wider area are relatively large. Constant supply of groundwater in the open aquifer, such as in Zagreb, presents the amount of water contained in the pores of the aquifer level below the lowest recorded water level. Thirty years ago it was estimated that the permanent groundwater stocks in this area are about 9x107 m3. However, the analysis of water surfaces for minimal levels of groundwater level and slope of the Zagreb aquifer in the period from 1976 to 2006, it was determined that the constant supply of groundwater is constantly decreasing. All together, in the period from the sum in 1976 to 2006 it was reduced by about 4%.
Seasonal groundwater supplies, which are created by underground water that accumulates in the pore area of the aquifer in the area of groundwater level fluctuations, or between the highest and lowest water level, in the given time period it was determined by analyzing water surfaces at the minimum and maximum groundwater levels in the period from 1996 to 2006 amounted to between 5.9 and 1.6 x107 x108 m3/year. (Kolić, 2008). Seasonal inventories fail to indicate the trend of change, which is understandable, because they depend on the annual amount of precipitation.
The comparison of changing inventory with an average annual flow rate of Zagreb pumping stations for the period from 1996 to 2003 has shown that the flow rates are greater than seasonal groundwater supplies. This means that a portion of flow rates that exceeds the variable supplies are replenished from the permanent supplies that are not renewable, causing their diminished over time, which means that the Zagreb aquifer is being "depleted" (Bačani etc. 2009).

Exploitation and protection of groundwater
South of Sava the water for the needs of organized water supply is being exploited in two extremely significant pumping stations. These are the well field, "Mala Mlaka" and "Velika Gorica." Besides that, the potential drinking water wellfield for the city of Zagreb and Zagreb County are sited at Črnkovec where the wellfiels “Kosnica” is placed.
The wellfield "Mala Mlaka" is located between the villages of Donji Cehi and “Mala Mlaka”, south of railroad Zagreb-Sisak. The pumping station has 10 dug wells, six drilled, and 109 piezometers in the wider protection zone. It is a proven hydraulic connection of the wellfield with Sava. The thickness of the aquifer layer in the area between Sava and the wellfield is not continuous and ranges from 6.0 m along Sava to over 30 m at the pumping station. The area around Botinec is critical where the supply of the aquifer occurs through only a few meters horizontally. Southwest of the pumping station is the fault contact with the Sava terrace, and the hydraulic impact of this border on the pumping station is not thoroughly examined. The results of mathematical modeling suggest that a certain flow of water should be on that side, which for now is still not proven. At the pumping station about 1.4 m3 / s is exploited. In the design and construction of the pumping station it was expected to supply with 1800 l / s and the conditions of flow ensured this amount. After the regulation of the Sava riverbed it caused lower levels of ground water at the pumping station, it was then necessary to drill wells 40 m deep to expand the pumping station to a deeper level. The tendency of decreasing the level continues and it is assumed that the projected amount of groundwater can be provided only by constructing a system for artificial infiltration.

Mala Mlaka wellfield protection is performed based on the ***„Decision on the protection of sources Stara Loza, Sašnjak, Žitnjak, Ivanja Reka, Petruševec, Zapruđe and Mala Mlaka“*** since July 19th 2007. According to this Decision, III. protection zone is common to all the mentioned well fields (Figure 3.6.-8). The outer limits of the III. sanitary protection zone passes about 3 km west-northwest of the Zagreb airport area, so it is located outside the zone of sanitary protection.

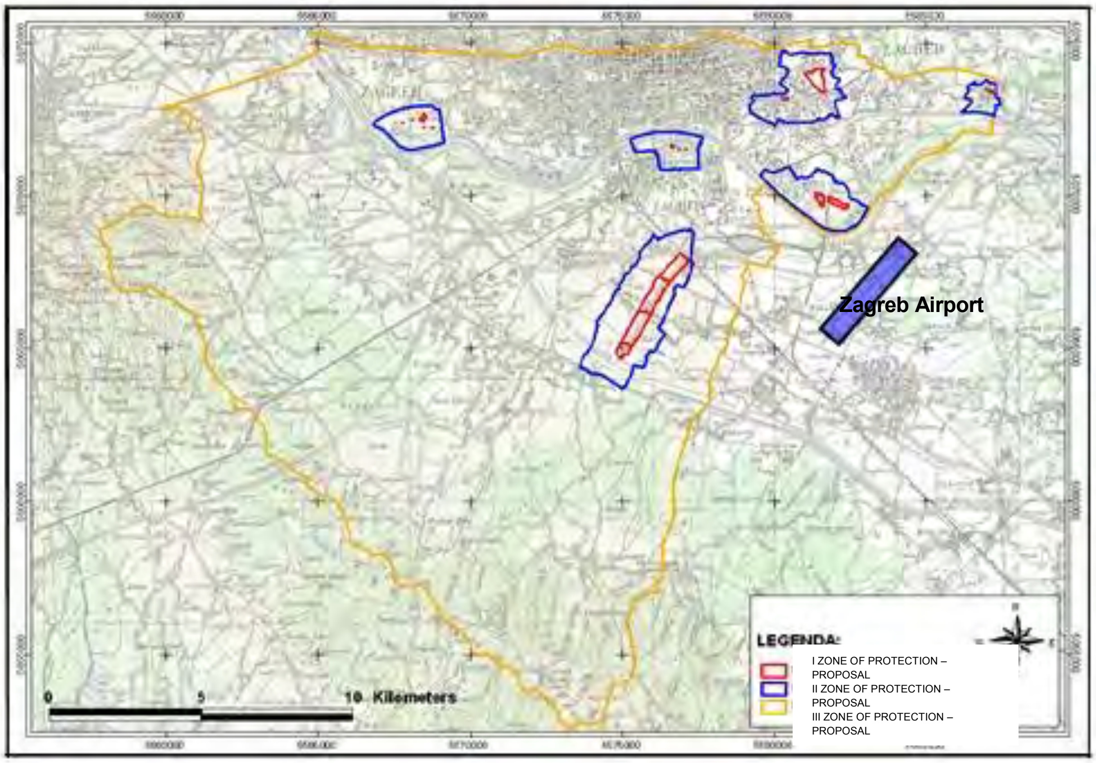


Figure 3.6.-8. Zones of sanitary protection of sources Stara Loza, Sašnjak, Žitnjak, Ivanja Reka, Petruševec, Zapruđe and Mala Mlaka "(according to the Study of well field protective zones in the City of Zagreb – I phase)

The well field Velika Gorica is located west from the City of Velika Gorica, and serves for water supply to the city of Velika Gorica and Zagreb. The pumping station consists of 5 drilled wells, and went into operation in 1987. The wells are from 35.8 m to 46.0 m deep. The well field includes an alluvial gravel-sand aquifer, which is established by drilling on the depth range of about 4 to 44 meters. The aquifer horizon is built from fine-grained to coarse gravel with a larger proportion of coarse sand. The roof has of dust and semipermeable clay. The basement is developed unevenly. Some of the wells pierced in the clay at a depth of 79 meters, while in the others in the basement it drilled through dust sand. Fri derivative wells in an irregular cross schedule can give you about 1.14 m3 / s of water. Currently, all five wells with a capacity of 0.9 m3 / s The aquifer is an open type, which means that it has a hydraulic connection with Sava, so that the groundwater level changes during the year depending on hydrologic conditions.

The City Council of the City of Velika Gorica, on its 12th meeting held on October 29th 2010 adopted a Decision on the protection of drinking water sources Velika Gorica (Official Bulletin of Velika Gorica No. 8/2010.). By this Decision, in order to protect the drinking water source in Velika Gorica from contamination or other impacts that may adversely affect the safety of the water or its yield, defined the zone sanitary protection of water resources and protection measures prescribed and renovation of the water source, sanitation and other conditions for maintenance and other protective measures.

Zones are defined on the basis of previous water research papers which are in "the Study of well field protection zones in Velika Gorica ", Zagreb, 2009., which was prepared by made it Mining and geological-Petroleum college at the University of Zagreb.

With the exploratory work an open aquifer has been discovered with intergranular porosity for which the following zones are determined: III. ZONE - zone of limits and controls, II. ZONE – zone severe restriction Zone I - Zone of strict protection regime.

Zones are bounded by boundary lines shown on topographic maps at a scale of 1:25000 for III. zone (Figure 3.6.-9), topographic maps at the scale of 1: 5000 for the II. zone and cadastral maps at the scale of 1: 1000 for the first zone. The displays of zones in reduced scale are an integral part of this Decision published in the Official Gazette along with the text of the Decision

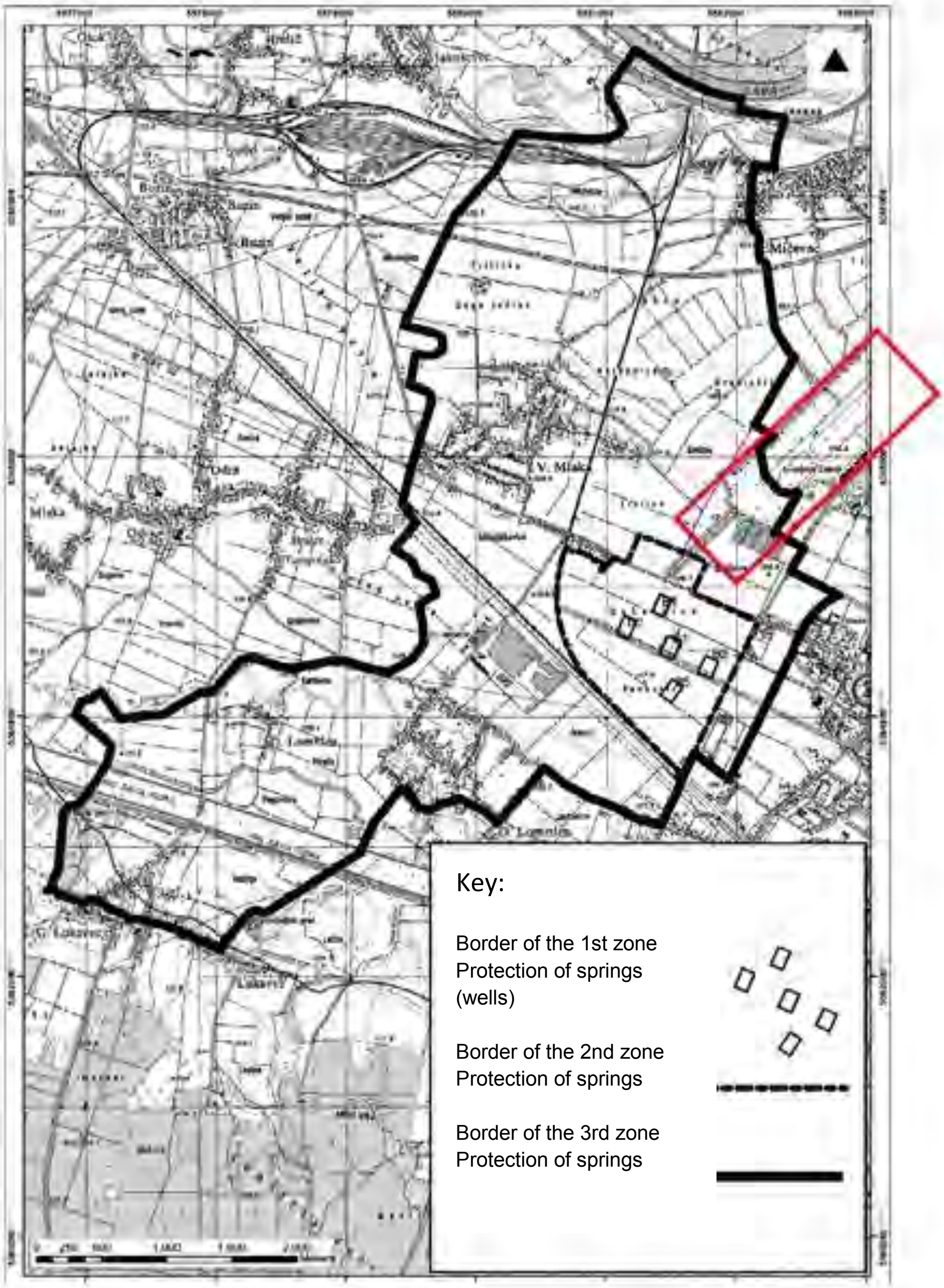


Figure 3.6.-9. Zones of well field sanitary protection of Velika Gorica (according to the Decision on the protection of drinking water sources Velika Gorica (Official Gazette of Velika Gorica No. 8/2010)

From the picture above it is evident that a small part in the III. protection zone is entering the final southwestern runway of Zagreb airport. Given the need for the reconstruction of the runway in the area of the construction of the drainage system for contaminated storm water, special attention during construction will be required to take in this part.

Well field Kosnica I phase at the final selected location is being prepared for performance since 1999, and at this point has all the necessary permits to start construction (location and construction permit)

The pumping station is part of the future wellfield Črnkovec, which should be a major regional well field included in the drinking water supply of the City of Zagreb, Zagreb County and parts of neighboring counties with the highest capacity of 4000 l / s. Works are currently being executed at the well field Kosnica phase I. In late 2010 property-related legal proceedings were completed related to the entry into the ownership of the land in the I. water protection zone of the pumping station. During January 2011 the works were completed related to the performance of all six wells of the well field with adopting and and test pumping. In preparation is the documentation for the wellfield connection permits (TK networks, electric power, drainage pumping station). The capacity of the pumping station at this stage is 900 l / s. The pumping station is not yet in service, but the decision was brought on source protection ("Official Bulletin of Velika Gorica ", number 15/04), and thus the space zone came under a particular protection regime prescribed by the Decision. According to the Decision, the external border of the III. zone of sanitary protection goes about 300 yards north of the area of Zagreb Airport (Figure 3.6.-10), so that the whole area of the Zagreb airport is located outside the zones of sanitary protection of drinking water sources "Kosnica I phase".

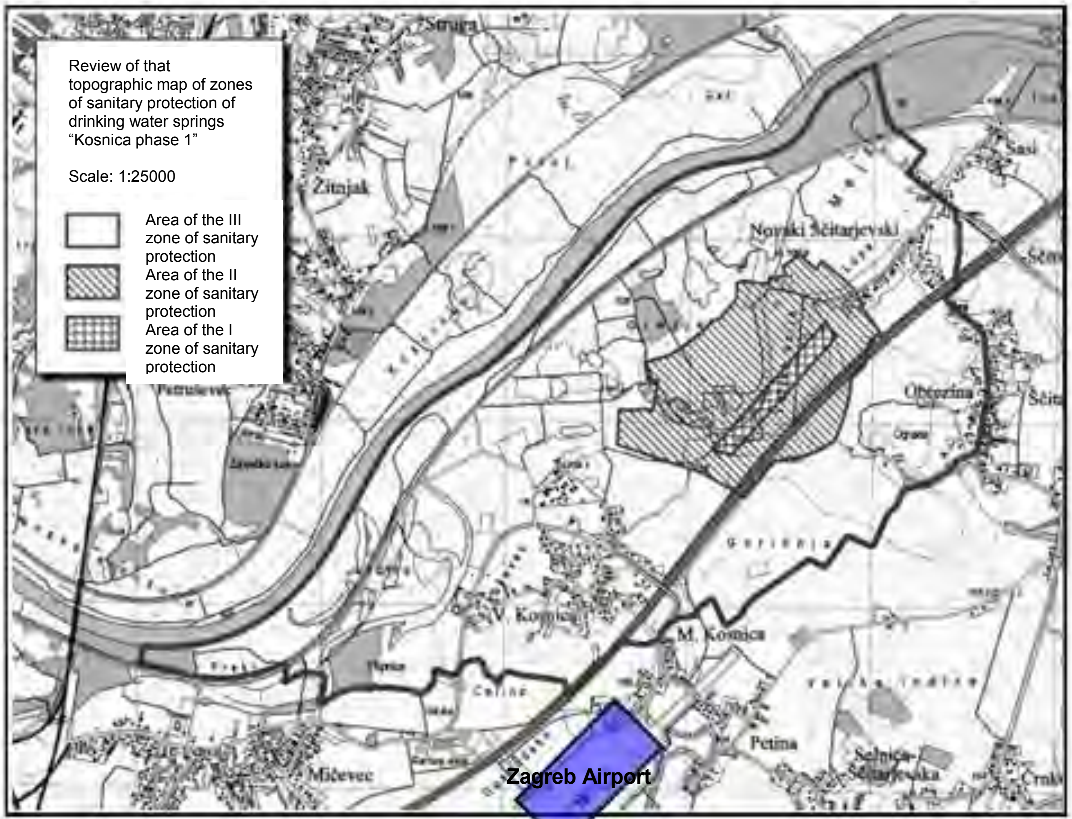


Figure 3.6.-10. Zones of sanitary protection of drinking water sources "Kosnica I. phase" (according to the Decision on the establishment of sanitary protection of drinking water sources "Kosnica Phase I" Official Gazette of the City of Velika Gorica No. 15/2004.

<u>The potential water protection area Črnkovec</u> it is established by the Regional Plan Zagreb County as unexplored or under-explored area, especially on the sensitive area which restrict the operations previously performed in the space of previous hydrogeological research, and all in the goal of effective protection of future wellfields. Črnkovec well field as the future, the last remaining major water supply operation includes wellfield Kosnica (Mičevec), Kosnica (I, II., III. phase), Kosnica East Črnkovec - immediate area, the planned total capacity of 4000 - 5000 liters / sec. The immediate area of the Črnkovec well is located between settlement Črnkovec Črnkovec to the north and Donja Lazina to the south. It is a vast and poorly explored area with somewhat weaker filtration properties from wellfield Kosnica, but with a thicker covering of sediments, which are a good protection of the aquifer from surface contamination to the underground. It is known that there are three aquifer

layers, and that is the lowest part of the aquifer at a depth of 100 m and the impact of the river Sava is far smaller than the effect on the well field Kosnica.

The Proposal of the Spatial plan of areas with special features (hereinafter PPPPO) Črnkovec - Zagreb airport, the potential water protection area Črnkovec is divided into the narrower and wider zone of protection (Figure 3.6.-11).

Within these areas are determined, with the approval of the competent authorities, the special conditions of use and protection. The narrower zone of protection is formed directly around the planned well fields, based on previous experience in establishing sanitary protection zones for well fields on the area of the County and the City of Zagreb. It includes two surfaces in coverage of PPPPO Črnkovec- Zagreb Airport, comprising:

- Narrower Protection Zone 1 - for the planned well field Kosnica (I, II., III. Stage), Kosnica Mičevec and Kosnica East
- Narrower Protection Zone 2 - for the planned well field Črnkovec - close locations
- Broader Protection Zone covers the remaining space of the Potential water conservation area Črnkovec.

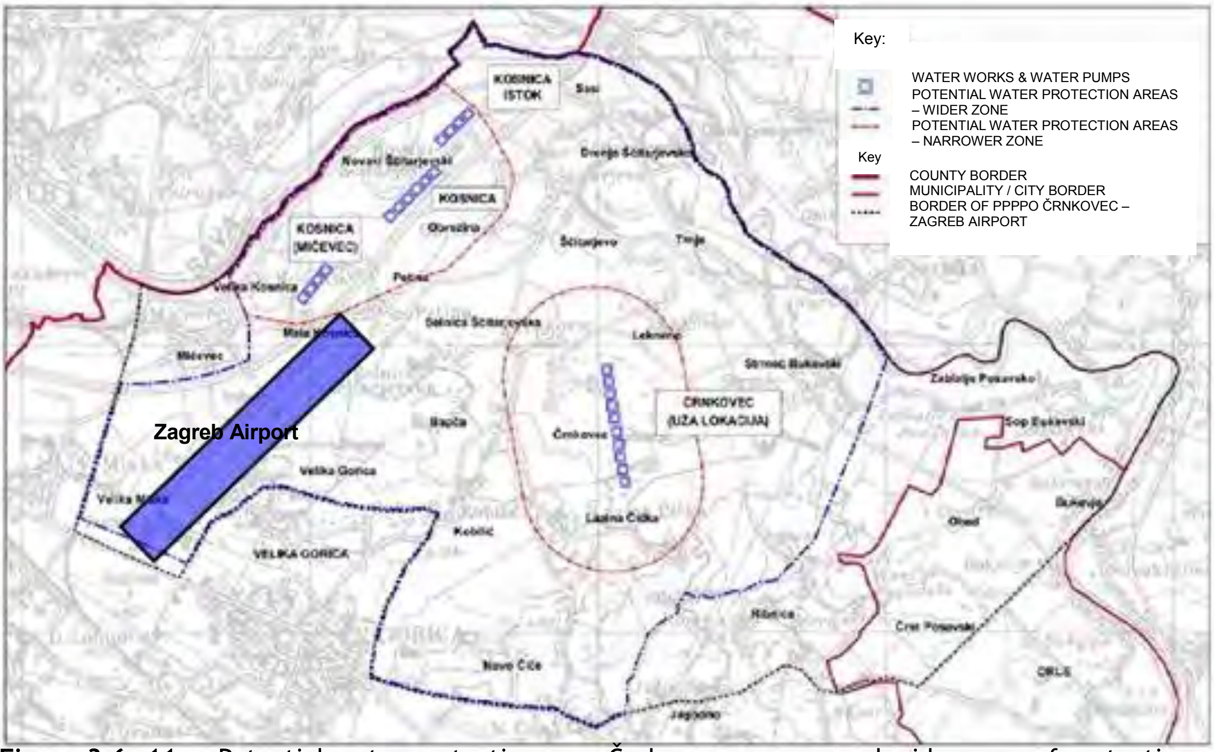


Figure 3.6.-11. Potential water protection area Črnkovec - narrow and wide zones of protection
Source: proposal PPPPO Črnkovec - Zagreb Airport

The coverage of the project Zagreb airport is located outside the immediate protection zones 1 and 2, but in the wider zone of potential water conservation area Črnkovec.

Under the proposal PPPPO Črnkovec - Zagreb Airport, in the wider zone of protection it is not allowed to::

- discharge of untreated sewage,
- storage, treatment and disposal of waste,
- construction of facilities for recovery, treatment and disposal of hazardous waste
- construction of facilities for the production and storage of hazardous and radioactive substances or other plants that can compromise the quality or yield of groundwater
- construction of chemical and industrial plants of hazardous pollutants for water and the water environment,

- construction of industrial facilities, and conducting the activities in which dangerous substances are used or those that accur as waste, without connection to the public sewerage system,
- construction of petrol stations without double skinned tanks, with devices for automatic detection and leak detection and safety facility (Bundwall)
- construction of roads, airports, parking lots and other transportation and handling areas without controlled drainage and adequate treatment of contaminated storm water before discharge into a natural receiver,
- underground and surface mining of minerals other than geothermal and mineral water
- execution of exploration and exploitation wells, except those related to water research works for public water supply and renewable energy
- removal and disposal of the top layer of land except on the construction of buildings,
- transport of dangerous goods by road and railways outside the approved corridors or without the implementation of appropriate measures of protection,
- The use of herbicides based on atrazine mjera zaštite,

3.6.1. The results of previous monitoring of groundwater

The airport is located south of Zagreb, in the central part of the Zagreb aquifer and covers an area of about 300 hectares. The terrain in the the surface area of the Zagreb airport air built of alluvium second (middle) Sava terrace (a2), and only in the extreme northeastern part of the floodplain sediments (ap). Lithological composition of the terrain in the area which includes building a new terminal at Zagreb airport fits the foregoing description of the wider area. In support of this best is the data obtained by drilling three wells structural closest to the future location of the future new passenger terminal.
Locations of wells ZG-3-B-69, ZG-3-B-105, and ZG-4-P-34 are shown in Figure 3.6.12, and their lithological profiles are shown in Figures 6.3.12, 3.6.12b and 3.6.12c.

Figure 3.6.-12. Locations of wells from a database EGPV for which we have data on the lithological column

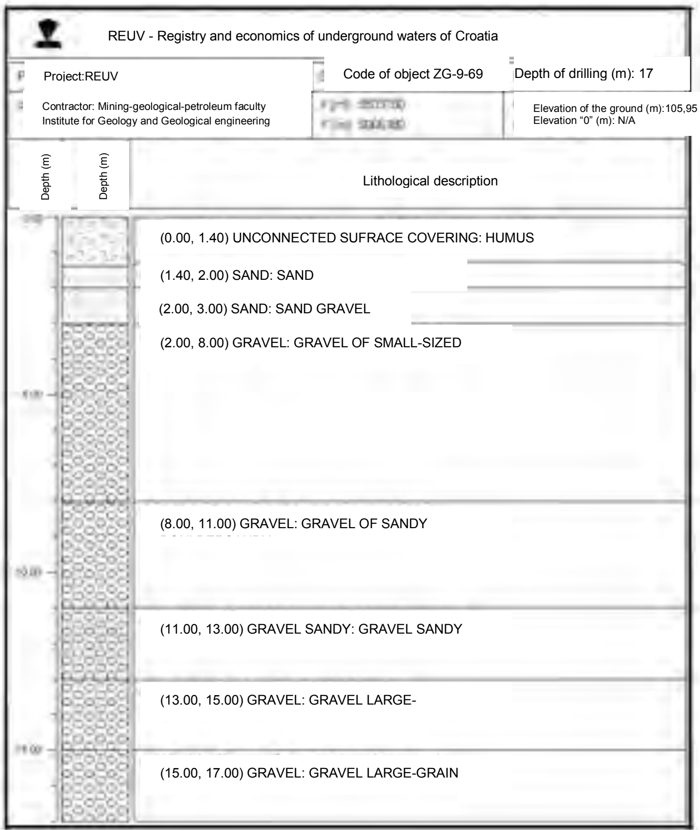


Figure 3.6.12-a. Lithological column of well ZG-3-B-69

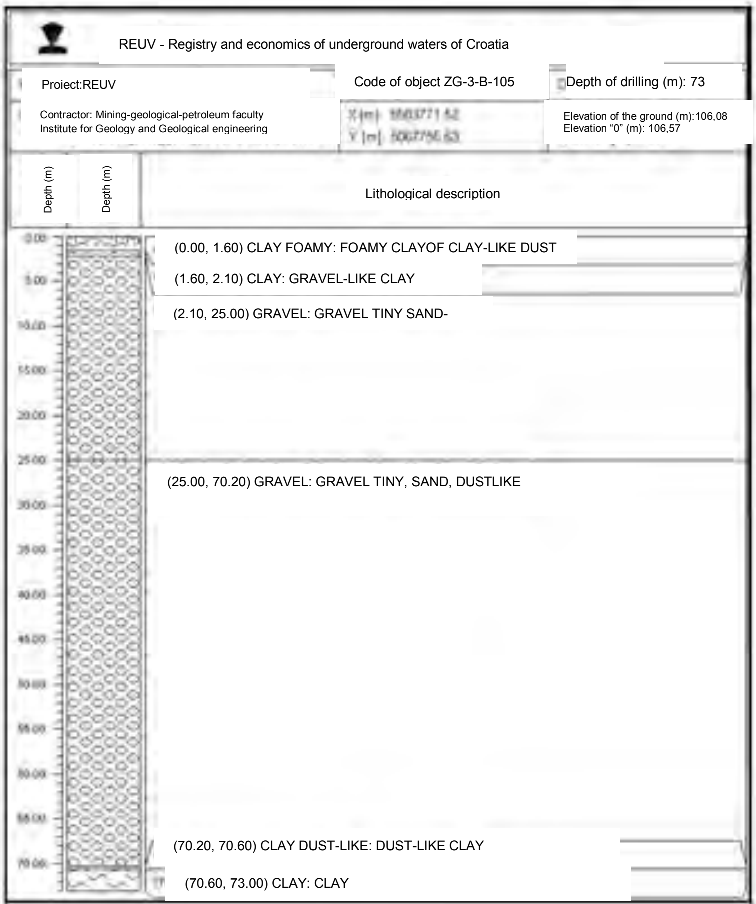


Figure 3.6.12-b. Lithological column of well ZG-3-B-105

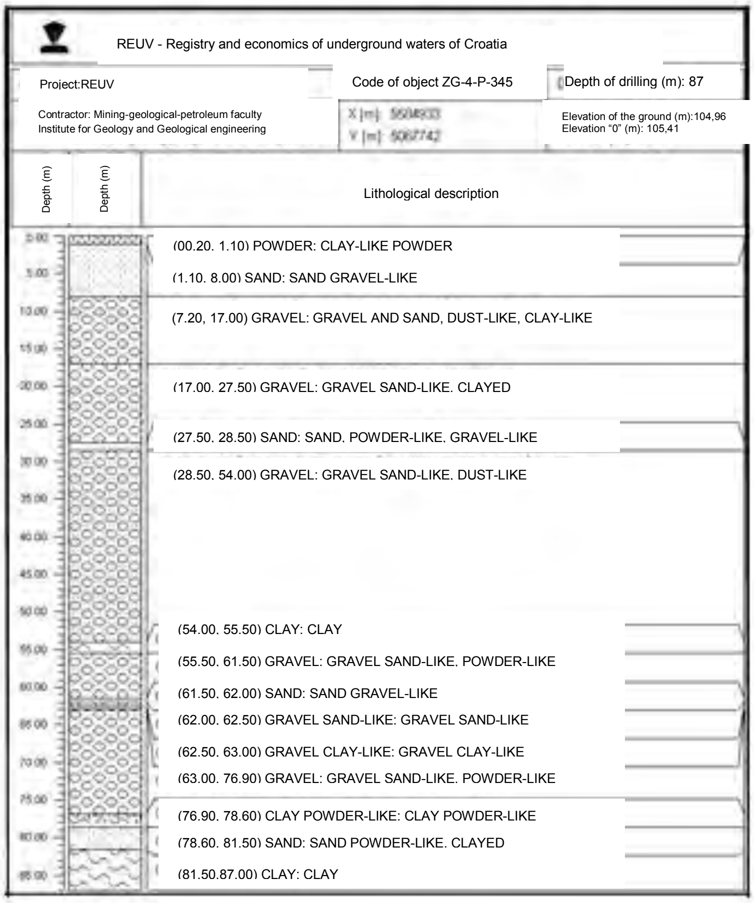


Figure 3.6.12-c. Lithological column of well ZG-4-P-34

On the basis of data from these and other wells, it can be said that on the whole area of the airport, the thickness of the roof blanket is small and ranges between 1 and 2 m (Figure 3.6.-13th).

Figure 3.6.-13. Map of roof blankets of the aquifer in the area of Zagreb Airport

The thickness of the aquifer ranges from about 100 m in the south to about 80 to 90 m in the north (Figure 3.6.-14).

Figure 3.6.-14. Map of the thickness of the aquifer in the area of Zagreb Airport

Upper thirty feet are alluvial sediments (Figure 3.6.-15), and the remaining are sediments of lacustrine origin.

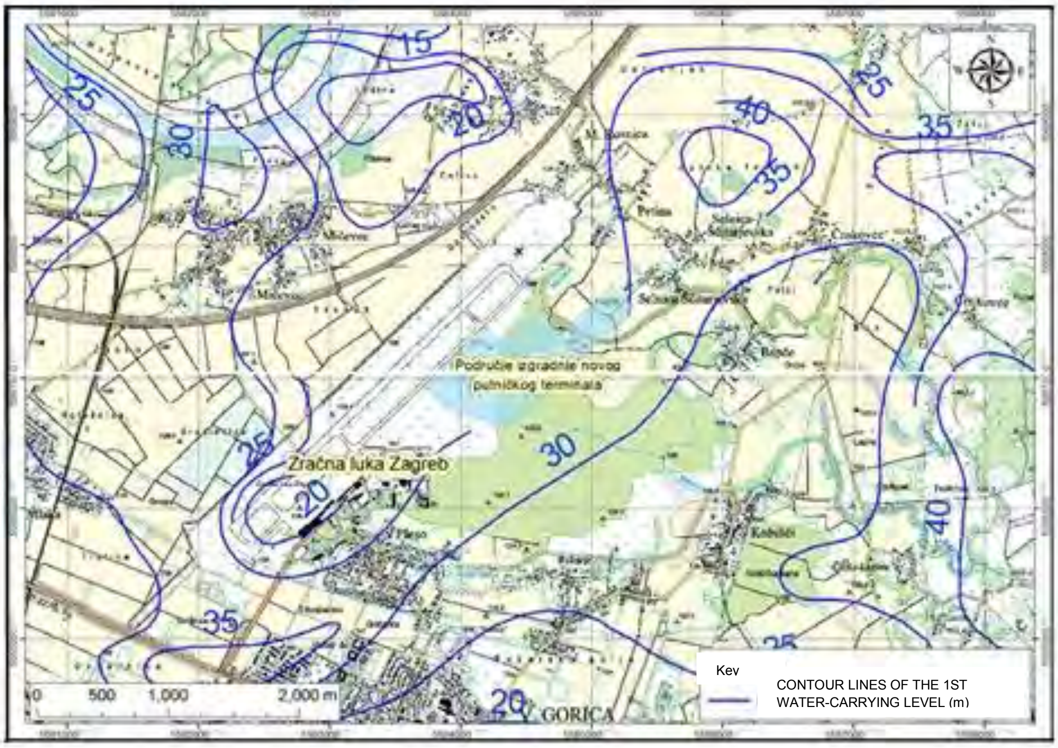


Figure 3.6.-15. Map the thickness of alluvial sediments ("first aquifer") in the area of Zagreb Airport

Hydraulic conductivity of the aquifer sediments is about 2000 m / day. Groundwater levels range from about 100 meters during low water to about 102 meters during the period of high water (Figure 3.6.-16).

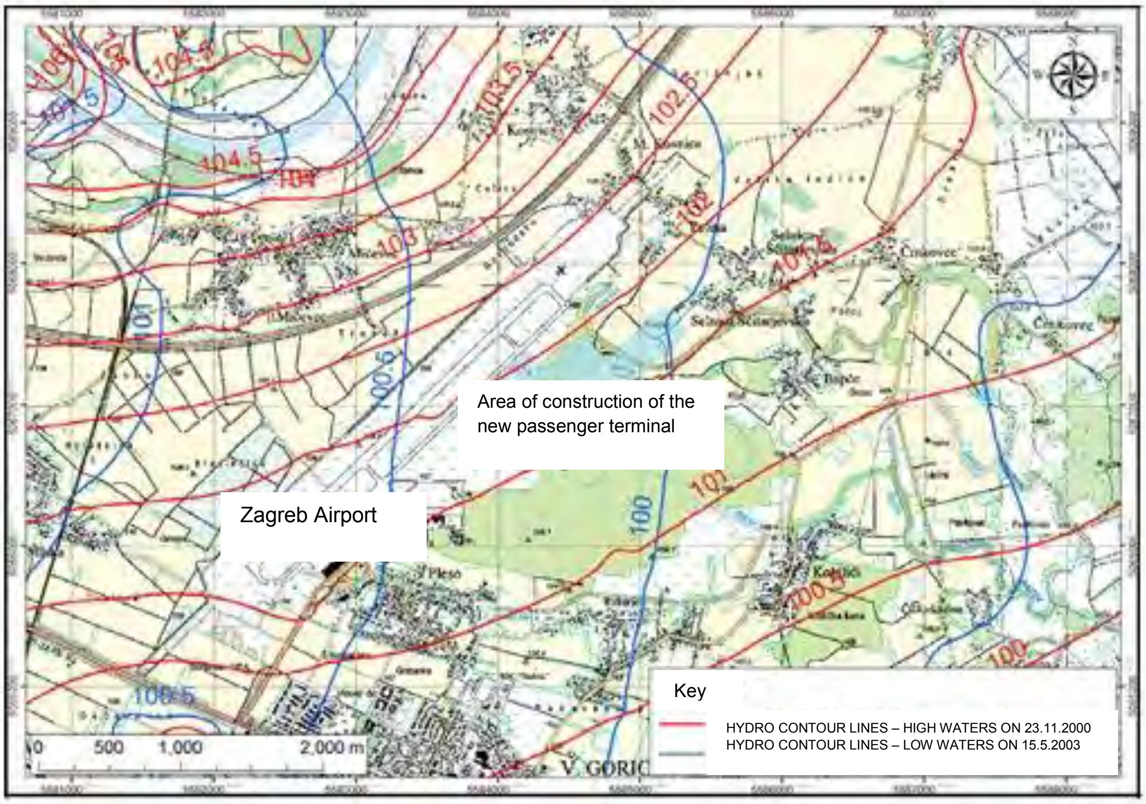


Figure 3.6.-16. map of hidroizohipsi in the area of Zagreb airport during high and low water levels.

Since in the area of the airport terrain heights range between 106.4 meters in the south and 105.1 m in the north, it means that the ground water, depending on hydrological conditions is at a depth of between 3.1 and 6.4 m below the ground surface.

Groundwater levels fluctuate during the year and up to 3 m This is best seen in level-grams of minimum and maximum annual groundwater level recorded in four piezometers (observation well PPC-8, PI-35, CD-10-2, and PPC-14), and which are closest to the location at which it is the construction of a new passenger terminal (Figure 3.6.-17).

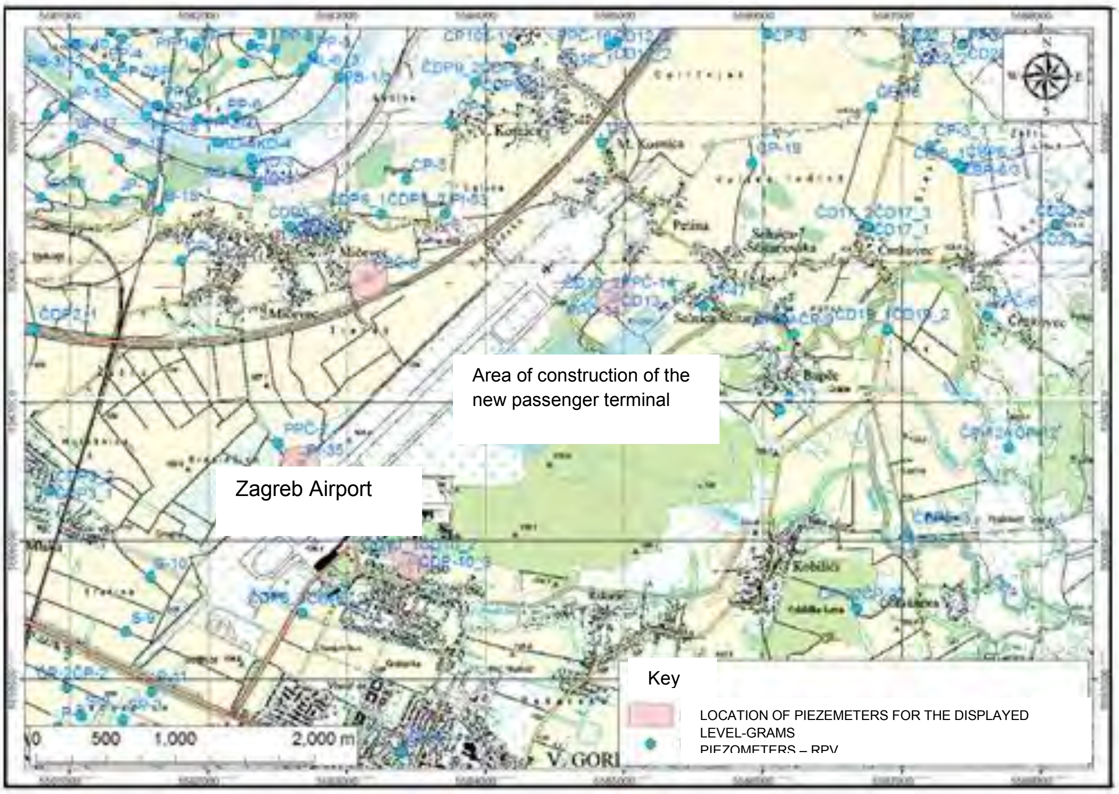


Figure 3.6.-17. Map of the location of the piezometer PPČ-8, PI-35, ČD-10-2, and PPČ-14

The piezometer PPČ-8 is located in Mičevac and is the closest to the Sava River. The level of underground water in it has been observed since 1980 (figure 3.6-18). The lowest level of underground water of 99.48 meters above sea level was registered 10.08.2007 and the highest level of 106.47 meters above sea level was registered 19.10.1980.

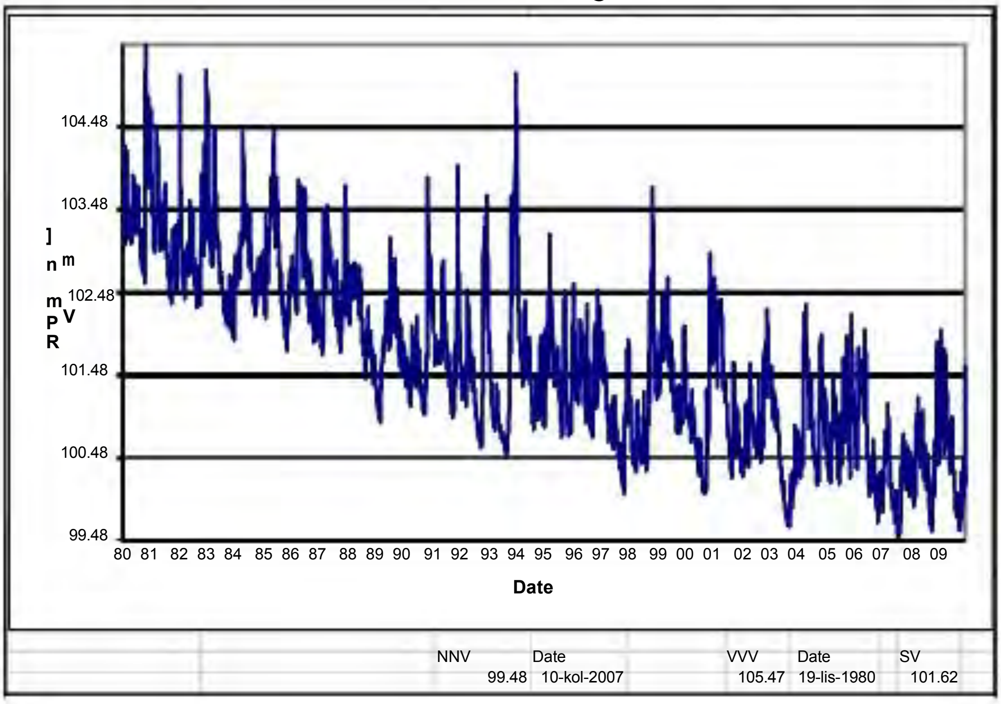


Figure 3.6.-18. level-gram of the PPČ-8 piezometer

Piezometer PI-35 is located along the western edge of the protective belt of the runway. The level of underground water in it has been observed since 1972 (figure 3.6-19). The lowest groundwater from 99.55 m above sea level (asl)was recorded 20.08.2007 and the highest since 105.80 als on 18.5. in 1972.

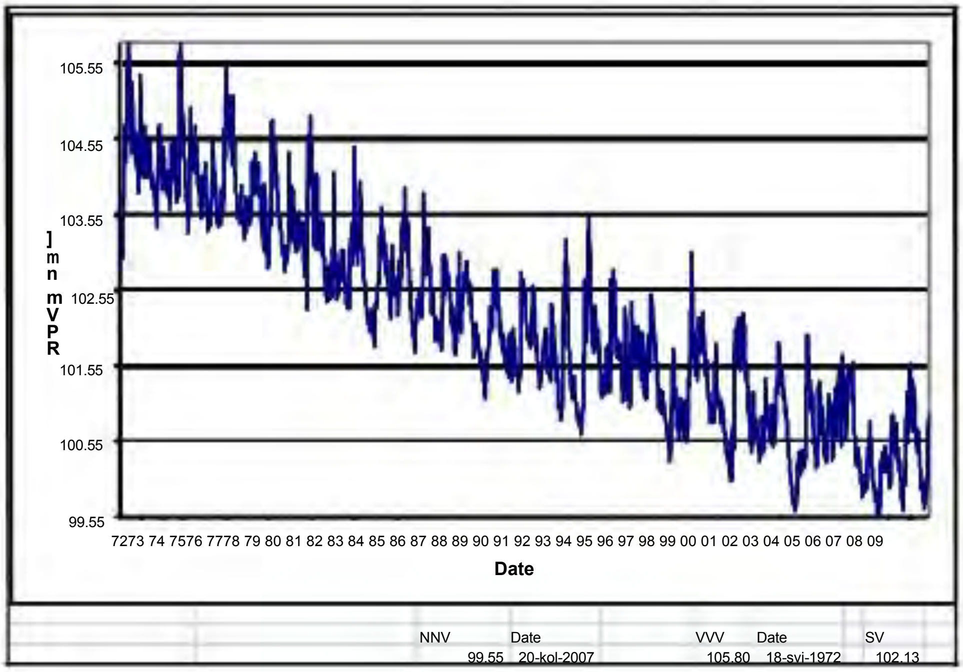


Figure 3.6.-19. Level-gram piezometers PI-35

Piezometer ČD 10-2 is located in the settlement Pleso. The groundwater levels in it have been observed since 1987 (figure 3.6-20.). The lowest level of the underground water was 99.38 m asl recorded on 27.08.2007, and the highest of 102.90 m asl was on 14.12 in 1992.

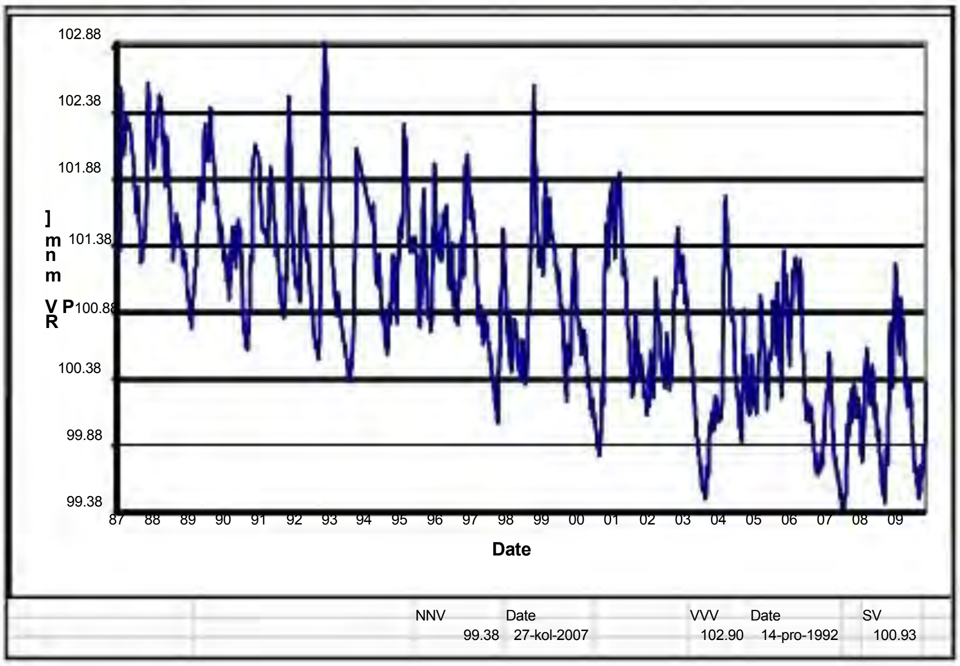


Figure 3.6.-20. Level-gram piezometers ČD-10-2

Piezometer PPC-14 is located at the northern end of the area of the airport and the closest location of the future new passenger terminal. Groundwater levels are observed in it since 1980. (figure 3.6.-21). The lowest level of groundwater of 99.14 m above sea level was recorded recorded on 22.10.2009, and the highest of 104.14 m asl was on 19.10.1980.

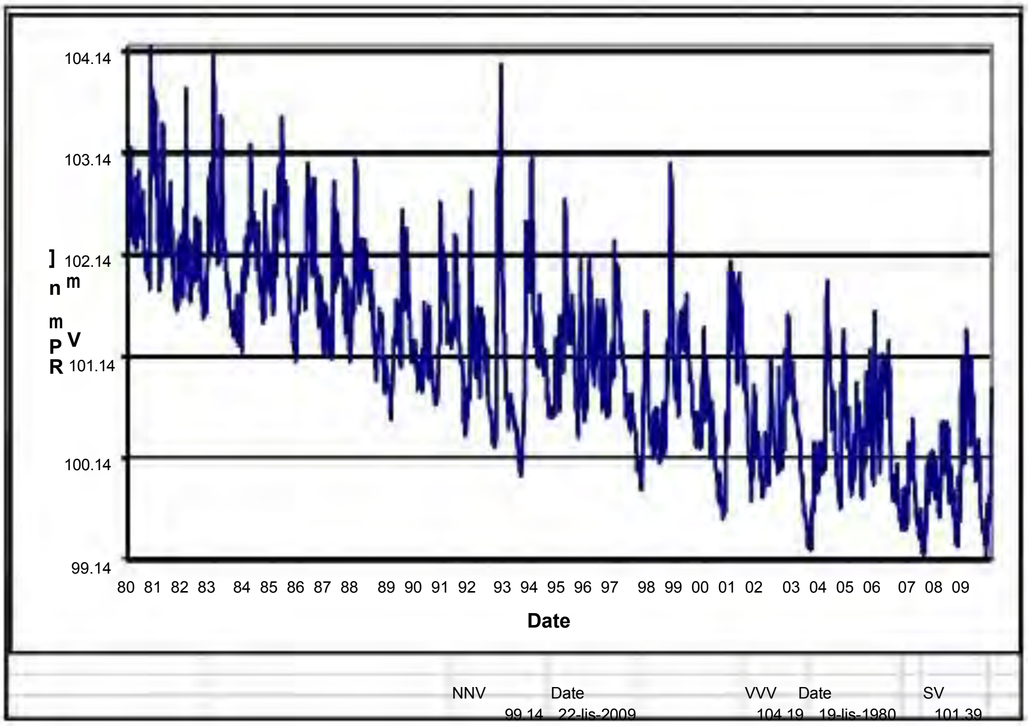


Figure 3.6.-21. Level-gram of piezometers PPČ-14

All level-grams clearly show the trend of a permanent lowering of the groundwater levels. During periods of low water levels, the groundwater flow takes place over the space Airports from west to east with a hydraulic gradient of about 2 x 10-4 (Figure 3.6.-16). This means that, with the adopted value of the hydraulic conductivity of 2000 m / day and the default value of effective porosity of 15%, the groundwater flows at a speed of about 3 m / day.
At high water levels, the underground water flows through the area of the airport from the northwest to the southeast with the hydraulic gradient of about 7 x 10-4 (Figure 3.6.-16). With the above values of hydraulic conductivity and the effective porosity groundwater in the conditions of high water, it flows at a speed of about 9 m / day.
The area which foresees the construction of a new passenger terminal at Zagreb Airport has been building objects and activities have been carried out which are related to air traffic for more than 50 years. Through all this time, no significant adverse impacts to groundwater have been noticed. It is true though that the analyzes results of the ground water from wells for fire water, which are located approximately 250 m southwest of the existing passenger terminal building, on three occasions (05.09., 17.09. and 25.09.1998) taken in developing the study of the environmental impact of the construction of Zagreb Airport (Rajer, B. 2000), have shown that the water contains higher concentrations of suspended substances, and oil and grease and mineral oil more than in amounts allowed for drinking water, while all other measured parameters were within the acceptable limits. This undoubtedly indicates the pollution of groundwater, but since it is not a well for the supply drinking water, it can be a consequence of prolonged un-pumping of water (suspended substances) and the use of unclean equipment for extraction (oil and grease, and mineral oil) and not the impact of the facilities and activities of Zagreb Airport. This is supported by more recent research.
Specifically, the systematic monitoring of groundwater quality in the area of Zagreb Airport has been ongoing since 2001, when in this area, 5 piezometers were set for taking water samples (Figure 3.6.-22).

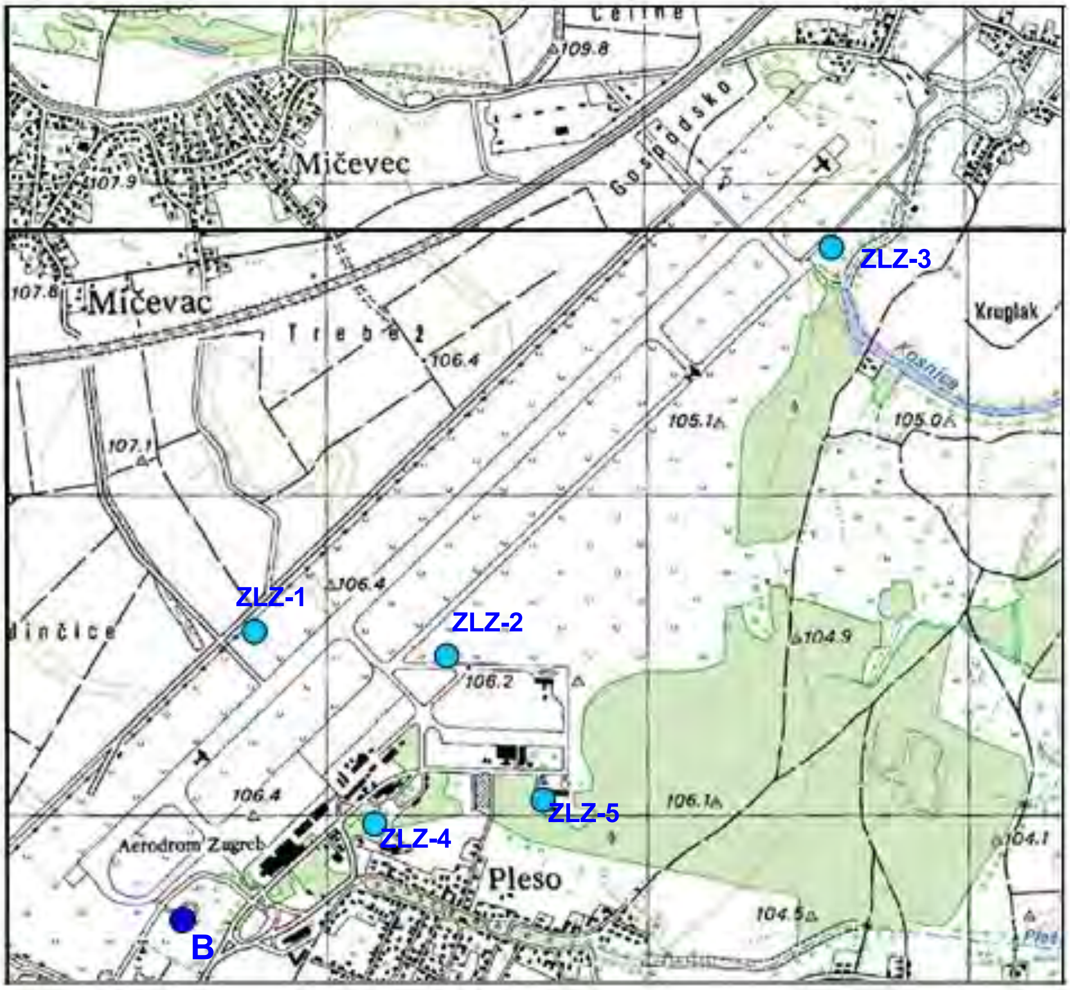


Figure 3.6.-22. Location of sampling groundwater at the airport Zagreb, M 1:25.000

(-ZLZ-1, ZLZ-2, ZLZ-3, ZLZ-4 and ZLZ-5- piezometers in the area of the airport , B -well for firefighting water)

Piezometer ZA-1 is located in the west, or upstream of the Zagreb Airport facilities. The groundwater quality at the entrance profile of the airport is monitored, or without affecting airport facilities. Piezometer ZA-2 is located to the east, or downstream from the middle of the runway. Piezometer ZA -3 is located at the northeast, next to the runway, piezometer ZA-4 is located downstream of the terminal building, and piezometers ZA- 5 is the farthest from the runways and is located downstream from it, near the Aviation School.

Apart from these five piezometers, analyzed also were water samples from wells for firefighting water (B) located southwest of the existing passenger terminal building and piezometers ČDP-10/3 in the settlement of Pleso. Sampling and laboratory analyzes is performed by the Branch of the Water Supply and Sewage of Zagreb Holding. Monitored were the following parameters: water temperature, turbidity, color, pH odor, KMnO4 consumption, dissolved oxygen saturation, oxygen, conductivity, ammonia, nitrites, nitrates, chlorides, sulfates, phosphates, phenols, total and mineral oils anion detergents, organic solvents, organic pesticides, Na, K, Fe, Mn, Cr-uk, Cu, Zn, Ni, Cd, Pb, UBB (370C), UK, FC and fecal streptococci of sulfate-reducing Clostridia.

Since during the entire time of monitoring, no significant change tendencies were noticed in the quality of the groundwater in the area of the airport in relation to the quality of water from piezometers from pezometers from flowing areas of the water pumps, the current situation can be described as based on the last report (Jakuš, B. and Bradić, D. 2010), in which the results are shown for the analysis of 23 samples (2 samples from the piezometer ZA-1, 3 samples from the piezometer ZA-2, 3 samples from the piezometer ZLZ-3, 4 samples from the piezometer ZA-4, 4 samples from the piezometer ZA-5, 3 samples from wells for firefighting water and water samples from four piezometers ČDP-10/3).

The summarized results of the measurements are as follows:

- The groundwater temperature varied depending on the location and time of sampling, between 12.70 C and 16.10 C.
- The turbidity and color was not registered in any of the samples, while the smell was noticeable in three samples of groundwater from piezometer 5.
- The measured pH values were between 7.14 and 7.30, and the electrical conductivity was between 695 and 830 µS/cm.
- The concentrations of dissolved oxygen ranged between 0.1 and 5.5 mg/l, which depending on the temperature of ground water resulted in an oxygen saturation of 1 to 53%.
- The measured KMnO4 consumption values ranged between 0.40 and 0.60 mgO_2 / l (MDK for drinking water is 5.0 mgO_2/l).
- Ammonia was found in two samples from piezometer ZA-2 (0.35 mg/l 0.91 mg l) and 4 samples from piezometer ZA-4 (1.78 mg/l 2.00 mg/l 1.55 mg/l 0.76 mg/l) (MDK = 0.5 mg/l).
- Nitrites were found in one sample of water from piezometer ZA-2 (0.06 mgNO2 / l) and piezometer ZA-5 (0.45 $mgNO_2$/l) (MDK = 0.50 $mgNO_2$/l).
- Nitrates were found in all water samples at concentrations between 7.3 $mgNO_3$/l and 52.6 $mgNO_3$/l, but only in one sample from piezometer ZA-2 measured a concentration of (52.6 $mgNO_3$/l), which was slightly higher than MDK (MDK = 50 mg/l)
- chlorides, sulfates, sodium and potassium were determined in low concentrations, or well below MDK.
- Total and mineral oils were also present in low concentrations. Concentration of the total oils ranged between 7.2 and 49.5 µg/l (MDK not regulated), and minerals between 0.6 and 7.8 µg/l (MDK = 20 µg/l).
- Phosphates and organogenic pesticides were found in samples of groundwater from one object.
- Phenols were found in a sample of water from piezometer 1 (0.53 µg/L) in one sample of water from piezometer ZA-2 (0.29 µg/l) and two samples of water from piezometer ČDP-10/3 (0.65 µg/l and 0.59 µg/l), but always at concentrations lower than the MDK (MDK = 1.00 µg/l).
- anion de-agents were found in one sample of water from piezometer ČDP-10/3 (5.0 µg/l), the observation well ZA-4 (7.50 µg/l) and the piezemeter 5 (5.00 µg/l), but also in much lower concentrations than MDK (MDK = 200 mg/l).
- Organic solvents (chloroform, trichloroethene and tetrachlorethene), were sporadically registered in samples from all objects, but in concentrations several tens of times lower than the MDK.
- Iron was present in 19 samples of groundwater at concentrations between 0.3 and 123.2 µg/l, that is still below the MDK (MDK = µg/l).
- Other heavy metals were found occasionally in groundwater samples from most objects, but in very low concentrations typical of any underground water from the surrounding area.
- Aerobic bacteria (UBB 370C) were present in 20 water samples in numbers from 2 to 270 in 1 ml of water

- Total coliform bacteria (NBK) were found in 5 samples.
- Fecal bacteria were found in one sample.
- Fecal streptococci were isolated in 8 samples (one sample from a well with firefighting water and fro piezometer ZA-1, piezometer ZA-2, piezometer ZA-3 and piezometer ZA-4, and 4 in the sample from piezometer ČDP-10/3.

As a conclusion, most of the defined parameters of water quality were found in very low concentrations, or well below MDK regulated by the Codebook on drinking water (OG 47/2008). The criteria from the Codebook were not met from samples of underground water which was bacteriologically contaminated (UBB, UK, fecal streptococci, sulfate-reducing clostridia), and samples that had a noticeable odor (three samples from piezometer ZA-5), containing ammonia (1 sample from piezometer ZA-2 and 4 samples from piezometer ZA-4) and nitrate (1 sample from piezometer ZA-2) at concentrations over MKD. The potential cause of the appearance of ammonia may be urea-organic compound of chemical formulas (NH2) 2CO which are used for de-icing runways, as well as an artificial fertilizer. Since the largest concentration of ammonia was in the sample of water from piezometer ZA-4 taken 27.05.2010, it is most likely that urea, used for de-icing, can be excluded as a cause of groundwater pollution. Thus, the contaminants are likely consequences of agricultural production that takes place in the wider area of the airport and poor quality or damaged systems for the drainage of fecal water (as in the case of piezometer ČDP-10/3, which is located in the settlement Pleso) and cannot be attributed to the activities and facilities of Zagreb Airport.

3.7. HYDROLOGICAL CHARACTERISTICS

Based on the Decision on the borders of water areas ("Official Gazette", No. 81/10), the area of the Zagreb County in its entirety belongs to the Danube River water area, or an area from which all waters flow, by surface or underground, to the Danube River. The most significant streams with very large drainage areas in the water area of the Danube River, along the river Danube, Drava, Mura, Sava, are the Kupa and Una with numerous tributaries.
The Sava River Basin is divided based on the Decision of the boundaries of the area sub-catchments, small basins and sectors ("Official Gazette", No. 97/10), the sub-basin area River basin and sub-basin area of the river Drava and Danube. The subject area of the Plan is located in the area of the sub-catchments of the Sava River, or in the area of the small catchment "Zagreb Prisavlje" which territorially covers the City of the Zagreb and part of the Zagreb County (cities Jastrebarsko, Samobor, Svete Nedelja, Velika Gorica, Zapresić and municipalities Bistra, Brdovec, Dubravica, Jakovlje, Klinča Sela, Krašić, Kravarsko, Luka, Marija Gorica, Orle, Pisarovina Pokupsko, Pušća, Rugvica, Stupnik, Žumberak).
In the broader work area, the most important waterways are Sava River and Odra River, which, based on the Decision on the list of Class I waters ("Official Gazette", No. 79/10), are assigned to waters category I. From the surface waters in the observed area are also smaller streams: Kosnica, Bapča, Želin, Ribnica and Savišće, and stagnant water or the Novo Čiče Lake close to the settlement Novo Čiče.

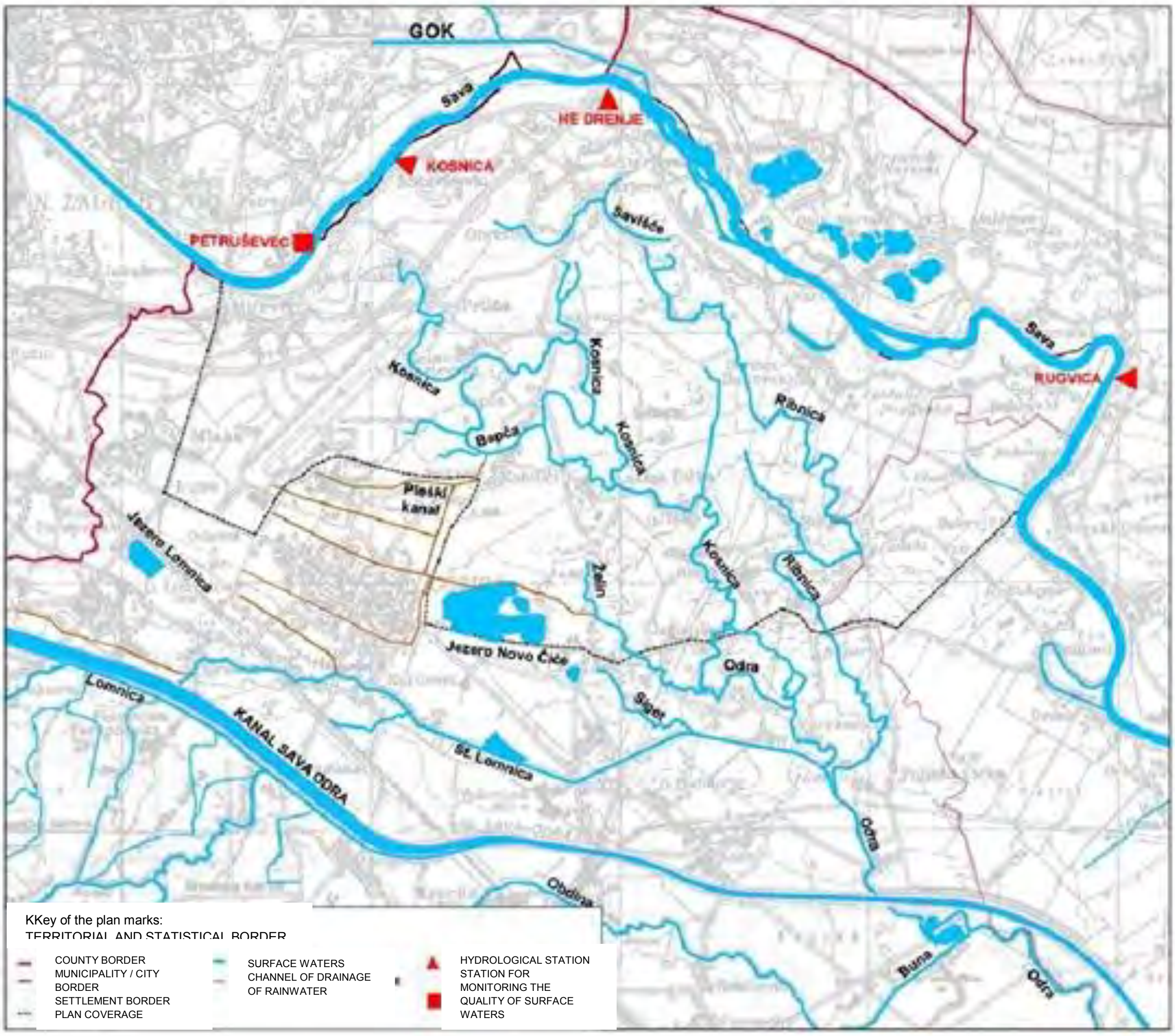


Figure 3.7.-1. Surface waters on the wider scope of the work

The Sava River

The Sava River, as an interstate water category I, represents the major aquifer in the area of the Zagreb County and the City of Zagreb.

The length of the Sava River, from its source in the mountains of western Slovenia to its estuary with the Danube, is about 944 km. The catchment area is 97,713 km^2, of which 25-26% drains in Croatia. The basin is characterized by a great water force but also a considerable variability in flows in time. Entering Croatia, the Sava River from the mountainous areas enters the low-lying region which brings large amounts of material in which gravel is predominant. The Sava riverbed in the area of Croatia has a very small slope, and the bulk of the fall is realized in the Zagreb area. While in the upstream areas the erosion processes prevails, the downstream of Zagreb prevails with the accumulation of material. The deposition of heavy sediment raises the Sava riverbed causing it to move to the right or left. The turning and meandering lengthens the basin and decreases the slope, and at the higher position of the Sava riverbed, it causes overflowing of waters and flooding of the Sava plain. On the part through Zagreb, the Sava River is channeled in order to protect it from flooding larger areas and the possibility of further expansion of the city.

At the nearby area, not one open watercourse enters into the Sava River. The basin of the Sava has an average width of 110 to 120 m, and meanders in the hinterland, remained cut off with defense embankments made along the river. Before the defense embankments and regulation work in the basin of the river, the Sava River in this section meandered with big curves, of which the dead inlets were left deep in the hinterlands. With its hydrological characteristics, the Sava River significantly affects the water regime of the hinterland space. The Sava is under constant influence of human activities as one of the central Pannonian rivers and the edge of the mountains in Slovenia, which in some places further increases the impact on underground aquifers, as well as nearby aquifers.

The flood Defense of the Sava waters is carried out within a multi-purpose flooding defense system of Middle Posavlje. The flood control system represents a number of Middle Posavlje existing and planned constructions and interventions that seek to provide a level of protection for towns and settlements, farm buildings, protection of nature, sport and recreation facilities and conditions for a stable agricultural production. The size of the flooded areas depends on the water level of the Sava River and its tributaries. The water level and basins of the Sava River are mainly influenced by rainfall in its catchment area, and the frequent occurrence of high water after the snow melts in mountainous region of the Alps, even when the Zagreb area has no heavy rainfall. The emergence of a high water level is characterized by two peaks – in autumn and spring.

The mentioned area is covered by the hydrological data of the Water-measuring Station Zagreb and Kosnica. The water level and basins of the Sava River are mainly influenced by rainfall in its catchment area, and the frequent occurrence of high water after the melting of snow in the mountain the Alps, even when the Zagreb area has no heavy rainfall. During the period of the year, the maximum water levels of the Sava River are in the first half of January, April, May, June, then in October, November and December, while the lower water levels are related to the vegetation periods of July, August and September. Natural factors that affect water levels of the Save River are of cyclical character. Far more significant water level changes occur as a result of changes in the river bed due to hydraulic operations, and are reflected in the lower bottom basins, resulting in an increase in the flow profile of the river basin. Morphological changes were made due to anti-erosion works in the upper part of the basin, regulatory works in the basin and over-extraction of gravel, especially in the area of Kosnica, where the impact threshold (water stairs) at the thermal power station TE-TO under which the water level is about 4-5 m lower than upstream. The average drop in water levels along the Sava i River in Zagreb was around 0.4 m / km, while on the part of the hydrological station "TE-TO supply channel" to hydrological cells "TE-TO lower water", whose mutual distance is about 620 yards, an average of about 5 m or 8 m / km. This difference in the water level of the Sava over such a small distance causes about 20 times the average decrease of the Sava water level than on other parts of the flow, which is the largely reflected on the levels of underground water.

By comparing the cross section at the water-measuring station VS Kosnica, in the period from 1967 - 1995, observed was the deepening and lowering of the plate by about 1.5 m and an increase in the transverse bed profile by approximately 130 m^2.

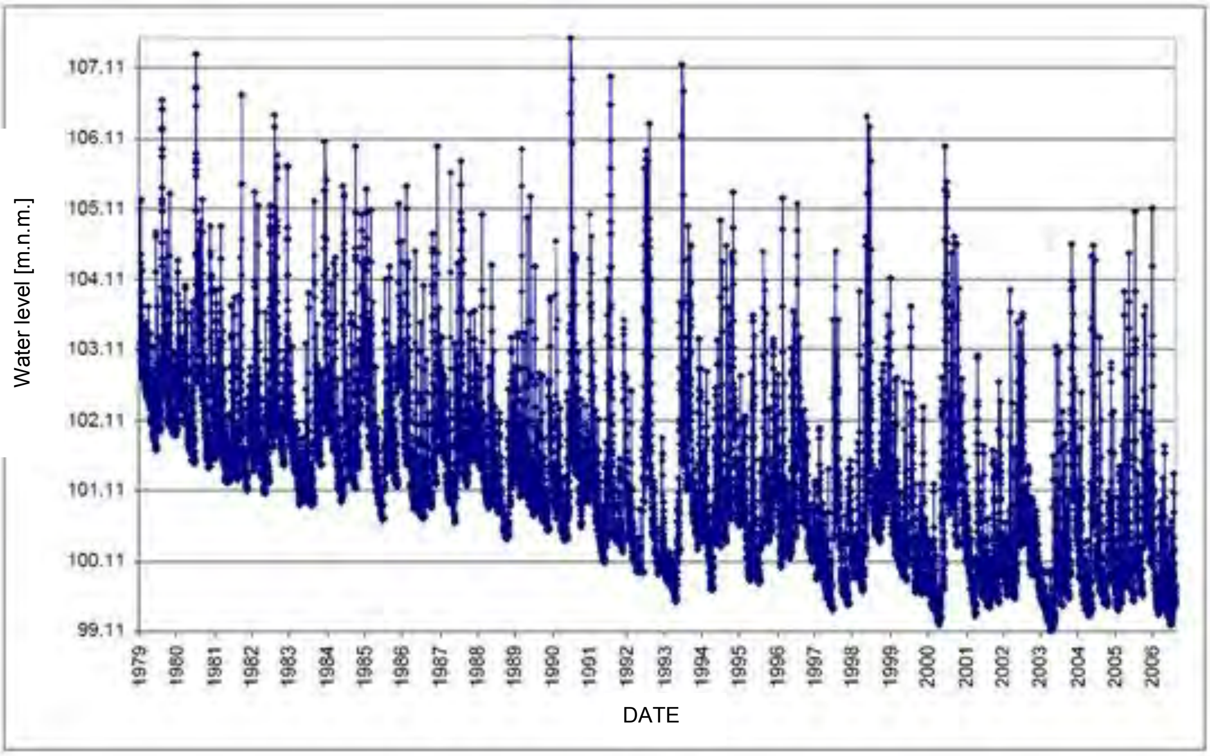


Figure 3.7.-2. Level-gram of Sava at the water-measuring station Kosnica for the period 1979 to 2006. Source: Report for the Protection zones of water pumps of Velika Gorica (Mining, Geology and Petroleum Faculty, 2009.)

On the basis of annual water levels of the Sava River on the water-measuring profile Kosnica, visible is a continuous trend of lowering the water levels of the river basin over a longer period of observation. The largest measured flow of the Sava River from 3,126 m^3/s was recorded in October 1964, when a large part of Zagreb flooded. Certainly the amount of water was even greater because a large amount of the water spilled out of control of the water-measuring devices. The mean flow of the Sava River for the period 1926-1988 was 314 m^3/s, and for the period 1975-1995 it was 308 m^3/s, but it is a fairly equalized value of the medium flow for the entire period of observation. The middle flow is affected by a large number of activities in the basin, from deforestation to the construction of upstream hydropower plants. The lowest recorded flow occurred in 1947 and was 47.5 m^3/s, and in 1971 it was 53.5 m^3/s, and therefore much higher than the lowest and the highest flow rate of 1:65. This places the Sava River into a group of highly variable flow dependent on hydro conditions, which has a direct impact on the groundwater level change in the impacted area of the river. The Sava River in its natural conditions with its varying flow effects the changes of groundwater levels. Sava is under constant influence of human activities, as one of rivers of the central Pannonian basin and marginal mountains in Slovenia, which in some places further increases the impact on underground aquifers.

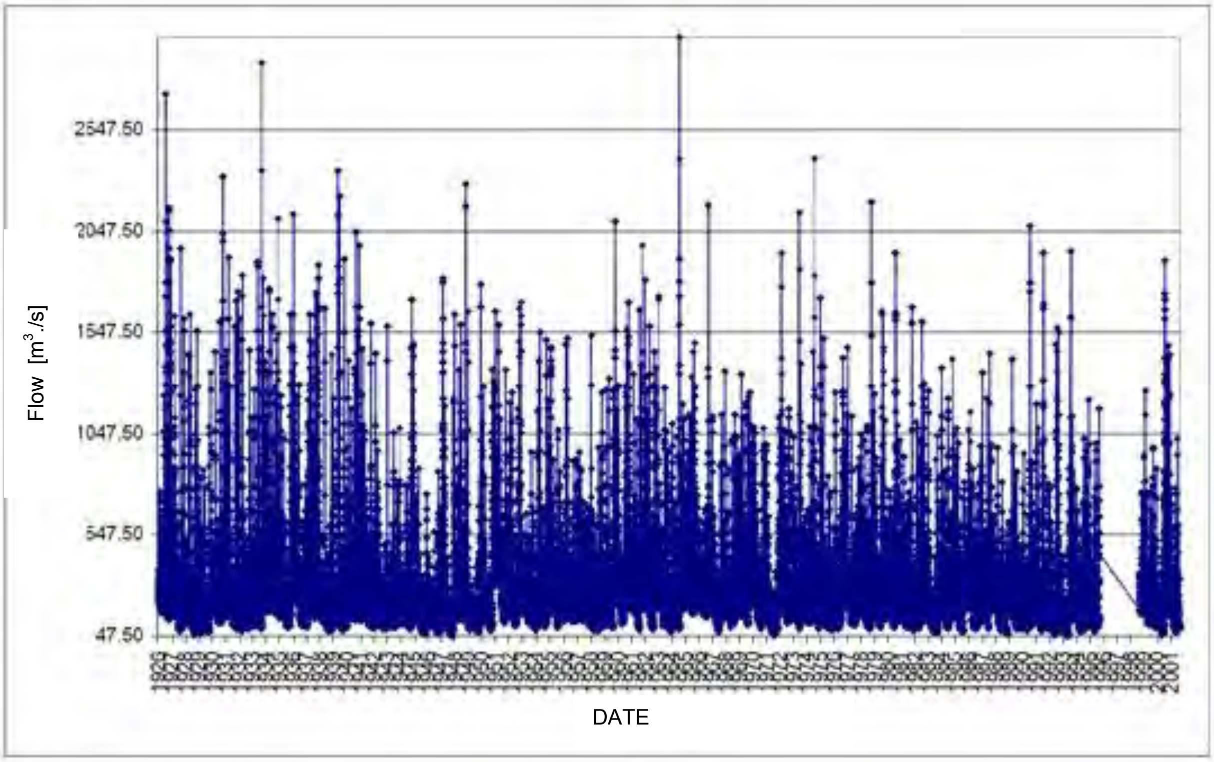


Figure 3.7.-3. . The hydrograph of the Sava at the water-measuring station Zagreb for the period from 1926 to 2001. Source: Report for the Protection zones of water pumps of Velika Gorica (Mining, Geology and Petroleum Faculty, 2009.)

According to data from the Study of interaction of the Spatial Plan of the Zagreb County content of anticipated content in the area of Zagreb Airport and Črnkovec water pumps, the water of the Sava River at the Petruševec station is of very variable quality, depending on water levels and the degree of dilution. A good indicator of the general state of the water quality is parameter $KMnO_4$, which significantly increases during low water levels of the river, when discharged wastewater upstream has a large impact on the total mass of water in the river. The same goes for the content of dissolved oxygen, which is much higher in the winter than in the summer, during low water levels of the river. The nitrate content in the Sava River is relatively low, with possible variations. The largest changes show the content of total and mineral oils, which is connected with periodic discharges of wastewater into the river. Therefore, the water of the Sava river is periodically loaded with pollutants, and the quality of the water is in the range of I to IV types, however, the last four years the water of the Sava River does not exceed the value specified for the type II quality of surface water, and for some parameters it may even fall into type I water. Improving the quality of the waters of the Sava River is the result of general developments in the basin, where there are less hazardous industries and more wastewater treatment. However, it should be noted that the waters of the Sava River have a lot of iron and sometimes manganese. The water is of poor bacteriological composition and is constantly in the range of type IV to V, but in this area in recent times there have been some improvements, and in 2003, the water in the Sava River was type II quality from the aspect of bacteriological contamination.

The negative impact of the river on the groundwater quality in natural conditions is lost by filtration through layers of gravel already after 180 yards, but with the construction of the pumping station and the long-term filtration with increased speed of underground stream, a gradual expansion of this zone should be expected towards the water pumps, especially Kosnica-east. Additionally, it should be mentioned that the nuclear power plant Krško, which uses the water of the Sava River basin as technological water and returns the excess back downstream into the river. Eventual incidents could have disastrous consequences for the entire Zagreb underground aquifer and all groundwater in the Sava River Basin downstream from the plant. A temperature increase because of the plant's operation cannot have a significant impact on groundwater.

Odra river

The Odra River, another major watercourse in the observed area has clear and strong sources, which had emerged from the groundwater of the right bank of the river Sava. The Odra is a lowland river with a slow flow, with a total length of 83 km, the size of the catchment area is approximately 846 km^2, of which 415 km^2 is located in the Zagreb County. According to the terrain elevation, the Odra basin is divided into hills (includes Vukomeričke hills and a small part of eastern Plešivica) and valleys on the portion located in the wider area of the work. The concerned area, in the lowland part of the basin, the streams that flow into the Odra River are Želin, Kosnica, Ribnica and Bapča, along with Siget and Stara Lomnica which are located right next to the border of the Plan. Besides the flow of surface water, the water regime of the large waters of the Odra River are influenced by the underground water regime. However, the extremely high flows can be created only due to surface runoff, which, given the geological characteristics of the soil, allow the creation of a small special inflows. From sources in the direction of the south, the Odra River flows through the "tap" in the relief Sava canal – the Odra. A few kilometers downstream is the end of the canal and the river again runs its natural trough through the Odransko field parallel to the Sava River, and near Sisak it flows into the Kupa River.

The Zagreb County Spatial Plan proposed the spring area of the Odra River for protection, pursuant to the Protection of Nature Act as significant landscape. In the upper part of the source area of the Odra River is a typical lowland rural landscape, important from the hydrological, water supply and botanical standpoint, and is rich in bird species.

According to data for the Odra River for 2001 – 2003, at the location next to the bridge Čička Poljana, the physical-chemical parameters and oxygen and biological parameters were within limit values set for water type I or II. Regarding nutrients, increased were only those values of nitrogen compounds in the form of nitrates and only for the year 2001 (type III) and from organic compounds of mineral oil for 2002 and 2003 (type III).

Other surface waters

From surface waters in the observed area are the smaller streams: Kosnica, Bapča, Želin, Ribnica and Savišće. A feature of these streams is that they drain the groundwater of alluvial, gravel-sand horizons. At the initial part of the flow of Kosnica and Ribnica, the basin would be filled only in the rainy period and during high groundwater levels and water levels of the Sava River. However, due to the continuing trend of lowering of groundwater levels, both these streams, especially Kosnica, is drying on the upstream part of its course. These impacts are less frequent in the river Ribnica because it somewhat deeper cut into the ground. The streams are formed only a few kilometers to the southeast, in the area with elevations lower than the Kosnica pumping areas, where these streams collect water from the underground and around the settlement Novo Čiče along with smaller streams (Želin, Bapča, Siget and Stara Lomnica)and flow into the Odra River. Slightly upstream from the estuary of the Odra River, near the settlement Jagodno, the stream Kosnica in the period from 1979 – 1982 had the maximum flow rate of 1.18 m^3/s, which was almost the same flow as Ribnica stream (1.12 m^3/s). From the above stated it is evident that due to the long-time lowering of the Sava River water levels and the levels of groundwater, the steams Kosnica and Ribnica do not have a significant effect on the hydrological relationship on the area of the Kosnica pump.

A rainwater drainage system is built partly on a narrow area of Velika Gorica and rainwater is discharged into watercourses of Želin, Bapča and Kosnica and Stara Lomnica. The Odra River is the ultimate, common natural receiver of rainwater from the subjected area of the Plan. Within the network of open channels or the former amelioration channel of the Odranskog field in the inner city area of Velika Gorica, the collected rainwater water is still discharged into the creek Želin. Rainwater from the settlement Pleso and Zagreb Airport is gravitationally collected and taken by the Pleso channel to the Bapča stream or the Kosnica stream.

3.8. PEDOLOGICAL CHARACTERISTICS

Characteristics of the soil over a wider area of the work
General view of the characteristics of the soil are shown in the area covered by Figure 3.8.-1. Therefore, the area around the terminal zone of Zagreb Airport and the future access roads are covered. Figure also shows the construction of the terminal zone of Zagreb Airport relating to the first phase, and the future construction zone that will be built in the second phase.

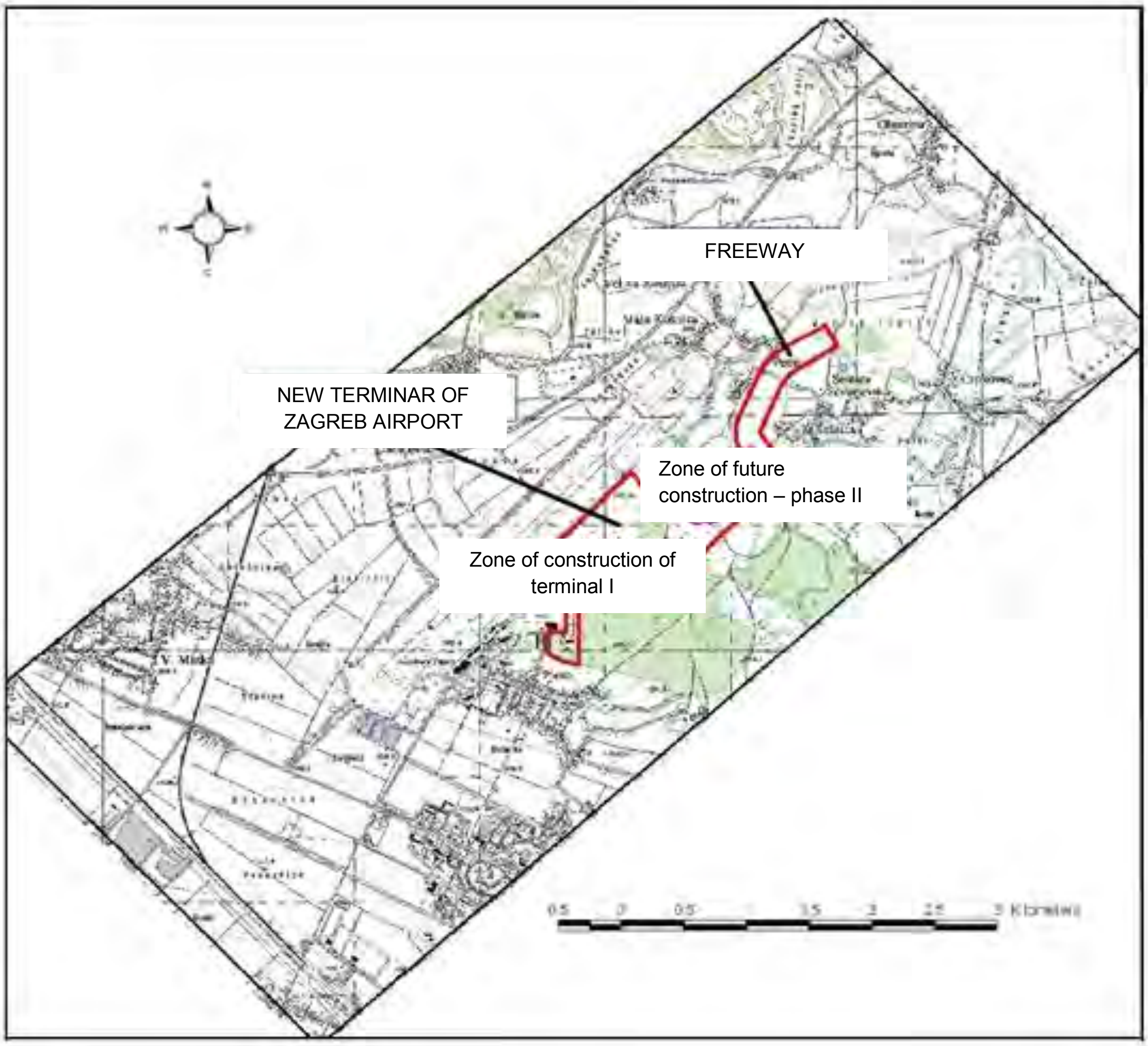


Figure 3.8.-1: Location of the new terminal for Zagreb Airport with access road

<u>Condition of soil pollution with heavy metals</u>

Based on the report "State of contamination of soils in the area of the Zagreb County" (Romić and associates, 2004), a high average content of heavy metals was identified in the wider area of the new Zagreb Airport terminal. At the same time, one of the major anthropogenic sources along with the others is stated by Zagreb Airport. Specifically, in the wider area of the runway operations, there is the deposit of particles from the air which can be loaded with heavy metals, which occur during the combustion of jet fuel. This is particularly important since Zagreb Airport now does not implement the monitoring of surrounding agricultural land, which will be necessary to introduce as a measure of control and the protection of human health.

Soil Map of the wider area of impact from the work

For a description of the current state of the ground in the wider area of impact, a soil map was made which is displayed in Figure 3.8.-2. The stated map was prepared on the basis of existing soil maps of the Zagreb County with a scale of 1:100,000. Table 3.8.-1. shows the mentioned soil map key with the stocktaking of the area. With analysis and processing of the made soil map and its key, it was determined that several types of soil appear and their list and basic characteristics are shown in the following chapters.

Table 3.8.-1: Key of the soil map of the wider area of the work

Cartographic soil unit		
No.	**Name and composition of systematic units**	**Surface, ha**
1	Rendzina on alluvial gravel and sand Eutric brown on a Holocene deposit Semigley (alluvial field) carbonaceous	1273,6
2	Eutric brown on a Holocene deposit Luvisol typical	429,6
3	Semigley (alluvial field) carbonaceous Alluvial gley and non-gley carbonaceous Marsh gley hypogley, mineral	1397,4
4	Marsh gley hypogley, mineral, carbonaceous Marsh gley amphigley, mineral, carbonaceous Semigley (alluvial field) carbonaceous and non-carbonaceous	51,5
5	Alluvial carbonaceous, middle deep and deep loamy Alluvial carbonaceous gley, deep and very deep	26,6
6	Marsh gley hypogley, mineral, carbonaceous Marsh gley amphigley, mineral, carbonaceous	26,0
7	Settlement	27,6
8	Water surfaces	41,1
Total		**3273,4**

Characteristics of systematic units on the wider area of impact

Analysis of the soil map found that in the study area there are six soil types which appear in more low or systematic soil units. From the sections of automorphic soils it was determined that rendzines, eutric brown and lessive soil appears in this way. From the sections of hydromorphic soils, it was determined that semi-gley, gley alluvial and marshy ground appears. Below are presented the main features of individual types and lower systematic units of soil.

Rendzine is the humus soil of an accumulative class, which in this area appears on alluvial gravel and sandy and loamy textural. Characterized is only the presence of humus accumulation (A) of the horizon, below which is parent material. As a member of the dominant soil combination, it appears in mapped unit 1, while it does not appear as a secondary member. The properties of rendzines dominantly depend on parent substrates. The most favorable properties have loamy rendzines which are shallow to medium deep soil depending on the depth of gravel and sand, good natural drainage, with a distinct automorphic way of wetting, loamy texture, is very favorable, crumby and stable structure, favorable water air relations with extremely good water stability. These are mostly calcareous soils, well humus, and well stocked with nitrogen. They are poorly stocked with physiologically active phosphorus are and their potassium is in moderation. The sand and skeletal rendzines have much worse physical and chemical properties. Rendzines, as the ground, have been used in agricultural production of a long time, which is why it is very anthropogenized.

Figure 3.8.-2: Soil Map of the wider area of construction of Zagreb Airport and access roads

Eutric brown soil (Eutric Cambisol) belongs to the class of cambic soils and has a very high production potential. It is characterized by the presence of the cambic ("B" v) horizon. It comes as member of the dominant soil combination in mapped unit No. 2, and as a secondary member of land combinations in mapped unit No. 1. It occurs on alluvial drifts with a mainly loamy textural content. These are mostly loam soils, with stable crumble structure, with good water and air permeability relationships. They have favorable natural drainage. They are very porous with a high capacity for water. These soils have good pedo-chemical properties. They have slightly acid reactions in water, they have humus from 2-4%, and their nitrogen as well to rich stocked. They are low in physiologically active phosphorus, and low to moderate in potassium. And eutric brown soil has been for a while in intensive agricultural production, which is why it is anthropogenized.

Luvisol soil belongs to the class of eluviation illuvial soils characterized by the presence of eluviation (E) and an illuvial argiluvic (B) horizon. It appears only as a secondary member of land combinations in the mapped unit no. 2. Loess soils are highly differentiated, medium deep to deep soils. They have a loamy texture on the surface and clay loam to clayish loam in the argiluvic horizon. The arable horizon has a powdered to crumbly unstable structure, and argiluvic have a moderately coherent structure that crushes the pisiform in pea-like aggregates. Water air relations are somewhat unfavorable, because the soil is prone to compaction, and given the tendency of this soil, they are unfavorable for the germination of sensitive cultures. The chemical properties are weak to moderately favorable. They have a weak acid to strongly acid reaction depending on the material on which they occurred. These are low humus to very humus soil which is good to very rich in nitrogen. Physiologically active phosphorus content is very low, and potassium levels are moderately to well stocked. The degree of saturation of the adsorption complex in the soil bases is mediocre on average. Mostly they are very anthropogenized due to prolonged use in agriculture.

Semi-gley (alluvial meadow) is a soil that characterizes the presence of groundwater beneath 1.0 m of soil, or the semi-gley manner of wetting. It occurs in association with the dominant units in the third mapped unit, and as an accessory in the 1st and 4th mapped unit. Areas where they are located represent columned areas of alluvial beams, which have embankments for defense from flooding. According to pedo-physical properties, these are very favorable soils. They have a predominantly loamy texture, and deep loose soils. The structure of these soils is crumbly to pisiform, and the soil permeability to water is moderate to moderately low. These are porous soils with favorable water-air relations. These are mostly calcareous soils, but there are also non-carbonate soils. The soil reaction in water varies slightly acid to alkaline. The humus content in these soils ranges mostly within the boundaries of good to very humus soils. They are moderate to rich in nitrogen content. The supply of physiologically active phosphorus is very poor to poor, although some sections show a good supply as a result of increased individual fertilization. Most are middle-stocked with physiologically active potassium. Almost all of these soils are anthropogenized.

Alluvial soil (fluvisol) which belongs to the class of undeveloped hydro soils, represents the most recent alluvial deposits. It appears as the dominant member of the combinations in the land of mapped unit No. 5, and as secondary in mapped unit No. 3. These soils have recently been flooded, but after the construction of the embankment of the Sava River there is no more flooding so their direction of development is going towards the emergence of semi-gley soils. These soils today have a good drainage and favorable texture, are deep, have little humus, active nutrients, and good base saturation. Outside of the inudation zone, these soils are mostly very anthropogenized as well as other soils.

Swamp gley soil (eugley) belongs to the class of gley soils. It is characterized by the presence of excessive wetting with superfluous water. It appears in association as the dominant unit in 4 and 6 of the mapped unit, and as a secondary in the third mapped unit. These soils are predominantly pastures and meadows and arable land, and they occupy the lowest geomorphic positions in the area. Its soils have very limited pedo-physical properties, so without amelioration they can generally used as meadows and pastures. Below we describe the major units with respect to the different issues according to the way of wetting and necessary measures of drainage.

-Hypogleyic- soil is moistened exclusively with groundwater and in relation to other units of the eugley, this is the best soil for lawns and pastures, and from them with ameliorative measures it is possible to obtain the best hydroameliorated soil. These are somewhat lighter soils in texture, from sandy loam to silty clay, but they are predominantly loamy texture. The structure is coherent in the lower parts and the surface layer often has a pea-like to crumbly texture. Porosity is large, the soils are plastic, medium sticky, and the relationship of micro and macro pores are unfavorable. The water porosity has highly variable values, especially in the surface horizons, which is understandable. The values of unreachable waters are moderate to high. They have more favorable chemical properties. The soil reaction in water is 6.7 to 7.4, therefore from non-carbonate to carbonate form. In their carbonate hypogley the carbonate content reaches up to 15% $CaCO3$. These are quite humic soils with good to rich nitrogen content. They are poorly stocked with physiologically active phosphorus, and potassium is poor to good. The values of the adsorption complex of these soils are good. They have a high degree of saturation of the adsorption complex of the soil databases, and mediocre capacity of adsorption.

-Amphigleyic pedo-physical soil has more favorable characteristics than previous units and according to their characteristics, they are more difficult to reclamate than hypogley. These soils have a poor water-air relationship, which have a high capacity for water, and a very small volume for air. The permeability of these soils for water is very small. According to the reaction of the soil, the soil may be acidic to alkaline. These are very humus soils. This comes from the fact that the values of nitrogen are quite high. They are on average very poorly stocked with active phosphorus, and potassium is poor to good.

Features of mapped soil units in the wider area of impact

On the soil map 5 mapping units were separated, for which the names and composition of soil was given in the map key. It should be noted that the mapped units are set land combinations which consist of 2-3 systematic units. The basic features of the mapped soil units that include parent material, slope, depth of organic soil drainage, the dominant method of wetting and the texture of the soil surface, are shown in Table 3.8.-2. The mentioned features fully characterize the systematic and mapped soil units.

Table 3.8.-2: Basic features of surface mapping units

Mapped unit of the soil		Features of mapped units of soil					
Numb.	Name	Main substrate	Slope	Ecological depth of the soil	Drainage	Dominant way of wetting	Texture of the surface layer of soil
1	Rendzine on alluvial gravel and sand Eutric brown on holocene sediment Semigley (alluvial meadow) carbonate	Holocene gravel and sand	Straight	Medium deep to deep	Good	Automorphic	Clay-loam loam
2	Eutric brown on holocene sediments Luvisol typical	Holocene gravels and loam	Straight	Deep to very deep	Good	Automorphic	Loamy clay -like
3	Semigley (alluvial meadow) carbonate Alluvial and colluvial soils neo-gleyic carbonate, swamp glay, hypo-glay, mineral	Holocene gravel and loam	Straight	Vera deep	Good	Semi-gleyic	Loamy
4	Swamo gleyic hypogleyic, gleys, amphigleyic, mineral, carbonate, semi-glay (alluvial meadow) and carbonate non-carbonate	Holocene deposits	Straight	Medium deep	Incomplete	Hypo-gleyic	Loamy-loam-, clayic
5	Alluvial carbonate, medium-deep and deep loamy alluvial calcareous, colluvial soils, deep and very deep	Alluvial deposits	Straight	Deep to very deep	Incomplete	Alluvial	Loamy
6	Swamp gleyic, hypogleyic, mineral, carbonate, swamp gleyic, amphigleyic, mineral, carbonate	Holocene deposits	Straight	Medium deep to shaloow	Incomplete to week	hypogleyic and amphigleyic	Loamy-loam clayic

Land use in the wider area of impact is shown in Figure 3.8.-3.

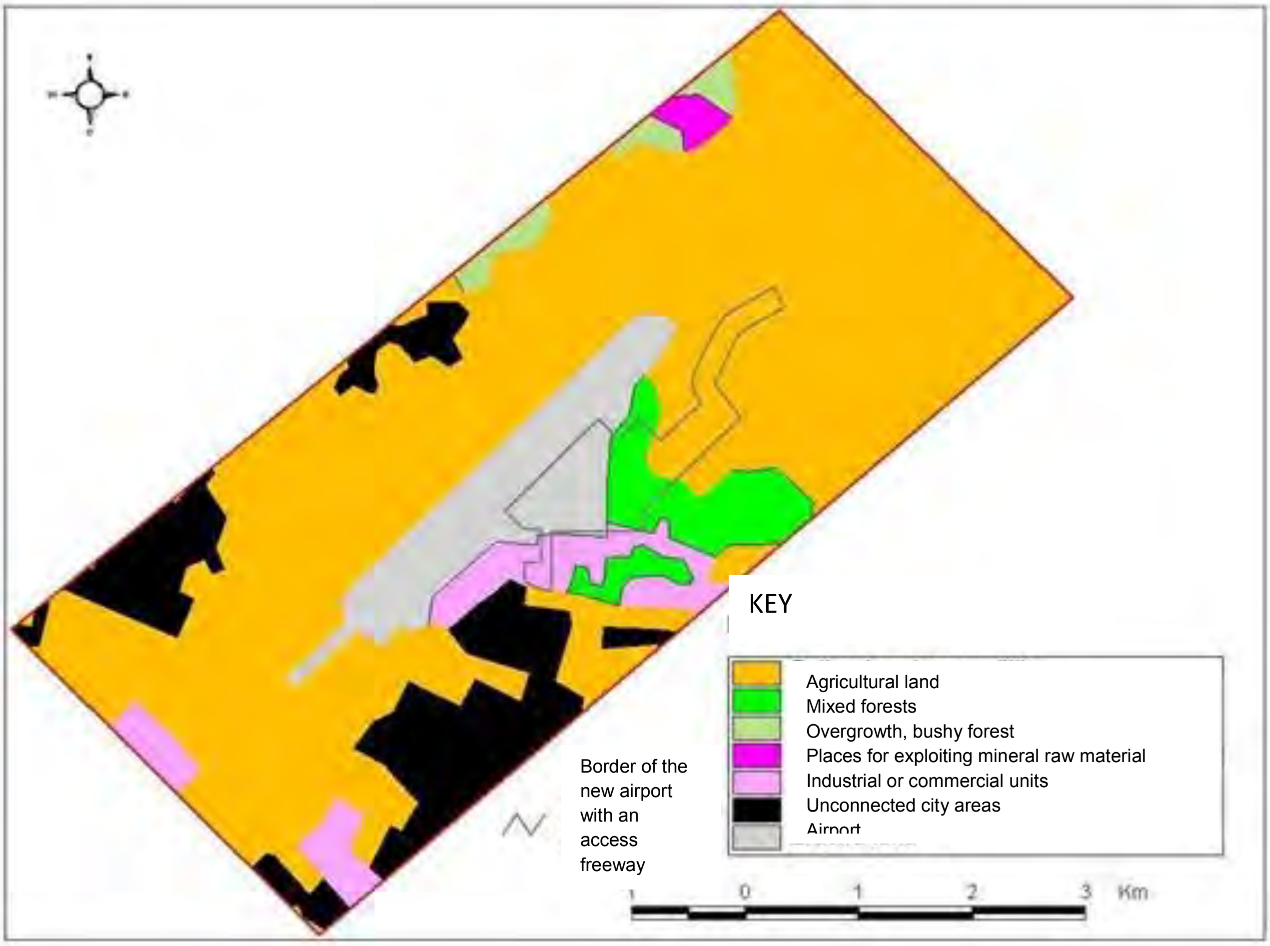


Figure 3.8.- 3: Map of the ways to use the land on the wider area of impact

Based on the above map, it was found that the wider impact of the project area is dominated by agricultural land which occupies about 67% of the study area. The surfaces of other classes are shown in Table 3.8.-3.

Table 3.8.-3: Class of surface and way of using the land on the wider area of impact

Name of use	Surface ha
Agricultural land	2207,5
Mixed forests	147,4
Overgrowth, brushy forest	51,6
Places for exploiting mineral raw materials	19,8
Industrial or commercial units	170,9
Disjointed urban areas	401,7
Airport	274,5
Total	3273,4

Agricultural land dominates In the wider area of the existing airport and the area of the new passenger terminal of Zagreb Airport, which is necessary to take into account in the evaluation of impact.

Soil Map of the area of construction for the new passenger terminal of Zagreb Airport and access roads

The soil Map for the area of work for the construction of Zagreb Airport is built on existing data and supplementary field observations. This map that is shown in Figure 3.8.-4, has three mapping units defined. By analyzing the soil map legend (Table 3.8.-4) it was found that in this area has four soil types, eutric brown soil, semigley (Alluvial meadow), swamp gleys, hypogleyic and alluvial. Displayed below are the features of these types of soils.

Table 3.8.-4: Key to the soil maps in the area of construction for the Zagreb Airport

Cartographic unit of soil		Surface, ha		
Nmb.	**Name and composition of systematic units**	**Under foresters**	**In agriculture**	**Total**
1	Eutric brown on holocene deposits Semi-gley (alluvial meadow) carbonate	5,8	-	5,8
2	Semi-gley (alluvial meadow) carbonate Alluvial and colluvial soils neo-gley carbonate	0,3	26,6	26,9
3	Semi-gley (alluvial meadow) carbonate Alluvial and colluvial soils neo-gley carbonate Swamp gley hypogleyic, mineral, carbonate	29,2	28,1	57,3
4	Road			0,2
5	Parts of settlements with yards			0,9
6	Waterways			2,7
7	Military land with buildings			60,0
Total		35,3	54,7	153,8

Features of systematic soil units in the area of the construction of Zagreb Airport

Eutric brown soil (Eutric Cambisol) belongs to the class of cambic soils and has a very high production potential. It is characterized by the presence of cambic ("BV") horizon. It comes as a member of the dominant soil combination in the mapped unit No. 1. Areas in which they this type of soil is located is completely forested. It appears in an alluvial loam textural. These are loamy soil, non-carbonate, stable crumble structures, good water and air permeability relationships. They have favorable natural drainage. These pedochemical soils have favorable properties. Slightly acid reactions are in water, humus is 2 - 4%, and they are well stocked with nitrogen. Physiologically active phosphorus is low, and potassium is weakly to moderately stocked.

Semigley (alluvial meadow) is a soil that characterizes the presence of groundwater beneath 1.0 m deep soil, of the semigley manner of wetting. It occurs in association as a dominant units in 2 and 3 of the mapped unit, and as a secondary in 1 mapped unit. According to pedo-physical properties these are also very favorable soils. They have a predominantly loamy texture and area very loose. The structure of these soils is crumbly to pea-like. These are porous soils with low water air relations. These are predominantly calcareous soils. The reaction of the soil in water is around slightly alkaline. The content of humus in these soils ranges mostly within the boundaries from good enough to very humus soils. They are mostly moderate to rich in nitrogen content. Most are medium supplied with physiologically active nutrients. Soils that are located in the agricultural land are very anthropogenized.

They swamp gleyic hypogleyic ground belongs to the class of gley soils. It is characterized by the presence of excessive wetting of a high water level. It occupies the lowest parts of the field. It comes in association as a secondary member of the land combination in the mapped unit number 3. These are by texture loam to clay loam soils. Their structure is coherent in lower parts, and the surface layer often has a crumbly to pea-like structure. The ratio of micro and macropores is suitable, although the water-air ratios are unsuitable due to the high levels of groundwater. The reaction in water is a weak alkaline, the supply of humus is good and the supply of nutrients is medium. Some of these soils which are located in agriculture are largely very anthropogenized.

Alluvial soil (fluvisol) which belongs to the class of undeveloped hydro soils represents the most recent alluvial deposits. It occurs as a secondary member of the land combinations in the mapped unit number 2 and 3. These soils in an earlier period were flooded, but after construction of the embankment of the Sava River there was no more flooding so these soils are now used in intensive agriculture. They are characterized by good drainage, sandy loam to silty texture, weak humosity and moderate nutrient availability, especially in those soils which are used in agriculture.

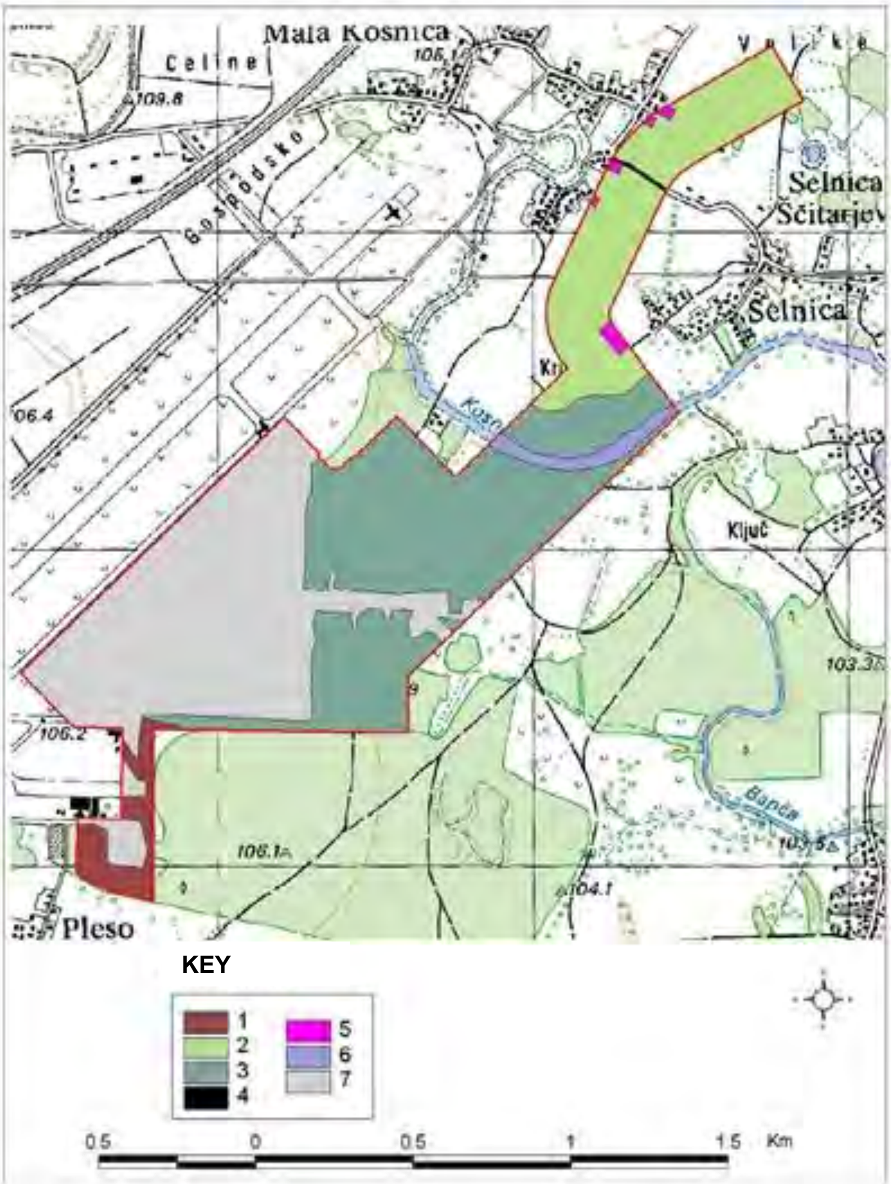


Figure 3.8.- 4: Pedological map of the construction area of the new terminal of Zagreb Airport

3.9. PROTECTED AREAS

The area covered by the work does not have protected natural values by the Nature Protection Act.
With the Zagreb County Spatial Plan, the Spatial Plan of Development of the City of Velika Gorica and Spatial Plan of Development of Orle, the wider area has identified the following natural assets that are proposed to be protected by the Nature Protection Act (Official Gazette No. 70/05, 139/08):

1. IN THE CATEGORY OF PARK FORESTS:
Oak groves along the Zagreb Airport (Velika Gorica)
The oak grove at the airport Pleso is located across the airport terminal building. It represents the last remnant of a once native oak forest. On a larger surface, the oak is relatively healthy.

2. IN THE CATEGORY OF SIGNIFICANT LANDSCAPES:
The source area of the river Oder (Velika Gorica, Orle)
The source area of the Odra River in its upper part is a typical lowland rural landscape where a rich hydrographical network is intertwined, which consists of a number of streams (Želin, Kosnica, Ribnica, Bapča, etc.) which emerge with numerous clear and strong springs. The area is important for the hydrological, water supply and botanical point of view, and is rich in bird species.
Vegetation of the area consists of willow, alder, some poplars, reeds and bush.
Today this area is quite impaired with improper construction, a pending sewer system, as well as strictly technical regulation of certain watercourses, and behavior of the neighborhood residents of the area who dispose of waste by burying it in some sources.

3. IN THE CATEGORY OF MONUMENTS OF PARK ARCHITECTURE:
The park around the parish church of St. Martina Ščitarjevo (Velika Gorica)
The church and the spacious courtyard are surrounded by a fence with two entrance doors. A beautiful specimen of a secular chestnut tree has been preserved in front of the main entrance. Individual trees as well as the original fence have been preserved in the area of the park.

4. IN THE CATEGORY OF NATURAL MONUMENTS:
English oak along the slope of the embankment in Bukevje (Orle)
The solitary oak tree dominates its habitus on the Sava embankment as a landmark in the area. It is located on a part of the embankment near the settlement Bukevje. The tree is vibrant and with proper habitat and a branched crown.
Furthermore, the stated spatial plans have also separated areas of especially valuable regions – natural and cultivated landscapes which are protected with the spatial plan measures with these plans. Among these regions in the observed surface coverage, highlighted is the **Belt along the Sava River (Velika Gorica, Orle)**, recognized as a valuable region – cultivated landscape. In the typical lowland rural landscape meanders stand out from the typical lowland forest vegetation composed of willow, alder, poplar, oak and some wild ash that spreads out in a landscape with traditional settlements and villages, where wooden houses are still preserved. With the planning and regulation of Sava, the natural characteristics of the landscape, the flora and fauna are lost, and this decreases the biological variety of the region.

3.10. ECOLOGICAL NETWORK

In the vicinity of the planned work, within a radius of 10 km, there are two areas of the ecological networks of the Republic of Croatia important for birds: **Turopolje - HR1000003** and **HR1000002 Sava near Hrušćica (with surrounding gravel)**. The edges of both areas are located within a distance of 5 km from the border of the work area. At a distance of about 3 km is the ecological network **HR200116 Sava**. The acceptability of the planned work on the ecological network has been the subject of the Report of previous evaluations of acceptability of the new passenger terminal of Zagreb Airport on the ecologic network. The report was prepared by the Institute IGH Plc. in January 2012. The Ministry of Environmental Protection and total revenues issued the Confirmation Class: 612-07/12-01/0064, Reg. No.: 517-12-4 from February 28, 2012 that the planned project will have no significant impact on the conservation objectives and integrity of the ecological network (Annex 2, Book III). Therefore, the ecological network, possible impacts on the ecological network and mitigation measures and environmental monitoring networks and the proposal of measures of protection and monitoring the state of the ecological network is still not considered in this study on the impact on the environment. In Figure 3.10.-1 we give an extract of the State Institute for the Protection of Nature - a graphical representation of the position of the planned work in relation to the area of the ecological network.

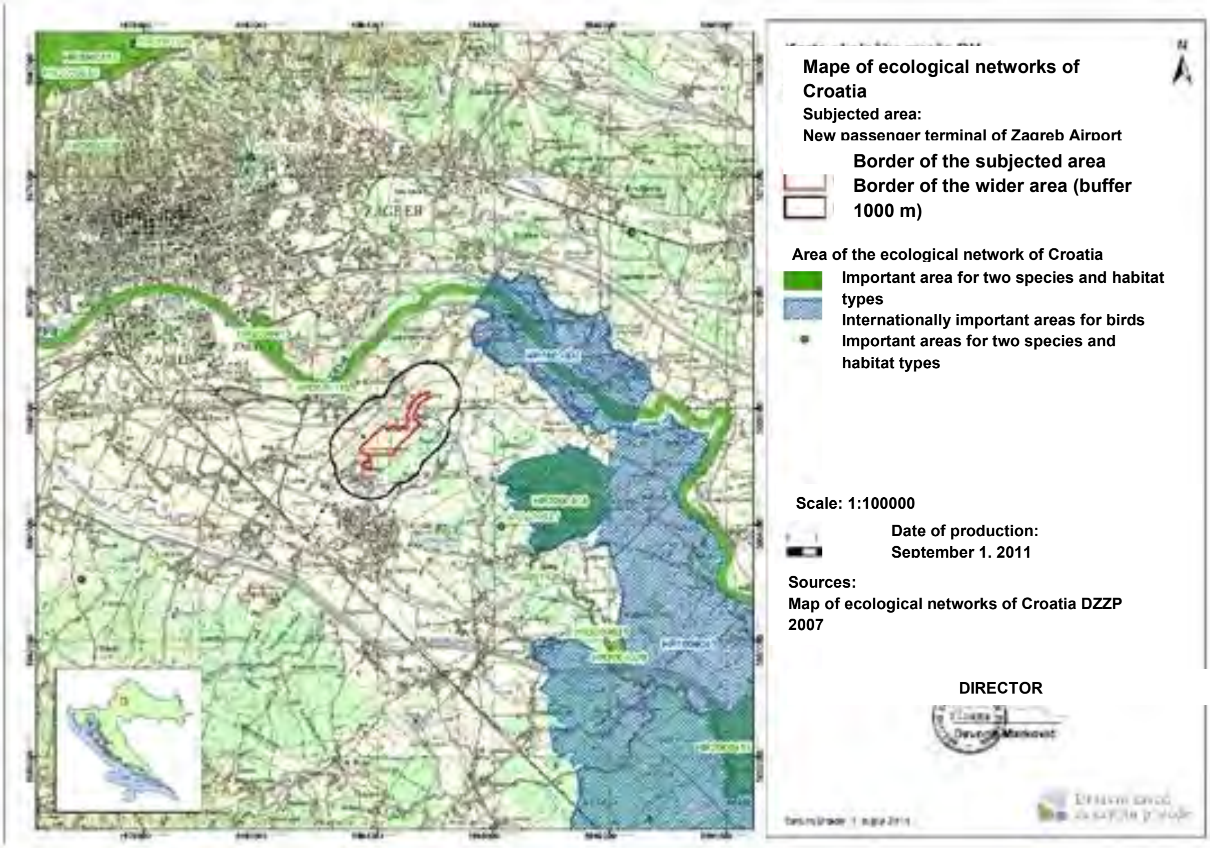


Figure 3.10.-1. Locations of the work in relation to areas of ecological networks of the Republic of Croatia

3.11. FLORA AND FAUNA

3.11.1. Habitat

The area of the project of building a new terminal at Zagreb airport, a total area of 1.3 km2, located north of the town of Velika Gorica, near the Zagreb Airport.
According to the map of habitats of RC, the dominant habitats in the project area mosaics of cultivated areas, which occupy about 46% of the total site area (Figure 3.11.1.-1). Intensively cultivated arable land comprises about 0.6%, and mixed oak-hornbeam forests and pure hornbeam about take about 5.8% of the total site area. A significant part (about 40%), are infrastructural surfaces. The rest are rural areas (the edge of Petina and Selnica Šćitarjevska) which occupy about 4.1% of that city housing surface, which makes about 1.5% of the total project scope.

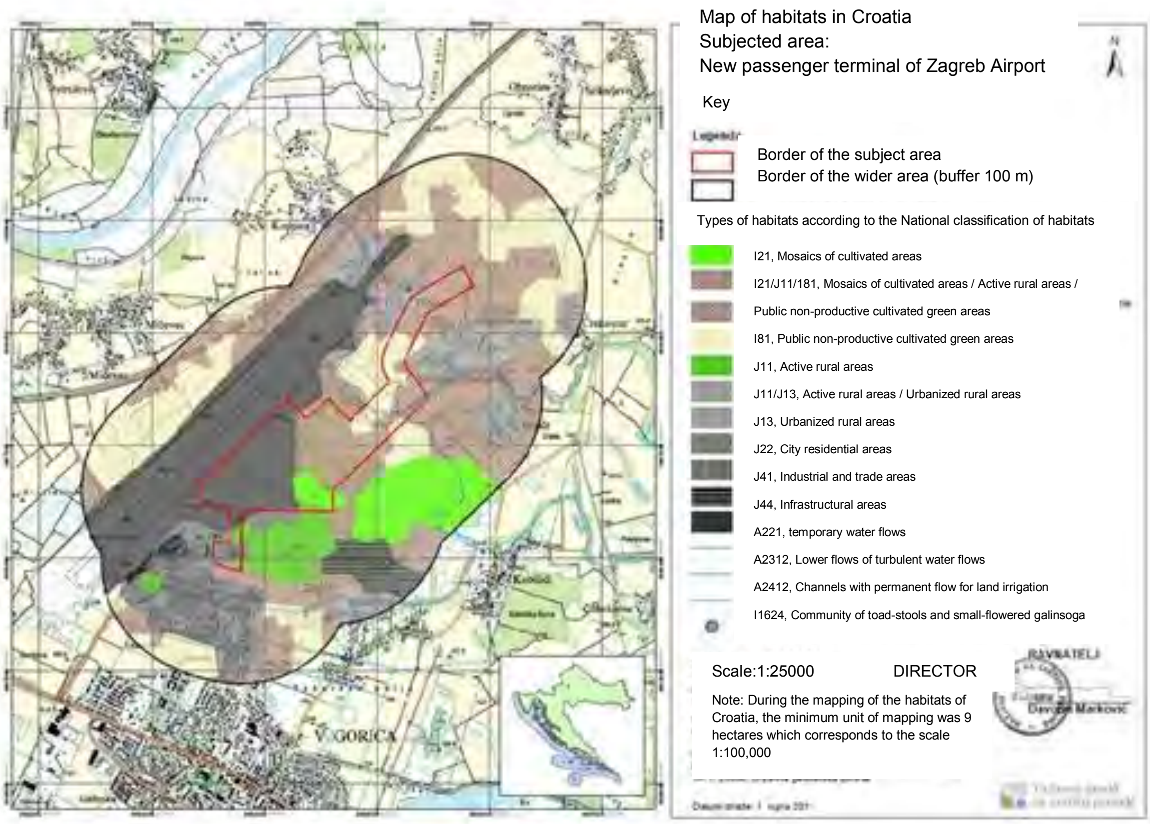


Figure 3.11.1.-1. First certified extract from the map of habitats

By touring the site area it is determined that many pitches (fields and hay meadows) are now abandoned (about 25% of the total area). They are located at different stages of vegetation succession, and many of them are already at the stage of low shrubs (Figure 3.11.1.-2).

Figure 3.11.1.-2. Abandoned arable land and hay meadows on the location of the project in different phases of vegetative succession.

The area of operation covers the Kosnica channel in the length of about 600 m. Given that the channel occasionally dries up, and its shores are regularly mown, along the stream there is no developed wetland vegetation or cane (Figure 3.11.1.-third) and it has a very small, almost negligible, value as a habitat for water birds and wetland habitats.

Figure 3.11.1.-3. Dry riverbed of Kosnica Channel. The bank of the channel is mowed regularly.

The buffer zone (immediate vicinity of the intervention, or a belt 1 km wide around the border of the site area) includes the same habitat as the project area. And in that zone (Figure 3.11.1.-first), the most common are habitats mosaic rural landscape (35% of the total buffer zone). However, the proportion of intensively of used arable land in the buffer zone is much higher (about 21%), and the areas of infrastructure are much smaller (21%) than in the area covered by the project. Mixed oak-hornbeam and pure hornbeam forests cover about 7% of the total surface of the buffer zone.

Figure 3.11.1.-4 forests of oak and hornbeam at the location of the project.

3.11.2. Flora

The climazonal vegetation community with its composition clearly reflects the mutual complex influence of the climate, terrain and soil. According to horizontal articulation, it generally enters the widest scope of continental Euro Siberian-North American region (Holarktis), and includes the central sub-area determined with the climax of oak and hornbeam (Qerco-Carpinetum croaticum Horv.) According to vertical division it is divided into two sub-belts. The area Vukomeričke gorice matches the mountain (Kolinska) belt with a mesophilic climax of oak and hornbeam (epidemio-Carpinetum betuli Borh.; Querco-Carpinetum croaticum Horv.), on the base of real brown forest podzol. The lowland area corresponds to the continental planar zone, which compared to the surrounding hilly areas are characterized as a modified bio-climate. It is determined by regional half-wet and wet forests of oak (Genisto elatae-Quercetum roboris Horv.).
Given the climate and general local environmental conditions, the areas of oak forests were somewhat differentiated into a few types of forest communities. In the framework of a permanent community of floody oak woods (Genistoelatae-Quercetum roboris Horv.) in Turopolje prevails a species in the lower system category (Quercus robur var. tardissima Mat.), so called. "Jelenščak" that unlike ordinary oak thrives in damp areas and is adapted to frost areas. In the north-western plains of Turopolje and the City of Velika Gorica, where flood protection changed the primary ecological conditions, significant changes have taken place in environment conditions, there are significant changes in this lowland stand into a stand of oak forest and ordinary hornbeam (Carpino betuli - Quercetum roboris Horv.; Genisto-Quercetum roboris carpinetosum Horv.). It extends mostly to the higher level of Sava flood plain and terrace, on moist soil, but out of direct flooding. However, locally, the lower aquatic and wetland parts, moist characteristic habitats remain crucial for vegetation. Therefore, here there are highly developed aquatic and wetland communities of ash, alder, willow and poplar.

The project area of Zagreb airport has three types of forests:

1. Forests of oak and hornbeam (Carpino Subas. betuli - Quercetosum roboris)
2. Forests of oak woods with large gorse and trembling (pale-yellow) sedge (Subas. Genisto elatae-Quercetum roboris caricetosum brizoides Horvat 1938)
3. Floodplain forest of black and white poplar (as. Populetum nigrae-albae Slavnić 1952)

Forests of oak and hornbeam (Carpino Subas. betuli - Quercetosum roboris) are developed on the entire land area of oak and have an optimal habitat in Posavina, Podravina, Pokuplje and central Croatia. In this area, it occupies about 35% of total forest area, which is the highest percentage of a phytocenoses. One of characteristic sinecological conditions for the phytocoenosis is that it is still evolving on the timbers and wet timbers that are outside the range of flood waters (except possibly short term wet timbers). Hornbeam is the best indicator of this community because it withstands short transient flooding but cannot stand standing water and a high groundwater level. The community has wide ecological amplitude, comes on hydromorphic soils as pseudogley, pseudogley-gley, epiglej, semigley and hypogley and on automorphic soils, luvisol on loess and eutric Cambisols. Typical forests of oak and elm originated from natural succession from Genisto elatae-Quercetum roboris forests where hydraulic engineering works that were carried out (drainage, flood control) accelerated the progressive selection. It is due to the gradual reducing of humidity, spreading and occupying suitable habitats, and compared to other oak forests it presents a stable phytocoenosis. In the structure of the stand dominate red oak to the height of 40 m, while the subordinate level has hornbeam maple, ash and cherry. The stands are grown in rotations of 140 years. Natural regeneration is done using the seeding cuts, seeds that arrived on the regenerated area from old mother trees. Such current type of management has provided complete protection of the habitat and its conservation in a more or less basic form, this type presents one of the most stable communities in the valley, it could be jeopardized by the abrupt change in the water regime. The floristic composition of this community consists of:
Tree layer: *Acer campestre, Carpinus betulus, Fraxinus angustifolia, Pyrus pyraster, Quercus robur, Tilia cordata*
Shrub layer: *Cornus sanquinea, Corylus avellana, Crataegus laevigata, Crataegus monogyna, Euonimus europeaus, Ulmus minor*
A layer of ground vegetation: *Ajuga reptans, Anemone nemorosa, Arum maculatum, Athyrium filix femina, Brachypodium sylvaticum, Carex brizoides, Carex remota, Carex sylvaticum, Circea lutetiana, Dryopteris filix-mas, Euphorbia amygdaloides, Fragaria vesca, Galeopsis tetrahit, Glechoma hederacea, Hedera helix, Lamium galeobdolon, Lysimachia nummularia, Oxalis acetosella, Polygonatum multiflorum, Ranunculus ficaria, Rubus*
hirtus, Rumex sangineus, Stellaria holostea, Veronica chamedrys, Veronica montana, Viola reichenbachiana.

Oak woods with a large gorse and trembling (pale-yellow) sedge (Subas. *Genisto elatae-Quercetum roboris caricetosum brizoides* Horvat 1938)
This sub-association comes in the western part of the Croatian Pannonian, on the elevated terraces in Pokuplje, Kalj, Turopoljski lug and central Croatia. According to sinecological conditions it is characteristic that it thrives in valleys on timber, wet timber and on the crossings of timber-strings. The level of basal water level in the spring and late autumn is high. This sub-association towards the elevation gradient is beneath the forest of oak and hornbeam on amphygley, epigleju, pseudoglej and hypogley. Soils are slightly flooding and acidic compared to the other sub-associations of oak and large gorse. According to the economic and other features of this transitional sub-association, it is particularly sensitive to changes in the water regime which led to its increase of drying in Turopoljski lug. These are generally mixed stands of high tree forms, and the ratio of the mixture except oak comes another polish ash, alder, elm and poplar, and on the edges are hornbeam and maple.

According to the floristic composition, the following appear in the tree layers:
Alnus glutinosa, Carpinus betulus, Fraxinus angustifolia, Quercus robur, Ulmus minor
In the shrub layer: *Corylus avellana, Crataegus laevigata, Crataegus monogyna, Frangula alnus, genista tinctoria ssp. Elata, Pyrus pyraster, Viburnum opulus*
In the layer of ground vegetation: *Aegopodium podagraria, Ajuga reptans, Carex brizoides, Circea lutetiana, Cirsium palustre, Cucubalus baccifer, deschampsia caespitosa, Dryopteris carthusiana, Geum urbanum, Humulus lupulus, Juncus effusus, Lycopus europeaus, Lysimachia nummularia, Lysimachia vulgaris, melampyrum sylvaticum, Mysotis scorpioides, Peucedanum palustre, Polytrichum commune, Potentila erecta, Ranunculus ficaria, Rubus caesius, Shropularia nodosa, Veratrum album, Veronica montana.*

Floodplain forests of black and white poplar (as. Populetum nigrae-albae Slavnić 1952) are on higher elevations of river islands, coasts and terraces in areas of rare and short floods from previous communities. In these elevated positions recent alluvial accumulation are low or completely absent so the humization process is primarily dominant in the soil, which is why we end up with the A horizon and testerial characteristics occur. The water level of the basal area is less than 100 cm, and the most common grounds are fluvisol humofluvisol. In economic terms, they used to be valuable stands but today they generally are placed in protected facilities and are left to natural development. Mixture ratio is different, recently there a growing presence of white poplar and foreign species. These stands are endangered by possible change in the water regime as well as the possible introduction of foreign species on their habitat

The tree layer consists of: *Fraxinus angustifolia, Morus alba, Populus alba, Quercus robur, Salix alba, Ulmus leavis*
The shrub layer: *Acer negundo, Cornus sanguinea, Crataegus pentagyna, Rubus caesius, Sambucus nigra, Viburnum opulus*
The layer of ground vegetation: *Aegopodium podagraria, Agrostis stolonifera, Calamagrostis epigejos, Carex remota, Circea lutetiana, Galium aparine, Glechoma hederacea, Humulus lupulus, Lycopus europeaus, Lysimachia nummularia, Poa travilis, Scrophularia umbrosa, Solanum dulcamara, Solidago gigantea, Symphytum officinale, Urtica dioica, Viola reichenbachiana*

3.11.3. Fauna

3.11.3. 1. Bird fauna

In the broader project area (Zagreb, Turopolje, Pokupski pool) in the last twenty years, the employees and associates of the Institute for Ornithology have conducted research of ornitofauna of different communities of birds and their qualitative and quantitative structure is relatively well known. The existing data allows for the creation of a quality assessment of possible impacts of the planned project on ornithofauna. The project site is located in the suburban area of Velika Gorica and Zagreb. The total area of the project is relatively small, and there are habitats that are represented in this area that are widespread and not threatened. The review of species (nesting, migratory and wintering birds) that are listed in the study show a list of expected (presumed) birds species for the project area and its immediate surroundings (Area about 1 km from the boundary of the planned project). The qualitative composition of bird communities and the list of species for the project area and the immediate surroundings are based on the literature data (Muzinić 1984, Radović 1987, Ćiković 2001, Kralj 2000, 2010 Šćetarić, Tutiš et al. 2009) and unpublished data from the archives of the Institute for Ornithology (including ornithological collection of information of the Institute and data on ringing birds). While evaluating certain species used as the maximum population density recorded in appropriate habitats in the wider project area.

Bird communities and their habitats in the scope of the project area
Regarding the distribution and representation of habitats for the project area, we can separate two bird communities: the community of birds of mixed mosaic habitats and the bird community of oak and hornbeam forests. Table 3.11.3.-1st lists the expected bird species in the project area and its immediate surroundings (buffer zone). The list includes 108 species of birds. In this area it is likely that regularly or occasionally 65 species of birds are nesting, and in the wider project area, in habitats such as those within the blunt surface, 13 additional species. Nesting birds of the wider area, which are included in the list, are species that are not nesting on the location of the project and in the immediate vicinity, but have a broad enough area of movement so they can sometimes find themselves in the area of direct impact of the project.
The project area and immediate surroundings are likely either regularly or occasionally used by 48 migratory and 27 wintering birds. Migrating and wintering birds are those species whose abundance increases during migration and winter, which means that there are birds residing in Croatia at that time from populations that nest outside Croatia. A species may be presented in an area with one or more populations, and at the same time have multiple statuses. Part of the species has all three statuses, or at the same time they are nesting, wintering and migrating birds (Table-1.3.11.3.).

Bird communities of mixed mosaic habitats
Mosaic habitats represent a complex of various types of habitats from which neither one occupies a sufficiently large compact area to be regarded as a special habitat.
A bird community of mixed mosaic habitats in the project area consists of species that are with feeding or nesting-related with mixed mosaic habitats that are made of small woods (alder, poplar, willow etc.), thickets, meadows, abandoned and active agricultural areas, hedges, canals etc. At the location there are not enough large grasslands (meadows) in order to develop independent bird communities. Grasslands cover only a small part of the area of study, and largely due to the cessation of mowing are in the phase of succession into scrub (Figure 3.11.1.-2). The mosaic of habitats include villages and intensively treated land in the project area. Mosaic habitats are regularly rich in species because they contain a variety of habitat types. They however lack species that are related to large and compact habitats (vast forests or grasslands). The potential composition of this community for the project area and its immediate surroundings is shown in Table 3.11.3.-1. In the project area and the buffer zone in these habitats there are probably 62 species of nesting birds, and in the wider project area probably 9 more species of birds.

Bird communities of red oak and hornbeam forests
Bird communities in mixed forests of red oak and hornbeam species consist of those birds that are directly associated with this woodland habitat by feeding and nesting. In the project area in this habitat, it is very likely that 27 species are nesting, and in a similar type of forest in a broader area there are probably five more species (Table 3.11.3.-1). The most abundant species in this habitat type are Fringilla coelebs chaffinch, robin Erithacus rubecula and chiffchaff Phylloscopus collybita (Kralj 2000).
As this is an isolated, middle age and relatively small forest complex that is located in an area of constant human activity, with great certainty, it can be concluded that the part of species that belong to the community of birds that habitat in the wider project area (Turopolje Pokupski bazen) do not nest here, which for nesting need old, vast forests, and are also sensitive to disturbance (white-tailed eagle, Haliaeetus albicilla, black stork Ciconia nigra, Lesser Spotted Eagle Aquila pomarina).

Analysis of the status and vulnerability of certain bird species
From 108 bird species that are on the list of expected bird species in the project area and its immediate surroundings, 102 species are protected by the Nature Protection Act (Official Gazette 70/05, OG 139/08, 57/11) and the Ordinance on declaring wildlife species as

protected and strictly protected (OG 99/09). As a strictly protected species in Croatia, 84 species are protected, while 83 species have this status during all year, and one species (forest Snipe Scolopax rusticola) is protected only during the nesting season. The rest of the year, this species has a status as a protected species. 18 species have a status of protected species, and only six species (Gull Larus michahellis, Black-headed Gull Larus ridibundus, urban pigeon Columba livia domestica, starling Sturnus vulgaris, field sparrow Passer montanus and sparrow Passer domesicus) are not protected by law in Croatia.
Most of the species are protected by the international conventions to which Croatia is a signatory. The Berne Convention protected 105 species: 69 species are on Appendix II, and 36 species in Appendix III of the Convention. The Bonn Convention (Annex II) protects 42 species. The Birds Directive protects 39 species - 15 species are listed in Appendix I, and 24 species are listed in Annex II and / or III.

Of particular importance for nature conservation are endangered species of birds at the global, European or national level that regularly or occasionally inhabit the project area or its immediate surroundings. Valuation of bird species with respect to their threat was done by the following criteria:

Endangered species at the global and / or European level.
Vulnerability at the global level is determined on the basis of the status of the species in BirdLife International (2010), and at the European level on the basis of BirdLife International (2004). It was determined that no one globally threatened or nearly threatened species is not on list of potential species for the project area. Among the species that vulnerable at the European level, potential nesting birdsin the project area and its immediate surroundings are partridge Perdix perdix and Lapwing Vanellus Vanellus. Both on the European level have a status of vulnerable (VU) species. Endangered species status on the international level is shown in Table 3.11.3.-2.

Endangered species in Croatia
Endangered species at the national level are determined on the basis of the review of the book Red Book of Croatian Birds (Tutiš et al., In press), and the categories are the following:

- Critically Endangered (CR) species are facing an extremely high risk of extinction
- Endangered (EN) species are at very high risk of extinction
- Vulnerable (VU) are species that are facing a high risk of extinction
- Deficient (DD) are species for which there are not enough quality data on distribution, abundance and population status that would directly or indirectly assess the risk of its extinction
- Nearly endangered species (NT) that are not currently threatened with extinction, but in the near future may become endangered
- Least concerning species (LC) are widespread and numerous species

Endangered species status on the national level is shown in Table 3.11.3.-2.

None of the potential nesting birds in the project area and its immediate surroundings have a status of an endangered species (CR, EN and VU) in Croatia. In the wider project area an endangered species nests- Montagu's Harrier Circus pygargus (EN). Five species in Croatia that have the status of Nearly Threatened (NT) are probably nesting occasionally or regularly in the project area and / or its surroundings, three types (Falcon Falco subbuteo, Barn owl Tyto alba and gray owl Athene noctua), possible nesting birds of mosaic habitats in the project area and its buffer zone, and two types (Honey buzzard Pernis apivorus and Ural owl Strix uralensis) are nesting birds of forest habitats in the broader surroundings of the project area.

None of the species that are potential migrating birds and / or wintering birds of the project area and its immediate surroundings have the status of a species threatened or nearly threatened migrating or wintering population in Croatia. By analyzing the status of species at the international and national level, out of 108 species potentially inhabiting the area of the planned project and its surroundings, eight species (partridge, lapwing, Hen Harrier, Hobby, barn owl, little owl, honey buzzard and Ural owl) are important in the protection of nature for which it is necessary to consider the potential negative impact of the project on their population.

Table 3.11.3.-1. List of expected bird species for the project area and its immediate surroundings (Buffer zone).

- Safety status of species at the national level is given by Red Book of endangered Bird of Croatia - 2010. (Tutiš et al., In press). The security status of species at the European level is taken from Birds in Europe (BirdLife International 2004), and on the global level by BirdLife International (2010). Categories are as follows: RE - regionally extinct, CR – critically endangered, EN - Endangered, VU - vulnerable, NT - Near Threatened, LC – least concerning, DD - data deficient. Status flags in Croatia are listed in columns depending on the status of a population which is applicable, where the column titles follow: GN - nesting population, PRE - migrating population ZIM – wintering population.
- Under the title of the column bird Communities, letter M in the column title relates to the bird communities of mixed mosaic habitat birds, and the letter Š on the community of forest habitat birds. The mark + indicates that the species belongs to the mentioned community.
- Under the title of the column Potential status of species in the project in the buffer zone explains what is the estimated status of the species in this field: G – nesting birds, Gšo – nesting birds of the wider area, P – migratory birds, Z – wintering birds.

	Croatian name of species	Scientific name od species	Potential stats of the type in the area of work and in the buffer zone			Community of birds		Safety status of the species				
								National level			global level	European razina
						M	Š	GN	PRE	ZIM		
1	siva čaplja	*Ardea cinerea*	Gšo	P	Z	+		LC			LC	
2	velika bijela čaplja	*Casmerodius albus*		P	Z	+		EN		LC	LC	
3	bijela roda	*Ciconia ciconia*	Gšo	P		+		LC			LC	Depleted
4	siva guska	*Anser anser*			Z	+		VU		LC	LC	
5	divlja patka	*Anas platyrhynchos*	Gšo	P	Z	+		LC	LC		LC	
6	škanjac osaš	*Pernis apivorus*	Gšo				+	NT	LC		LC	
7	eja močvarica	*Circus aeruginosus*		P		+		EN	LC		LC	
8	eja strnjarica	*Circus cyaneus*			Z	+			LC	LC	LC	Depleted
9	eja livadarka	*Circus pygargus*	Gšo	P		+		EN			LC	
10	jastreb	*Accipiter g entilis*	Gšo		Z	+	+	LC			LC	
11	kobac	*Accipiter nisus*	G	P	Z	+	+	LC			LC	
12	škanjac	*Buteo buteo*	G		Z	+	+	LC			LC	
13	vjetruša	*Falco tinnunculus*	G			+		LC			LC	Declining
14	sokol lastavičar	*Falco subbuteo*	G	P		+		NT			LC	
15	trčka	*Perdix perdix*	G			+		LC			LC	VU

16	prepelica	*Coturnix coturnix*	G	P		+		LC	LC		LC	(Depleted)
17	fazan	*Phasianus colchicus*	G			+		LC	LC		LC	
18	ždral	*Grus grus*		P		+			LC	LC	LC	(Depleted)
19	vivak	*Vanellus vanellus*	G	P		+		LC	LC		LC	VU
20	šljuka	*Scolopax rusticola*		P		+		CR	LC	LC	LC	(Declining)
21	burni galeb	*Larus canus*		P	Z	+				LC	LC	(Depleted)
22	galeb klaukavac	*Larus michahellis*		P	Z	+		LC			LC	
23	tamnoleđi galeb	*Larus fuscus*		P	Z	+					LC	
24	nječni galeb	*Larus ridibundus*		P	Z	+		NT	LC	LC	LC	
25	gradski golub	*Columba livia domestica*	G			+					LC	
26	golub grivnjaš	*Columba palumbus*	G	P		+	+	LC	LC		LC	
27	grlica	*Streptopelia turtur*	G			+		LC	LC		LC	Declining
28	gugutka	*Streptopelia decaocto*	G			+		LC			LC	
29	kukavica	*Cuculus canorus*	G			+	+	LC	LC		LC	
30	kukuvija	*Tyto alba*	G			+		NT			LC	(Declining)
31	ćuk	*Otus scops*	G			+		LC			LC	(Depleted)
32	šumska sova	*Strix aluco*	G			+	+	LC			LC	
33	jastrebača	*Strix uralensis*	Gšo				+	NT			LC	
34	sivi ćuk	*Athene noctua*	G			+		NT			LC	(Declining)
35	mala ušara	*Asio otus*	G		Z	+	+	LC			LC	
36	leganj	*Caprimul q us europaeus*		P		+		LC			LC	(Depleted)
37	čiopa	*Apus apus*	Gšo			+		LC	LC		LC	
38	vijoglav	*Jynx torquilla*	G	P		+		LC	LC		LC	(Declining)
39	mali djetlić	*Dendrocopos minor*	G			+	+	LC			LC	
40	crvenoglavi djetlić	*Dendrocopos medius*	G				+	LC			LC	
41	veliki djetlić	*Dendrocopos major*	G			+	+	LC			LC	
42	crna žuna	*Dr vocopus martius*	Gšo				+	LC			LC	
43	zelena žuna	*Picus viridis*	Gšo			+		LC			LC	(Depleted)
44	siva žuna	*Picus canus*	Gšo				+	LC			LC	(Depleted)
45	kukmasta ševa	*Galerida cristata*	G			+		LC			LC	(Depleted)
46	poljska ševa	*Alauda arvensis*	G		Z	+		LC			LC	(Depleted)
47	ševa krunica	*Lullula arborea*		P		+		LC			LC	Depleted
48	lastavica	*Hirundo rustica*	G	P		+		LC	LC		LC	Depleted
49	piljak	*Delichon urbicum*	Gšo			+		LC	LC		LC	(Declining)
50	prugasta trepteljka	*Anthus trivialis*	G	P		+		LC	LC		LC	
51	bijela	*Motacilla alba*	G	P		+		LC	LC		LC	

	pastirica											
52	žuta pastirica	*Motacilla flava*	G	P		+		LC	LC		LC	
53	palčić	*Troglodytes troglodytes*	G	P	Z	+	+	LC			LC	
54	sivi popić	*Prunella modularis*		P	Z	+		LC	LC		LC	
55	drozd imelaš	*Turdus viscivorus*	G	P	Z	+	+	LC			LC	
56	drozd cikelj	*Turdus philomelos*	G	P		+	+	LC	LC		LC	
57	mali drozd	*Turdus iliacus*		P	Z	+				LC	LC	
58	drozd bravenjak	*Turdus pilaris*		P	Z	+		NA	LC	LC	LC	
59	kos	*Turdus merula*	G	P		+	+	LC	LC		LC	
60	slavuj	*Luscinia me q arhynchos*	G	P		+		LC	LC		LC	
61	crvendać	*Erithacus rubecula*	G	P	Z	+	+	LC	LC		LC	
62	mrka ervenrepka	*Phoenicurus ochruros*	G			+		LC			LC	
63	šumska ervenrepka	*Phoenicurus phoenicurus*		P		+		LC			LC	(Depleted)
64	smeđoglavi batić	*Saxicola rubetra*	G	P		+		LC	LC		LC	
65	crnoglava batić	*Saxicola torquatus*	G			+		LC	LC		LC	
66	sivkasta bjeloguza	*Oenanthe oenanthe*		P		+		LC	LC		LC	(Declining)
67	muharica	*Muscicapa striata*		P		+		LC	LC		LC	Depleted
68	crnoglava muharica	*Ficedula hypoleuca*		P		+			LC		LC	
69	bjelovrata muharica	*Ficedula albicollis*	G				+	LC			LC	
70	vatroglavi kraljić	*Re q ulus i q nicapilla*		P		+		LC			LC	
71	zlatoglavi kraljić	*Re q ulus re q ulus*		P	Z	+		LC			LC	
72	trstenjak mlakar	*Acrocephalus palustris*	G			+		LC			LC	
73	žuti voljić	*Hippo lais icterina*		P		+		VU*	LC		LC	
74	brezov zviždak	*Ph v lloscopus trochilus*		P		+		NT	LC		LC	
75	zviždak	*Ph v lloscopus collybita*	G	P		+	+	LC	LC		LC	
76	šumski zviždak	*Phylloscopus sibilatrix*		P		+	+	LC	LC		LC	(Declining)
77	crnokapa grmuša	*Sylvia atricapilla*	G	P		+	+	LC	LC		LC	
78	siva grmuša	*Sylvia borin*		P		+		LC	LC		LC	
79	grmuša čevrljinka	*Sylvia curruca*		P		+		LC			LC	
80	grmuša pjenica	*Sylvia communis*	G			+		LC			LC	
81	crnoglava sjenica	*Parus palustris*	G			+	+	LC			LC	Declining
82	velika sjenica	*Parus major*	G			+	+	LC			LC	
83	plavetna sjenica	*Parus caeruleus*	G		Z	+	+	LC			LC	

84	dugorepa sjenica	Aegithalos caudatus	G			+		LC			LC	
85	brgljez	Sitta europaea	G			+	+	LC			LC	
86	dugokljuni puzavac	Certhia brachydactyla	G				+	LC			LC	
87	vuga	Oriolus oriolus	G			+	+	LC			LC	
88	rusi svračak	Lanius collurio	G			+		LC			LC	(Depleted)
89	veliki svračak	Lanius excubitor			Z	+				LC	LC	(Depleted)
90	šojka	Garrulus glandarius	G			+	+	LC			LC	
91	svraka	Pica pica	G			+		LC			LC	
92	gačac	Corvus frugilegus	Gšo			+		LC			LC	
93	siva vrana	Corvus cornix	G			+		LC			UR	
94	gavran	Corvus corax	Gšo			+		LC			LC	
95	čvorak	Sturnus vulgaris	G	P		+		LC	LC		LC	Declining
96	vrabac	Passer domesticus	G			+		LC			LC	Declining
97	poljski vrabac	Passer montanus	G			+		LC			LC	(Declining)
98	zeba	Fringilla coelebs	G			+	+	LC	LC		LC	
99	sjeverna zeba	Fringilla montifringilla			Z	+				LC	LC	
100	žutarica	Serinus serinus	G			+		LC	LC		LC	
101	zelendur	Carduelis chloris	G			+		LC	LC		LC	
102	čižak	Carduelis spinus			Z	+		LC	LC		LC	
103	češljugar	Carduelis carduelis	G		Z	+		LC	LC		LC	
104	juričica	Carduelis cannabina	G			+		LC	LC		LC	Declining
105	zimovka	Pyrrhula pyrrhula			Z	+		LC			LC	
106	batokljun	Coccothraustes coccothraustes	G			+	+	LC			LC	
107	velika strnadica	Miliaria calandra	G			+		LC			LC	(Declining)
108	žuta strnadica	Emberiza citrinella	G			+		LC			LC	

Table 3.11.3.-2. List of expected bird species for the project area and its immediate surroundings (Buffer zone).

- Under the title Status of species on an international level in the Table is specified under what Convention / directive is a species protected. In separate columns for the Bern convention, Bonn convention and Birds Directive are listed in the Appendices where the bird is located.
- The column Legal protection explains the conservation status of each species in Croatia under Nature Protection Act (OG 70/05, NN 139/08, 57/11) or the Ordinance on Proclamation of wildlife species protected and strictly protected (NN 99/09). If the column does not hold any mark it is a species that in Croatia is not protected by this law, while the marking SZ marks the strictly protected, and Z is the protected species.

red. br	hrvatsko ime vrste	znanstveno ime vrste	Zakonska zaštia vrste u Hrvatskoj	Status zaštite vrste na međunarodnoj razini		
				Bern	Bonn	EU dir
1	siva čaplja	*Ardea cinerea*	Z	lll		
2	velika bijela čaplja	*Casmerodius albus*	SZ	II		I
3	bijela roda	*Ciconia ciconia*	SZ	II	ll	I
4	siva guska	*Anser anser*	SZ	lll	ll	II-A/III-B
5	divlja patka	*Anas platyrhynchos*	Z	lll	ll	II-A/III-A
6	škanjac osaš	*Pernis apivorus*	SZ	II	ll	I
7	eja močvarica	*Circus aeruginosus*	SZ	II	ll	I
8	eja strnjarica	*Circus cyaneus*	SZ	II	ll	I
9	eja livadarka	*Circus pygargus*	SZ	II	ll	I
10	jastreb	*Accipiter gentilis*	SZ	II	ll	
11	kobac	*Accipiter nisus*	SZ	II	ll	
12	škanjac	*Buteo buteo*	SZ	II	ll	
13	vjetruša	*Falco tinnunculus*	SZ	II	ll	
14	sokol lastavičar	*Falco subbuteo*	SZ	II	ll	
15	trčka	*Perdix perdix*	Z	lll		II-A/III-A
16	prepelica	*Coturnix coturnix*	Z	lll	ll	II-B
17	fazan	*Phasianus colchicus*	Z	lll		II-A/III-A
18	ždral	*Grus grus*	SZ	II	ll	I
19	vivak	*Vanellus vanellus*	SZ	lll	ll	II-B
20	šljuka	*Scolopax rusticola*	**SZ - gnijezdeća pop..** **Z - negnijezdeća pop.**	lll	ll	II-A/III-B
21	burni galeb	*Larus canus*	SZ	lll		II-B
22	galeb klaukavac	*Larus michahellis*	SZ			
23	tamnoleđi galeb	*Larus fuscus*	SZ			II-B
24	riječni galeb	*Larus ridibundus*		lll		II-B
25	gradski golub	*Columba livia domestica*		lll		II-A
26	golub grivnjaš	*Columba palumbus*	Z			II-A/III-A
27	grlica	*Streptopelia turtur*	SZ	lll		II-B
28	gugutka	*Streptopelia decaocto*	Z	lll		II-B
29	kukavica	*Cuculus canorus*	Z	lll		
30	kukuvija	*Tyto alba*	SZ	II		
31	ćuk	*Otus scops*	SZ	II		

32	šumska sova	*Strix aluco*	SZ	II		
33	jastrebača	*Strix uralensis*	SZ	II		I
34	sivi ćuk	*Athene noctua*	SZ	II		
35	mala ušara	*Asio otus*	SZ	II		
36	leganj	*Caprimulgus europaeus*	SZ	II		I
37	čiopa	*Apus apus*	SZ	III		
38	vijoglav	*Jynx torquilla*	SZ	II		
39	mali djetlić	*Dendrocopos minor*	SZ	II		
40	crvenoglavi djetlić	*Dendrocopos medius*	SZ	II		I
41	veliki djetlić	*Dendrocopos major*	SZ	II		
42	crna žuna	*Dryocopus martius*	SZ	II		I
43	zelena žuna	*Picus viridis*	SZ	II		
44	siva žuna	*Picus canus*	SZ	II		I
45	kukmasta ševa	*Galerida cristata*	SZ	III		
46	poljska ševa	*Alauda arvensis*	SZ	III		II-B
47	ševa krunica	*Lullula arborea*	SZ	III		I
48	lastavica	*Hirundo rustica*	SZ	II		
49	piljak	*Delichon urbicum*	SZ	II		
50	prugasta trepteljka	*Anthus trivialis*	SZ	II		
51	bijela pastirica	*Motacilla alba*	SZ	II		
52	žuta pastirica	*Motacilla flava*	SZ	II		
53	palčić	*Troglodytes troglodytes*	SZ	II		
54	sivi popić	*Prunella modularis*	SZ	II		
55	drozd imelaš	*Turdus viscivorus*	Z	III	II	II-B
56	drozd cikelj	*Turdus philomelos*	Z	III	II	II-B
57	mali drozd	*Turdus iliacus*	Z	III	II	II-B
58	drozd bravenjak	*Turdus pilaris*	SZ	III	II	II-B
59	kos	*Turdus merula*	Z	III	II	II-B
60	slavuj	*Luscinia megarhynchos*	SZ	II	II	
61	crvendać	*Erithacus rubecula*	SZ	II	II	
62	mrka crvenrepka	*Phoenicurus ochruros*	SZ	II	II	
63	šumska crvenrepka	*Phoenicurus phoenicurus*	SZ	II	II	
64	smeđoglavi batić	*Saxicola rubetra*	SZ	II	II	
65	crnoglava batić	*Saxicola torquatus*	SZ	II	II	
66	sivkasta bjeloguza	*Oenanthe oenanthe*	SZ	II	II	
67	muharica	*Muscicapa striata*	SZ	II	II	
68	crnoglava muharica	*Ficedula hypoleuca*	SZ	II	II	
69	bjelovrata muharica	*Ficedula albicollis*	SZ	II	II	I
70	vatroglavi kraljić	*Regulus ignicapilla*	SZ	II	II	

71	zlatoglavi kraljić	*Regulus regulus*	SZ	II	ll	
72	trstenjak mlakar	*Acrocephalus palustris*	SZ	II	ll	
73	žuti voljić	*Hippolais icterina*	SZ	II	ll	
74	brezov zviždak	*Phylloscopus trochilus*	SZ	II	ll	
75	zviždak	*Phylloscopus collybita*	SZ	II	ll	
76	šumski zviždak	*Phylloscopus sibilatrix*	SZ	II	ll	
77	crnokapa grmuša	*Sylvia atricapilla*	SZ	II	ll	
78	siva grmuša	*Sylvia borin*	SZ	II	ll	
79	grmuša čevrljinka	*Sylvia curruca*	SZ	II	ll	
80	grmuša pjenica	*Sylvia communis*	SZ	II	ll	
81	crnoglava sjenica	*Parus palustris*	SZ	II		
82	velika sjenica	*Parus major*	SZ	II		
83	plavetna sjenica	*Parus caeruleus*	SZ	II		
84	dugorepa sjenica	*Aegithalos caudatus*	SZ	lll		
85	brgljez	*Sitta europaea*	SZ	II		
86	dugokljuni puzavac	*Certhia brachydactyla*	SZ	II		
87	vuga	*Oriolus oriolus*	SZ	II		
88	rusi svračak	*Lanius collurio*	SZ	II		I
89	veliki svračak	*Lanius excubitor*	SZ	II		
90	šojka	*Garrulus glandarius*	Z	lll		II-B
91	svraka	*Pica pica*	Z	lll		II-B
92	gačac	*Corvus frugilegus*	Z	lll		II-B
93	siva vrana	*Corvus cornix*	SZ	lll		
94	gavran	*Corvus corax*	SZ	lll		
95	čvorak	*Sturnus vulgaris*		lll		II-B
96	vrabac	*Passer domesticus*		lll		
97	poljski vrabac	*Passer montanus*		lll		
98	zeba	*Fringilla coelebs*	Z	lll		
99	sjeverna zeba	*Fringilla montifringilla*	Z	lll		
100	žutarica	*Serinus serinus*	SZ	II		
101	zelendur	*Carduelis chloris*	SZ	II		
102	čižak	*Carduelis spinus*	SZ	II		
103	češljugar	*Carduelis carduelis*	SZ	II		
104	juričica	*Carduelis cannabina*	SZ	II		
105	zimovka	*Pyrrhula pyrrhula*	SZ	lll		
106	batokljun	*Coccothraustes coccothraustes*	SZ	II		
107	velika strnadica	*Miliaria calandra*	SZ	lll		
108	žuta strnadica	*Emberiza citrinella*	SZ	II		

3.11.3. 2. Bat fauna

At the study area or in the immediate vicinity of the area the potential area is widespread with nine species of bats (Tvrtković (ed.) 2006, and Pavlinić Đaković 2010). Eight recorded species are listed in Appendix II of the Directive on the conservation of natural habitats and of wild fauna and flora and as such are included in the Proposal of potential Natura 2000 sites for bats. All nine species recorded in the Red Book of Mammals of Croatia. The recorded species are:

Miniopterus schreibersii (Kuhl, 1817) - Common bentwing bat
The species is at the regional level in the category of endangered species (EN) and the global evaluation that it is a potentially endangered species of bats (NT).
Myotis emarginatus (Geoffroy, 1806) - Geoffrey's bat
The species is at the regional level in the category of vulnerable species (NT) as that global estimate is that these is a risk species (VU).
Rhinolophus euryale Blasius, 1853 - South Horseshoe
Regional risk assessment is the same for this type, as the global one - it is a risk species (VU).
Rhinolophus ferrumequinum (Schreber, 1774) - Greater Horseshoe Bat
Regional risk assessment of this type is the same as the global one - it is a potentially endangered species (NT).
Rhinolophus hipposideros (Bechstein, 1800) - Lesser Horseshoe bat
Regional risk assessment of this type is the same as the global one - it is a potentially endangered species (NT).
Myotis myotis (Borkhausen, 1797) - a big bat
Regional risk assessment is the same for this type as the global one - it is a potentially endangered species (NT).
Plecotus austriacus (Fischer, 1829) - Grey big-eared bat
The species is at the regional level in the category of endangered species (EN) as the global assessment of species has not been determined and it is a species that is not well known (DD).
Myotis bechsteinii (Kuhl, 1817) - Bechstein's bat
Regional risk assessment of this type is the same as the global one - it is a risk species (VU).
Barbastella barbastellus (Schreber, 1774) - Barbastelle bat
Regional Assessment of vulnerability of this species has not been determined, so far it is of a type that is not well known (DD), and the global assessment is that this is a high-risk type (VU).

Bat colonies
A review of gathered information about family colonies of bats in the studied area within a radius of 5 km, there are no recorded colonies. A review of known winter colonies of bats in the study area within the radius of 5 km, there are no recorded colonies. A review of known colonies at the time of migration in the study area within the radius of 5 km, there are no recorded colonies.

Important areas
By separating the important areas for bats (the site and the area around the site which size depends on the species on which the important area relates to) within 5 km according to the Scientific analysis of twelve species of bats with Annex II of the Directive on the conservation of natural habitats and of wild fauna and flora for the needs of the Proposition of potential Natura 2000 sites for bats, there are no important areas for bats.

The results of field studies

Transects were issued during two field visits (Figure 3.11.3-1.) in September 2011. The results of the transect of September 23, 2011 in the form of activity of individual bat species is shown in Figure 3.11.3-2. It is a transect close to the airport fence, with which we wanted to check the possible use of the habitat in the immediate vicinity of the existing complex. A total of 5 species and two groups were recorded.

Figure 3.11.3.-1. Transects (red) performed during two field visits in September 2011.

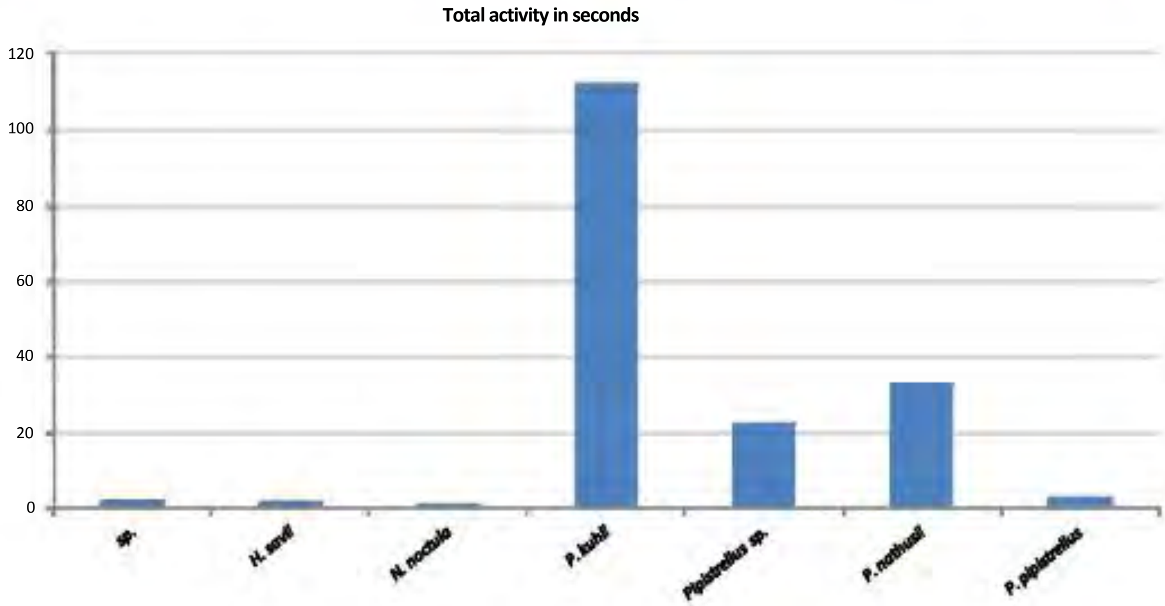


Figure 3.11.3.-2 Results of the transect 23.09.2011

The highest activity of bats of the genus Pipistrellus was recorded that they hunted prey using an orchard which is located next to the fence of the airport. Tracked bats stayed outside the fence during hunting.

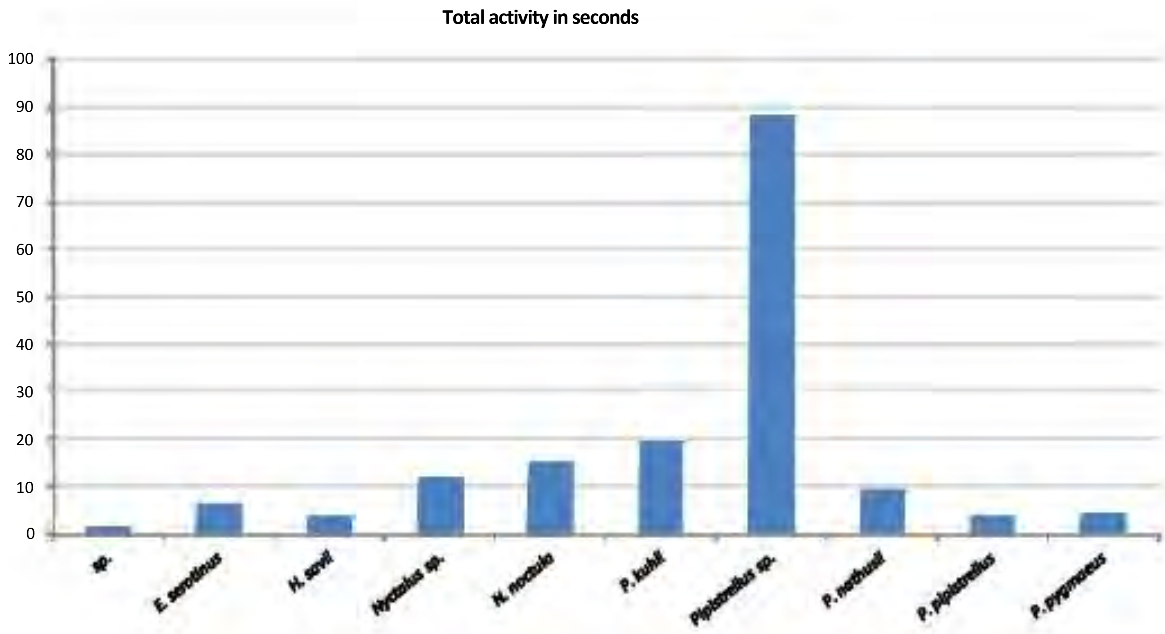


Figure 3.11.3.-3. Results of the transect 24.09.2011

Transect 24.09.2011. (Figure 3.11.3.-3) passes southeast of the airport through a mosaic of populated areas, open habitats (meadows, pasture, arable land) and smaller forest and bushy parts. The highest recorded activity was of the genus Pipistrellus and species N. Noctula. A total of 7 species and 3 groups were recorded.
The results of these field studies clearly show that certain species of bats adapted to the existing impact of the airport and that without any disturbance or negative effects they use hunting habitats in the immediate vicinity of the airport runway. Primarily this refers to species of the genus Pipistrellus – Common pipistrelle, forest bats, dwarf bat miniature marsh bats. Besides these, the route of the second transect recorded activity of Common noctule that can be related with the hunt in this area. Other recorded species used the area used it only during flight.

Analysis
Generally speaking, recorded was the activity of the species that are well adapted to life in urban and urbanized areas (Pipistrellus, Nyctalus) and to which the existing airport infrastructure does not present a negative effect, or these species fully adapted to the current circumstances.
In field research there has never been one of 9 species whose potential areal affects the distribution of the studied area. Even though we cannot exclude their occasional use of the wider project area, taking into account their environmental requirements (Dietz et al. 2009) and the fact that it is already an existing airport and urbanized area, it is very likely that the area itself does not have great significance for this species nor hunting habitat or as a potential place for shelter.
Greater horseshoe bat (Rhinolophus ferrumequinum) is a species uses for hunting characteristic open (meadow) habitats (earlier in the season) and the technique of hunting "ambush", which is usually tree branches (edges of trees and shrubs). The distance of these hunting habitats in the average is 2.1 km from the colony and rarely exceeds 5 km (Dietz and oth. 2009).

Southern Horseshoe Bat (*Rhinolophus euryale*) as a hunting habitat uses more closed circuits of vegetation (shrubs, woods) while the more open forest habitats while hunting descends all the way to the ground or uses the "hunt from an ambush" technique. The distance of these hunting habitats in the average are 2.2 to 9.3 km from the shelter (Dietz and oth. 2009).
Chreibers' bat (*Miniopterus schreibersii*) can hunt around street lamps, in the forests below line of treetops, over streams and other bodies of water and near vegetation. The existence of extremely high summer and winter colonies indicates that due to the limited availability of food it has to travel large distances to the hunting habitats. But so far there is no published telemetry research.
Geoffrey's bat (*Myotis emarginatus*) is dependent on a structured forest, forest edges and meadows. At these places they hunt near vegetation and trees within and collect insects from leaves. They avoid open areas. They mostly follow the line of woods and streams. Wildlife habitats are up to 12.5 km away from the shelter (Dietz and oth. 2009).
Eared bat (*Myotis myotis*) mostly hunt low, at a height of 1-2 m. They prefers beech forests without shrubs. On the surface, not covered with vegetation, it has free access to the ground where its the main food is (beetles). The wildlife habitat is located mostly within a radius of 5-15 km around the shelter but can be located up to 26 km. The changing of the shelter is at a distance of up to 34 km. Females look for places to breed at a distance of 12 km from the family shelters (Dietz and ost. 2009).
Types of Bechstein's bat (*Myotis bechsteinii*), **western barbastelle** (*Barbastella barbastellus*) **and lesser horseshoe bat** (*Rhinolophus hipposideros*) are related to the forest as a primary hunting habitat and in most cases are selected for shelters in hollow trees.
Grey long-eard bat (*Plecotus austriacus*) is a species of open habitats which in the studied area most likely uses artificial shelters.

3.11.3. 3rd Mammal fauna

Mammals, after birds, are the largest group of terrestrial vertebrates in Europe with more than 230 known species. Besides a large number of them, they are characterized by a great variety of movement, their feeding and size. Mammals of Europe taxonomically belong in 9 orders of which 6 are terrestrial (land), one is aerial (air, flying), and one aquatic (water).
Mammals of Croatia are, by number of species, a fairly large and diverse group of the 100 recorded species (Antolović et al. 2006.). Small mammals are a group of mammals which usually include insectivores and rodents. This group of mammals in Croatia is represented by nearly 40 species which makes them the most numerous element of our teriofaune.
Much like amphibians, small mammals according to their abundance, biomass and space occupy the food chain and have a very important place in the ecosystem. Because of their abundance and feeding they are the biggest problem for man, which is why many species are called pests or vermins. Different types of small mammals coexist on the same area occupying different ecological niches within which they exploit different resources.
They may vary according to the type or types of food that are used in feeding, time of activities way of reproducing the habitats they occupy.
For the analysis of the teriofaune of the observed area literary data is used for Turopoljski lug (Leiner 1985, Kovacic 1988; Baltić et al. 1997), which represents the site which is ecologically most similar to the observed area since it is located in a flood plain along River Odra. Taken into consideration is some unpublished data on mammals in Zagreb and its immediate surroundings. If you analyze the fauna of this wider area around the city of Zagreb and Turopolje area during previous studies, there were more than 20 species of mammals. This number represents more than half of small mammals and nearly a quarter of all Croatian Mammals and points to the great diversity of this part of the teriofaune.
Systematic list of mammal species in the wider area of impact:

1. RED: **Erinaceomorpha - similar to hedgehog**

I. Family: Erinaceidae - salamanders

Erinaceus roumanicus Barrett-Hamilton, 1900 - white-breasted Hedgehog

II. Family: Soricidae - shrews
Sorex araneus Linnaeus, 1758 - shrew
Sorex minutus Linnaeus, 1766 - a little shrew
Neomys anomalus Cabrera, 1907 - marsh shrew
Neomys fodiens (Pennant, 1771) - Water shrew
Crocidura leucodon (Herman, 1780) - two colors shrew
Crocidura suaveolens (Pallas, 1811) - garden shrew
III. Family: Talpidae - mole
Talpa europaea Linnaeus, 1758 - European mole
2. RED: **Rodentia - rodents**
IV. Family: Sciuridae - Squirrels
Sciurus vulgaris Linnaeus, 1758 - Squirrel
V. Family: Gliridae - dormice
Muscardinus avellanarius (Linnaeus, 1758) - hazel dormouse
VI. Family: Castoridae - Beavers
Castor fiber Linnaeus, 1758 - the beaver
VII. Family: Cricetidae - hamsters
Clethrionomys glareolus (Schreber, 1780) - bank vole
Arvicola amphibius (Linnaeus, 1758) - water vole
Ondatra zibethicus (Linnaeus, 1766) - muskrat
Microtus agrestis (Linnaeus, 1761) - meadow voles
Microtus arvalis (Pallas, 1778) - field voles
Microtus liechtensteini (Wettstein, 1927) - Balkan voles
VIII. Family: Muridae - mice
Micromys minutus (Pallas, 1771) - dwarf mouse
Apodemus agrarius (Pallas, 1771) - striped field mouse
Apodemus flavicollis Melchior, 1834 - yellow-necked field mouse
Apodemus sylvaticus (Linnaeus, 1758) - wood mouse
Rattus norvegicus (Berkenhout, 1769) - brown rat
Mus musculus Linnaeus, 1758 - House mouse
IX. Family: Myocastoridae - nutria
Myocastor coypus (Molina, 1782) - nutria

Mammals of Europe have a very low degree of endemism because most species are quite widespread. Among mammals of the wider area of impact is only is less widespread (endemic) species which is widespread in northern Italy, Austria, Slovenia, continental Croatia and Bosnia and Herzegovina.

Important habitats
Mammals are primarily present on almost all types of terrestrial habitats, while certain types use damp and aquatic habitats. Most species of small mammals of the wider are well adapted to occasional flooding and no problems exist in floodplains and wet habitats like Turopolje or Lonjsko Polje. Their populations fluctuates in abundance and composition of the as a result of the cycle and intensity of flooding. However, species such as aquatic and marsh shrews, beavers, muskrats, water vole, nutrias, and even rats use the water and the aquatic habitat as their primary and dominating place of residence. The impact area is located in the former flood plain of the river basin, and here are still present various types of permanent and temporary aquatic and wetland habitats. The location of the project is only 3 kilometers from the Sava River, and around the area of impact, there are several smaller rivers and water surfaces - Kosnica, Bapča and Pleški channel.

The view of expected mammal species
Despite the large number of species (24) that were recorded in the Zagreb area and Turopolje, in the area of impact we can expect fewer species. Specifically, the territory of the future airport is already under some anthropogenic influence and does not have all types

of open and forest habitats, or aquatic habitats favored by characteristic species of insectivores and rodents. Expected values are: white-breasted hedgehog, shrew, garden shrew, mole, squirrel, meadow vole, field vole, striped field mouse, wood mouse, house mouse and rat.

Mammals of the impact area are protected under the Ordinance on designating wild species that are protected and strictly protected "(OG 99/09), none of which species are strictly protected, while four species are in the category of protected species. Some species are covered and protected under the Bern Convention (Convention on the Conservation of European Wildlife and Natural habitats). On Appendix III of the Berne Convention, as a protected species, there are two shrews and squirrels. No species of mammals presented in the area of interest are in the European Union directives on the protection of natural habitats and of wild fauna and flora (Habitats Directive). According to the IUCN categorization, squirrels in Croatia are considered a potentially endangered species (NT). (Antolović et al. 2006)

White-breasted Hedgehog - Erinaceus roumanicus Barrett-Hamilton, 1900
The white-breasted Hedgehog is a widely distributed species of Central and Eastern Europe all the way to Siberia. It prefers open habitats, shrubs lands and forest edges. It is very common even in stronger anthropogenic areas either rural or urban, where they inhabit fields, meadows, parks etc. The only all the more common reason of threat to this species is road killing due to intensive traffic.

Shrew - Sorex araneus Linnaeus, 1758
Unlike the hedgehog, the shrew inhabits colder and wetter habitats, protected from thick vegetation such as bushy areas and forests. However it is quite adaptable to habitat conditions, and can also be found in the drier and more open areas. The largest negative influences that threaten the shrew are the destruction and degradation of natural habitats and accumulation of harmful substances in food (insects and other invertebrates) as a result of pesticides and other contaminants. Therefore, it is interesting as an indicator of soil contamination. Despite the perceived negative impacts it is not considered an endangered species. Listed at Annex III of the Berne Convention, and according to the Regulations on the proclamation of protected wildlife species and strictly protected (NN 99/09), the shrew is a protected native species.

Garden shrew - Crocidura suaveolens (Pallas, 1811)
And garden shrew is very widespread species. It is considered to be adaptable and a common species throughout its range. It prefers more open and drier habitats, such as fields, meadow and steppe areas. However, it is very common in anthropogenic habitats (fields, vineyards, cemeteries) and within settlements (parks, a stack of shadows, barns, houses). It feeds on insects, like most shrews. It is a short-lived species with a life span only a year or two. The only obvious, are indirect negative impacts through the use of pesticides and herbicides. It is not considered to be an endangered species. It is listed at Appendix III of the Bern Convention, the Codebook on designating wildlife species protected and strictly protected (OG 99/09), the garden shrew is a protected native species.

European mole - Talpa europaea Linnaeus, 1758
The mole is a widespread species and in general it is common in appropriate habitats. It is often considered a pest species due to their specific way of life and behavior. Since the fossorius typical species, the only requirement for the presence of a mole is a deep enough layer of earth. However, it avoids coniferous forests and habitats with sandy soil, stones or excess groundwater. It feeds on earthworms and other invertebrates in the soil. Although the population intensively exterminated them as pests, the mole is not threatened as a species so it is not considered an endangered species.

Squirrel - Sciurus vulgaris Linnaeus, 1758
It is palearctically spread from the Atlantic to the Pacific coast. Although it is considered common types throughout the distribution area, a reduction was registered in different populations. At places it is considered a pest because of the damage it does to bark and by eating buds of trees. It prefers forest habitats, but is very happy to live in bushed areas as well as parks and gardens. It primarily feeds on seeds, bark, buds, but sometimes eats young birds and eggs. The main reason the squirrel is endangered is the destruction and degradation of forest habitats, as well as the conversion of forest contents to monoculture. Based on the rules on declaring wild species protected and strictly protected (OG 99/09) the squirrel is a protected native species. It is listed at Appendix III of the Bern Convention as a protected species, according to IUCN categorization, in Croatia it is a potentially endangered species (NT).

Field vole - Microtus agrestis (Linnaeus, 1761)
The field vole is a very common and widespread Palaearctic species. The population fluctuates significantly in numbers in cycles of 3-4 years. In the years when they are extremely numerous they cause considerable damage to crops and young forest stands. Field voles inhabit very different open and woodland habitats, and are also present in anthropogenic habitats.

Common vole - Microtus arvalis (Pallas, 1778)
This is a widespread species across Europe and western and central Russia. Similar to the field vole, populations are occasionally extremely numerous when they do a lot of damage to crops and plantations. They prefer the more open (non-forested) habitats, and very often inhabit agricultural areas.

Striped field mouse - Apodemus agrarius (Pallas, 1771)
They are spread from central Europe to China and is a very common and numerous species. Sometimes the population “explodes" to extremely large numbers. They inhabit different un-forested habitats at the edges of forests, meadows, marshes, fields, and anthropogenic habitats like gardens and parks.

Wood mouse - Apodemus sylvaticus (Linnaeus, 1758)
The wood mouse is present mainly in Europe and North Africa. It is a frequent and ubiquitous species, but populations also oscillate strongly in number over different years. Very often it is considered a pest because of the problems it causes to human crops and plantations. It inhabits a very wide range of habitats from completely natural, to poorly anthropogenic and totally urban with the same habitat in forest and open areas. The wood mouse is a slightly larger omnivore than the previous species where other than plant components, it also eats various invertebrates.

House mouse - Mus musculus Linnaeus, 1758
The house mouse, thanks to man, is the most widely distributed species in the world. In addition to its global distribution, it is a very numerous and common species. It is usually present in all types of anthropogenic habitats, either rural, urban, and avoids the woodland and desert habitats. It has been considered to be one of the biggest pests for centuries.

Brown rat - Rattus norvegicus (Berkenhout, 1769)
The brown rat originally comes from Asia, and thanks to man, it is distributed across the world. On favorable habitats (urban areas), its population is very numerous. It prefers slightly cooler and wetter habitats, and is often associated with water.

3.11.3. 4. Amphibian fauna

Amphibians are the smallest group of vertebrates in Europe with about 50-odd recorded species. The reason for such a small number of amphibians is their attachment to warm and humid, mostly subtropical and tropical habitats, where they are represented with many species and populations. In contrast to these temperate regions, the number of species is drastically reduced.

Amphibians in Croatia are, by number of species, only a small group of 20-odd species (Hutinec and associates, 2006). However, their number and places they occupy in the food chain have a very important place in the ecosystem. Amphibians, although land animals, still remain much of their life tied to water, where they feed and reproduce. Different types of amphibian often coexist in the same area because they occupy different ecological niches within which they exploit different resources. They may vary according to the type or size of prey they feed on, their time of activity or parts of the habitat they occupy.

For the needs of analyzing amphibian fauna in the area under observation literature data was taken from Turopoljski lug (Džukić and associates, 1981; Janey-Hutinec 1997; Obradović 1995) which represent the habitat and ecologically most similar to the observed area since it is located in a floodplain lowlands along the Odra River. Taken into consideration was also some unpublished data on amphibians in the Zagreb area. If the fauna of this wider area around the city of Zagreb and Turopolje area is analyzed, in previous researches there were 17 species of amphibians. This number represents a great diversity in relation to the total number of species recorded in Croatia. Amphibian fauna of this area presents mainly characteristic fauna of Central and Eastern (Triturus dobrogicus, Pelobates fuscus) Europe.

Systematic list of species of amphibians in the wider area of influence:

First ORDER: Caudata or Urodela - Repas

I. Family: Salamandridae – salamanders

Salamandra salamandra (Linnaeus, 1758) - the fire salamander

Ichthyosaura alpestris (Laurenti, 1768) - alpine newt

Lissotriton vulgaris (Linnaeus, 1758) -common newt

Triturus dobrogicus (Kiritzescu, 1903) - Danube crested newt

Triturus carnifex (Laurenti, 1768) - Italian crested newt

Second ORDER: Anura - frog

III. Family: Bombinatoridae - Mukača

Bombina bombina (Linnaeus, 1761) - Fire-bellied toad

Bombina variegata (Linnaeus, 1758) - Yellow-bellied toad

IV. Family: Pelobatidae – true toads

Pelobates fuscus (Laurenti, 1768) - common spadefoot

V. Porodica: Bufonidae - gubavice

Bufo bufo (Linnaeus, 1758) - common toad

Pseudepidalea viridis (Laurenti, 1768) - Green Toad

V. Family: Hylidae – tree frogs

Hyla arborea (Linnaeus, 1758) - European tree frog

VI. Family: Ranidae - true frog

Rana arvalis Nilsson, 1842 - brown marsh frogs

Rana dalmatina Bonaparte, 1840 - Agile Frog

Rana temporaria Linnaeus, 1758 - meadow brown frog

Pelophylax ridibundus (Pallas, 1771) - a large green frog

Pelophylax esculentus (Linnaeus, 1758) - a little green frog

Pelophylax lessonae (Camerano, 1882) - common frog

Among amphibians in the wider sphere of influence, has no endemic fauna is very, however the fauna is very interesting and varied.

Important habitats

Amphibians are present on almost all types of water and terrestrial habitats. But the distribution, ecology, behavior and biology of amphibians have been largely conditioned with the schedule and presence of water in the environment. Most species observed are, by their space and biology, mainly related to damp and water habitats. For most species, these are also constant habitats. Most species have a cycle that consists of terrestrial and aquatic stages. There are differences between species and so particular species are strongly associated with water throughout the year (complex of green frog Pelophylax). Other species are related to water only during breeding periods (brown toads and frogs). The moist terrestrial habitats of meadows and forests are generally used by the brown frog and salamander. Some species use only temporary water surfaces such as ponds and puddles (yellow-bellied toad). The impact area is located in the former flood plain of the river basin, and still here are present various types of permanent and temporary aquatic and wetland habitats. The location of project is just 3 kilometers from the Sava River, and around the area of impact there are several smaller rivers or water surfaces - Kosnica, Bapča and Pleski channel.

Review of expected amphibian

Despite the number of species (17) that were recorded in the wider area, at the area impact we can expect a smaller number of species. Specifically, certain types of amphibians are related to specific habitats either during reproduction or the remainder of the year, so they are less likely to expected here. The expected types are: colorful salamander, mountain Newt, common newt, yellow-bellied toad, toad, tree, brown marsh frog, forest brown frogs and green frogs (green frog complex).

Amphibians in he impact area are protected under the Codebook on designating wild species protected and strictly protected (OG 99/09), where six types are strictly protected and the remaining species are in the category of protected species. Amphibians are covered and protected by international conventions. Pursuant to the Berne Convention (Convention on the Protection European Wildlife and Natural Habitats) strictly protected species (Appendix II) are considered 6 species, while all the remaining are listed on Appendix III of the Convention as protected types. Based on the European Union directive on the conservation of natural habitats and of wild fauna and flora (Habitats Directive), 6 species deserve increased attention. On Appendix II (species whose conservation requires the creation of special protected areas) of the directive, there are two types of this species. According to the same convention, there are 5 species that need special protection (Annex IV) Two species of green frogs that are listed on Annex V shall be deemed that their taking from nature and usage is necessary to be regulated with specific management measures.

Fire Salamander - Salamandra salamandra (Linnaeus, 1758)

It inhabits almost all of western, central and southern Europe. Although inhabited mainly on forest habitats, it is known as a very resilient species capable of surviving on, for amphibians, seemingly unfavorable habitats. In open habitats its population is much smaller than in the woods. During the reproductive period it may be found in ponds and streams. It is known that the greatest threat to its populations is the destruction of forest habitats and water pollution in which it reproduces. It is located in Appendix III of the Berne Convention. According to the Codebook on the Proclamation of wildlife species protected and strictly protected (OG 99/09) [hereinafter Policy], it is considered a protected species (Z).

Smooth newt - Lissotriton vulgaris (Linnaeus, 1758)

The smooth newt is a common species in continental Croatia. It is least associated with water of all European newts. It mainly inhabits different habitats, such as wet land gardens, forests, rocks, etc. It is water bound only during periods when breeding in pools and ponds, and in waters with well-developed water vegetation. Along with favorable aquatic habitats, the surrounding terrestrial habitats are very important as well and provide adequate living conditions during the terrestrial phase.

The smooth newt's major threat is pollution and the destruction of reproductive and other habitats. It is believed that to preserve its population, the conservation and protection of water surfaces covered with small aquatic vegetation such as bars is most important. The species is listed in Appendix III of the Bern Convention. As the fire salamander, this species is also protected under the Codbeook (OG 99/09))

Danube crested newt - Triturus dobrogicus (Kiritzescu, 1903)
The Danube crested newt belongs to larger newts as well as its relative, the large newt. It is mostly prevalent in the area around the Danube and its tributaries, and is quite frequent in the vicinity of human settlements in and around agricultural fields. It prefers calm waters such as puddles and ponds with dense aquatic vegetation. However, during its reproductive period it uses occasional waters, canals and ditches. It is very connected to the water in which it retains for a long time after mating. It is threatened by the vanishing, modification and cultivation of its habitat, as well as the pollution of watercourses and drainage. It is stated in Appendix II of the Bern Convention and Annex III of the Habitat Directive. According to Croatian law (Codebook) it is considered a strictly protected species. According to the criteria of the International Union for Conservation of Nature (IUCN) the Danube crested newt has the status of a Near Threatened species (NT) at the European level as in Croatia (Red Book of Amphibians and Reptiles of Croatia).

Yellow-bellied toad - Bombina variegata Linnaeus, 1758
The Yellow-bellied toad is prevalent mostly in western, central and southern Europe. It is mainly a day species that prefers casual and shallow waters, standing waters, ponds and puddles. It is strongly associated with aquatic habitats. Interestingly enough, the yellow-bellied toad is an opportunist since relatively well tolerates the pollution of the habitats it inhabits. But with increasing anthropogenic pressures, the number of its population has decreased. It is believed that greatest danger for them is the disappearance of small bodies of water such as bar or pits and pollution. This species is listed in Appendix II of the Bern Convention and Annexes II and the IV Habitats Directive. According to the provisions of the already mentioned Codebook, the yellow-bellied toad is a strictly protected species.

Common toad- Bufo bufo (Linnaeus, 1758)
This species is very widespread and is present in almost all of Europe. In optimal conditions, the number of its individuals can be up to 200 units / ha. It is mainly active at night and is one of the most versatile types of amphibians. It resides on different Habitats from the usual continental habitats to the dry Mediterranean area. For breading it uses mostly shallow standing water or slow-flowing water with developed water vegetation. When breeding, it often executes mass migration towards constant, reproductive water surfaces. Such a life cycle makes them very vulnerable during mass migration to hatcheries, and on site because of the great concentration, or the number of individuals. After mating and laying eggs and leaving the hatchery it returns to the land where it lived, where it lives alone and guards its own area. The primary reasons these types of species are threatened are due to reducing habitat due to land reclamation, construction of pathways, overuse of insecticides, pesticides and generally due to various pollution. It is located in Appendix III of the Berne Convention, and in Croatia it is a protected species (the Codebook).

Tree Frog - Hyla arborea (Linnaeus, 1758)
It is present in almost all of Europe which fell abundance of its populations. It is a nighttime type that prefers different habitats that have highly developed vegetation. Because of its ability of agile climbing, it usually resides above the ground, on some parts of plants. It is endangered by the loss of its reproductive habitat, isolation and habitat fragmentation, pollution and increasingly intensive use of agricultural, forest and other surfaces. Habitat protection is currently considered the best method for protecting the populations of the toad. It is on the list of protected species of European and Croatian ordinances and Conventions.

It is listed in Appendix II of the Bern Convention and Annex IV of the Directive of habitats. According to IUCN criteria, in Croatia it has the status of Near Threatened species (NT) (Red Book of Amphibians and Reptiles of Croatia).

Marsh brown frog - Rana arvalis Nilsson, 1842
It is believed that this is the most abundant species among brown frogs in Central and Eastern Europe. This brown frog resides mainly in the drier and open habitats, and in Croatia it is very common in forest habitats, forest edges, clearings, ponds, swamps, fields and thickets. It reproduces in mostly peaceful and standing waters, the shallower areas and in temporary waters. Most often it is threatened by the destruction of the habitat and spawning habitat and industrial pollution. In Croatia it is a strictly protected species under the Codebook, and is stated in Appendix II of the Berne Convention and on Annex IV of the Habitats Directive.

Agile frog - Rana dalmatina Bonaparte, 1840
This widespread species is present in western, central and southern Europe. It mainly inhabits more humid than exclusively aquatic habitats and can be found in gardens, wet meadows, thickets and forests, while outside the breeding season it comes also to the drier areas. During mating it chooses shallow, standing or temporary water. The agile frog is threatened with changes and loss of natural habitat and drainage and reduced amounts of water during reproduction. It is located in Appendix II of the Bern Convention and Annex IV of the Habitats Directive. It is a strictly protected species under Croatian law.

Complex green frog - Pelophylax ridibunda, Pelophylax lessonae, Pelophylax esculenta
These three types are also called the green frog complex because two types of hybridization formed a third and often hybrids and similar types are located in the same area. Their populations are generally large and numerous, and the distribution is quite broad. They are probably the largest groups of amphibians in this area. They are strongly associated with aquatic habitats and habitat in pools, ponds, lakes and rivers, but also in wet meadows, reeds and other wetlands. They are very resistant due to environmental conditions and pollution. They prefer open habitats with dense vegetation. They are the least threatened amphibian species and are among the most resistant to environmental pollution. They live not only in contaminated water from households, but also close to industrial plants where most other species cannot survive. They are found in Appendix III of the Bern Convention and Annex IV (Pelophylax lessonae) and V of the Habitats Directive. While the large and small green frog is a protected species, the common green frog is a strictly protected species.

3.11.3. 5. Reptile fauna

Reptiles were the first vertebrates that completely adapted to terrestrial habitats. Given their physiological and anatomical features, they are most numerous in tropical and subtropical areas. In temperate areas they are much fewer in number in species, but also in abundance of populations. In most ecosystems, reptiles have a very important and distinctive role. With respect to their type nutrition, they are at the top of many food chains as skilled predators so they are very valuable as indicators of "health" and the quality of the environment. It is also known to hold the balance of populations of other animals and participate in transmitting energy through the ecosystem.
In Europe, according to the latest data, there are approximately 150 species of reptiles with more then 100 species of lizards, while the less represented are snakes and turtles. Reptile fauna in Croatia makes 40-odd species that are still largely distributed in the coastal area. Some of them have a much wider distribution, while others live in a narrow range and have high environmental demands. Reptiles are predominantly thermophilic animals that prefer warmer habitats. So in relation to the coastal area and Dalmatia, continental Croatian is significantly less populated with reptiles (unlike the reverse relationship in the case of amphibians). The total number of species of reptiles in the continental Croatian is 13.

In the wider area during previous studies there was reported a total of 10 species reptiles, including one species of turtle, four species of lizards and five snakes. This number accounts for more than 25% of Croatian reptiles, and 80% of the continental Croatian reptiles. The reptile fauna of the observed area mainly originated from the European area. Grass Snake (Natrix natrix), a Palaearctic species, a widely spread European species is the blind-worm (Anguis fragilis), common lizard (Lacerta agilis), smooth snake (Coronella austriaca). A narrower spread of middle-European species, which is the center of this range, is the wall lizard (Podarcis muralis) and whitefish (Elaphe longissima) and dice snake (Natrix tesellata). For certain species such as the horned viper (Vipera ammodytes), this is almost the northern boundary range.

Systematic list of species of reptiles in the wider area of influence:

First ORDER: Testudines (Chelonia) - Turtles
I. Family: Emydidae - pond turtles
Emys orbicularis (Linnaeus, 1758) - terrapin

Second ORDER: Squamata - Squamata
II. Family: Anguidae - lizards
Anguis fragilis Linnaeus, 1758 - knobs
III. Family: Lacertidae - Lizard
Lacerta agilis Linnaeus, 1758 - Meadow Lizard
Lacerta viridis (Laurenti, 1768) - common lizard
Podarcis muralis (Laurenti, 1768) - Wall Lizard
IV. Family: Colubridae - snake
Coronella austriaca Laurenti, 1768 - Smooth snake
Zamenis longissimus (Laurenti, 1768) - whitefish
V. Family: Natricidae - moon snails
Natrix natrix (Linnaeus, 1758) - Copperhead
Natrix tessellata (Laurenti, 1768) - fishing boats
VI. Family: Viperidae - Vipers
Vipera ammodytes (Linnaeus, 1758) - viper
Vipera berus (Linnaeus, 1758) - common adder

Among reptiles of the wider area of impact there are no endemic species, but despite this fact and the relatively small number of species, the fauna is interesting and varied.

Important habitats
Reptiles unlike amphibians are much less dependent on aquatic habitats and are present mainly on terrestrial habitats. The distribution, ecology, behavior and biology of reptiles are largely determined by the amount and intensity of solar radiation, but also adequate places to hide. Most species of the observed area are mainly connected to dry terrestrial habitats. Unlike reptiles, amphibians are generally not dependent on the water, especially during the deposition and incubation of eggs. There are only three types more or less associated with moist habitats and those are dice snakes mostly in greater measures, while the copperhead is much more "plastic" in its habitat selection and tolerance towards the amount of moisture. Knobs and the common adder also tolerate a certain amount of moisture. The remaining species mainly populated drier, less sheltered and elevated places.
The wider impact area is located in the former flood plain of the river Sava, and here are still present various types of permanent and temporary aquatic and wetland habitats. The location of the airport from the river basin is only 3 kilometers, and around the areas of impact there are several smaller rivers or water surfaces - Kosnica, Bapča and Pleški channel.

Overview of the expected species of reptiles

Despite a dozen species which have been recorded in the wider area, the very area of impact is inhabited by a smaller number of species of reptiles. In fact, some species of reptiles are related to specific habitats and substrate exposure and prefer dry, hilly terrain. Based on the above, the expected species of reptiles in the area of impact are:

Pond turtle - Emys orbicularis (Linnaeus, 1758)

The European pond turtle is present in almost all of Europe, and is considered the northernmost widespread turtle. It usually inhabits still or slowly-flowing waters rich in aquatic vegetation. It is a common and characteristic species of aquatic habitats (ponds, pools, and calmer parts of the river course) where the bottom is muddy and is well covered with vegetation. It rarely uses terrestrial habitats, although the land is very agile on the land. It has been shown that these types of individuals strongly relate to their place of hatching and do not go away from it. This makes them quite sensitive to any change in the natural habitat. It is endangered throughout its areas of distribution and is considered to be one of the reptiles whose population has decreased most during the past 20 years. Reasons which are responsible for such changes are fragmentation and the desiccation of wetlands, climate change, and the development of industry, pollution and use of pesticides. Since the pond turtle hibernates in the mud, they are threatened with changing and cleaning channels and other bodies of water. According to the Regulations on declaring wild species protected and strictly protected (OG 99/09) [hereinafter Codebook] they are considered strictly protected species. They are listed in Annexes II and IV of Habitats and on Annex II of the Bern Convention. They are also found in the Red Book of Amphibians and Croatian reptile species in the category low-risk (NT), and it is classified in the same category on the European level.

Slow worm - Anguis fragilis Linnaeus, 1758

The slow worm inhabits almost all of Europe and is one of the few reptiles that comes up all the way to the polar zones. It inhabits different habitats from lowland to almost mountainous (almost 2000 m above sea level). It withstands temperature extremes, and often prefers wetter places. It usually inhabits places with a lot of vegetation, such as forests, woods, shrubs, meadows, etc. It often resides near to, and within human settlements, where it uses anthropogenic features to hide and find a convenient place of residence. Is not considered a particularly endangered species, and the only thing that threatens it is the possible destruction of its natural habitats and unnecessary killing because people often mistake it for a snake. According to the Codebook (OG 99/09), the slow worm is a protected species. It is on the list of animals from the Annex III Bern convention.

Meadow lizard - Lacerta agilis Linnaeus, 1758

The meadow lizard inhabits the whole of Europe and part of Asia to Siberia. It is mainly a lowland species, but can be found up at a height up to 1500 m. It withstands a wide range of conditions and different habitats and lives even in human settlements. It usually inhabits sunny places like plains, bushy and grassy slopes, edges of forests, hilly areas, vineyards, meadows, fields, plains, gardens, etc. Lately its number has decreased in all of Europe because of the destruction and degradation of its habitat due to increasingly intensive constructions, conversion of barren land into fertile, landscaping and the use of chemical additives. The meadow lizard on the basis of the Codebook (OG 99/09) is in the category of strictly protected species. Other than protection at the national level, it is on Appendix II of the Bern Convention and in Annex IV of the Habitats Directive.

Grass Snake - Natrix natrix (Linnaeus, 1758)

It inhabits almost all of Europe and is one of our most common snakes. The grass snake prefers moist and aquatic habitats, but resides in the bushes, meadows and even along the coast. On favorable habitats it is often very large, and there is one registered snake for every few meters of water. It is a very good swimmer and often hunts in water, although it is not exclusively water-related.

In some Central European countries the grass snake is considered a vulnerable or sensitive species, whereas in our population it is largely stable. It was noted that it is very often killed on roads, especially in juvenile forms. According to the Codebook on declaring wild species protected and strictly protected (OG 99/09) the grass snake is a protected species (Z). Besides this, the grass snake is classified in Appendix III of the Berne Convention.

The dice snake - Natrix tesselata (Laurenti, 1768)
The dice snake is an Eastern European and West Asian species. Although its population is not as dense as the grass snake population, the dice snake has been recorded at different sites along the water. Although by environmental requirements it is somewhat similar to the grass snake, dice snakes of all European snakes are mostly related to water, which is where they mostly dwell. It is an excellent swimmer and can dive for longer periods of time, but it moves on land just as well. Its habitat is made of faster and slower currents and standing water. Unlike grass snakes, they artfully climb trees. During reproduction time they can be seen more frequently on land and on the banks of water surfaces. Reasons that the dice snake is threatened are usually associated with changing habitats, river regulations, drainage, irrigation, pollution. In most countries in which it lives, is protected by law. In Croatia the dice snake is a strictly protected species pursuant to the Codebook of protected and strictly protected species (OG 99/09), and according to the Red Book of amphibians and reptiles it is in the category of species for which there is insufficient data (DD). According to European legislation it is on Appendix II of the Bern Convention and Annex IV of the Habitats Directive.

Common adder - Vipera berus (Linnaeus, 1758)
The common adder is a typical continental herpetofauna, and inhabits the entire area of Europe except the western part. Like the slow-worm, thanks to the characteristic reproduction, it goes all the way to the polar zones. It is one of three true vipers in Croatia. It inhabits large number of different habitats such as open woods and bushes, hedges, edges of forests and fields, meadows, marshes, etc. As a rule, it prefers moist habitats. The populations in much of Europe are fragmented due to habitat loss and fragmentation and other anthropogenic impacts. It is protected in most European countries because of problems with the modification and disappearance of its suitable habitats. The common adder, according to the above Codebook (OG 99/09) is a protected species, while according to the European criteria it is listed in Annex III of the Bern Convention.

Reptiles are primarily terrestrial organisms that inhabit virtually all existing land habitats. Some species with their biology are connected to moist and aquatic habitats for dwelling and hunting prey. Such aquatic species in this area are the pond turtle (Emys orbicularis) and two species of snake of the Natrix genus, the grass snake and the dice snake. The land habitats with developed vegetation (edges of groves, hedges, meadows) are used by the slow worm, meadow lizard and common adder.
Reptiles in the observed areas are protected pursuant to the "Codebook on the proclamation of wild species as protected and strictly protected" (OG 99/09), with 3 kinds of strictly protected, and the remaining is in the category of protected species. Given that in this space there are common central European species of reptile, none of them is in the category of endangered (threatened) species according to the IUCN categorization. Reptiles are covered and protected under international conventions. According to the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) 7 are a strictly protected species (Appendix II) reptiles – Emys orbicularis, Lacerta agilis and Natrix tessellata. Based on Annex III, the other 3 types are also protected - Anguis fragilis, Natrix natrix and Vipera berus. According to the European Union’s Directive on the protection of natural habitats of wild fauna and flora (Habitats Directive), Annex II (species whose conservation requires establishment of special protected areas) it only lists the Bar turtle Emys orbicularis. According to Annex IV (species that require strict protection) of that directive, there are 4 protected types: Emys orbicularis, Lacerta agilis, Natrix tessellata and Vipera berus.

3.12. CULTURAL AND HISTORICAL HERITAGE

Introduction
The conservation foundation for the preparation of the Study of Environmental Impact of Zagreb Airport – new passenger terminal handles the cultural and historical heritage of the border zone which includes procedures and areas closer to the environment. The area administratively belongs to the City of Velika Gorica and settlements Bapča, Kosnica, Pleso, Selnica Šćitarjevska. The method of preparation and contents of the conservation background are aligned with the Codebook of Impact Assessment to the Environment (OG 59/00, 136/04, 85/06) and the Act on the protection and preservation of cultural property. Data in the conservation background are based on reference literature, on records of cultural goods of the Ministry of Culture and authorized museum institutions and on the results of field surveys.

Method of work
During the processing of the cultural heritage of this area, the following information was used: general reference literature, information on cultural resources and conservation substrate which developed Croatian Ministry of Culture, Directorate for Cultural Heritage Conservation Department in Zagreb, and the results of the reconnaissance, delimitation and field surveys. Performed was a field survey in the scope of the planned area of about 1000m, in the zone of direct and indirect impact. Cartographic data is shown on the scale of 1:10 000 and includes information about protected and registered historical and cultural values in the construction impact zones, according to the nomenclature of Article 7 of the Protection and Preservation Cultural Property Act OG 69/1999 and the Codebook on the content, methods of making and cartographic processing of spatial planning documents. In the area of influence of the following types, present are cultural heritage and tracked historic and cultural values:

- Cultural landscape - the landscape or its part that has historically characterized structures that testify to man's presence in that area:
- Cultural and historical structures of urban character;
- Rural entities - areas and resorts with traditional architecture, ethnological and toponym amenities;
- The memorial area and features - area, place, a monument and a features regarding historical events and people;
- Archaeological sites and sites;
- Historic buildings:
- Religious buildings,
- Buildings of traditional architecture,
- Small scale structures

Impacts of the construction of a new passenger terminal at Zagreb airport on protected cultural property and registered cultural-historical value is regarded as direct and indirect:

- Direct influence is any physical destruction of these buildings/ Localities within the zone of impact (the framing area within 250 m of the planned procedures as area borders impact on archaeological sites and individual cultural and historical values).
- Indirect impact is considered jeopardizing the integrity of the associated space cultural property (the framing area within 1000 m of the planned project, as well as the border area of impacts on cultural property).

Based on the analysis of the impact of constructing a new terminal at Zagreb Airport on cultural heritage, historical and cultural value shall be determined by the degree of their vulnerability and applied will be the following security measures:

- Relocation sites - for all cases of physical destruction and endangering the fundamental value of cultural goods.
- Transfer of cultural property - in all cases when the above actions are possible, without compromising the core values of cultural goods.
- Protection of cultural goods on the spot - in all cases where a cultural good and its core values with special protective measures are possible to protect on the existing location.

- Research and documentation of cultural goods - measures to be implemented for all endangered cultural assets and included is the conservation of movable archaeological finds from endangered sites and zones.
- Supervision during construction - archaeological and conservation monitoring, constant or occasional, in the zone of direct impact.

Historical and cultural features of the area
The historical continuity of the population density of the Turopolje area where the work is planned begins in the earliest periods of prehistory and almost can continuously be monitored through all prehistoric and historic periods to the present day, which is referred to by numerous archeological findings. Favorable climatic and topographical conditions and traffic importance of this area constitute the backbone of the population density as early as prehistoric times, and especially at times of the Late Bronze Age, which is represented by random findings of cultures.

The area gained new significance after the first Roman military campaigns in Pannonia in 35 B.C.when Roman rule was extended to the Sava River. After the collapse of two major Illyrian-Celtic uprisings, a period began of rapid and peaceful development of the province of Pannonia. In the first century there were mass settlings of civilians, construction of roads and the establishment of new settlements. In the area which is had great transport importance, or along the road that was that was important before arrival of the Romans, in the 1st the century the largest and most important Roman settlement in the wider area – Andautonia was formed. At the time of the 1st – 4th century it was the administrative, political and cultural center of a unique region which is bounded on the north by Medvednica, Vukomeričke hills in the south and the Sava River in the east. The favorable traffic position enabled good communication with the surrounding area and Siscia (today's Sisak) as a center Province of Pannonia. Andautonia was located on the Roman state road Siscia - Poetovio (Sisak - Ptuj), and close to the other Roman state road from Emona - Siscia (Ljubljana - Sisak). The usage of the river as a waterway is proven by the remains of an Andautonian harbor found after World War II, in the southern part of the village Šćitarjevo. Due to changes in the flow of the Sava River, those are now in located in abandoned Sava backwaters. In places where it was easiest to access the Sava River, access roads were built, and the coast was used in two ways: as a port and as a transition. The most significant transfer is at Ivanje Reka on the former road Poetovio - Siscia where a wooden bridge was built.

The present village Šćitarjevo significantly covered the remains of Andautonia. Since 1969, conducted was archaeological research on the assumed range of the city, and since 1981 the systematic research was conducted in the yard and garden parish office, where in 1994 an Archaeological Park was opened. Many years of archaeological research has provided insight into the appearance and organization of the Roman city. Detected were roads, streets, sewage system, public and residential buildings. Sewage was carried out over the entire area of the town center. Regarding public architecture, the most complete is the famous city beach (spa) with a semicircular pool, quadratic number of rooms, corridors, canals, a water supply system and warm rooms (hypocaust). During the research, various archaeological materials were found- frescoes, fragments of mosaics, marble wall paneling, grindstones, ceramic and glass vessels, bronze jewelry, Roman coins and other items for everyday use. Within the area of the city found were Roman tombs, such as the remains of the city cemetery beneath the city baths. Previous studies have found only a part of the Roman city, whose territory stretched far beyond.

During the Great Migration, characterized by frequent changes and conflicts, this area was passed by various nations, which is proven by numerous archaeological finds. The permanent colonization of the area by the Croats can be found in the remains of medieval settlements.

Tatar invasions in the 13th century have fundamentally changed the way of life in the open areas. Turopolje in the early Middle Ages was a tribal parish, and in 1255 the Croatian – Hungarian King Bela IV granted Turopolje a status of royalty and therefore privileges, which the citizens of the “noble municipality " later defended for centuries. Since the Middle Ages, most of this area was called Cambuse Zagrabiensis or Campus Turouo and the residents of Turopolje are jobagioni (battlemented officers) of Zagreb. The people of Turopolje, basing their right to free noble property, for centuries have maintained their privileges, and at the end of the 19th century, the noble Municipality of Turopolje dies. A great historic milestone marks the fall of Bosnia under the Turks in 1463 year, when all over Croatia fortresses were being built along with the subdivision of medieval castles to defend against the attacks of the Turks. To defend their property, the people of Turopolje in the second half of the 15th century built the town of Lukavec. Although demographic conditions after the Ottoman invasion in this area did not drastically decrease, like in other areas in Croatia along border areas that have not fallen under Turkish domination, there was still abandonment of homesteads. Opportunities improved during the 16th century with a return to abandoned homesteads in parallel with the demise of the Ottoman pressure. In addition, this area was inhabited by migrants and refugees from vulnerable areas. Forms of population which were maintained in continuity until today were former market towns like Gorica which grew into the city of Velika Gorica, villages like seat parishes, and later (in the 19th century) and school, and a number of smaller rural settlements and manors as residential buildings of Turopolje nobles. The Pleso settlement organized along the creek and center turf the construction Pleso airport nearby, and changed its outlook. The central turf became the main park of the settlement, and Pleso today is a part of the urban area of Velika Gorica.

In 1959 on Pleso a passenger building for Zagreb Airport was built (founded in 1961). The concrete runway was 2,500 m long, and the passenger terminal had 1,000 meters. In 1966 a new passenger building was constructed and the runway was restored and extended runway, and a new administration building was constructed with a control tower. The same year the name was changed to Zagreb Airport. On the eastern part of the airport is also the military Air Force Base Pleso.

Analysis of the situation of cultural property and registered cultural and historical values
According to the list of the Ministry of Culture, the Department of Cultural Heritage, the Conservation Department in Zagreb, and the results obtained from the field visit, in a narrow zone direct impact on the environment (up to 250 m around the planned work) and the wider zone with indirect environmental impact (up to 1000 m around the planned project), the construction of the new passenger building Zagreb Airport terminal includes the following types of cultural goods / cultural historical values:

- cultural landscapes
- historic urban and rural settlements
- Memorial area and features
- archaeological sites
- historic buildings: religious, residential, public, commercial purposes
- Public sculptures.

3.12.1. Cultural Landscape

a) The landscape of the valley of the river Sava (marked on the map KK1)
The Cultural Landscape encompasses an area where quality coexistence is expressed through anthropogenic forms (architecture and spatial patterns) and natural wonders. It is a rural, agricultural landscape formed by organic means, with centuries of development and interaction between man and his natural environment, and as a continuous landscape its role is kept alive even today. It is closely associated with traditional ways of life and at the same time it provides tangible evidence of its historical development.

The analysis of the structure of the landscape comes from the relief as natural substrates for the formation of anthropogenic space. The landscape of the valley of the Sava River in the area of the city of Velika Gorica belongs to the area of Turopoljska Posavina as unique spatial units of lowland and lowland character related to the Sava River. Apart from the relief, the manner of use of space was influenced through the course of history by other natural factors as well: the composition of the soil, water, flora boarding, and historical, social, economic and political activity. The characteristic pattern of the landscape is defined by historical villages of the elongated, line type or settlements branched and surrounded by agriculture soils, fields and meadows, and the remnants of the once vast Turopolje oak forests. The lowland area of the Sava River in the area of the City of Velika Gorica is an anthropogenic, organically sculpted landscape with historical continuity and preserved forms of human presence in the area in terms of architectural heritage or archaeological, spatial patterns that make the agricultural and forest lands. The lowland area of the landscape of the Sava River has preserved until today its historical characteristics, primarily in the typology of rural settlements, the characteristic matrix and the wooden architecture in the former villages was mostly replaced by new brick constructions, which still follows the typical historical pattern. The landscape that surrounds the settlement is cultivated with agriculture soils, chopped subdivisions, whose origins from ancient centuries with the prevailing cultures of grain (wheat and corn). The space has former backwaters of the Sava River still visible. Today they are drained and emphasized only with stream vegetation and willow trees.

3.12.2. Historical settlements

a) HISTORICAL CHARACTERISTICS OF RURAL SETTLEMENTS

<u>Zone of indirect impact</u>

Pleso (marked on the map: RN1)

The settlement of an elongated type extends on both sides of the field along the wide turf along the stream, which as central urban green spaces has been preserved until today. The formerly independent village was mentioned for the first time in the 15th century. Emphasized is the horizontal outline of the settlement without vertical dominants, except for the recent monument located at the central park area of the settlement. There is a preserved traditional matrix organization and a characteristic organization of parcels. Several valuable strokes of wooden buildings in traditional architecture can also be seen. The settlement in the 20th century expanded the network of new streets to the south and east, and then became an integral part of Velika Gorica. The most important historic building located in the area between Velika Gorica and Pleso is the wooden chapel of Wounded Jesus.

3.12.-1. Pleso settlement, sculpture of *the Ruptured Hoop*

3.12.3. Archaeological zones and sites

Zone of direct influence

a) THE ARCHAEOLOGICAL ZONE Andautonia (mark on map: AZ 1)
The historically urban agglomeration of the Roman city Andautonia was located on the territory of today's Šćitarjevo village. The natural, geographical and historical features the Zagreb area with the Andautonia is a complete area which was first urbanized with the arrival of the Romans. The governing Territory of Andautonia took the place of Zagreb basin and was bounded by natural boundaries (Medvednica to the north, the Samobor hills to the west, the Vukomeričke hills to the south and the Sisak area to the east). In the area of the settlement Šćitarjevo is the city centrer. The well preserved parts of the city spread 1000 meters to the north-south direction and 400 m to the east-west direction. Outside of this area placed were different suburban facilities, therefore Andautonia represents a unified whole urban and suburban area. The narrow areal of this unique region is bounded by the Sava River to the north and the east line of the present settlements Petina – Kosnica – Črnkovec – Lekneno to the south and the line Petina – Kosnica – Sava River to the west. That space the size of 16 square kilometers, along with the smaller area makes Andautonia a unique archaeological zone. In many places in the immediate vicinity of Ščitarjevo one can still follow the route of the Roman road since they are still present in the landscape today. Parts of the main and vicinal road were preserved, in the line of Bapča - Črnovec - Šcitarjevo; Lekneno - Šćitarjevo; Drenje Šćitarjevsko - scitarjevo; Sasi - Novak Šćitarjevsko - Šćitarjevo; Obrezina - Šćitarjevo; Črnkovec - Petina - Šćitarjevo. Necropolises were confirmed in Šćitarjevo, Črnkovec, Petina, and in Obrezina. In several places the remains of building materials were registered: Vratnice, Savišće, Gornja zemlja, Lekneno, Sasi and Obrezina, whose character indicates the dense construction of immediate surroundings.

3.12.-2. The archaeological site of the settlement Andautonia Šćitarjevo

b) POTENTIAL ARCHAEOLOGICAL SITES (PAL)
During the archaeological field survey of the area of the planned Zagreb Airport parking and the access roads at the locations marked on the map, more mobile archaeological sites were found: usable ceramics and building materials - bricks. Such a large amount of findings is not surprising because of the proximity of ancient Andautonia, the former urban center where the wider surroundings gravitated. The found archeological materials do not confirm the existence of archaeological sites on the position itself, but it does indicate its presence. Specifically, with the intensive agricultural tillage some findings can be moved up to several tens of meters from their original position. Pinpointed on the attached map are the exact positions findings, according to the attached list.

Potential archaeological site (PAL 1)
- Acres south of the creek Kosnica, findings of several fragments of medieval pottery

3.12.-3. Potential archaeological site (PAL 1)

Potential archaeological site (PAL 2)
- Acres south of the creek Kosnica, findings of several fragments of medieval pottery, one of which is one part of a bowel with a green glaze.

3.12.-4. Potential archaeological site (PAL 2)

Potential archaeological site (PAL 3)
- Acres along the southern bank of the river Kosnica, the findings are medieval pottery, parts of a pitcher, throat with handle, glazed green glaze

3.12.-5. Potential archaeological site (PAL 3)

Potential archaeological site (PAL 4)
- Acres next to the southern edge of the settlement Petina, findings of three pieces of antique brick

3.12.-6. Potential archaeological site (PAL 4)

Potential archaeological site (PAL 5)
- Acres along the south side of the road between Petina and Selnica, findings of ancient ceramics, especially the handle of a pitcher or amphora.

3.12.-7. Potential archaeological site (PAL 5)

Potential archaeological site (PAL 6)
- Acres between Petina and Selnica, the old bed of the stream, findings of two pieces of ancient pottery, one edge of a bowl

3.12.-8. Potential archaeological site (PAL 6)

Potential archaeological site (PAL 7)
- Acres north of the position Selnica on the position of the future roundabout, finding of an edge of a neck of an ancient pot and fragments of an ancient floor tile

3.12.-9. Potential archaeological site (PAL 7)

Potential archaeological site (PAL 8)
- Acres at the northern edge of the zone of the access road near the future bypass of Velika Gorica findings of several pieces of antique yellow and black usable ceramics

3.12.-10. Potential archaeological site (PAL 6)

Zone of indirect influence
c) ARCHAEOLOGICAL SITES

- Bapče, an accidental discovery of Roman coins (marked on the map: AL 1)
- Bapče, the route of the Roman road - Čohovo (marked on the map: AL 2)
- Pleso, Early Imperial Roman tomb (marked on the map: AL 3)
- Pleso Grabanka, antiquity (mark on map: AL 4)
- Velika Gorica, Visoki Brijeg, necropolis of the late Bronze Age (marked on the map: AL 5)
- Velika Gorica, Visoki Brijeg early Empire Roman necropolis, 1-2.st. (Marked on the map: AL 6)
- Velika Gorica - medieval cemetery - the church (marked on the map: AL 7)
- Velika Kosnica, Gradišće - antiquity, perhaps villa rustica (mark on map: AL 8)
- Velika Kosnica, Medvenica, artisan workshop facilities, suburban villas, Economy and port facilities (mark on map: AL 9)
- Velika Kosnica, (label on the map: AL 10)

3.12.4. Memorial area and features

Zone of indirect impalce

- Velika Gorica - Memorial "Ruptured Hoop" - Pleso (marked on the map: MO 1)
- Velika Gorica - City Cemetery (marked on the map: MP 1)
- Velika Gorica - war monument in Pleso (marked on the map: MO2)
- Mičevec monument to fallen soldiers (marked on the map: Mo3))

3.12.5. Historic buildings

a) RELIGIOUS BUILDINGS

Zone of indirect impact

Velika Gorica, Pleso, church (chapel) of Wounded Jesus (marked on the map: SG 1)
The wooden chapel was built in the 1785 and the Parish founded in 1983. It is a rectangular vessel tripartite sanctuary with the sacristy along the south wall, and the tower above the front-porch. Inventory from time of construction: the main altar of the Mother of Sorrows, the Coronation of Jesus and the pulpit. Renewed in 1896, 1982 and 1995.

Velika Gorica chapel of St. Filomena (marked on the map: SG2)
At the cemetery. Historicist chapel built in the late 19th century, cross-shaped, three-sided sanctuary and tower above the facade. The interior is vaulted and has an altar of St. Filomena. Restored in 1986.

3.12.-11. Wounded Christ Chapel in Pleso, chapel of St. Filomena in Velika Gorica

3.12.-12. Traditional / ethnological architecture in the village of Pleso

b) TRADITIONAL / ETHNOLOGICAL BUILDINGS

- Pleso (mark on map: EG 1)
- Bapco (mark on map: EG 2)
- Velika Kosnica (mark on map: EG3)

3.12.6. Small scale structures

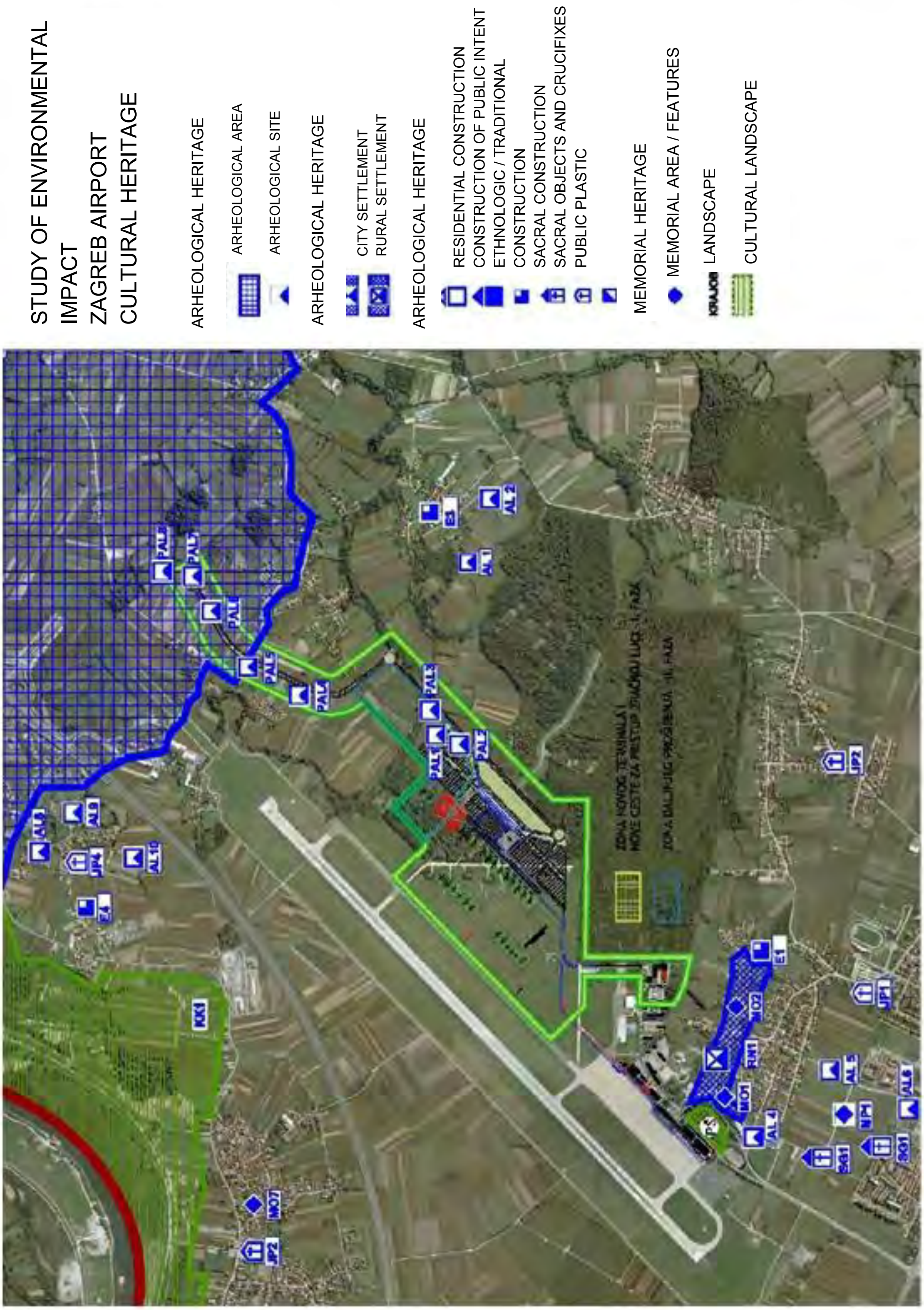
Zone of indirect impact
a) CRUCIFIXES

- Velika Gorica, a chapel on the road to Pleso (marked on the map: JP1)
- Mičevec, crucifix (marked on the map: JP2)
- Velika Gorica, crucifix in Rakarju (marked on the map: JP 3)
- Velika Kosnica, crucifix (mark on map: JP 4)

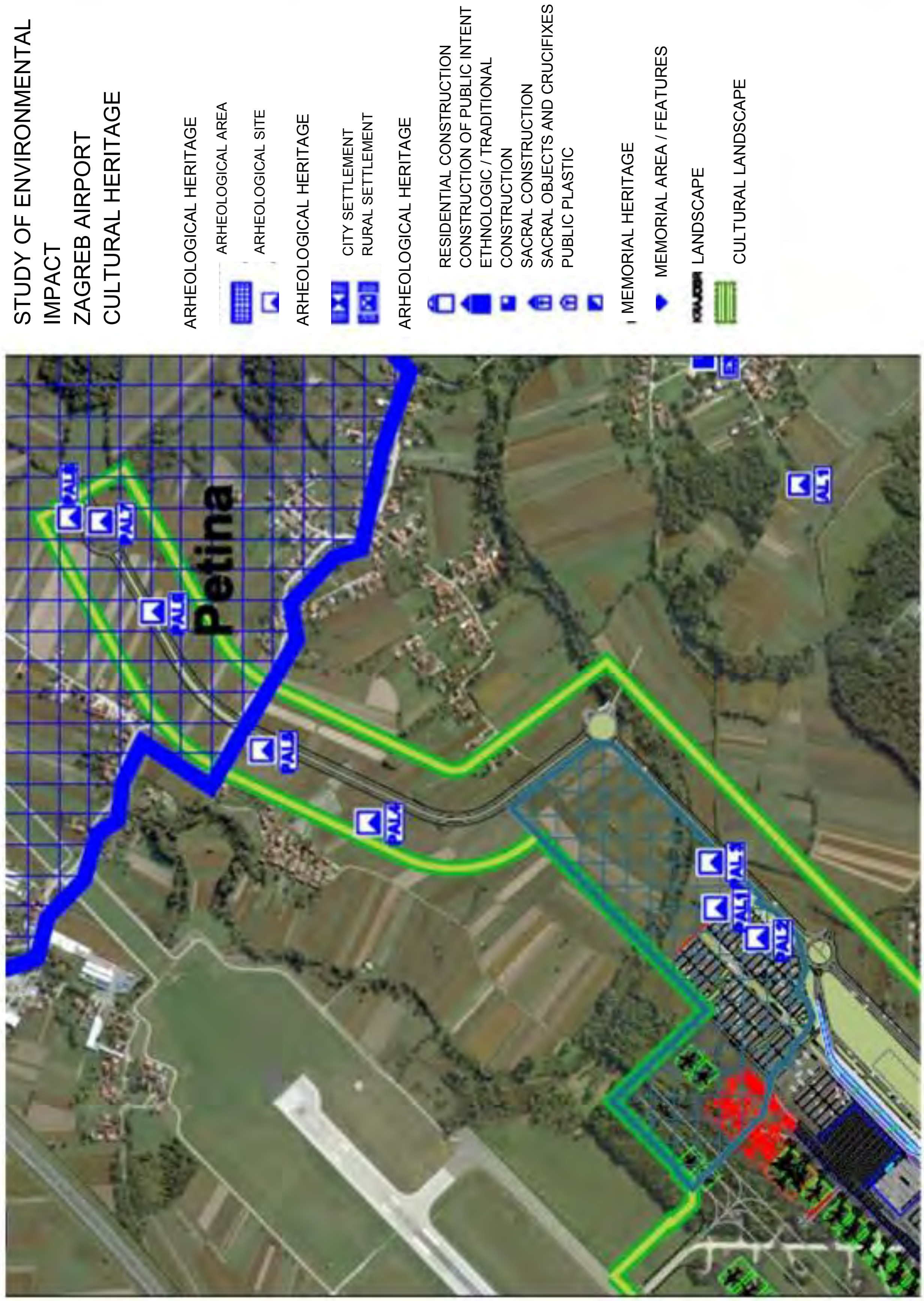
GRAPHIC ATTACHMENTS:

Appendix 3.12.-1. Cultural Heritage
Appendix 3.12.-2. Cultural heritage (detail)

Prilog 3.12.-1. Cultural heritage



Prilog 3.12.-2. Cultural heritage (details)



3.13. LANDSCAPE VALUES

The concept of landscape in the spatial planning context means a comprehensive spatial, biophysical and anthropogenic structure, ranging from completely natural, to predominantly or almost entirely anthropogenic. In fact, numerous combinations of biophysical and anthropogenic features create a coherent unit and give certain space a peculiar physiognomy.

Regarding the origin, the degree of anthropogenic change and ways of land use, the landscape can be generally classified into three characteristic forms: natural landscape, cultivated landscape and built or anthropogenic (urban, industrial, etc.) landscape. '

Source: Strategy of spatial planning of the Republic of Croatia, Republic of Croatia, Ministry of Spatial Planning, Construction and Housing, Department of Spatial Planning, Zagreb 1977.

Figure 3.13-1.: Landscape regionalization of Croatia according to natural features

By the landscape regionalization in the Strategy of spatial planning of the Republic of Croatia (I. Bralić, 1995) due to the natural characteristics, sixteen units are separated. The project in question belongs to the unit of Lowland areas of north Croatia. The basic physiognomy of the landscape unit is the agrarian landscape with complexes of oak forests and floodplain areas. Highlights, values and identity of the unit are presented by forest edges; fluvial-marsh environments (Kopački rit, Lonjsko polje, Spačvanske šume etc). The vulnerability and degradation of the units are in some places the shortage of forests in eastern Slavonia, the disappearance of hedges in agromelioration procedures; geometric waterway regulations and the disappearance of typical and experientially rich fluvial localities.

Natural geographical features

The natural-geographic area coverage is characterized by the Pannonian mega region to which almost the entire Zagreb County belongs, and the whole area is a low region from 97 to 109 m above sea level. The area covered by the plan includes the northeastern area of Turopolje, between Mičevac and Ščitarjevo. The spatial unity Turopolje in geographical terms is considered part Posavina, in the form of a large alluvial plain, between the Sava River and Vukomeričke Gorice, which gradually turns to the south into a hilly terrain. In the narrow sense, it stretches from south of Vrhovlje, south from Gustelnica and Dubranec, descending to Velika Gorica, and east to the River Sava. In the middle of Turopoljske ravnice it flows to the river Odra with its longest tributary - the stream Lomnica.
The area that occupies the wider project area belongs to the lowland area of Turopolje, cultivated fields, meadows and sometimes pastures and large oak forests in the southeast (Turopoljski lug) and south (Vukomeričke gorice). According to old authors, the name Turopolje is derived from the noun tur, which the Slavs called an animal, type of cattle extinct in the 17th. It belonged to a type of oxen, and in the period of migration of the Croats, it resided in these plains and wetlands in large numbers.

Figure 3.13-2.: Lowland Sava landscape and Turopolje
Source: Conservation foundation for PPPPO Črnkovec - Zagreb Airport, the Ministry of Culture, Department for protection of cultural heritage, the Conservation Department in Zagreb, November 2009.

Relief and landscape features

The wider coverage area lies in the lowland area of Turopolje. The river relief, up to the altitude 140 in the wider area, has the largest share in the surface of the area. It originated from the action of the river Sava, since the end of the Pleistocene geological period to today. According to data from the Regional Plan of Velika Gorica, a brief overview is given of the basic features of this river landscape in its three different versions: the floodplain, terrace and fluvial-marshy lowland. The floodplain (alluvial plain) is the most common type of valley and river relief. In natural conditions it is regularly flooded. The range is from about 5 km in the north-western part to about 12 km in the central, the the widest part of the wider area of the city. The floodplain is the lowest in its central part, and the Save river bed exceeds it in places up to 6 m. downstream of the project area, the relative difference is higher, where the lowest point Turopolje (97 m) covers the largest area. It is a fluvial-marshy lowland and floodplain area of the Odra River and the largest area of flood oak forests. Due to the implemented control of the flow of Sava for the last hundred years, cutting meanders, the determination and occasional deepening of the riverbed, construction of embankments, as the construction of facilities of defense from floods (channel Sava-Odra) the natural mechanism of Sava waters is altered. The floodplain no longer shapes the flood waters of the river Sava, so the micro relief forms are reflections of the past. Most common are timbers, river islands, inlets, still waters and streams and backwaters. Still waters are incurred by the artificial or natural cutting passages of the meander. They are located in the area of the entire width of floodplains and are generally dry, overgrown with grassy vegetation, and at the edges of with brittle willow (Salix triandrae) and poplar (Populus alba).

Inlets exhibit similar characteristics. At the time of the activities they separated the Sava islands. Streams, natural depressions which distribute the water into in the floodplain, are now mostly buried and covered with grassy vegetation. Timbers are also covered with brittle willow (Salix triandrae) and white willow (Salix alba) and poplar (Populus alba). A rich toponymic content tells us about past natural features of the environment : such as Otok, Otočec, Struga, Stružec, Prudi, Blato, Zablatje, Čret, Mlaka, Topolovec etc. The area of the river valley as a whole is very favorable in terms of settlement and agricultural valuation, and in especially higher parts of the flood and drain plane, where Velika Gorica was developed, and the terrace area of Turopolje, which is located outside the scope and risk of flooding.

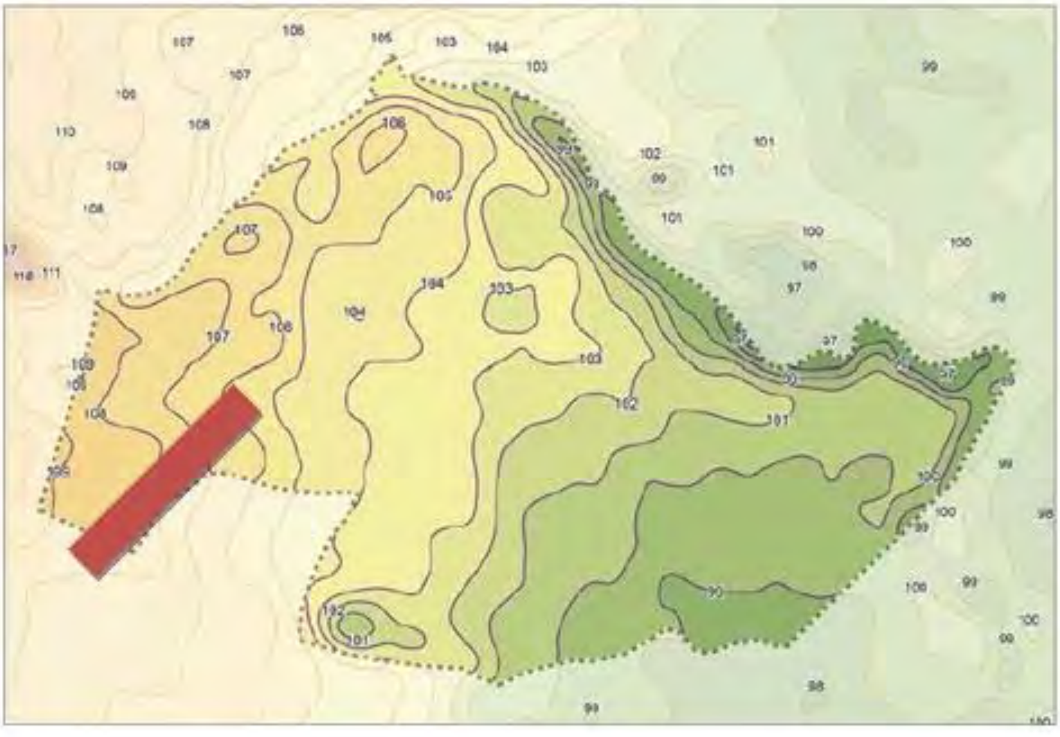


Figure 3.13-3. Characteristics of lowland river relief in the wider coverage at hand – the altitude from 97m (I) up to 109m (Z)

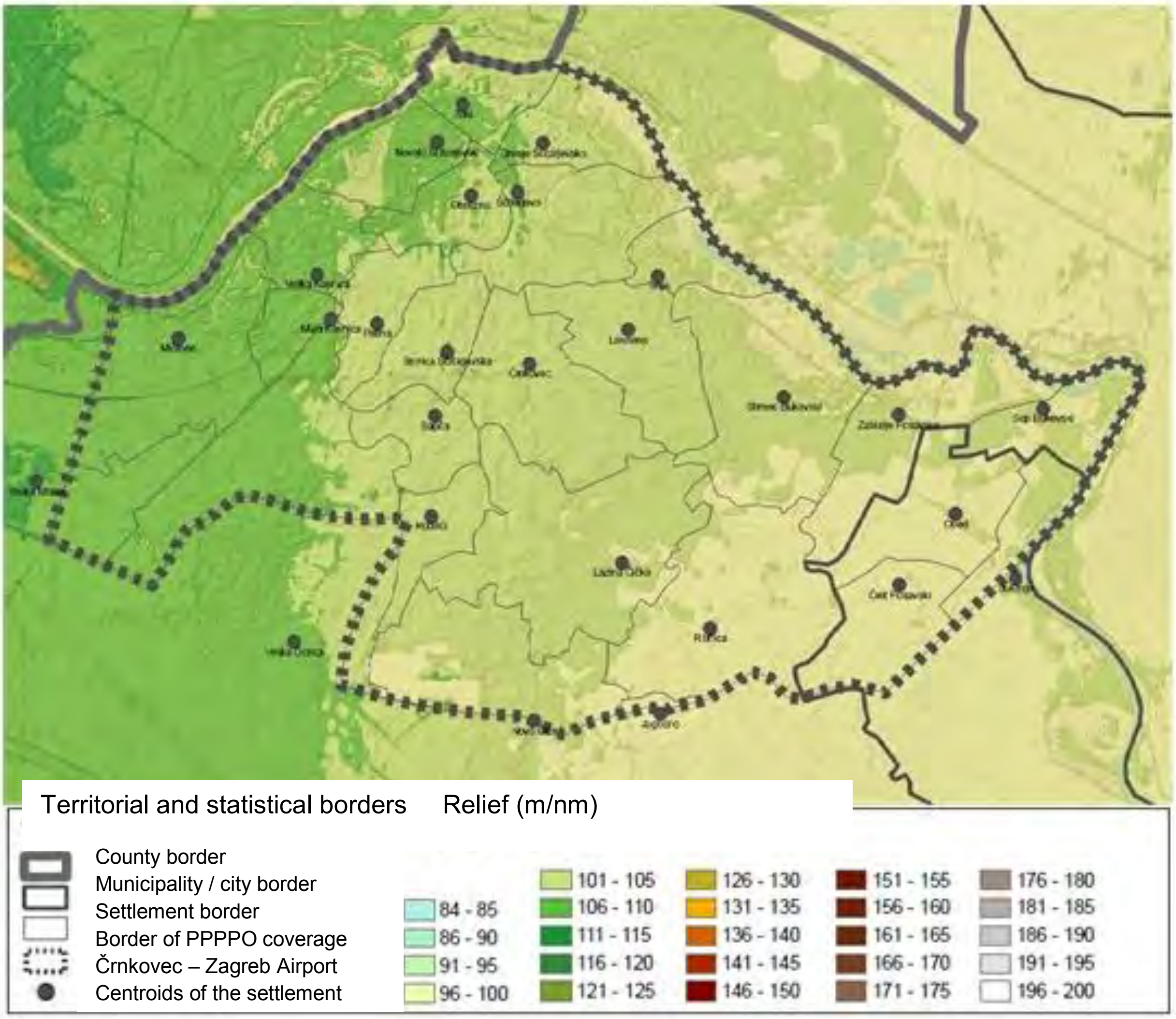


Figure 3.13-4. Relief features
Source: proposal PPPPO Črnkovec - Zagreb Airport, Cartogram 4, Department of Spatial Planning, 2011.

The project in question is in the valley of the river Sava in the town of Velika Gorica and belongs to the area of Turopoljska Posavina. General characteristics of the entire area of Turopolje consist in larger complexes of agricultural land, large forest complexes and longitudinal type settlements are typical of this area.

Evaluation and characterization of the historic landscape of the wider project area
(Source: proposal PPPPO Črnkovec-Zagreb Airport, Department of Planning, 2011)
Historical settlements
In the wider area of coverage, there are several historic villages with continuity from the middle Age. The exception is a village Ščitarjevo, with the settlement continuity from antiquity that was formed in archaeological area of the ancient town. Typical forms of wooden housing and economic architecture as part of the Pannonian cultural circle, namely Turopolje, were once the dominant architectural forms. Today they are preserved in a small number of examples, and offered the area of this cultural region to foreign architectural forms. Once homogeneous volumes villages, by building along the access road lost their spatial and morphological characteristics.
Historic buildings and architectural landscape circuits
In the wider project area, modest representative residential buildings belong to the category of construction landscape circuits – curia, with its outbuildings and gardens. Only a few examples are preserved, today in a very poor state of construction.

Archeological localities and zones

Because of the thousands of years of long historical continuity of settlement in this area, numerous physical evidence is preserved in the archaeological layer. In the wider area, the most important is the Andautonia ancient archaeological zone, which represents one of the most important sites in continental Croatian. The Andautonia ancient archaeological zone and other sites represent an important element of the cultural heritage, important for the historical and cultural identity of the area. Due to the level of exploration and research, they are classified as endangered and the least protected cultural objects. Potential sites are assumed on the basis of indicative toponyms, the geomorphological position, historical data, and as an area with material remains of historic buildings (the cemetery next to a medieval church, archeology of settlements with long historical continuity of settlement).

Assessment of the situation and the problems of the protection of historic and cultural resources

All the above mentioned types of cultural property in the coverage of the Plan are subject to constant changes and pressures, particularly because of its physical structure of sensitive wood ofethnological heritage which quickly deteriorates. The impact on cultural factors comes from: the pressure of development (demolition of traditional wooden and other historic architecture, location of economic content: gravel factory, traffic and the introduction of large infrastructure systems -lines), environmental pressures (pollution caused by road and air transport), natural disasters (Floods, droughts ...), neglect and lack of maintenance, lack of funding, unresolved property and legal relations. Reasons of devastation and threats of cultural goods are multiple - on one hand the pressures of development (derived and planned projects of infrastructure facilities, etc.) on the other, lack of maintenance and neglect of historic wooden buildings, and thus endangering their construction state. The features and character of historic settlements are particularly at risk of: expansion of construction areas along the road (and not according to urban concept) changes in the building structure in terms of the introduction of new architectural and aesthetic elements coming from other building traditions and lack of maintenance and demolition of the historic building structure that is part of the spatial identity. Elements that have a strong influence change the relations in the area, and thus decreases the value of the landscape unit, among others are: the exploitation of natural resources in the river landscape (gravel pits etc.), expansion of building areas in the landscape without detailed planning and urban development documentation, transmission lines, road and other infrastructure systems. Transmission lines and large Transport Systems (airport, road infrastructure, transmission lines, antennas, mobile operators) have a great visual and spatial reach and often become barriers in the area. Analyses showed that the largest traffic communication since ancient times are used by physical features of the terrain in the manner of using relief and other natural advantages, without destruction and causing conflicts in the area.

Expansion and changes in the structure of the settlements - new construction areas

The problem is expressed in the suburbs (former villages: Bapča, Selnica, Velika Kosnica and Mala Kosnica) that in the last decades show signs of changes, significant territorial expansion, but without proper zoning regulations. This change is sociologically conditioned, caused by immigration, especially in wartime and the post-war period, but also the movement of the local population. Settlements are being expanded along the road, not taking into account the typological characteristics of the historical pattern. This is how the building areas connect an uninterrupted series of construction along the roads, with no planning basis which would establish a quality spatial organization of settlements. These processes usually lead to the loss of spatial relationships of settlements and their surroundings and the landscape turns into built agglomerations of peri-urban characteristics, with no established formal and urban quality. The specificity of the area and one of the characteristic spatial patterns are recognizable matrices of unilaterally organized villages, with wooden building structures located in the coastal area of the river basin. Their morphology is conditioned by the physical features of this area, the river inlets and meanders that were followed the main street of the settlement along which a series of long, regular parcel wooden gable-oriented houses were built. Impressive images of such villages (Bukevje, Strmec, Zablatje) disappear, and the villages are transformed into unrecognizable

agglomerations. Except degradation of morphological characteristics, there are also problems of spatial character. By the expansion of settlements in quality landscape areas that surround it and represent zones of its exposure its recognizable image is in danger, and thus its overall historical and cultural landscape value. Problems are also bringing contents and activities that are sources of pollution or otherwise that can diminish and undermine the value of historical settlements (Traffic, noise, vibration, gases ...).
The archaeological zone of ancient Andautonia in Ščitarjevo is exposed to many depredations and destruction of archaeological findings caused by building houses and ancillary buildings, performed without archaeological supervision and control. It can be generally ascertained that today settlements in the protected archaeological zones spread their construction areas often will illegal building, without the control of archaeologists. In addition, the formative register of new construction has no foothold in the architectural forms of the area.

Conflicts in space

We use the term conflicts for content, form, structure and method of use which reduce or devastated landscape, cultural and historical values of the area, or are a potential danger to the future of cultural heritage. The current conflicts are: uncontrolled expanding of construction zones with architectural forms that are not from the same cultural circle - causing loss of spatial identity, disorganization of historic villages, the passing of Zagreb bypass through a unique archaeological space and landscape areas, exploitation of fields for gravel extraction and areas of illegal exploitation and other potential conflicts are: requirements for the expansion of the service areas, the planned HE Drenje and other planned infrastructure protection zones.

Figure 3.13.-5: Spatial Conflicts in the coverage of the Plan
Source: Conservation foundation for PPPPO, Ministry of Culture, November 2009.

Analysis and interpretation of the area within the concept of the landscape

The landscape is a specific geographic area that is the result of interactions between nature and man kind. Unlike natural which is untouched by man, every landscape in which man intervened enters the category of culture. The landscape is a set of tangible and intangible heritage, biological and cultural diversity, which represents a solid network interrelationship between man and his natural environment, the landscape reflects briefly interaction between nature and culture through its historical development. It is an undeniable fact that culture - a force that shapes the landscape, with its implications the landscape becomes cultural. Under the natural state of the landscape it is implied that its physical characteristics such as bedrock and soil, relief features, water, and the hydrographic network, forests and animal (wild) species. Cultural or anthropogenic landscape features reflect in the manner in its usage; settlements, architectural and other architectural forms, network communications, agricultural land, its culture and geometry of plots. The state of the landscape determine its natural (physical) and anthropogenic components. According to modern interpretations, the landscape is the physiognomy of the environment, it is a reflection of all phenomena on the surface of an area. The landscape, as a physiognomy of the earth's surface, is also the physiognomy of man's environment and its relationship as an expression and reflection of the management, use and conditions at a particular time. The analysis of landscape features of the project area includes the elements that during two thousand years of urban history had an impact on the determination of its present condition.

Spatial organization

At the level of a complete review of the space covered by the plan, the relations are being analyzed between settlements and respective environments and road communication networks through historical periods. The reference period is the end of the 18th century, the map data that allow the making of comparative maps. Topographic maps according to Josephine measures of Civil Croatia from 1863-4 were made in the ratio 1:2880 are the oldest historical indicator of the spatial organization, topographic and hydrographic features, agricultural usage and the organization and structure of each settlement. Cadastral maps from the mid-19th century made in the ratio 1:2880 accurately show the structure of each settlement and ownership of the geometry of space, but due to measurements they are more appropriate for a more detailed analysis of each of the settlements.

Road communications networks

As mentioned above, the period of the Middle Ages did not continue the tradition of building a quality road network, which was left from the Roman period on these grounds and as the new road network was neglected, and the Roman roads deteriorated. Stronger development of road construction followed after the end of danger from the Turks. The first significant road were built on the route Zagreb - Sisak via Velika Gorica, as part of the main river-road arteries of traffic economy in northern Croatia, until the establishment of railway transportation. Already 1862 it was opened to traffic on the railroad going from Zagreb to Sisak via Zidani most as an intersection of the so-called Southern Railways.

The specified network traffic passes along the edge of the area, and all other roads in this area have until the last decade of the last century to have meaning only for the local or regional traffic. The settlements are connected by a network of local roads and field paths with agricultural land.

Parcelling - distribution of land

Analysis and use of agricultural land by monitoring the spatial geometry of ownership - land subdivision, under the present situation shows that two types are present. Raster of symmetrical, organized plots of large size are noticed in areas closer to the river and on the area next to the resort Ščitarjevo. In the space between settlements Strmec and Bukevje, this parcelle coincides with the direction of the ancient ager and gives indications that it is a land consolidation, which has its foundations antic geometry. This is confirmed by the fact that until the middle of the 19th century, the area was part of the great noble estates of the fort Želin. The subdivision along the Odra River and of settlements Lazina and Ribnica deviate from regularity and orthogonal system, and the size of the plots show that they have much smaller surfaces. Along the edges of the plot are individual trees or hedges that create a mosaic spatial pattern.

Figure 3.13.-6: Left - irregular grid and smaller scale of subdivision, right - Proper Orthogonal subdivision grid, Source: Conservation foundation for PPPPO, Ministry of Culture, November 2009.

Characterization of the historic landscape / typification historic landscape

The characterization of the historic landscape is a key approach to the method of change management in the historic environment. According to the general characterization of the national framework, this area belongs to the low-lying areas, and in the regional classification of the area it belongs to landscape unit Turopoljsko Posavlje. The more detailed description of the type / nature of the Landscape unit Turopoljsko Posavlje, the lowland settlements along the Sava differ - unilateral matrices along the river or backwater from Novak, Sas, Drenje to Strmac, Sopa and Bukevje which matrix has a two-sided construction along the road. Central lowland area of Turopolje includes liner organized settlements along the road sides.

The analysis of visual and perceptual features - visual sensitivity and spatial landscape capacity

Analysis views, visual measurability and morphological features of landscape is one of the evaluation criteria values, and thus the possibility of new interventions in the landscape.

Documenting the spatial and morphological features

Within the cartogram views documented and evaluated are experiential aspects of space such as views, visual edges, spatial and architectural dominants, specific visual exposure, the conflicts in the region have also been documented. Based on these analyzes areas of visual sensitivity are estimated. The analysis of the level of visual exposure to the major roads and the movement on the Sava River embankment resulted in a visual map of the area of visual sensitivity. Results of the analysis are given in Figure 3.13.7. Space capacity is directly linked to the potential of the new projects in the area, the degree of preservation and the level of visual sensitivity are estimated with respect to the characterization and evaluation of landscape areas, the degree of preservation and the level of visual sensitivity. From the analyzes it is shown that the areas of the eastern part of the plan coverage, along the Sava riverare best preserved, and that all the valuable features and manner of usage should be preserved.

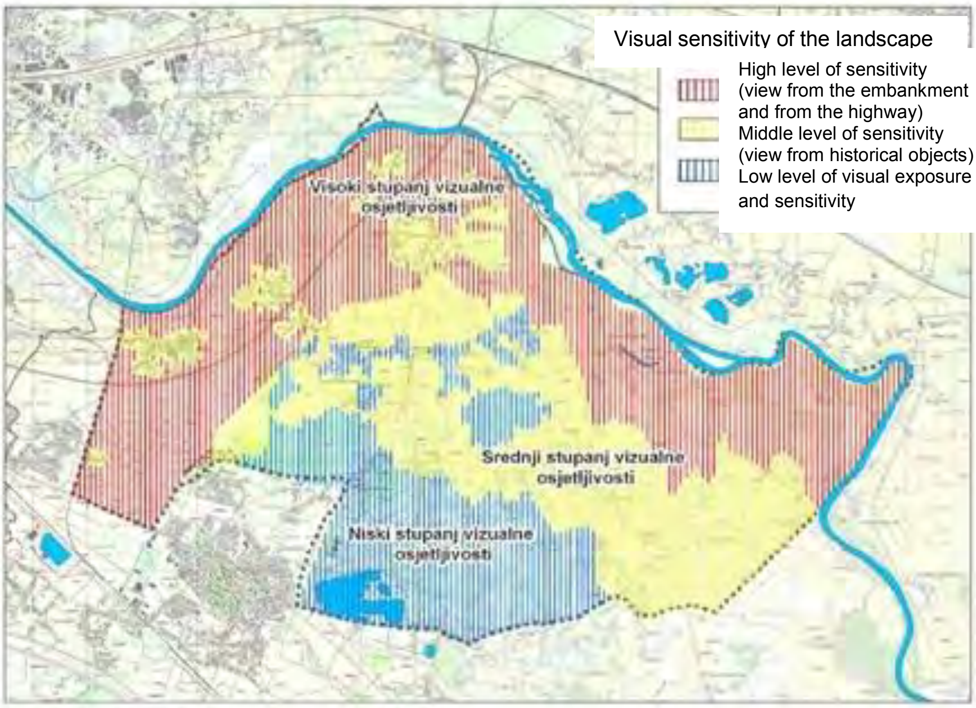


Figure 3.13.-7: The visual sensitivity of the landscape in the coverage of the Spatial Plan of Special features Črnkovec - Zagreb Airport

Source: Conservation foundation for PPPPO, Ministry of Culture, November 2009, GIS processing: Department of Spatial Planning of Zagreb County, 2010.

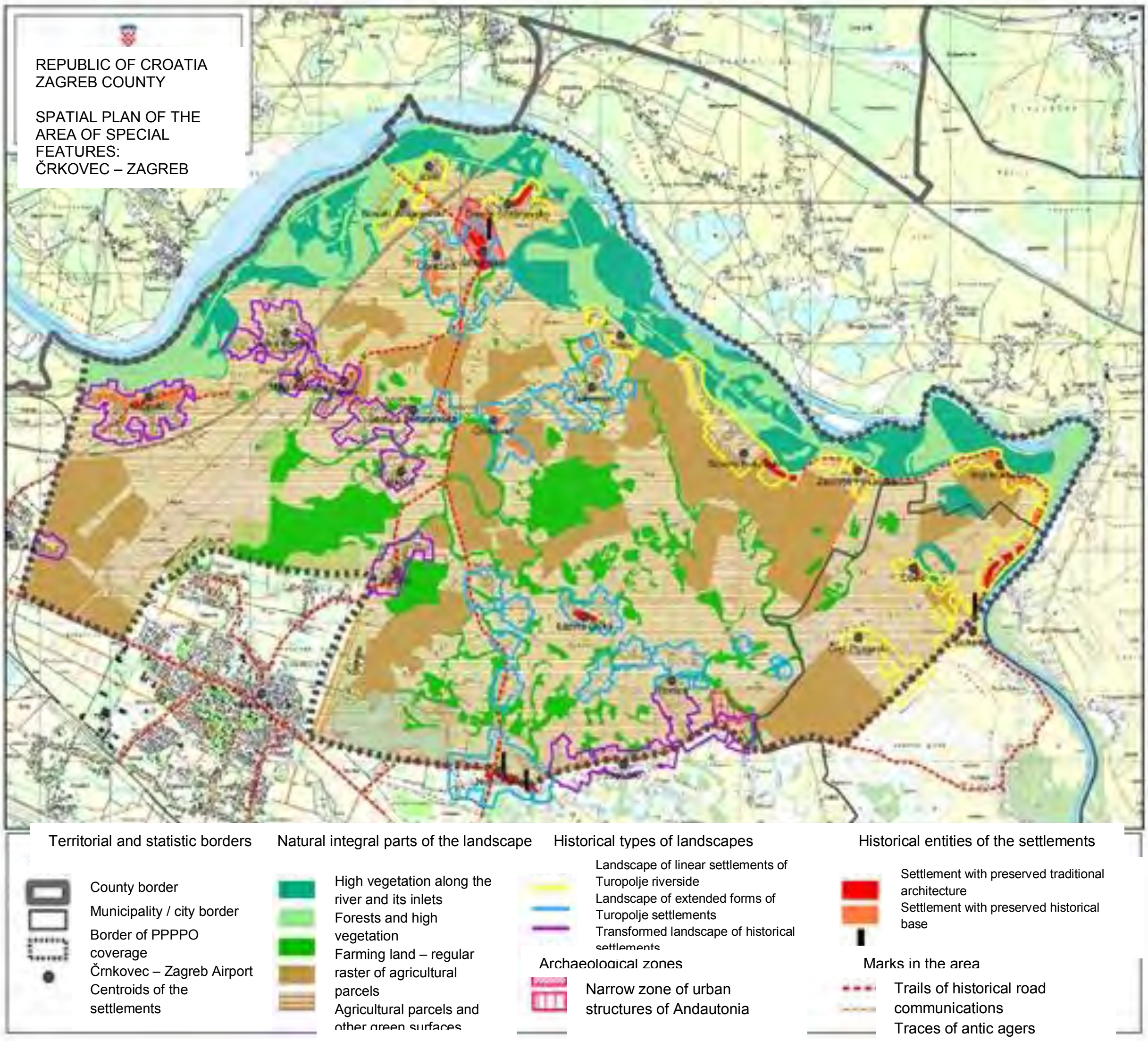


Figure 3.13.-8: Valuation and characterization of the historic landscape of the wider area of coverage
Source: proposal PPPPO Črnkovec - Zagreb Airport, Map 14, Department of Planning, 2011

Analysis of the immediate areas of operation

The entire experience of a certain area and its landscape is determined by the basic physical geographical elements especially relief, water, vegetation, and it depends on anthropogenic influences.

The project site is located within the cultivated areas and urban landscapes. Anthropogenic influence is the most important factor in the creation of this landscape, it was developed by a centuries-old influence of social and economic factors on nature. Due to human activities, the natural form of the landscape is less and the natural landscape experiences change and degradation, and transformation of cultivated and urban landscape. The basic impression of the experience of the landscape is low-lying area, agricultural processed, mild relief dynamics dominated by Zagreb Airport along with military airport base Pleso and the surrounding settlements.

Figure 3.13.-9: Looking to the future location of the terminal building from the military air base Pleso

The landscape structure of the investigated area was analyzed through recognition for land use and its surface, relief features and visual quality. Structural analysis of the immediate location of the project as the dominant elements in space recognize the existing Zagreb Airport along with a military aviation base Pleso, Velika Gorica and Lake Čiče, other elements of the landscape that are recognized are settlements, agricultural land and roads that create the landscape typical of the region.

Figure 3.13.-10. Structural analyses of the landscape

Anthropogenic spatial structures represent settlements with associated infrastructure and agricultural areas that dominate the space of coverage. Natural elements in the project area remain only in trace amounts, only a few trees. Settlements are traditionally located along line corridors and agricultural surfaces. The settlements are dominated by traditional architecture and in that area there are no facilities which by size or style jump out of the context of the local architecture and rural landscape. The traditional way of life based on farming and life in general from working on land, kept up to date. Agricultural lands create a mosaic structure to horizontal changes of cultures. The mosaic structure of the agricultural area is visible only from the air so you can say that from the perspective of human space it is not rich of the significant perceptual values.

Figure 3.13.-11: View of the future location of the passage of the access road from the northeast

The strongest line element in the area along the roads are former branches of Sava, today dried, pronounced hydrophilic vegetation, with sporadic "patches" of forest surfaces, the basic dynamic of this largely static landscape. Line character of these branches have been exacerbated by agricultural areas laid perpendicular to the former watercourses, this is how it is the water was the lowland relief baseline - the element of landscape formation.

Figure 3.13.-12: Kosnica river bed

In the area of the subject location changes are mentioned of elements forming the landscape without exceptional values, but with some elements and organization that should be preserved.

3.14. Settlements and population

Significant surfaces of construction zones were identified as the rural area for the future expansion of the construction area. In most cases, during the period from 1985 to 2004 these surfaces were not covered by new construction, but significant surfaces are built outside the construction areas, indicating that the settlements spread in other directions. On the other hand, due to longstanding reservation of space for the expansion of Zagreb airport, areas have not been established for four independent statistical settlements (Mala Kosnica, Petina, Selnica Šćitarjevska and Bapče), and part of the settlement Črnkovec. Regardless of prohibition of construction and planned relocation of settlements during the period from 1985 to 2004, the existing settlements continue to exist, and rebuild. In the period from 2001 to 2011 population number decreased in the settlements Bapče, Mala Kosnica and Petina, a slight increase was recorded in the settlement Selnica Šćitarjevska, and a large population increase was recorded in Črnkovec (see Table 3.14.-2nd: Population, households and housing units).

The existing settlements Mala Kosnica and Petina are located, according to the relevant documents of spatial planning, within the area for the development of Zagreb Airport, inside which the formation of construction areas is not allowed, and for the existing settlements there is an established regime of renovation until relocation. In the regime of rehabilitation untill relocation of the settlements allows the planning of necessary transportation and utility infrastructure and reconstruction of existing buildings, and all according to the conditions set forth in the Spatial Plan of Velika Gorica (˝ Official Gazette of Velika Gorica ˝, no. 10/06 and 6/08). The presented conditions and limitations in this space are necessary due to the proximity of the runway and other facilities of the airport to these settlements, and because of the constant and imminent danger and numerous negative impacts of these facilities on the inhabitants of these settlements, as well as because of the insurance of possibility for further expansion of the airport within this region.

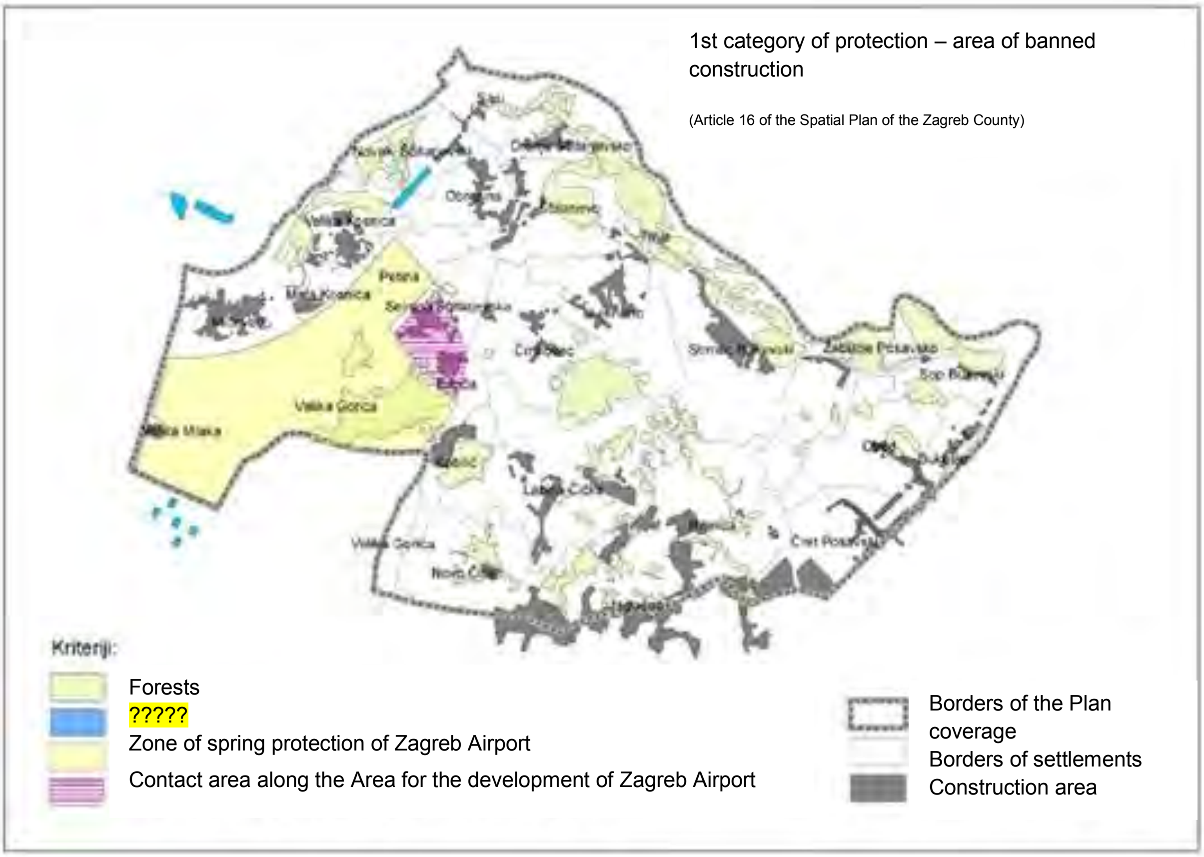


Figure 3.14.-1. The first category of protection - areas of prohibited construction
Source: Regional Plan of Zagreb County, GIS processing: Department of Spatial Planning, 2011.

Under the proposal PPPPO Črnkovec - Zagreb Airport (plan in development) settlements Selnica, Šćitarjevska and Bapča are within the contact area near the area for the development of the Zagreb airport.
Within this Contact area it is exceptionally permitted to form construction areas of settlements, in the spatial clearances of the existing building and under the conditions of the Spatial plan of the area of special features Črnkovec - Zagreb Airport and final provisions of the Regional Plan of Zagreb County - IV Amendments. The further development and expansion of settlements within the Contact near the area for the development of Zagreb airport is limited and directed to the reconstruction of existing facilities, while preserving historical matrice in the centers of settlements and traditional construction. It is planned to supply the settlements with basic traffic and public utilities, and the obligation of building a sewerage system to prevent further pollution of underground water resources is specifically determined.

The existing construction is considered to be construction according to official digital ortophoto bases DOF 5, in the scale of 1:5,000, developed by The State Geodetic Administration, recorded in the period up to 2010. Proximate analysis of recordings from 2006 within the area for the development of the airport it is established that there are about a hundred facilities covered by the regime of rehabilitation until relocation, and within the contact area over two hundred housing units that are exceptionally allowed the formation of construction areas and their legalization. A detailed analysis and determining the construction areas will be carried out through the preparation of amendments to the Spatial Plan of the City of Velika Gorica.

Within **controlled airspace** (CTR) of the Zagreb Airport, which is determined by the data of the Croatian air traffic control, are all the settlements in the wider impact area of the project of the subject Study. Terms of use within this area were determined by special regulations.

Since within the controlled airspace, as well as inside **Obstacle limitation surface of constraints** of the Zagreb Airport are all settlements from the wider area of impact of the project of the study. Obstacle limitation surfaces are determined in accordance with the Development Plan Zagreb Airport, and is divided into:
- Obstacle limitation surfaces for an existing runway
- Obstacle limitation surfaces for the planned alternative runway
- Obstacle limitation surfaces for the heliport

Within these areas it is not allowed to build buildings that pierce with their height theses surfaces and impede air traffic safety.

Limits of noise spreading around the runway at Zagreb airport were established in accordance with the Airport Development Plan airport, and it's about five zones of noise spreading:
1. Zone 65-70dB
2. Zone 70-75dB
3. Zone 75-80dB
4. Zone 80-85dB
5. zone 85dB <

Outside the sound contour of 65dB there are no limits to the development of residential areas, but the planning of the construction of public buildings (hospitals, schools, kindergartens, etc.) near the contour noise of 65dB previously recommends conducting analysis of noise and determination and implementation of protection measures.
Within the first and especially the second zone noise spreading, between 65 and 75 dB, is determined strict control of the further spreading of residential construction is determined. For the existing housing constructions within these zones, for which the terms are not

defined of rehabilitation to relocation but it may be found inside the existing construction areas of settlements (part of settlement Obrezina), it is necessary to determine measures for protection against noise. Within the third, fourth and fifth zones it is possible to plan only the contents in function of air traffic flow and contents in function of the development Zagreb Airport and facilities for special purposes.

Regarding that, on the area and along the area of Zagreb Airport are buildings of special purposes with certain restrictions that should be respected. Pursuant to the Regulations on the safety and security zones of military facilities, protective security zones of military facilities were established. Under the protection and safety zone of military facilities, a special regime of use was implied to the area to protect the interests of defense in a particular area and functional maintenance of military facilities, increasing security as well as the general safety of people and property. Areas restrictions in usage, depending on the facility specific purposes, are prohibited zone of construction (ZZG), restricted construction zone (ZOG), controlled construction zone (ZKG) and protective corridors for system connection.
In the forbidden zone of construction - ZZG (see section 3.1.3. Spatial plan of areas of special characteristics Črnkovec - Zagreb Airport (Final Draft Spatial Plan), which includes parts of the settlements Petina and Mala Kosnica and the marginal settlement Velika Gorica prohibits any construction, except for buildings, facilities and equipment for defense purposes. Exceptionally from the above mentioned, in the forbidden zone of construction is allowed the construction of a new passenger terminal at Zagreb airport with access roads, the other alternative runway and other facilities in the function of air traffic flow and transport, technical, service and other facilities in the function of the Zagreb airport, with special conditions and with the approval of the competent ministry. Detailed terms of use within that zone are defined in the Spatial Plan of Velika Gorica.

Social Activities
By special laws and standards and in accordance with the proposed system of central places and development centers, the type and number of buildings of public social services are determined by the network structures for each activity. For a specific category of the development center a proposal is made for public sports and recreational activities that thecenter or settlement should already have or already has, and it is shown in Table 3.14.-1: “Social activities“ (in the parentheses are the public sports and recreational activities that a particular settlement could possibly have). Social activities include public (administrative, judicial, civic associations, political parties and other public organizations, social, health, educational, cultural, religious), sports and recreational activities. Financial and related services, transport services, retail and hospitality, trade and other services in this chapter are not processed further.
Accommodation is provided for public services within the construction zone, with exceptions of smaller religious buildings and ethno museums.
The accommodation of sport and recreational activities scheduled both within and outside the settlement in or outside the construction area. Sports Centers (mostly local soccer fields), which are located in residential areas or close to the settlement, make the largest number of sport and recreational zones. Larger Sport zones are located in the countryside, as go-kart center near Mičevac. Except within the sport and recreation zones it is necessary to also enable recreational activities outside the zones (biking, fishing, etc.)

Settlements Bapča, Drenje Šćitarjevsko, Gornje Podotočje, Lazi Turopoljski, Mala Kosnica, Novaki Šćitarjevski, Ogulinec, Petina, Petrovina Turopoljska and Sasi, which are located in the wider area of influence of the Project of the subject Study are not listed in Table 3.14.-1, given that they are not in the system of central settlements and development centers.

Table 3.14.-1.: Social activities

	Larger regional (larger development) centre	Regional and larger local centre	Smaller local centre	Initial local centre
	Velika Gorica	Velika Mlaka		Velika Kosnica
		Scitarjevo	Mičevec	Obrezina
		Donja Lomnica	Črnkovec	(Selnica Scitarjevska)
		Lukavec	Gradići	Kobilić
		Vukovina		Gornja Lomnica
		Buševec		Staro Čiče
		Mraclin		Turopolje
				Rakitovec Okuje
Educational	nursery and kindergarten - main elementary schools - art school for music/dance - the centre for the education of adults - language school - high schools - community college	kindergarten - (nursery) - (main elementary schools) - regional class departments of elementary school	(kindergarten) - regional class departments of elementary school	(kindergarten) - (regional class departments of elementary school) - department for the correction of minors (basic and vocational high school) - Turopolje
Administrative	city council - city hall - mayor - administrative department of the city - city offices - (county offices) - main office - neighborhoods - city service of intelligence - police station - city units and headquarters for civil protection - city fire-fighting association (professional fire-fighting headquarters) - city commission for relations with religious communities - tax administration	local board - (local board council) - (local assembly of citizens) - association of volunteer fire-fighters	local board - association of volunteer fire-fighters	(local board) - (association of volunteer fire-fighters)
Judicial	county court - municipal court with land registry - magistrate court - state attorney			

	Larger regional (larger development) centre	Regional and larger local centre	Smaller local centre	Initial local centre
	Velika Gorica	Velika Mlaka		Velika Kosnica
		Scitarjevo	Mičevec	Obrezina
		Donja Lomnica	Črnkovec	(Selnica Scitarjevska)
		Lukavec	Gradići	Kobilić
		Vukovlna		Gornja Lomnica
		Buševec		Staro Čiče
		Mraclin		Turopolje
				Rakitovec
				Okuje
Citizen associations, political parties and other public organizations	association of crafts-men - city tourist board - city level of various associations, clubs, leagues, sections and other citizen associations - city level of political parties - city level of the Red Cross - auto club - driving school	(association of crafts-men) - political parties (basic unit) - offices of various associations - various clubs, sections and other citizen associations - driving school	offices of various associations - various clubs, sections and other citizen associations	various clubs, sections and other citizen associations
Social	centre for social care - homes for social care - centre for help and care - employment office - office for the pension and disability fund	(homes for social care)	(homes for social care)	(homes for social care)
Health	public health centre + certain forms of specialist and consultancy health protection	(health station – clinic of general medicine, nursing and dental service)	general health clinic	
Cultural	public institutions in culture established or owned by the city - public open university - galleries - museums - cinema - inside the public open university - city library - theatres - local radio station - publishing industry	home of culture - reading room - (amateur theatre) - (amateur radio station) - cultural-art societies - (associations of technical culture)	auditorium for cultural and other needs - reading room - (cultural-art societies)	(reading room) - (cultural-art societies)

	Larger regional (larger development)	Regional and larger local centre	Smaller local	Initial local centre
	Velika Gorica	Velika Mlaka		Velika Kosnica
		Scitarjevo	Mičevec	Obrezina
		Donja Lomnica	Črnkovec	(Selnica Scitarjevska)
		Lukavec	Gradići	Kobilić
		Vukovina		Gornja Lomnica
		Buševec		Staro Čiče
		Mraclin		Turopolje
				Rakitovec
				Okuje
	Various cultural			
	art and music			
	associations			
	independent artists			
	association of cultural			
	art associations			
	association and council			
	ociety of technical cultur			
	parish-parish office and church	parish-parish office and church		church
Religious	(convent) - (other religious associations)	church		
Sport and recreational	sociation of sport societ	(association of sport	certain sport	(certain sport
		societies)	clubs	clubs)
	sport associations and clubs- representatives	sport associations and clubs - open	one or more open sport fields	(sport field)
	city sport events	facilities: sport	(school-sport	
		sport field for various sports	hall)	
	open sport facilities: sport fields for various sports closed sport facilities: multifunctional hall etc. certain constructions for recreation, entertainment and rest	školsko-sportska dvorana		

According to Table 3.14.-2: "Population, households and housing units" in half of the villages, which are located in the wider area of impact of the subject Study, in the period since 2001 to 2011, had a drop in the population of about 1% to about 16% in some areas. The largest population decline is documented in the settlements Lazi Turopoljski (-15.94%) and Mala Kosnica (-15.52%).
In other settlements a slight increase in population may be noticed. The largest increase of population was recorded in the settlements of Gornje Podotočje (+65.35%), Velika Kosnica (+47.69%) Petrovina Turopoljska (+38.46%) Črnkovec (+23.65%) and Ogulinec (+19.35%).

Table 3.14.-2.: Population, households and residential units

Name of settlement	Surface of settlement (km^2)	Population number			Households (total number)	Residential units (total number)
		2001	2011	differ. u %		
Bapča	1,68	151	130	-13,91%	38	50
Buševec	4,17	906	889	-1,88%	300	363
Črnkovec	4,62	334	413	23,65%	115	141
Donja Lomnica	14,93	1.665	1.716	3,06%	538	801
Drenje Šćitarjevsko	2,23	212	202	-4,72%	64	73
Gornja Lomnica	2,49	534	582	8,99%	162	178
Gornje Podotočje	2,93	294	492	67,35%	134	166
Gradići	1,90	1.759	1.808	2,79%	520	588
Kobilić	1,56	524	520	-0,76%	174	190
Lazi Turopoljski	3,40	69	58	-15,94%	19	21
Lukavec	11,34	1.119	1.136	1,52%	335	397
Mala Kosnica	1,01	58	49	-15,52%	20	23
Mičevec	6,54	1.254	1.281	2,15%	369	418
Mraclin	12,93	1.106	1.068	-3,44%	340	459
Novaki Šćitarjevski	2,65	170	165	-2,94%	49	63
Obrezina	1,79	570	577	1,23%	187	214
Ogulinec	3,76	248	296	19,35%	95	134
Okuje	4,71	437	467	6,86%	150	183
Petina	1,84	218	211	-3,21%	65	80
Petrovina Turopoljska	2,63	507	702	38,46%	194	213
Rakitovec	10,37	567	573	1,06%	192	226
Sasi	1,67	172	164	-4,65%	47	55
Selnica Šćitarjevska	1,96	532	537	0,94%	142	162
Staro Čiče	3,02	787	783	-0,51%	263	322
Šćitarjevo	3,79	442	440	-0,45%	117	144
Turopolje	4,64	1.033	951	-7,94%	334	400
Velika Gorica	31,47	33.339	31.341	-5,99%	11.142	12.609
Velika Kosnica	2,13	541	799	47,69%	186	207
Velika Mlaka	6,07	3.306	3.326	0,60%	1.036	1.177
Vukovina	5,84	970	945	-2,58%	314	364

Source: Central Bureau of Statistics, Census 2001., Census 2011th - First results
Spatial Plan of the City of Velika Gorica (″ Official Gazette of Velika Gorica ″, no. 10/06 and 6/08)

3.15. ECONOMIC ACTIVITY

Agriculture

The type of land use in the construction area of a new terminal of Zagreb airport is shown in Figure 3.15.-1.

Based on the displayed map, it is shown that the area of construction of Zagreb airport and the access road, agricultural land covers 54.7 hectares or 35.6% of the study area, while forests with occasional thickets occupy 35.3 hectares or 23% of the study area. Among other classes, military land with facilities occupies the largest area of the land, whose area is 60 hectares or 39%, Table 3.15.-1.

Table 3.15.-1: Classes of land use in the area of construction of the Zagreb Airport

Naziv načina korištenja	Površina ha
Agricultural land	54,7
Forests	35,3
Road	0,2
Parts of settlements with yards	0,9
Water current	2,7
Military land with facilities	60,0
Total	153,8

Agricultural land covers the northern part of the area as well as the part for the future access road, while forests lie on the southern part of the area. Agricultural land is mainly used for arable farming, and then for growing vegetables and fruit crops.

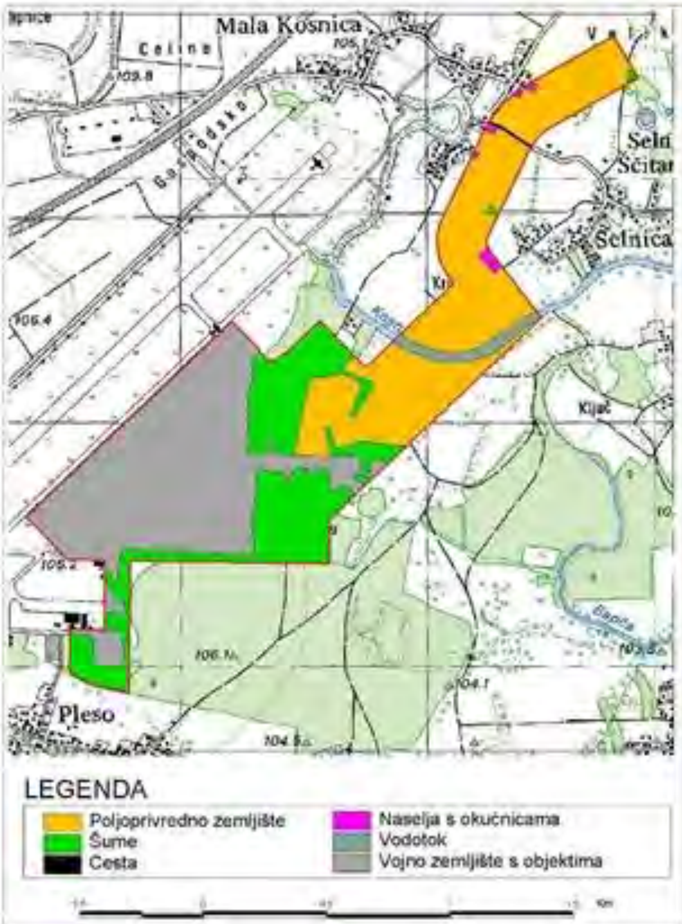


Figure 3.15.-1: Type of land use in the construction area of the new terminal of Zagreb airport

Figure 3.15.-2: Different ways of using agricultural land
(A-farming, b-vegetable growing and c-horticulture, d-neglected agricultural land)

Forestry

All forests and forest land in the wider area of Zagreb Airport are organized but static close to the runway from which are in the enclosed area. In the restricted area of the airport forests are mainly classified into special purpose forests for the Croatian Army. Forests in the wider scope of influence of Zagreb Airport are organized within two economic units that are included within the forestry of Velika Gorica, on the upper northwest edge is G.J. "Savski vrbaci", and in the southeastern part it continues to GJ Turopoljski lug.

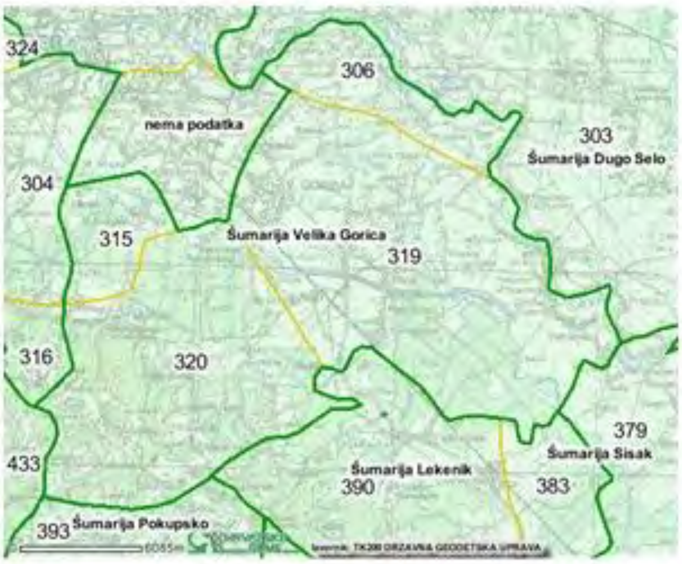


Figure 3.15.-3. The distribution of forest management units in the wider coverage zone (source: www.hrsume.hr)

Management Unit "Savski vrbaci" is situated 6-8 km northeast of Velika Gorica near or on the right bank of the Sava River and extends, slightly winding, in a length of 12 km in the direction approximately east-west and in the direction of the Sava River. It is composed of 14 mutually more or less distanced complexes of different dimensions, which in the narrow sense, the majority (sections 1 - 4), are located in the area between the southern embankment of the Sava River and private land to the south with the fact that all of these complexes touch the embankment or successively stand along it, while sections 5 and 6 are situated between the old defense embankment and the Sava River, so they are for now within the inundation area (unlike the first four sections out of the area while at the fourth section the new embankment has not yet been completed). The largest separated complex is section 4, which is located in the middle of the unit, and its surface area is 73.95 ha, while the smallest complex section is 3 whose surface is only 14.07 hectares. Altitude ranges 98-109 meters above sea level. This management unit consists of six departments with an average area of 46.00 ha or of 41 sections. The structure of land coverage is shown in Table 1. According to purpose, economic forests dominate with 203.10 ha (97.5%) and special purpose forests occupy 5.18 ha, respectively (2.5%). The growing stock of the forests is 7025 m3, and the annual exchange increment is 345m3. These types of trees dominate the domestic poplar, the willow and sheer Euramerican Poplar (Table 3.15.-3).

Table 3.15.-2: structure of land cover of Economic Unit Savski vrbaci

Categories of soils	State in 2000.g.
	ha
overgrown land	203,06
glabrous productive land	43,01
glabrous unproductive land	2,96
barren land	27,05
total:	276,08

Table 3.15.-3. display of growing stock and increment by tree species in Economic Unit Savski vrbaci

Type of trees	growing stock		growth	
	m^3	%	m^3	%
1	2	3	4	5
P. ash	228	3	14	4,1
Locust	258	4	9	2,6
OTB	632	9	33	9,6
Willow	1962	28	92	26,7
D.poplar	2257	32	132	38,3
Ea.poplar	975	14	37	10,7
C.poplar	-	-	-	
OMB	10	-	-	
Alder	-	-	-	
Mullberry	-	-	-	
Plane	-	-	-	
C.pine	703	10	28	8,0
TOTAL:	**7025**	**100**	**345**	**100**

Economic Unit Turopoljski lug is located about 5 km southeast of Velika Gorica, which is about 4 km southwest of the Sava River in a diamond-shaped area measuring 22 x 8 km with a longer site to the northwest-southeast. The biggest part of the unit is made of an extra complex northwest-southeast in an area measuring 13.75 x 8 km. The northernmost point of the edge is section 3 (near the settlement Dautović), and the southernmost is at section 138b (Lekenička stream) which is the southernmost point of the whole unit. The most exterior point of this complex is towards the northeast, perpendicular to the direction of the extension of the edge of section 68a (on the Odra) and the westernmost is at section 25a (near the village Buševac).

To the west, the unit borders mainly with agricultural landholdings to approximately a cut-off direction that is made up of the settlements Gornje and Donje Podotočje, Kuče, Rakitovec, Turopolje to Buševec. After that (south) the unit is separated from the rail line and is bordered with the economic unit Peščenica - Cerje Šumarije Lekenik, and in some places agricultural land all the way to Lekenički Stream which is the border on the southeast along the Odra River. To the northeast this complex mostly stretches along the Odra River, except to a limited extent, or to the village Čička Poljana where it borders with private agricultural land. Across the relief channel Sava-Odra it borders with complex the Turopolje dome and with new a stream of the Buna stream it connects again with the Odra River and along it, it stretches all the way to the junction with Lekenički Stream. This Economy Unit consists of 142 stations with an average area of 30.83 ha. Registered are 340 sections with an average area of 12.29 ha.
The structure of land cover in this management unit is shown in Table-3.15.8. The largest part is covered with land of 4053.72 hectares. According to intent, the Economic Unit Turopoljski lug prevails with economic forests with 4123.44 ha, with a total wood volume of 1,143,314 m3 while a small part consists of special purpose forests with 56.40 hectares. Among species, the oak, hornbeam, alder and ash trees dominate (Table 3.11.-5).

Table 3.15.-4. The structure of land coverage in Economic Unit Turopoljski Lug

Categories of soils	State in 1995 ha
overgrown land	4053,72
glabrous productive land	126,12
glabrous unproductive land	105,49
barren land	92,13
Total:	4377,46

Table 3.15.-5. Display of wood reserves and increment by tree species in Economic Unit Turopoljski Lug

types of trees	Growing stock		growth	
	m^3	%	m^3	%
1	2	3	4	5
beech	7522	0,6	153	0,6
English oak	856699	73,8	17470	67,1
European ash	54746	4,7	1289	5,0
hornbeam	121597	10,5	3532	13,6
locust	168	-	4	-
fruit tree	1569	0,1	44	0,2
OTL	17041	1,5	512	2,0
alder	98092	8,5	2875	11,1
willow	103	-	3	-
D.poplar	505	-	23	0,1
Ea.poplar	602	0,1	18	0,1
OML	1867	0,2	55	0,2
TOTAL:	1160512	100	25979	100

Hunting

The coverage of the work is located on the grounds of the Joint hunting grounds "Črnkovec" (Reg. No. 38, total area of 3460 ha.) This area has the following game species most present: roe deer (Capreolus capreolus), wild boar (Sus scrofa), Hare (Lepus europaeus), pheasant (Phaisanus colchicus), partridge (Coturnix coturnix), Mallard (Anas platyrhynchos), woodcock and quail. Hunting is mostly a sports - recreational activity, but there is a growing tendency towards developing hunting tourism.

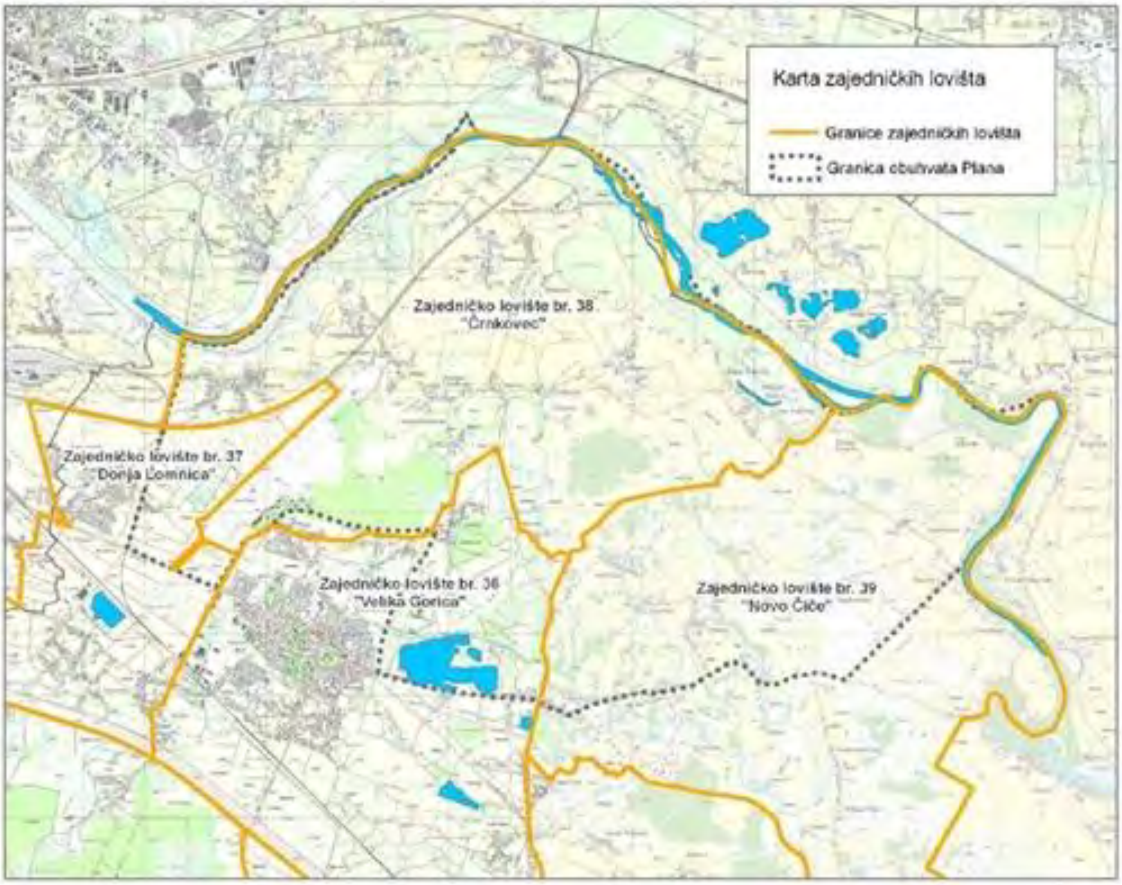


Figure 3.15.-4. Schedule of common hunting grounds in the coverage of the Plan
Source: proposal PPPPO Črnkovec - Zagreb Airport, Institute for Spatial Planning, 2011

Tourism

The observed area, due to its location in the central part of the Zagreb County and along the administrative border with the City of Zagreb as well as its favorable transportation position and, primarily due to the wealth of natural, cultural and historic resources, has excellent tourist potential. The utilization of this potential depends on traffic and availability of information to tourists and tourist equipment on the level of resources. Tourist equipment implies a set of features that make some resource a tourist attraction and includes preservation, promotion, public access, features, direction pointers, and the existence of information and promotional material.

Out of tourism resources of the area, cultural heritage is certainly worth mentioning - cultural and historical sites from prehistoric times through the Middle Ages to the present day. The unique value of Turopolje is in its wooden churches and chapels as well as manors representing the highest degree of popular baroque architecture in northern Croatia. There are also natural resources - particularly valuable and registered landscapes along the Sava and Odra River, which provide an opportunity for excursion, recreational, hunting and fishing tourism. Mentioned should also be the sports and recreation potential of Lake Čiče. The number of tourism resources, however, is still at odds with the level of tourist equipment, which must be one of the important objectives for the future development of this area.

3.16. SOCIOLOGICAL ANALYSIS

Introductory remarks
The task of the social analysis was to examine the influence of Zagreb Airport to on nearby settlements (Primarily Petina and Mala Kosnica), and local residents and their quality of life in the immediate vicinity of the airport. The problems are the extent and characteristics of the burden on the environment by the traffic of aircrafts. Spatial planning documents propose as a permanent and long-term solution - relocation, or short-term – renovation to movement. In 2000., Ph.D. Vladimir Lay (author of the sociological analysis) has made a sociological analysis to study the environmental impact of Zagreb Airport (Engineering of Oil and Gas, Zagreb, 2000). 12 years later, we can say that there is no big news according to the general elements of the influence. Under the influence of expansion, modernization and increase in planning the Zagreb Airport, the pressure on the local environment will grow. According to this issue, the emphasis in on this sociological analysis.

The results of field studies
The sociological analysis was performed among the local citizens of the northeastern part of the Airport. While working on the sociological analysis, and based on experience in the field of research while making the same analysis for the EIS construction Zagreb Airport 1999 – 2000, we considered it useful to refresh our old understanding of the underlying issues from the perspective of people on how the aircrafts and the Airport have everyday affects on them . We organized a local presentation of the people of New Airport terminal Zagreb.6
A meeting with citizens from Velika Kosnica, Petina, Črnkovci, Bapča and Seline held October 27th 2011 at the Kosnica firehouse, 100 meters from the beginning of the eastern corridor and the airport runway. The objective of this first meeting, which responded with about 80 people was to inform citizens in front of the Institute IGH dd, as the maker of the Study on environmental impact. They came and elected representatives of Local Board Konica, Črnkovci, Bapča and Selnica. We collected their questions and views.
The second meeting was held at October 11th 2011 in the same place, and invited citizens of Petina and Mala Kosnica, two settlements that at the first interview turned out to be the most vulnerable due to the pressure of air traffic of the Zagreb airport. The turnout was also large[7] in the first communication with the citizens the major questions are some of the questions which we listed some of the most important.

1. Depending on where they are from the interviewees are sharply divided into two groups. In the first group they are from distant settlements, and in the second group are residents from the nearest settlements Petina and Mala Kosnica. The first talked about the need for them, because of the noise and air pollution to recieve a kind of ecological annuity. It had been even the suggested (TA) an annuity of 1500 kn per month per household! In addition, one Former pilot of JAT and Croatialinesa (SP), who says that he perfectly understands how aircrafts pollute the environment and what are the practices of environmental rents for citizens in the close proximity to airports in the world, the cited the example of compensation to households that were flown over on low altitudes in the amount of 900 DM per month in Stuttgart, Germany. These suggestions are ridiculous to the citizens of Petina and Mala Kosnica and seemed irrelevant because such money is not going to solve anything. The only solution is indicated by many interlocutors is to finally relocate, which is only discussed for years, and a fair financial compensation for the buildings. Some of these buildings were after 1975 built illegally. It is advocated that the objects should be compensated regardless of the illegal status that some of them have.

---

[6] The Local Board of Kosnica helped us in organizing meetings. We thank the young and managing team of the Local Board headed by Goran Milicević for helping to organize meetings and carry out surveys in the settlements Petina and Mala Kosnica.
[7] The record from both meetings was made by the secretary of Local Board Kosnica, Mario Radoš. We are thankful for the work attachment in the making of this
sociological analysis. Available at: http://www.mo-kosnica.hr/

Finally, the impact of the Zagreb airport on the local environment has the reaction of the local public in two basic groups. Output resolution is precisely in the direction differential precise treatment of this reaction. The request of the residents and Mala Kosnica for relocation is almost unique in the answers of the respondents and it is supported by spatial planning. Problems with negative environmental impacts in the settlements located farther from the Airport impacts on the environment settlements located far from the airport, according to the results of tests with that population they are of significantly lower intensity.

2. Sources from the settlements around the Airport emphasize that with the spreading of the Zagreb airport, an increase in traffic will occur in the air and on the roads around their settlements. If now the environment condition is bad, they ask, how it will be in the new conditions. They express fear of the larger and, therefore, according to them, and noisier aircrafts.

3. It is required from the maker of the EIS noise map for these places. Interlocutors pointed out that for these settlements they handle with mostly up to 70-75 dB and they are sure that the noise reaches more decibels. They state that at low landing, with larger aircrafts, in particular, therefore, specific situations, it is a "deafening noise that disturbs the nerves and the organism, and not only the ears ". The value of about 70 dB is an average value that has nothing to do with life, say the they are disturbed about some peak values of noise, and they feel them on their, skin, not some average values. At the end they suggest it there should be measurements and always in these areas and that only that method would give a true result.

4. Interlocutors pointed out that the air of aircrafts in landing and taking off contaminated and that they can smell. They wonder (Ž.H.) "How many pollutants, heavy metals are in one ton of fuel? What falls to the ground and enters into our lungs during the combustion of fuel in a small speed during takeoff and landing? " It is stated that nothing that is planted in the garden can grow.

5. Besides these elements of damaging the environment, the problems are mentioned of occasional disturbance of the TV signal – the pilots that fly over the settlements are sometimes quests in the radio shows.

6. A few interlocutors stated that in most households in Petina and Mala Kosnica a member of the household died from cancer. The fact was stated (Ž.H) that in part of Petina in 18 households only three of them died of natural causes, and the others of cancer. The interlocutors explain this with air pollution, inhaling gasses and particulate matter that are from the aircraft flights. Among the interlocutors there were unhappy participants who have given examples from their families. The mentioned examples are younger people that started to get sick and get treated of cancer.

7. Representative Črnkovec MO (M.Č.) stated that the Regional Plan of Velika Gorica right is in the process of the fourth revision and that according to the same the settlements Petina and Mala Kosnica are supposed to completely relocate. According to this it is acknowledged that there are no conditions for life in these areas. The settlements Črnkovec, Selnica and Bapča are predicted for the development of the new airport Zagreb.

The general critical view of present citizens and the local public is clear. No one has anything against the expansion and modernization of the Zagreb airport, but there is great dissatisfaction and agitation, and even human hurt related to long-term neglect of their difficult living conditions. The Board of Velika Gorica was specially described as careless under which authority these settlements belong. In the conditions of the spreading of Zagreb airport the citizens unanimously believe that now is the right time to make a special move that would save the local citizens from a "very poor quality environment and overall environmentally very poor quality of life in these areas."

Attitudes of the citizens about living conditions in the settlements Petina and Mala Kosnica

Settlements Petina and Mala nKosnica, next to the airport, next to the runway on the east side, were established long ago from the villages of the same name, and then by the constructions in the last 3-4 decades. Citizens of these settlements are mostly natives. Petina has only about 25% or about 20 immigrant households, and in Mala Kosnica only one family. The citizens of these settlements are prohibited of any construction since 1975 and everything that was built from then on is illegal. The temporary status hovers over these families, people, houses, and there is no certainty about moving. In such circumstances, they cannot plan the future of new generations and they cannot have an equal status to the other citizens. Parts of the houses do not even have a city sewer and water lines.
The talks with the representatives of local committees in these settlements that are mentioned date back to 1967. Then the three families in the locational disadvantage position to the former airport "moved from the state," and a few families received compensations of 500,000 dinars of that period. For many years these resorts have an ungrateful status of the settlements where construction is prohibited, and life is always temporary. The Spatial Plan of the City of Velika Gorica, which is constantly revised year after year, plans relocation for these settlements. The relocation never happens. There is not even a quality conversation about it. The city Velika Gorica in this issue shows certain neglect for this area. Interlocutors say "We are the appendix of Velika Gorica." The spatial plan of the area with special features (PPPPO) Črnkovec and Airport Zagreb" since October 2011 these places are still generally referred to as the ones that should be relocate, and it is operationally imposed "the prohibition of formation and expansion of existing building sectors and ESTABLISMENT OF THE REGIME OF RENOVATION TO MOVEMENT".8
Here, a total of nearly 200 families live, also in Petina there are around 50 facilities, mostly residential with gardens and Mala Kosnica has about 25 households, a total of 75. Coming from the following analysis of air pollution and noise pollution in the chapters 4.2.1. and 4.2.2. it is clear that of all settlement, these are under the most burden of the airport, particularly aircraft flying in the close proximity of housing and other facilities.
A respondent resident of Mala Kosnica, number 12, in November of 2011 said "Move us as soon as possible while we are still alive ". An immigrant from Bosnia from Male Kosnica 9 said "I live in a noisy, environmentally unhealthy zone. Behind the house 400 meters away is the highway, forward from the house 150 meters away is the runway. From the noise I feel an increased heart rate. It is already an intolerable place for living ". From Petina an interlocutor says: "With the current traffic is difficult to live with the noise and stench. And how bad will it be with the increase of air traffic."
At the second meeting on 10.11.2011, the problems of health and environment in these two settlements were heard out. Repeated were allegations of sweltering noise and traffic pollution and numerous illustrations were given. In focus was the proposal of several interlocutors that the two cities should be moved out. The people against this were few in number.
By suggestion of the citizens, it was agreed to implement a small survey among citizens of Petina and Mala Kosnica. The questionnaire was formed by the author through proposals articulated by the participants of the meeting. The questions were: 1. settlement; 2. The owner of the household - the owner of the apartment, garden, owner outbuilding; 3. Over the next few years do you want to move from this area to an area by your choice, provided that the abandoned house and garden receive fair and adequate compensation? (Yes or no); 4. What form for yourself and your household is considered appropriate (money, replacement houses and yards at a location of your choice, apartment replacement)? 5. Is someone in your family from 1960 died of cancer? Specify kinship and year of death?
The survey was carried from 15.11 to 30.11.2011 by visiting households. The intent was that all citizens from these two settlements be interviewed. A smaller part of the households did

[8] See: SPATIAL PLAN OF SPECIAL CHARACTERISTICS - ČRNKOVEC AND ZAGREB AIRPORT, II Compulsory attachments, the Proposed Plan for public hearing, Summary for the public, pp. II, 8 - 6 Institute for Spatial Planning of the Zagreb County, October 2011.

not want to fill out the questionnaire. 20 owners of households in Mala Kosnici were surveyed were and 47 were surveyed in Petina; a total of 67 households inhabited by close to 200 people.

By processing the replies, we obtained the following picture.

1. From Mala Kosnica and Petina, almost all respondents want to move out. In Petina out of 46 respondents, three do not want to leave, and in Mala Kosnica it is 1 out of 20. One source says, "I prefer not to be moved", but decided to leave because due to health reasons.
2. Almost all households own a house, garden and barn. Only a few households do not have a barn. Part of what was built after 1975 has no license because legal-planned construction in this area would be impossible.
3. The almost only desirable form of compensation is payment in cash provided that for the abandoned house and garden and outbuildings a fair and adequate compensation is obtained. 45 of 46 citizens from Petina and 17 of 20 from Mala Kosnica decided on this. In addition, in Petina one respondent wants a replacement apartment and in Mala Kosnica one household along with money would accept a replacement house and garden, and only with money would they accept the variant of a replacement apartment.
4. In almost all households someone close to the family has died of cancer. In Kosnica a total of 20 households reported a total of 19 deaths from cancer, and in Petina in 46 households there were 35 deaths from cancer. Listed were the closest cousins, grandparents, fathers, and mothers, mother in laws and father in laws, sisters and brothers. Lung cancer, stomach cancer and breast cancer with listed.

Conclusion

Given the results of the sociological research, in this study special attention was focused on the analysis of the impact of air transport on air quality (Chapter 4.2.1) and noise emission (4.2.2.), which was later perceived through its impact on the health of the population (Chapter 4.2.3).

3.17. ANALYSIS OF THE RELATIONSHIP OF PROJECTS ACCORDING TO EXISTING AND PLANNED WORK

3.17.1. Storage and supply of airline fuel

The storage and supply of jet fuel to aircrafts at Zagreb Airport today is performed by INA Avioservis Zagreb. Fuel for aircrafts is kerosene-jet fuel and aviation gasoline for piston engines. The supply of airline fuel is done by tanks with a 30t capacity. The air-fuel is produced and brought from the the INA refinery in Rijeka. The tanks come through the Zagreb - Rijeka highway, continue to the Zagreb byass, go down to the node for Zagreb Airport, continue on Velikogorička and Rudolf Fizera street and come to the site of INA Avioservis. For the purposes of meeting today's airline fuel consumption, the delivered annual average is between 7 and 8 tanks a day (210,000 - 240.000l). The peak daily reception during summer 2011 amounts to 18 tanks, while the average summer consumption is 10-12 tanks (300,000 - 340.000l). The consumption or sale of aviation fuel largely depends on the price of fuel in the Republic of Croatia so these amounts must be adopted conditionally in the calculation of future consumption and aviation fuel sales at Zagreb Airport. The available tank capacities provide the required amount of fuel for the planned traffic of Zagreb Airport.
INA Avioservis Zagreb is located in the area of Zagreb airport, on an area with a surface of 20,000 m2 which is fenced with wire and approximately 100 m east of the main terminal building of the airport. The Avioservis is accessed by road, which is a continuation of the main road to the airport. In the northern part of the area of the Avioservis is an input / output upwards the runway which is connected to the circular roads with a loading facility and a filling station. The northern area and access roads to the loading facility are paved as well as the area in which all objects are placed. On the west side is the main entrance to the parking lot, and on the northwest side is the entrance for emergency vehicles. Parts that are not paved are grassy areas with a few trees, and there are no facilities on these parts.
INA Avioservis Zagreb has an operational plan of intervention measures in case of extraordinary and accidental pollution of water. The operational plan determined the evaluated threat to water in case of water pollution, prevention measures to avoid water pollution and treatment organizations, the scope and manner of implementation of the measures in the event of pollution and the method of disposal of hazardous and polluting substances that caused pollution.

Mechanization - at the location of the Avioservice Zagreb, there are aviation tanks for the needs of Zagreb Airport with the following capacities:
- 20 000 lit. - Jet fuel JET A-1
- 40 000 lit. - Jet fuel JET A-1
- 45 000 lit. - Jet fuel JET A-1
- 60 000 lit. - Jet fuel JET A-1
- 60 000 lit. - Jet fuel JET A-1
- 5 000 lit. - Fuel for piston aircrafts AB 100 LL

Aboveground tanks - in the area of INA Zagreb Avioservis there is a total of 3 steel aboveground tanks, welded constructions, each has its own concrete pool (bund). The tanks are equipped with a system for rainwater and potentially oiled water by means of the drain valve which is opened when necessary. They are equipped with a stable installation of cooling and fire fighting.

NMB.	OVERHEAD CONTAINER	Name of dangerous substance	QUANTITIES (t)	container in function

	mark	capacity			
1.	R1	1000 m^3	jet fuel JET A-1	800	da
2.	R2	1000 m^3	jet fuel JET A-1	800	da
3.	-	5000 m^3	jet fuel JET A-1	800	ne

Underground tanks - in the area there is a total of 8 underground steel tanks buried in the ground with a overlay of 1 meter. They were constructed as lying single-leveled and waterproof, and tested for water-tightness. They are equipped with an electronic system to monitor the quantity, a high level alarm, an overflow protection system, cathodic protection, measuring rod for fuel control, and a connection for charging and cap, and inlet and return water and vent pipes. The tanks are equipped with fixed installations for cooling and fire fighting.

NMB	UNDERGR. CONTANIER		Name of dangerous substance	QUANTITIES (t)	container in functiom
	mark	capacity			
1.	R3	100 m^3	Avgas AB 100 LL	72	da
2.	R4	100 m^3	Avgas AB 100 LL	72	da
3.	R5	100 m^3	Avgas AB 100 LL	72	da
4.	R6	50 m^3	Avgas AB 100 LL	36	ne
5.	R7	50 m^3	Avgas AB 100 LL	36	ne
6.	R8	20 m^3	EDG	16,9	da
7.	R9	10 m^3	EDG	8,45	da
8.	R10	10 m^3	BMB	7,42	ne

3.17.2. Device for purifying wastewater Velika Gorica

Wastewater treatment plant (WWTP) of Velika Gorica is an integral part of the public drainage of Velika Gorica and its suburbs, and is built like a classical mechanical - biological unit with active sludge with a second (II) degree of purification.
The current situation of devices as well as the equipment is poor. The capacity devices are too small to be able to purify the wastewater that comes to the device in a quality manner. The equipment of the unit is old and part of the system is not functioning (sludge treatment). The disposal of sludge from the wastewater treatment plant is carried out in open in the soil , in excavated lagoons located close to the unit.
Aggravating circumstances for the optimal management and maintenance is the substantial connection of significant amounts of rainwater to the system of public drainage in parts of Velika Gorica and surrounding settlements where there is no constructed drainage system, and the discharge of large amounts of industrial wastewater without appropriate treatment.
The study of the construction of sewerage systems and wastewater treatment in the city of Velika Gorica, the Feasibility Study (Hidroinženiering Ltd. Hidroprojekt-ing, 2010), has

planned for construction a new conventional device for purifying wastewater of Velika Gorica. Given that the area in question belongs to the estuary of a sensitive area and with agglomeration load of more than 10,000 ES, a unit with the third (III) degree of purification is planned to be constructed. The planned size of the device is determined as a result of screening analysis of the needs of users for sewerage services and wastewater treatment for the year 2043.
The planned WWTP of Velika Gorica is conceived in a conventional biological process of treatment which includes three steps of purification, and the capacity of the unit involves the needs for purifying sanitary waste from the airport site. The treatment of wastewater, including polluted rainwater from Zagreb Airport on the future device Velika Gorica obtained principle agreement from the utility company of the City of Velika Gorica, VG Water Supply ltd.

3.17.3. Construction of the second runway

Zagreb Airport now has 42,000 aircraft operations annually, of which about 33,000 operations of passenger aircraft with 65% cabin aircraft occupancy. In accordance with ICAO documents (Annex 14, Airport Planning Manual) and IATA (Airport Development Reference Manual) the number of aircraft operations defines the number of runways. According to the ICAO Airport Planning Manual (Doc 9184) a single runway can perform 195000-240000 aircraft operations per year, which means that one runway is adequate for a turnover of around 15 million passengers a year, for example, with one runway, Airport Venice Marco Polo (VCE) serves about 10 million passengers a year, and Airport London Gatwick (LGW) more than 31 million passengers a year. According to the Master Plan Update of Zagreb Airport the second runway is anticipated when the traffic exceeds 15 million passengers a year, and according to traffic forecasts, it is not expected in the next 30 years (until 2040).
The airport of the capital city should provide a second runway in case the main on is out of service and therefore, Zagreb Airport, in cooperation with the City of Velika Gorica reserved the northwestern zone area of Zagreb Airport for the construction of a multi-modular cargo center (Zagreb Airport Cargo City), which implies also the construction of trails for access to the same. By extending this taxiway, and in accordance with global best practices (LGW and VCE), it could be used as a replacement runway landing track for landings and takeoffs of aircrafts. In this way, the problem of a spare runway is solved with far less resources required.
Once again we emphasize that the construction of the second runway is part of a planned procedure and is not the subject of this SUO.

3.17.4. THE RELATION OF ZAGREB AIRPORT TO OTHER AIRPORTS IN THE REPUBLIC OF CROATIA

Conditions of the tender for the concession of Zagreb Airport asked that Zagreb Airport be transformed into a regional air transport hub with a strong network of airlines operators, including incentives for the establishment of direct intercontinental flights to Zagreb.
Such a strategy in the conditions of the tender offer and the most economically favorable bidder strengthens the function of Zagreb as an aviation hub in order to increase traffic to the Croatian capital, but also indirectly to other airports in the Republic of Croatia, which leads to the conclusion that there is no way that any carrier will cease to fly to coastal destinations as a direct consequence of strengthening the network of flights of Zagreb. The goal today among others thins is to bring travelers and tourists to destinations on the coast.
At the same time, strengthening Zagreb Airport as a regional hub that connects Zagreb and distant destinations will contribute indirectly to connecting with other Croatian airports ports and their traffic increase.

3.18. COLLECTED DATA AND IMPLEMENTED MEASURES ON THE LOCATION OF THE PROJECT

The meteorological data was processed on a meteorological base for the needs of this document in November 2011 by the DHMZ. **Hydro-geological data** was made based on the geological survey in 2011 by Darko Mayer Ph.D.

The geological data was made on the basis of the geological survey in 2011 which was done by Božo Prtoljan Ph.D. **The pedological features** are made based on research conducted for the purposes of this paper done by Prof. Stephen Husnjak. Information about the **flora, forests and forestry** was taken from available professional backgrounds. Data from Vesna Tutiš Ph.D was used for impact assessment on **ornithofauna**. In assessing the impact on ornithofauna used were the results of recent field surveys. In the wider area of intervention (Zagreb, Turopolje Pokupski pool) the last twenty evaluations were conducted with different bird communities so their qualitative and quantitative structure is relatively well known. To assess the impact of the **bat fauna**, implemented was the research done by Dr.Sc. Igor Pavlinić. Transects were conducted during two field releases in September 2011. To estimate the impact on mammals, used were the results of Dr.Sc. Igor Pavlinić, and to assess the impact on amphibians and reptiles data from Martine Podnar PhD was used. Data on landscapes was collected through field research, analysis of the spatial features and visual quality and on the basis of an existing photo-documentation and relevant literature. Field studies were conducted during November 2011. The conservation base that was made for the purpose of the Impact Report on the environment of Zagreb Airport-new passenger terminal handles the cultural and historical heritage within the border zone of work and surrounding areas. During the processing of the **cultural heritage** of this region used was the following information: general reference literature data on cultural resources and conservation substrates prepared by the Ministry of Culture, Department for the Protection Heritage, Conservation Department in Zagreb, and the results of reconnaissance, delimitation and field surveys. Performed was a field processing of the area in the range of 1000m around the planned area, in the zone of direct and indirect impacts. Impact assessments regarding health were performed through the research of Jagoda Doko Jelinić PhD. **Sociological analysis** for the needs of the study were conducted by Vladimir Lay Dr. Sc. in 2011.

4. DESCRIPTION OF THE ENVIRONMENTAL IMPACT DURING CONSTRUCTION AND USE OF PROJECT

Given that every spatial change more or less affects the appearance and quality of that area, the environmental impacts of the new passenger terminal airport for Zagreb Airport can be broken down into:

- **impact during project construction**
- **impacts during the use of the project**

By recognizing these effects environmental measures can be proposed that would eliminate or minimize the negative impacts on the environment. Based on previous analysis, the defined environmental quality impact of construction areas and the established data on the environmental status, the content and manner of the planned work is described below and possible environmental impact is evaluated.

With the aim of defining a precise methodology for determining the likely impacts of the project on environmental components (in the phases of their construction, use and after cessation of use) and subsequent determination of the acceptability of the environmental load, impacts are evaluated by their:

- **Feature**
  - *positive impact (the intervention component of the environment can have a positive impact)*
  - *negative impact (the intervention component of the environment can have an adverse impact)*
- **Strength**
  - *little impact (1)*
  - *moderate impact (2)*
  - *strong impact (3)*
- **Character**
  - *direct impact (intervention directly impacts environmental components)*
  - *indirect impact (intervention directly impacts environmental components)*
  - *cumulative impact (the procedure alone had no significant impact on components of the environment, but impact is possible in synergies with others (existing or planned) interventions)*
- **Duration**
  - *temporary impact (the impact is related to the time of construction)*
  - *short-term impact (the impact is present within one year)*
  - *medium-term impact (the impact is present within ten years)*
  - *long-term impact (the impact is present for more than ten years)*
  - *lasting impact (impact is present throughout the useful life of the project)*
  - *casual influence (impact is present periodically throughout the life use of the project)*

Given the above criteria, any potential impact on the individual component environmental is given a significance rating which is taken into account when considerations the acceptability of environmental impact and to propose measures of protection and monitoring of the environment as follows:

A	**highly significant negat. impact on the environment**
B	**a significant negative impact on the environment**
C	**little adverse effect on the environment**
U	**The environmental impact cannot be estimated**
N	**has no impact on the environment**
P	**positive impact on the environment**

4.1. ENVIRONMENTAL IMPACT DURING THE CONSTRUCTION PROJECT

4.1.1. Impact on air quality

In the construction phase of the new passenger terminal at Zagreb Airport, there will be dust due to the work area (especially in the dry season), the loading / unloading of earth material, transport of freight vehicles on the land surfaces and alike. According to the valid regulation (*Regulation on the limit values of pollutants in the air, OG 133/05*), the limit value of PM_{10} is 50 g/m^3 for 24-hour sampling.

Also, there will be an increase in emissions due to the operation of machines for excavation, loading and transport of dredged materials, and other machinery (compactor, paving machines, rollers, ...). Except for impact on the location of the project, additional burdens will occur on all local, county and state roads along where traffic is carried out. These impacts will be temporary.

Given the scope of the project and the spatial location of the site, it can be concluded that with the use of protective measures, the underlying construction project will be suitable for the environment from the aspect of impact on the air.

Table 4.1.1.-1. Impact on air quality during construction

IMPACT ON THE AIR QUALITY DURING CONSTRUCTION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	DURABILITY
Construction of the new passenger terminal	-	1	DIRECT	TEMPORARY
Construction of access roads and other traffic surfaces	-	1	DIRECT	TEMPORARY
Construction of energy plants	-	1	DIRECT	TEMPORARY
Construction of a drainage system	-	1	DIRECT	TEMPORARY

Given the recognized effects of the project on air quality during construction, the impact is rated as **slightly significant negative impact (C)**.

4.1.2. Impact on increasing the level of noise

During construction works, applied will be classic construction machinery, which typically produces noise levels of over 80 dB. Also, the sources of noise are also transportation equipment and activities of people. Increased noise levels at the location of the project are inevitable, temporary in character and represent short-term impact, significant on the location itself.

Table 4.1.2.-1. Impact on the increase in noise levels during construction

IMPACT ON LIFTING THE LEVEL OF NOISE DURING CONSTRUCTION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	DURABILITY
Construction of the new passenger terminal	-	1	DIRECT	TEMPORARY
Construction of access roads and other traffic surfaces	-	1	DIRECT	TEMPORARY
Construction of energy plants	-	1	DIRECT	TEMPORARY
Construction of a drainage system	-	1	DIRECT	TEMPORARY

Regarding the recognized impacts of the work to an increase of levels of noise during construction, the impact is evaluated as **small insignificant negative impact (C)**.

4.1.3. Impact on water

When performing low-level engineering, the upper humic soil layer is removed with thickness of thirty which eases the filtering of eventually spilled liquid contaminants to the groundwater. Since this work uses different construction machines, there is a potential danger of motor oil, fuel and antifreeze leaking. This can occur because of operator negligence with the machines, because of failures (burst pipes in hydraulic machine parts), or because of breakdowns (puncture in the the fuel tank, sump and cooler).
Groundwater quality may be affected and with contaminated material (unwashed gravel and sand from the remains of organic matter) that is built into the placenta roads, and parking aprons or insulating materials which are soluble in water.
Works that fall into the category of high-rise can potentially have less impact on groundwater. Here it should be emphasized that the construction of the central building of the new passenger terminal, which will be have a basement level that will reach to a depth of 6 m below surface, or approximately up to the level of 99.0 m above sea level. This means that the lower levels will penetrate into the aquifer, depending on the water level about 1 to 2 m below the water table, and due to pumping water from the foundation pit, there are potential local impacts on groundwater quantity and dynamics in water, and in the case of using low-quality insulating materials there may be impact on the quality of the groundwater.

Table 4.1.3. -1. Impact on the water during construction

IMPACT ON THE AIR QUALITY DURING CONSTRUCTION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	DURABILITY
Construction of the new passenger terminal	-	2	DIRECT	TEMPORARY
Construction of access roads and other traffic surfaces	-	1	DIRECT	TEMPORARY
Construction of energy plants	-	1	DIRECT	TEMPORARY
Construction of a drainage system	-	1	DIRECT	TEMPORARY

Based on the previously presented, it can be concluded that during construction there are certain risks of water pollution. With careful execution of works and compliance with environmental protection measures, the potential impact of the planned project on water during construction is assessed **as slightly significant negative impact (C).**

4.1.4. Impact on soil

The redesign in land use in the area of construction of Zagreb Airport are reflected at different stages of construction, and as shown in Figure 4.1.4.-1.
The construction area of the new terminal of Zagreb Airport is substantially located in the area of agricultural land. Given the high production potential of most of the established soils, agricultural production is highly developed and extensive. Slightly fewer regards forested land.
The total land, in the area of the construction phase of Zagreb Airport, which will be lost with permanent redesign amounts to 21.7 ha. In doing so, agricultural land covers 5.6 hectares, and forest land 16.1 ha, Table 4.1.4.-1.
From the determined 5.6 ha of agricultural land, most of goes to farmland for crop and vegetable production.

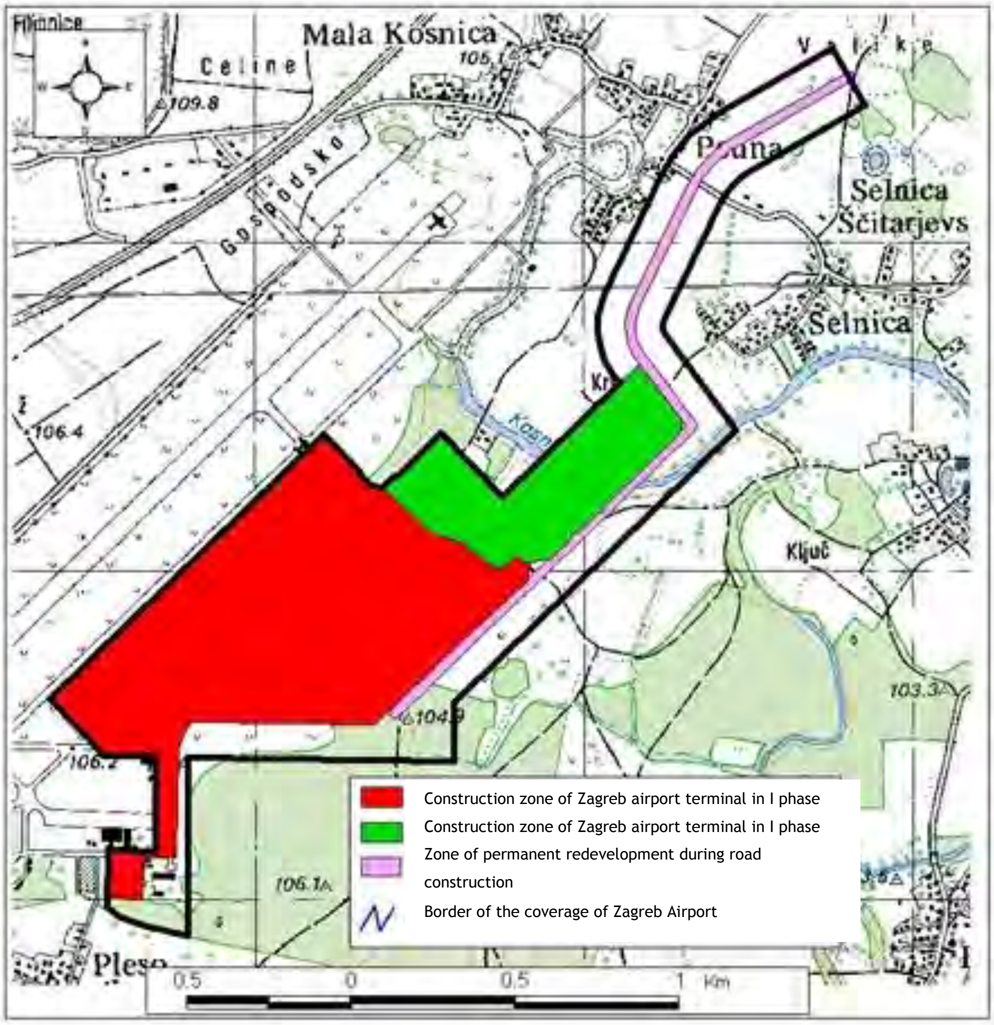


Figure 4.1.4.-1.: Display zone of the construction of Zagreb Airport terminal in phases

Table 4.1.4.-1.: Area (ha) of mapping units within the zone of permanent redesign for the construction of the new terminal of Zagreb Airport

Mapping units of the soil		Construction zone of the terminal I phase			Construction zone of the terminal II phase		
Broj	Naziv	Under forests	In agricul-ture	Total	Total forests	In agri-culture	Total
1	Eutric brown on holocene semigley-drifts (alluvial meadow) carbonate	2,3	-	2,3	-	-	-
2	Semiglej (alluvial meadow) carbonate -Alluvial-gleyic and neogleyic carbonate	-	-	-	-	2,4	2,4
3	Semiglej (alluvial meadow) carbonate -Alluvial-gleyic and neogleyic carbonate -paludal Gleyic hypogleyic, mineral, carbonate	13,8	5,6	19,4	5,2	14,4	19,6
Total		16,1	5,6	21,7	5,2	16,8	22,0

The total land area in the second phase of the construction of Zagreb Airport (or in the zone of the future construction), which will be lost with permanent re-assignment, is 22.0 ha. Thereby, the agricultural land covers 16.8 ha, and the land under forests is 5.2 ha, table

4.1.4. - 1. And in this zone, most of the land consists of arable land-intensive agricultural and horticultural production. A smaller part of the agricultural land is currently neglected due to reduced interest in agriculture.

Construction area of the access road also passes largely through agricultural land. Given the high production potential of most of the determined soils, the agricultural production in this area is highly developed and extensive. A very small part of the land is forested.

The total land area in the construction of the access road that will be lost due to permanent re-assignment, is 6.9 ha, while respecting the corridor of 30 m. Therefore 5.8 hectares fall to agricultural land, and land under forests only 1.1 hectares, table 4.1.4.-2.
Since the identified 5.8 ha of agricultural land, most of the land fall so farm land for farming and vegetable production, and a small part to orchards.

Table 4.1.4.-2.: Area (ha) of the mapped units within the zone of permanent construction redesigned for access roads

Mapping units of the soil		Under forests	In agri-culture	Total
Nmb.	Name			
1	Eutric brown on holocene semigley-drifts (alluvial meadow) carbonate	-	-	-
2	Semigley (alluvial meadow) carbonate -Alluvial-gleyic and neogleyic carbonate	-	4,0	4,0
3	Semigley (alluvial meadow) carbonate Alluvial-gleyic and neogleyic carbonate -paludal Gleyic hypogleyic , mineral, carbonate	1,1	1,8	2,9
Total.		1,1	5,8	6,9

<u>Erosion, soil stability</u>
The immediate base and the wider surface area is anticipated for the work of is made of clastics (gravel and sands), or more rarely loess deposits that have a high ratio of spending (mechanical, erosion, etc). Also, clastic sediments have a very high hydraulic bandwidth vertically so that the planning and execution of deep foundations, construction of facilities, pipelines and maneuvering areas can reach accelerations of erosion and abrasive effects, which can trigger the liquefaction of sediments and thus significantly impair the capacity of substrate-based or general excavation. There should be special attention to potential liquefaction in areas constructed of alluvial or marsh sediments.

<u>Dust particles from traffic</u>
On the basis of the planned measures and work, and description of the project, it can be determined that the construction of the new passenger terminal of Zagreb Airport will not have a negative impact on the changes in the physical, chemical and hydro-pedological properties of the surrounding farmland. The negative impact is possible only in terms of possible contamination of the soil surface in width up to about 100 - 200 m along the border of the terminal which borders with agricultural land, if traffic passes on that part. Specifically, in suspension with heavy metals, dust particles from the roads are released and accumulate in the soil, where the distance at which the scattering occurs depends mostly on the size of these particles.

Table 4.1.4.-3. Impact on soil during construction

IMPACT ON SOIL DURING CONSTRUCTION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	DURABILITY
Construction of the new passenger terminal	-	1	DIRECT	TEMPORARY
Construction of access roads and other traffic surfaces	-	2	DIRECT	TEMPORARY
Construction of energy plants	-	1	DIRECT	TEMPORARY
Construction of a drainage system	-	1	DIRECT	TEMPORARY

Due to the conversion of land required for the construction of project facilities, the most significant impact is in the area of the conversion of agricultural land and soil loss on the route of the construction access roads. The area of the new passenger terminal is located in the area of the military base Pleso, so the redevelopment of these areas is not considered significant in terms of loss of agricultural land. With careful execution of works and following the environmental protection measures, the potential impact of the planned intervention on the ground during construction is assessed as **small adverse effect (C).**

4.1.5. Effect of the intervention on the flora and fauna

4.1.5.1. Effect of the intervention on the fauna

There are two possible levels of impact anticipated from the planned works on the existing fauna. Primarily there can be impact due to **changes in the habitat** (indirectly), and on the hand, there ca be direct adverse impact on the species level, or the **species itself**.

Ornithofauna

The project construction will cause a complete loss of existing natural (forest) and semi-natural habitats (mixed mosaic of habitats) in the project area. The stated habitats listed in the described zone are of no special importance for bird fauna.

Habitats in the project area and its immediate surroundings in quality are not separated from similar habitats in the wider project area is very well represented. We estimate therefore, that the planned project would not have significant adverse effects on bird communities of mosaic and forest habitats in general. Also, the construction of the project will not be destroyed or jeopardize some of the most important habitats for birds.

<u>Impact assessment on the kinds of special importance for nature conservation</u>

Of the total number of bird species in the project area and its immediate surroundings, separated are eight species (partridge, lapwing, hen harrier, hobby, screech owl, little owl, honey buzzard and fish hawk) important in the protection of nature for which it is necessary to consider the potential negative impact of the project on the local population.

The partridge is nester of open habitats along the agricultural areas. Based on the density of the species in Pokupsko basin (D. Radović, oral) it is estimated that in the zone of the project with buffer zones a maximum of 10-30 pairs of this type can nest. The destruction of habitats in the operations zone and an increase of noise in the buffer zone would lose a maximum of 5-10 pairs, which is negligible compared to the total population in Croatia which is estimated at 4000-6000 pairs.

The lapwing is a potential nester of arable surfaces and grassland in the zone of the project with a buffer zone. Research conducted in the area of Gmajna determined the density of about 6.9 pairs/km2 (Šćetarić 2010). Given the presence of suitable habitats in the project zone with buffer zones it is estimated that up to 30 pairs in the area can nest. Annihilation of habitats in the project area and an increase in noise in the buffer zone could cause a reduction in number of about 10 pairs, which is negligible compared to the total population of lapwing in Croatia which is estimated at 4000-6000 pairs.

Harrier is a nester of open habitats (grasslands and agricultural areas). On the work area and buffer zones there are important habitat areas of this type, but they are largely fragmented and dotted with settlements, infrastructure areas, thickets and groves, etc., and the harrier's nesting in this area is not probable. It is possible, however, that it is exploited as a hunting ground, probably irregularly, by birds nesting in the surrounding area. The construction will cause the loss of about 0.7 km2 of habitat suitable for the feeding of the harrier. As these habitats in the area are plentiful, it is very unlikely that this loss, nor an increase in noise in the remaining habitats in the buffer zone, will not significantly affect the population of the harrier. The impact on the harrier therefore is considered to be negligible.

Honey Buzzard and Jastrebac are nesters of vast wood complexes. Since the area of the forest in the area of operations and the buffer zone is small (0.7 km2 in total area of the project with buffer zones) and is located on the campus of the military airport it can be concluded that these species do not nest in it. It is possible, however, that it is sometimes used by young birds during dispersion. With the planned work, 0.08 km2 of forest will be destroyed that lies within the location of the work, and about 10% of the total forest area of the project location with buffer zones. The quality of the remaining forest habitat will be reduced due to increased levels of noise. These changes would not significantly affect the population of the Honey Buzzard and buzzard and intervention will not cause a reduction in numbers (lost pairs) of these species. Therefore, the impact from work for these two types is negligible.

Barn owl and the little owl are potential nesters of mosaic habitats in the area location of the work with the buffer zone. These are species with a relatively low population density and are estimated to be in the location of the project with the buffer zone maximum nesting of one pair of every kind.

The Hobby falcon is a potential nester on mosaic habitats. It is also a type with low density populations and it is not likely that more than one nesting pair is on the work location buffer zones. With the planned work, these three types will lose part of their hunting area and potential prey. Due to the increased noise reduced will be the quality of the habitat in the immediate vicinity of the project. For owls, especially the barn owl that seek food at low altitude there will be an increase in the risk of harm in head-on collision with a vehicle, which is in this case a significant cause of mortality (Fajardo 2001). Due to the relatively small area of the intervention and the fact that in the area there are many mosaics of habitats, it is likely that this species could survive in the buffer zone. The maximum drop in the population can be estimated at 1 pair of each type which is significantly (5 to 40 times) smaller than the loss of 1% of the total croatian population these species (Table 4.1.5.-first).

Table 4.1.5.-1. Species of special importance for nature conservation for the work location and its immediate surroundings with estimates of couples in the subject area and at the national level.

SPECIES	NUMBER OF PAIRS				
	project zone	bafer zone	estimated loss	total population of Croatia	1% total population of Croatia
Montagu's Harrier *Circus pygargus*	0	0	0	60-80	0.6-0.8
honey buzzard *Pernis apivorus*	0	0	0	150-250	1.5-2.5
Eurasian Hobby *Falco subbuteo*	0	1	≤ 1	500-600	5-6
the grey partridge *Perdix perdix*	1-4	10-30	5-10	15.000-25.000	1.500-2.500
Northern lapwing *Vanellus vanellus*	4	30	≤ 10	4.000-6000	40-60
Common barn owl *Tyto alba*	0	1	≤ 1	1.500-2.500	15-25
little owl *Athene noctua*	0	1	≤ 1	1500-2500	15-25
ural owl *Strix uralensis*	0	0	0	700-1000	7-10

Based on the above stated, we estimate that the planned project will have no significant adverse impacts on species of special importance for nature conservation.
The planned intervention will cause a complete change or loss of existing habitats in zone of the work. Since the total area of the work is small (about 1.3 km2), and that its larger part covers the mosaic of habitats in which widespread and numerous types reside, we believe that the potential impact of wok on the populations of endangered bird species is negligible.
Given the size of the work zone and the composition of the habitat, we believe that loss or change of habitats in the work area will not have a significant impact on the population of widespread and common birds species or the wider project area or on the national level.

Bat fauna
Taking into account the possible negative effects such as loss of hunting areas and the destruction of shelter in hollow trees during construction works for the planned airport expansion airport "Pleso", there will be negative impacts on bat fauna.

Mammals
A large number of habitats present in the work area are already under certain anthropogenic influence (deforested areas, agricultural areas, regulated streams, orchards, settlements, etc.) so that the remaining natural habitats are relatively small (woods, meadows, streams channels) and fragmented.
During the construction, there is intensive use of construction equipment and vehicles, which leads the harassment of small mammals in the area because of the impact of noise and vibration. Animals typically react to the disturbance and noise by trying to avoid such adverse effects and run to more favorable adjacent and nearby habitats where it is possible and such habitats exist there, which will happen in this case as well.

Amphibians
Waterways and canals in the area of influence are not overly represented, but there are remains of a once proliferated water network of the flood plains of the Sava River. They represent places of utmost importance for amphibian fauna primarily due to their dependence on propagation in aqueous media, but also because of retention of some species in the water and out of mating season (Pannonian newt, green frogs). The nearest channel Kosnica during the year is mainly dry, so we feel that because of construction there will not be a significant impact on amphibians.

Reptiles
During the execution of there is often harassment of animals where they withdraw to untouched and more peaceful parts of the habitat. As reptiles are quite mobile, they can avoid such adverse impacts.

Table 4.1.5.-2. Impact on fauna during construction

IMPACT ON FAUNA DURING CONSTRUCTION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	DURABILITY
Construction of the new passenger terminal	-	2	DIRECT	TEMPORARY
Construction of access roads and other traffic surfaces	-	1	DIRECT	TEMPORARY
Construction of energy plants	-	1	DIRECT	TEMPORARY
Construction of a drainage system	-	1	DIRECT	TEMPORARY

Given the identified impacts, the potential impact of the planned project on fauna during construction was rated as **slightly significant adverse effect (C).**

4.1.5.2. Impact of the work on flora and habitats

With the construction of the work, there will be a complete loss of existing natural (forest) and semi-natural habitats (mixed mosaic of habitats) in the work area. Disappear will mosaic habitats in the area of about 0.7 km2 and forest habitats in an area of approximately 0.08 km2. Habitats in the project area and its immediate surroundings are not separated in quality from similar habitats in the wider work area which is very well represented. It is estimated that the planned work will not have more significant adverse impacts on flora and habitats because of the loss of vegetation in the area of work.

Table 4.1.5.-3. Impact on flora during construction

IMPACT ON FLORA DURING CONSTRUCTION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	DURABILITY
Construction of the new passenger terminal	-	3	DIRECT	TEMPORARY
Construction of access roads and other traffic surfaces	-	2	DIRECT	TEMPORARY
Construction of energy plants	-	2	DIRECT	TEMPORARY
Construction of a drainage system	-	1	DIRECT	TEMPORARY

Given the identified impacts, the potential impact of the planned project on flora during the construction was rated as **little significant effect (C).**

4.1.5.3. Impact on forests

The procedure will directly reach approximately 0.08 km2 of forest. It regards primarily forests where there is no regular management done, but rather special purpose forests for military purposes. However, according to the presented credit value, forests in which the procedure will immediately have impact have a very large generally beneficial role (34 points) which will be disrupted with their removal.

The evaluation of beneficial functions of forests in the project area was made on the basis of methodology given in the Codebook on Forest landscaping (OG 111/06, OG 141/08). For each of the functions an explanation was given, and the total number of points is shown in Table 4.1.5.-4.
The stands are located on the level area so it does not have any protective function regarding protection from erosion, inundations and floods. However, the stands significantly affect the protection of the area and the airport runway from the wind and snow drifts (4). The impact on the water regime, since it is a forest complex located very close to the Sava streams and aquifers is very significant (4). With regard to their impact on the application on soil fertility and agricultural production it is negligible (2). Forests are next to the inhabited place so that the impact on the climate is very great (4). As these are covered forests, their role towards the protection and improvement of the environment is very significant (3). Due to the formation of oxygen and the cleaning of the atmosphere and that it regards middle-aged and mature forests that protect the populated areas from the emissions of chemical substances caused by traffic and the forest belt that protects the settlements from noise, this segment is very significant (4). According to recreational tourism and health function, the forest is in the area of transit tourism (PWS) (3). The stand has a moderate impact on the fauna and hunting (2). The forest is used for the needs of the armed forces or for the protection of visual space (8).

Table 4.1.5.-4. Evaluation of beneficial functions of forests in the project area

Protection of soil, roads and other objects from erosion and floods	*Influence on the water regime hydropower system*	*Impact on the fertility of soil and farming production*	*Impact on the climate*	*Protection and improvement of mans environment*	*Creating oxygen and cleaning the atmosphere*	*Recreational, tourist and health function*	*Impact on the fauna and hunting*	*Protective forests and forests of special use*	*Total*
1-5	1-4	1-4	1-4	0-3	1-4	0-3	0-3	8-10	
4	4	2	4	3	4	3	2	8	34

Given that, individually and in the total amount of scoring is high, beneficial functions of forests within the project area is very large with respect to all non-economic services provided in relation to the airport and towards the population of wider surrounding area.

Table 4.1.5.-5. Impact on the forests during construction

IMPACT ON FORESTS DURING CONSTRUCTION				
PROJECT SEGMENT	**FEATURE**	**INTENSITY**	**CHARACTER**	**DURABILITY**
Construction of the new passenger terminal	-	1	DIRECT	PERMAMENT
Construction of access roads and other traffic surfaces	-	1	DIRECT	PERMAMENT
Construction of energy plants	-	1	DIRECT	PERMAMENT
Construction of a drainage system	/	/	/	/

Given the still relatively small forest area, the possible impact of the planned project on the forests during construction is assessed as little **significant negative effect (C).**

4.1.6. Effect of the intervention on the cultural and historical heritage

Assessment methodology
The proposed construction of a new terminal at Zagreb airport is located in the lowland landscape of the valley of the Sava River alongside the existing built airport system. The wider area includes a historical continuity of settlement and use since prehistoric times, since it would in ancient times experience a high degree of urbanization associated with the location of the urban Andautonia center. The immediate area includes the zone of direct influence; it is part of a broader area of the ancient city, where fields were placed, the villa rustica and roads. Despite the fact that the area of Zagreb Airport was urbanized in the second half of the last century by the building and the construction of the airport runway, there is always the possibility that during earthwork excavations for the foundations and ground floors they encounter objects of archaeological significance. The density of archaeological sites, as well as their considerable number in the zone with indirect effect makes this category of cultural heritage especially endangered. The dense archaeological topography of the area, as well as the nature of archeology, allow the assumption of possibility of discovering new archaeological sites during earthworks. Except traditional buildings and public sculpture in the settlement Pleso, all other individual cultural and historical buildings (religious, public, residential, traditional / ethnological low construction, memorial) are located in the general area with indirect influence and within built-up areas of the village. The listed individual cultural and historical buildings included in the group that belongs to religious buildings and structures recorded traditional buildings in the settlements Bapča and Pleso. These buildings are located in the zone of indirect impact of the planning of the construction of the passenger terminal at Zagreb airport. Since during the modern urbanization processes most of the buildings of traditional construction on the study area have disappeared and been replaced by new construction, these traditional values, as well as rare and valuable testimonies of the historical development of rural areas require adequate protection in order to not only, with the construction minimize their degree of vulnerability, but also to stimulate their regeneration. Individual cultural and historical buildings (historic settlements, ethnological heritage, civic buildings, religious heritage, memorial heritage, public sculptures and urban equipment) are located in the zone with indirect influence.

1. CULTURAL LANDSCAPE
The cultural landscape of the valley of the river Sava by building a new airport terminal of Zagreb airport is not threatened in the zone with direct influence. It will change the way of using space and spatial patterns.
b) zone with indirect influence
- **Sava valley (marked on the map: KK 1)**

2. HISTORICAL SETTLEMENTS
In addition to the settlement Pleso, all other historic settlements are located in the zone with the indirect influence and are not directly threatened by the construction of a new passenger terminal of Zagreb airport. During construction, the settlement Pleso would be affected by the increased transport of construction materials by trucks.
a) zone with direct influence
Historical characteristics of rural settlements
- Pleso (mark on a map RN1)

3. ARCHEOLOGICAL SITES AND ARCHEOLOGICAL ZONES
Potential archaeological sites (PAL) are directly threatened by future construction. The density of existing archaeological findings in the area near the new passenger terminal of the airport points to the possibility of finding new locations not specified the field survey.

a) zone with direct influence
ARCHAEOLOGICAL ZONE

- Andautonia, (mark on the map AZ 1)

POTENTIAL ARCHAEOLOGICAL SITES

- PAL 1
- PAL 2
- PAL 3
- PAL 4
- PAL 5
- PAL 6
- PAL 7
- PAL 8

b) Zone with indirect influence
ARCHAEOLOGICAL LOCALITIES AND SITES

- Bapča, a random discovery of Roman coins (marked on the map: AL 1)
- Bapča, the route of the Roman road - Čohovo (marked on the map: AL 2)
- Pleso, Early Imperial Roman tomb (marked on the map: AL 3)
- Pleso Grabanka, antiquity (mark on map: AL 4)
- Velika Gorica, Visoki Brijeg, necropolis of the late Bronze Age (marked on the map: AL 5)
- Velika Gorica, Visoki Brijeg early Empire Roman necropolis, 1-2.st. (Marked on the map: AL 6)
- Velika Kosnica - medieval cemetery - parochial church (marked on the map: AL 7)
- Velika Kosnica, Gradišće - antiquity, perhaps villa rustica (mark on map: AL 8)
- Velika Kosnica, Medvenica, artisan workshop facilities, suburban villas, economy and port facilities (mark on map: AL 9)
- Velika Kosnica, (mark on map: AL 10)

4. MEMORIAL FIELDS AND FEATURES

Besides the "Ruptured hoop" in Pleso, other objects of memorial heritage can be found in the zone of indirect impact, and are not directly threatened by the construction of the new passenger terminal. During construction the settlement Pleso and memorial heritage will be threatened by increased transport by trucks.

b) zone with indirect influence

- Velika Gorica - memorial "Ruptured hoop" - Pleso (marked on the map: MO 1)
- Velika Gorica - City Cemetery (map marker: MP 1)
- Velika Gorica – NOB monument in Pleso (marked on the map: MO2)
- Mičevec monument to soldiers (marked on the map: MO3)

5. HISTORIC BUILDINGS

Historic home and public buildings are located in the zone with the indirect effect not directly affected the construction of the new terminal building airport.

SACRAL CONSTRUCTION

Sacral monuments are located in the zone with indirect influence, and are not directly affected by the construction of a new airport terminal..

b) zone with indirect influence

- Velika Gorica, Pleso, Church (chapel) of wounded Jesus (marked on the map: SG 1)
- Velika Gorica, chapel st. Filomen (marked on a map of SG2)

ETHNOLOGICAL CONSTRUCTION

Except for a few examples of traditional buildings, ethnological heritage of the settlement Pleso, other examples of these types of heritage are in the Zone with indirect influence and are not directly affected by the construction of a new passenger terminal of the airport.

b) Zone with indirect impact

- Pleso (mark on map: EG 1)
- Bapče (marked on the map: EG 3)
- Velika Kosnica (map marker EG4)

6. OBJECTS OF SMALL SCALE: PUBLIC PLASTIC AND URBAN EQUIPMENT

Public plastic and urban equipment is in the area of indirect impact and is not directly threatened by the construction of the new passenger terminal of the airport.

CHAPELS AND CRUSIFIXES

b) Zone with indirect impact

- Velika Gorica, a chapel on the road to Pleso (marked on the map: JP1)
- Mičevec, crucifix (marked on the map: JP2)
- Velika Gorica, crucifix in Rakarje (marked on the map: JP 3)
- Velika Kosnica, crucifix (mark on map: JP 4)

Table 4.1.6.-1. Impact on cultural resources during construction

IMPACT ON THE LANDSCAPE DURING CONSTRUCTION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	DURABILITY
Construction of the New passenger terminal	-	2	DIRECT	TEMPORARY
Construction of the access roads and other traffic surfaces	-	2	DIRECT	TEMPORARY
Construction of the energy plant	-	1	DIRECT	TEMPORARY
Construction of the discharge system	-	1	DIRECT	TEMPORARY

Given the identified impacts, the potential impact of the planned project on cultural property during construction is assessed as a significant negative effect (B).

4.1.7. Impact of the project on the landscape

Construction of a new passenger terminal is planned at the anthropogenized area along the location of the existing airport on the site of the military base. The subject location is not characterized by significant landscape values. During Project construction, negative visual impact due to the presence of machinery, equipment and building materials in the project area is expected. The impact is short-lived and characterized during project construction.

Table 4.1.7.-1. Impact on the landscape during construction

IMPACT ON THE LANDSCAPE DURING CONSTRUCTION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	DURABILITY
Construction of the New passenger terminal	-	1	DIRECT	TEMPORARY
Construction of the access roads and other traffic surfaces	-	1	DIRECT	TEMPORARY
Construction of the energy plant	-	1	DIRECT	TEMPORARY
Construction of the discharge system	-	1	DIRECT	TEMPORARY

Given the identified impacts, the potential impact of the planned project on the landscape during construction was assessed as slightly negative effect (C).

4.1.8. Generation of waste

During construction, hazardous and hazardous waste will occur from construction materials and packaging and municipal waste as a result of people working at the site. Disposal of waste at the location of the project may cause adverse effects on the environment as a whole. During construction, there will be an excavation from which part of it will be used for landscaping, and some will be submitted to an authorized waste collector for further disposal. Given the size of the project, waste collection that will be organized within the project area includes procedures prescribed by the law. No significant impact of waste on environmental quality at this stage of the intervention is expected. For all types of waste that will be generated during use, compliance with applicable laws and subordinate regulations governing the treatment of certain categories of waste should be ensured.

Table 4.1.8.-1. The impact of waste generation during construction

IMPACT OF THE OCCURRANCE OF WASTE DURING CONSTRUCTION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	DURABILITY
Construction of the new passenger terminal	-	1	DIRECT	TEMPORARY
Construction of the access roads and other traffic surfaces	-	1	DIRECT	TEMPORARY
Construction of the energy plant	-	1	DIRECT	TEMPORARY
Construction of the discharge system	-	1	DIRECT	TEMPORARY

Given the identified impacts, the potential impact of waste during construction is estimated as a slightly negative effect (C).

4.1.9. Impact on the population and the area in relation to the traffic flows

Due to increased frequency of transport of materials and techniques of construction at the site, a change in traffic conditions that can be avoided with the timely regulation traffic can occur. The planned duration of the works was made on the basis of the conservative estimated dynamic plan:

a) Phase I - the planned duration of the works of the first phase of construction is 29 months in the period from 2013 to 2015.

b) Phase II - the planned duration of the works of the second phase of construction is 24 months during 2022 - 2023.

1.) Expected daily number of trucks and construction machinery outside the project area, on public roads:

DESCRIPTION	MONTH																												
PHASE I	M 1	M 2	M 3	M 4	M 5	M 6	M 7	M 8	M 9	M 10	M 11	M 12	M 13	M 14	M 15	M 16	M 17	M 18	M19	M20	M21	M22	M23	M24	M25	M26	M27	M28	M29
NUMBER OF MACHINES AND TRUCKS : (THE AVERAGE ACCORDING TO THE DAY OF THE MENTIONED MONTH)	17	30	30	30	30	30	41	41	41	41	41	44	43	43	43	43	42	42	30	30	30	30	30	25	19	21	21	18	12

DESCRIPTION	MJESEC																							
PHASE II	M 1	M 2	M 3	M 4	M 5	M 6	M 7	M 8	M 9	M 10	M 11	M 12	M 13	M 14	M 15	M 16	M 17	M 18	M 19	M 20	M 21	M 22	M 23	M 24
NUMBER OF MACHINES AND TRUCKS: (THE AVERAGE ACCORDING TO THE DAY OF THE MENTIONED MONTH)	11	20	20	20	20	24	27	27	27	27	27	24	20	20	20	20	20	22	19	15	15	10	6	5

An involvement is expected of an average of 6 operation vehicles a day, which means that the peak of the daily load can expect no more than 250 cargo operation vehicles. During the construction phase, an increased traffic load is expected on the surrounding roads due to material transport in freight vehicles with a total weight of 20-27 tons. To access the site Zagreb bypass (A3)will be used, Radnička cesta over the Homeland Bridge and the eastern bypass of Velika Gorica, with a connection to the main access road to the airport building (road D - Figure 1.3.4. - 1). This "route" will be used during both phases of construction. Using local rural roads is not appropriate for this type of traffic (unfavorable geometry, large traffic load, noise, dust, lack of footpaths and etc).

For the duration of the works in phase1, it is necessary to buy a minimum of land for the access road (D) in order to form a minimum of building road and through the connection, connect to the eastern bypass of Velika Gorica.
In stage 2, on access road D there will be a temporary connection to the construction site. Through the access road D, all the construction site traffic and regular traffic for the airport will take place at the same time. This will cause a disruption of the regular traffic and it necessary that the contractor prepares a solution for temporary traffic regulation and obtains a consent of the relevant institutions.
The greatest burden during working hours of construction on the surrounding network will be at the level of about 250 operations (driving), which gives an average of 25 operations per one hour. Such a number and frequency of crossings will not affect the flow in the Eastern Bypass of Velika Gorica, Radnička cesta and Zagreb bypass (A3). All materials for the production of concrete needed for the construction works will be shipped to Zagreb airport from factories of concrete products (TBP) Pojatno - Viadukt dd. Vehicles for the transport of materials will be trucks with a total mass of 20-27 t. From TBP Pojatno vehicles enter the state road D1. They move in the direction of Zagreb, and in the junction Zaprešić enter the highway A2 and continue in the direction of the Zagreb bypass (A3) to the junction Kosnica, where they separate on the eastern bypass of Velika Gorica and enter through a temporary connection to the construction site of the Zagreb airport. Asphalt for the construction of Zagreb airport will be transported by trucks to the total weight of 20-27 t from the asphalt base Trstenik Nartski - Viadukt dd. Vehicles will move from the base through the county road Ž1036 to Ivanje Reke, where they will continue through Slavonska avenija and junction of Ivanja reka, by Zagreb bypass (A3) continue to move west towards the junction Kosnica. Here they separate to the eastern bypass of Velika Gorica and enter through a temporary connection to the site of the Zagreb airport. All machinery and construction machinery will be shipped from Radnička cesta (the base of Viadukt) through the junction Kosnica in eastern bypass of Velika Gorica, and over the temporary connection to the site.The analysis of the overall traffic impact on the future roads and construction traffic due to construction site construction of a new passenger terminal, it can be concluded that the new temporary traffic - Technology Solutions, maintain the same level of fluency in Zagreb bypass (Highway A3) and long-term high level of service on the eastern bypass of Velika Gorica and Radnička cesta.

Table 4.1.9.-1. Impact on the population and the area in relation to the traffic flow during construction

IMPACT ON THE POPULATION AND SPACE ON THE TRAFFIC FLOWS DURING CONSTRUCTION				
PROJECT SEGMENT	**FEATURE**	**INTENSITY**	**CHARACTER**	**DURABILITY**
Construction of the new passenger terminal	-	2	DIRECT	TEMPORARY
Construction of the access roads and other traffic surfaces	-	2	DIRECT	TEMPORARY
Construction of the energy plant	-	1	DIRECT	TEMPORARY
Construction of the discharge system	-	1	DIRECT	TEMPORARY

Given the identified impacts, the potential impact of the planned project on the population and space in relation to the traffic flow during construction is assessed as a slightly significant **negative impact (C).**

4.1.10. Risk assessment of ecological disaster

During the construction of a new terminal at Zagreb airport, the risk of ecological disaster primarily covers accidents and accidents during construction. Good engineering practices during construction operations, but also during the design phase will reduce the possibility of such events, which, in view of the sensitivity of the area, potentially could cause significant problems. The low viscosity of the fuel enables an easy penetration into the ground. The importance of considering this danger is particularly important due to the fact that the project is located within the well field, while the soil is very porous. Specifically, the location of the procedure as well as the current Zagreb airport is located in the central part of the Zagreb aquifer. The terrain is composed of a surface layer of gravel, sands and some siltstone clay. Groundwater, depending on hydrological conditions is found at depths of between 3.1 to 6.4 m below the ground surface. All this means is that the danger of uncontrolled emissions may result in serious environmental pollution of the soil and groundwater. Sources and actions which may cause leaks are the same as those at the risk of fire / explosion. Comparing the impact on the environment from danger of fire and pollution of soil and water, the latter is being more pronounced. Although fire is a faster phenomenon that will probably be dealt with in the shortest period of time, and as a result has an impact on people, property and the environment, with the pollution of soil and water is the opposite. The consequence of penetration into the soil and water pollution is a long-term problem for the human health and environment. Renovation procedures are complex and lengthy.

Analysis of the risks associated with soil and groundwater

For the purposes of risk analysis, a matrix with the estimated severity of the consequences and probability of appearance is used. The observed potential adverse event is the worst case that may occur at the source. The assessment of severity of consequences to a specific receptor is divided into classes:

Distribution of severity of consequences to the receptor

Classes	**Human health**	**Soil and Water**	**Ecology**	**The built environment**
Serious	Irreversible damage	Abundant penetration into the soil and significant groundwater pollut.,	Changes to the one or more plant or animal types or ecosystems	Irreparable damage to buildings, installations and enviroment
Limited	Periodic health effects on humans	Limited penetration into the soil, pollution of waste water or low ground water pollution	Changes in the population density of insensitive species of plants and animals	-Damage to buildings installations and the environmenti
Poorly	Slight short-term effects on health	Slight contamination of wastewater	Some changes in the density of population, but without negative impact on the ecosystem	Simple renovation of buildings and installations
Slightly	No measurable effects for human health	No measurable indicators of waste water pollution	No significant circumstances in the density of the population	Very low levels of damage to buildings and installations or

[9] Source: Environmental Impact Assessement of the Expansion of Bristol International Airport, september 2005, Entec

	in the environment or ecosystem	just cleaning

Likelihood of the event

Almost impossible	0-5%
Unlikely	5-45%
Probable	45-55%
Quite probable	55-95%
Almost sure	95-100% (happned before)

Risk classification matrix

Seriousness of the consequence					
Serious	Low	Low to medium	Medium to high	Very high	Very high to high
Limited	Insignificant to low	Low	Middle	Middle to high	High
Poor	Insignificant	Low	Low	Low to medium	Middle
Insignificant	Insignificant	Insignificant	Insignificant to Low	Low	Low
	Almost impossible	Unlikely	Probable	Quite probable	Almost certain

Likelihood of the event

Meanings of the stages and risks

Insignificant	No significant damage (sources of actions are not the potential for significant damage)
Low	Possible slight damage to the receptor
Middle	Possible local periodic damage. It may be necessary to implement corrective actions.
High	It is likely for the receptor to be significantly damaged in case the corrective measures are not carried out
Very high	High probability of serious damage to the receptor without appropriate corrective measures

Table 4.1.10. contains a review of the risk assessment of environmental disasters (without fire / explosion) for the most significant sources / activities and materials during the construction of the NPT of Zagreb airport. Shaded risks are such that require mitigation measures in order to reduce the risk.

Since the project site is located in a sensitive area (wider protection zone of the planned water fields in Črnkovec), the possible effect of extraordinary events during construction is evaluated as a **significant negative effect (B).**

Table 4.1.10. Risk evaluation of ecological accidents (without fire/explosions) for the most important sources/work and substances during the construction of NPT

Sources	Substance	Receptors	Mode of action	Types of hazards	Seriousness of the consequences on the receptor	The probability of occurrence of an event	Classification of risk
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**
Construction machinery	Fuel, oil, antifreeze	Contractors	Skin contact, ingestion, inhalation of vapor and dust	Harmful to human health	Limited	Unlikely	Low
		The public	Skin contact, ingestion, inhalation of vapor and dust	Harmful to health	Limited	Unlikely	Low
		Ground	Penetration of harmful substances, direct contact	Contamination of the soil	Serious	Probably	Middle to high
		Groundwater	Penetration of harmful substances	Contamination of groundwater	Ozbiljna	Probably	Middle to high
		Object in the airport	Effects of danger. chemicals, vapors and gases in the air	Danger to the building, service equipment and human health	Limited	Probably	Middle

4.2. ENVIRONMENTAL IMPACT DURING THE USE OF THE PROJECT

4.2.1. Impact on air quality

EFFECT OF AIR TRAFFIC ON ATMOSPHERIC POLLUTION

Due to increasing traffic and industrialization, a growing number of pollution in the air has harmful effects on human health and the environment. Air pollution from air transport depends mainly on the intensity of air traffic, aircraft types and meteorological conditions. Combustion of aircraft fuel (kerosene) generates greenhouse gases – carbon dioxide (CO_2) and water vapor (H_2O), and nitrogen oxides (NO_x), sulfur oxides (SO_x) and soot. Pollution in the air can be chemically altered due to mutual chemical, photochemical and catalytic reactions, resulting in even more harmful compounds, called secondary pollutants - ozone, acid precipitation, clouds that act as greenhouse gases etc.

Exhaust emissions and particles from aircraft engines are mostly in the tropopause zone (8-12 km above the Earth's surface), while at airports, during takeoff and landing, they are much smaller. The air quality of airports is affected by emissions generated through aircraft engines, utility vehicles and passenger transport. From the total amount of exhaust emissions it is estimated that 70% is nitrogen oxide and 30% carbon monoxide (ICAO1993.)

According to the Commission EU[10], the current fleet of subsonic aircraft consumes about 130-160 million tons of fuel annually. The share of air transport in total anthropogenic emissions is relatively small (2-3% CO_2 and 2-4% for NO_x), but because of the constant growth of air traffic, it can significantly affect the weakening of the ozone layer and climate change in the future. The International Civil Aviation Organization ICAO adopted a series of recommendations and pollution emission standards made for the aircraft engines, to which it is possible to mitigate the risk of impact of these substances on human health and the environment. It should be noted that continuous efforts are underway to introduce measures that will contribute to the decrease of aircraft emissions:

- advancement of technology in aircraft and their engines, alternative use of kerosene-based fuels, improvement of the air traffic management system, etc.

Impact of aviation on global warming and the thinning of the ozone layer

As previously stated, air travel generates greenhouse gases and contributes to global warming and climate change. In 2005 the aircrafts produce about 3% of all greenhouse gas emissions in the European Union, 87% more than in 1990 (According to expert estimates, global air passenger transport will grow 5% a year from 1990 to 2015). Although the airline industry has so far been exempted from the obligation to participate in efforts to reduce pollution (as with road traffic), the European Commission has decided to apply to airport transporters a quota system for their maximum permitted emission, introduced as the Kyoto Protocol. The current document of the European Commission presents White Paper - Roadmap to a Single European Transport Area – Toward a competitive and resource efficient transport system (Brussels, 2011), and it gives aims to achieve a 60% reduction in greenhouse gas (GHG) emissions. These goals refer also to the air traffic, and are determined by the specific strategies and initiatives planned to be implemented, such as the creation of the Single European Sky and air traffic management system (SESAR), improving the efficiency of airports, their better integration with the rail network, etc. In addition, in 2009 the certification program of Airport Carbon Accreditation was launched, which in 2011 included 43 airports (over 600 million passengers), with the goal of better management and

[10] Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and The Committee of the Regions: Air Transport and the Environment Towards Meeting the Challenges of Sustainable Development, COM (1999) 640 final

The reduction of CO_2 emissions. **Under terms of the tender for the selection of the concessionaire of the Airport Zagreb, the concessionaire's obligation is the fulfillment of the Airport Carbon Accreditation program.**

- Changes to the Earth's radiation balance due to anthropogenic greenhouse effect which is associated with global climate change or global warming of the lower layers of the troposphere;
- changes the ozone content of the atmosphere, which on one side affects the intensity of radiation of the earth's surface and filtering harmful UV-radiation, on the other hand, the ozone presents an important greenhouse gas;
- changes in the oxidative capacity of the atmosphere due to the increased concentrations of tropospheric concentration of the ozone and the impact on the bio-geo-chemical circulation of other environmentally important, substances in traces.

While air traffic in the total emissions of CO_2, NOx, CH_4 and CO participates in the quantitative small volume, the most important emission on the cruising altitude flight regimes in the tropopause (8-12 km), where the planes appear as the only anthropogenic contaminants. At these altitudes the naturally caused concentrations of these trace gases are very small, their retention is several times higher than in the lower layers of the troposphere, the measured values of the atmospheric temperature are the lowest, where emissions have a greater impact than the same concentration at the surface of the Earth.

Carbon dioxide (CO_2) is a natural component of the atmosphere, but when it enters the atmosphere in more quantities it acts as a greenhouse gas and has an indirect impact on the environment. The concentration of CO_2 in the atmosphere of the last few decades has increased significantly due to increased consumption of fossil fuel. Air travel creates from 2 to 3% of the total CO_2 emissions caused by the combustion of fossil fuels, or about 12% of the total CO_2 emissions caused by traffic. Significant contribution to reducing the amount of CO_2 released into the atmosphere is a trend of efficient aircraft engines with reduced fuel consumption. The amount of water vapor (H_2O) created by aircrafts negligible compared to the proportion of water vapor in the atmosphere through evaporation on the Earth's surface. Water vapor in the stratosphere and the upper limit of the tropopause is derived exclusively from aircrafts and has a dominant share in comparison with other greenhouse gases. Water vapor also creates so-called condensing lines which favor the onset of high, icy cirrus-clouds which most likely contribute to the greenhouse effect. As with CO_2, emissions of water vapor from the aircraft is proportional to the quantity of combusted fuel. Nitrogen oxides (NOx) in the atmosphere mostly as a mixture of nitrogen monoxide (NO), dioxide (NO_2, N_2O_2) trioxide (N_2O_3) and pentoxide (N_2O_5). Nitrogen oxides are formed in the atmosphere as a result of fuel combustion of aircrafts at a high temperature, and according to weight they are the most common contaminant in air traffic. Above the tropopause they contribute to the destruction of ozone, and in the atmosphere with volatile organic compounds and other reactive gases (CH_4, CO) in the presence of solar radiation, participate in the formation of the ground-level ozone. The quantity of nitrogen oxides emitted the highest altitude cruise and represent the share of air transport by only 3% of total anthropogenic NOx emissions, while amount is equal to the concentration of the pollution of gas from the stratosphere into the troposphere. Air traffic has a slight impact on the presence of CO, CH_4 and SO_2 in the atmosphere. Aviation emissions of NOx and SO_2 11 have indirect climate effects. Estimates of the role of air traffic in the formation of the ozone are in the range 7-12%. If we assume a further growth of

[11] SO_2 emissions have indirect climate effects, because over sulfate aerosols they contribute to the degradation of the ozone. In the last 20 years there has been an annual increase of 5% of its stratospheric concentrations.

air transport, with an annual rate of 5%, the conditioned increase in the concentration of ozone cruising altitudes will amount to 20-30% (Steiner et al, 2003).

The impact of air transport on the air quality of airports

Air traffic affects the air quality of airports and surrounding areas. The local quality of air, emissions generated through engine aircraft engines, utility vehicles and vehicles for the transport of passengers. Planes during landing and takeoff produce significant amounts of gases: nitrogen oxides (NOx), carbon monoxide (CO), oxides of sulfur (SOx) incompletely burnt hydrocarbons (CnHn) and smoke. Particulate matter (PM) have the most dangerous health effects in relation to other emissions. The creation of these pollutants are also contributed from other sources related to the airport, and include the burning of fossil fuels: equipment for airplanes on the ground (in passenger vehicles, transport vehicles for luggage, fuel tanks ...), road transport to the airport facilities and supply of energy. Due to the toxic and carcinogenic properties, polycyclic aromatic hydrocarbons (PAHs) have a significant impact on human health. For the assessment of air quality at the local level, the emissions occurring during the LTO - Landing-Takeoff Cycle are being monitored. The emission of harmful substances is caused in the surface layer of the atmosphere to the height of mixing (about 900 m). On the concentrations of individual pollutants in the area of the airport and beyond, an important role have traffic characteristics traffic flow and meteorological conditions.
The work of the major aircraft engine emits 45% of all emissions of the airport. Approximately the same percentage is emitted from vehicles to transport passengers to / from the airport, while the auxiliary vehicles and auxiliary engines emit 10% of emissions.
Emissions of carbon dioxide and nitrogen oxide emissions depend on the combustion of fuel. In the case of complete combustion (ideal case), CO2 and water would be produced. Incomplete combustion at lower temperatures and speeds produce high emissions of carbon monoxide and hydrocarbons, whereas the more complete combustion and high temperature reduces emissions of CO, but increases nitrogen oxide emissions. New technological solutions of aircraft engines and the use of new materials, reduced emissions of nitrogen oxides NOx (10 - 40%), carbon monoxide CO (70%), and hydrocarbons. IPCC projection shows that there will be reached by 2015 further improvement in fuel consumption of 20% , and by 2050 improvement in fuel consumption will be as much as 40 - 50%..

Impact of road transport vehicles and ancillary public conveyances of the airport on air pollution

Motor vehicles emit about 150 harmful substances that enter into the atmosphere as exhaust gases caused by internal combustion engines. With regard to the impact on the environment and human health, the most important carbon monoxide, carbon dioxide, hydrocarbons, nitrogen oxides, sulfur dioxide and lead. Carbon dioxide is produced during the cold starting of the engine and during work at low revs.
Hydrocarbons evaporate from the feed materials. They occur at low revs and high engine load. According to the toxicity polycyclic aromatic hydrocarbons, benzene and benzopyrene are separated from this group. Sulfur dioxide is primarily produced by the work of diesel engines, and less by the work of gasoline engines. With regard to sulfur content, the use of heavy fuel oil, containing Sulfur in more than 1% is prohibited.
Nitrogen oxides are formed by the combustion of fuel in the engine at high pressures and temperatures with the presence of oxygen. The greatest amount occurs during the middle vehicle load.
From heavy metals, road transport vehicles emit mostly zinc, copper and lead, as well as nickel and cadmium in smaller amounts. Heavy metals are emitted by airborne particles. Lead represents a burden for the environment, noting that its emission is significantly decreased since the use of unleaded petrol. Soot and particulate matter entering the atmosphere as a component of the exhaust gases, but also due to mechanical wear of tires and braking systems of aircrafts and other vehicles on the runways and roads. We distinguish total suspended particles (TSP) and, depending on

the aerodynamic diameter: particles of 10 µm (PM10) of 2.5 µm (PM2, 5), of 1 µm (PM1), and ultrafine particles (UFP), with a diameter below 0.1 µm. Non-methane volatile organic substances (NMVOC) are significant according to the formation of the tropospheric ozone. Some NMVOC substances like benzene and xylenes are highly toxic. Anthropogenic emissions are mainly due to solvent use and road transport.

IMPACT OF THE SPREADING OF ZAGREB AIRPORT ON THE QUALITY OF AIR

As previously explained, the airport due to the significant increase in air traffic is playing an increasingly important role in air pollution. Besides the expansion of space, the airport expansion implies an increased number of aircrafts and higher number of passengers to be transported to the airport, which automatically means increased road traffic. Together with the various activities that take place in the airport and its surroundings, there will be additional impacts to air pollution.

In **the phase of use** of the project, air pollution during the operation of Zagreb Airport will occur under the influence of the exhaust gases. The factors that will directly affect the transport and emissions of exhaust gas in the airspace around the project:

- The spatial locations and position of roads on the ground,
- development level and the type of vegetation along the route,
- The size and speed of the traffic flow,
- Standards of maintenance and (average) age of airplanes, cars, buses ...
- meteorological conditions.

SOURCES OF POLLUTION

Sources of emissions are:

- Aircrafts (main and auxiliary engines)
- Devices on the ground (tractors and cargo aircraft, fuel tanks, repair and other vehicles),
- The access vehicles (vehicles of passengers, employees, carriers, and other people that use the airport),
- energy plant.

a) Aircraft

Planes can be divided into three types in accordance with the purpose and frequency of use, size and profile of operation: commercial, civil and military.

For the project (primarily) we are interested in commercial aircraft for transport passengers and cargo. The engine of the aircraft produces exhaust gases and particles of high temperature that could be released at high speed through the jet engines and mix with the surrounding air.

As previously explained, this process takes place mainly in the zone of the tropopause (8 - 12 km above the Earth's surface), with the dominant negative influence in the form of discharge greenhouse gases (CO2 and water vapor). **Despite the fact that air traffic has global impact, when considering the impact of the subject project on air quality we focused on the activities that will take place within the airport and its immediate environment.** The subject of the impact assessment was a ground layer of the atmosphere in the so-called mixing zone, which corresponds to a vertical column of air from the earth's surface to the the level of mixing.

[12] *mixing zone* - the layer of the earth's atmosphere in which the chemical reactions of pollutants can significantly affect the concentration of contaminants in the ground. According to the EPA, the mixing zone height of 900 m is taken into account, although in many cases it is significantly lower (EPA, 1999).

In addition to the main engine, an additional source of pollution in large aircrafts is the extra Engine (Auxiliary Power Unit - APU), which is used to start the main engine during departure of the aircraft. After that, aircraft supplies electricity and performs venting. Also, the auxiliary engine powers a generator and provides the necessary power to operate the aggregate when the main engines of the aircraft do not work (airplanes during their stay in the country). If the airport has its own power supply and a source of ventilating air, the aircraft can connect to them (after landing). During the aircraft operations of landing, takeoffs and movements within the airport, the extra engine produces exhaust gases like larger machines (HC, CO, NOx, SO2).

b) Devices on the ground and access vehicles
Motor vehicles emit polluting substances into the atmosphere through the exhaust pipe during fuel combustion, and also a certain amount of fuel is emitted from fuel evaporation from the tank, evaporation from the device for fuel feeding and lubricant evaporation from the pan. The composition and quantity of emissions depend on the type of vehicle (passenger car, bus, tractor ...), fuel type and speed of the car.
The exhaust gases of automobile engines recorded about 150 poison organic and inorganic compounds, most notably CO, NOx, SO2, particles of dust etc. Previous studies have shown that pollutants emissions severely drop with distance from source, usually by legality logarithmic functions, so in the distance of 10-35 m it amounts only to 20% of the source value.
During the operation of the airport, sources of pollution from roads are extra devices and vehicles[13] (tractors and cargo aircraft, fuel tanks, service and other vehicles) and the access of vehicles (passenger cars, employees, carriers, and other persons use the airport).

c) The energy plant
Inside the building power plants, 2 blocks of plant will be placed for the production of electricity and thermal energy, including cooling (*CHCP - Combined Heat, Cooling and Power*). Using the technology of *Dry Low Emissions* and natural gas as fuel, the gases will contain NOx and CO.

COMPONENTS OF EXHAUSTE GASES
Given the recorded sources of air pollution, the most significant component of exhaust gases that will be released during the operation of the airport are given below:

- **Carbon (IV) oxide - CO_2** - colorless gas essential for life on Earth – is the product of respiration, and is required for photosynthesis. The increased concentration of CO2 in the atmosphere has an impact on increasing the greenhouse effect, and is manifested through the heating of the troposphere and stratosphere. The normal concentration in the atmosphere is 0.039%. Anthropogenic influence on the burden of the atmosphere is caused by the complete combustion of fossil fuels. It should be noted that of all forms of transport, road traffic is releasing 80% of CO2. There is no technology that in the process of the combustion of fossil fuels removes CO2, but this can be achieved by developing vehicles with reduced fuel consumption, using alternative fuels or other forms of transportation (such as rail transport).

- Carbon (II) oxide - CO - toxic, flammable gas that occurs due to incomplete combustion of substances containing carbon (such as fossil fuels). Unlike the closed space in the open it is not dangerous to humans because in contact with oxygen from the air it is converted to CO2. Otherwise, the use of catalytic converters in motor vehicles can be virtually eliminated.

[13] GSE - Ground Support Equipment

- **Nitrogen oxides - NO_x** ¤ are formed in the combustion process at high temperatures. High temperature and pressure in the aircraft engine promotes the reaction between atmospheric nitrogen and oxygen, mainly during takeoff and climbing, during the maximum engine temperature. First NO is produced which requires an oxygen atom during and after combustion, then NO2 is formed during combustion with an excess of oxygen.

  Since 1996, ICAO (International Civil Aviation Organization) toughened the standards for aircraft engines, and expected further toughening in the future. Nitrogen Oxides are toxic and can produce ozone14 in reaction with oxygen in the surface layer and in the troposphere, while in the stratosphere they contribute to the reduction of concentration of the ozone.
  Most poisonous is NO2 - causes inflammation of the pharynx, trachea and bronchi with the appearance of headaches and coughing. It very quickly enters the lungs, where it merges with the hemoglobin producing compounds that block the action of the lungs. In combination with CO it causes death.

- **Hydrocarbons - HC** ¤ main component of jet fuel. Incomplete combustion of fuel in the engine during the "slow" operation causes the emission of non-combusted hydrocarbons, some of which are toxic (or polycyclic aromatic coal. - PAH).

- **PAU** with two and three aromatic rings are stable in the gas phase, while the PAH with more of them are in the air generally linked to the particles. Research has found a direct relationship between exposure to PAU and suffering from lung cancer (Chang et al, 2006).

- **Benzo(a) pyrene (BaP)** is often used as an indicator of the presence of PAU in food and air (Lee et al, 1981, WHO 2000). Toxicity of other PAUs is transformed into factors of equivalent toxicity (TEFs) BaP in order to evaluate their relative toxicity (Byeong-Kyu and Van Tuan, 2010). BaP contributes most to the appearance of malignant disease, followed by DahA, Ind. and BbF15 (Pufulete etc, 2004).

- **Sulfur (IV) oksid - SO_2** ¤ primarily responsible for the phenomenon of acid rain, because SO2 is oxidized with oxygen from the air, forming SO3, which in contact with water turns into sulfuric acid. SO2 emission is proportional to the quantity of combusted fuel, and the concentration of sulfur in fuel.

- **Water vapor - H_2O** ¤ vapor condenses, creating tracks that are sometimes visible behind the aircraft at high altitudes. H2O emissions from aircrafts are proportional to the the quantity of combusted fuel. The data shows that there is a connection between condense core in the trace and the formation of Cyrus, which likely contributes to the greenhouse effect. Therefore, air traffic contributes to the generation of steam, but the contribution of the airport is negligible.
- **Particulate matter - PM** ¤ represents a wide range of different chemical and physical substances. Principally are discrete particles that exist in the condensed phase (Liquid or solid) and considering the aerodynamic radius they are divided into several magnitudes PM (mostly <40 μm), PM10 (<10 μm), PM2, 5 (<2.5 μm).

The are generally composed of sulfate, nitrate, chloride, ammonium compounds, organic carbon, elemental carbon and metals. The combustion of coal, oil, diesel, gasoline,

[14] Ozone can irritate the respiratory system, causing coughing, throat irritation and / or uncomfortable feeling in the chest. In addition, ozone can reduce lung function and contribute to harsh deep breathing (breathing becomes faster and shallower than which is common). Ozone can also aggravate asthma, lead to pneumonia, irreversible reduction of lung function. Effects of ozone are particularly influence people that stay in the air, people with respiratory diseases, asthmatics, and children. The ozone also harms plants (yield and productivity).

[15] DahA - Dibenzo(a,h)antracen
Ind - Indeno (1,2,3-cd)piren
BbF - Benzo(b)fluoranten

wood ... emissions are produced that that contribute to the formation of particulate matter. The machine of the aircraft releases NOx into the atmosphere which reacts in a manner to form a secondary PM2, 5 Suspended particles can remain in the atmosphere for days or weeks and can travel through the atmosphere for hundreds or thousands of miles. As for the land-based sources of pollution, the component of large dust deposits mainly in their proximity (10 - 30 m), while the fine dust spreads over great distances. The direction of the spreading of the dust cloud is dependent on the direction of the dominant wind.

In comparison to other harmful emissions, particulate matter (PM) has a dangerous effect on human health. If they are less than 10 μm, their harmfulness is reflected in the manner that they retain in the lungs, and can cause bronchitis and other disorders. In this regard, adverse effects of aircrafts on human health are enhanced by the fact that most emitted particles are smaller than 2.5 μm (PM2.5). Dust particles which are larger than 10 μm are a minor annoyance to people, but can pose a significant obstacle to vegetation, depending on the type of dust. Impact on coniferous plants is worse than on deciduous trees, as the deciduous plants naturally eliminate harmful effects by dropping leaves.

About 80% of particulate matter PM10 in the urban area is emitted from road transportation, friction and incomplete combustion (Popescu, 2011).

Other environmental impacts associated with the disposal of NOx and particulate matter: acid clusters, water eutrophication, ozone damaged plants, endangering visibility.

- **Heavy metals** ¤ very dangerous due to long term retention in the soil and accumulating in living organisms. Emission sources are: stationary (Industry, households), mobile (transport), natural (volcanic eruptions, forest fires) sources and accident situations. Road transport vehicles (as one of major sources), mainly emit zinc, copper and lead, and in smaller quantities nickel and cadmium. Heavy metals are emitted by airborne particles. Lead is a great burden on the environment, noting that its emissions significantly reduced since the since the use of unleaded petrol.

SIMULATIONS OF AIR POLLUTION

To determine the impact on air quality, simulations were carried out using ISC-AERMOD View software for 3-D modeling of the dispersion of air (U.S. Environmental Protection Agency). Pollutant emissions are estimated based on the meteorological conditions, characteristics of the pollution sources and terrain.

Meteorological data

Meteorological conditions were estimated based on the measurement data from the meteorological basis for EIA of a new passenger terminal at Zagreb airport (MHS, 2011). The medium monthly values of temperature and pressure were taken into account.

It is assumed the wind blowing from all directions can obtain a **potential zone contamination** around the site area. Given the measured values of wind rose and the closest impact zone (Velika Gorica), the worst wind is from the directions N and NE, which blows with an annual incidence of about 4, or 7% (see Figure 4.2.1.-1). A significant proportion of the rose winds, and winds from the southwest quadrant (SW, NE), due to the lower density of settlement northeast of the project will have less negative impact.

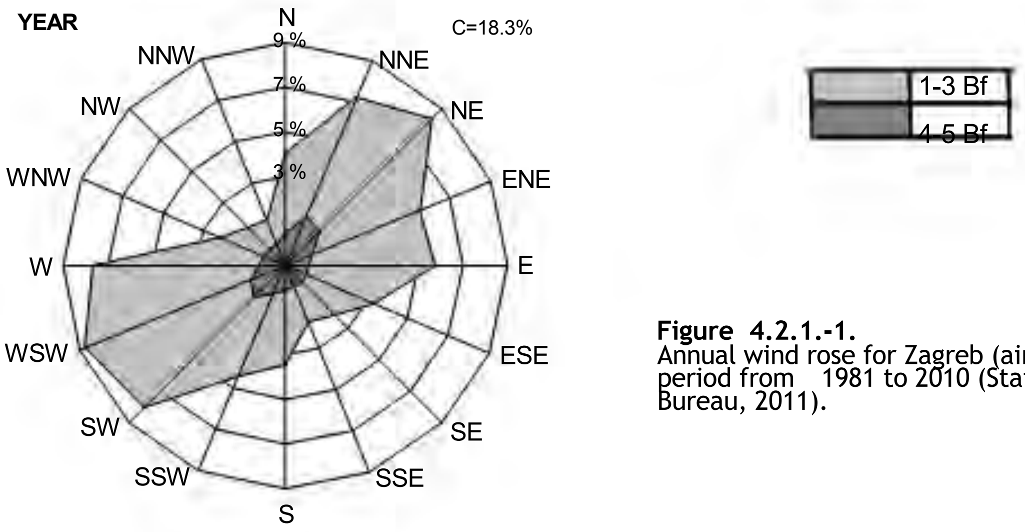


Figure 4.2.1.-1.
Annual wind rose for Zagreb (airport), for the period from 1981 to 2010 (State Weather Bureau, 2011).

Characteristics of pollution sources

a) Aircraft

Table 4.2.1.-shows the prognosis of air traffic according to the higher growth scenario (InetVISTAS, 201 016 - Appendix A).

Table 4.2.1.-1. Forecast of air traffic according to the higher-growth scenario

	2009.	2024. (Phase I)	2040. (Phase II)
Total of passengers	2.067.913	5.000.000	8.000.000
Annual growth rate (%)*		6,1	4,4
Total aircraft operations	37.435	75.630	100.290
Annual growth rate (%)		4,8	3,2
Total cargo (metric tons)	7.214	19.630	29530
Annual growth rate (%)		6,9	4,5

* Cumulative annual growth rate compared to 2009.

Based on the analysis of aircraft categories in Zagreb airport (InetVISTAS, 2010), a projection was made of particular types of commercial aircrafts in the designed period.

Table 4.2.1.-2. Projected number of particular types of commercial aircrafts in Zagreb airport

ICAO aircraft Category	Ratio (%)	2009	2024 (Phase I)	2040 (Phase II)
A	0,0	0	0	0
B	10,8	4.043	8.168	10.831
C	88,2	33.018	66.706	88.456
D	1,0	374	756	1.003
E	0,0	0	0	0
F	0,0	0	0	0

[16] InterVISTAS (2010): Traffic Forecast - public-private partnership - Zagreb Airport

Given that, according to current practice, most air operations are carried out in July[17] and a average of 20% higher than the medium annual traffic, analysis of NOx and PM10 was conducted for that month, as the time of averaging between 1 and 24 h is being considered. Analysis BaP is made for the average annual traffic according to the higher growth scenario, since the averaging period is 1 year. It should also be kept in mind that the daily dynamics of air traffic in Zagre airport, with the following characteristics (InetVISTAS, 2010):

- The first wave of departure occurs in the morning, about 8 h, followed by the incoming peak activity at 9h;
- The second major wave of departures occurs early in the afternoon;
- The third and last wave occurs in the evening when business travelers return home.

Daily line with the arrival in the morning and return in the evening are typical for a business-oriented airport.

Aviation operations within the mixing zone is defined as the *landing-take-off cycle* (LTO):

1. The approach to the runway (Approach - Landing): is measured from the moment of entry of the aircraft into the mixing zone until landing.
2. Movement on the runway and idle upon arrival (Taxi / Idle-in): time from landing to shutdown of the machine when the aircraft arrives at the "door."
3. Idling and movement on the runway at departure (Taxi / Idle-out): time from ignition of the machine to take off.
4. Takeoff (Takeoff): lasts until the aircraft reaches a height of about 150 to 300 m
5. Climbing (climbout): until after the aircraft has passed the zone of mixing.

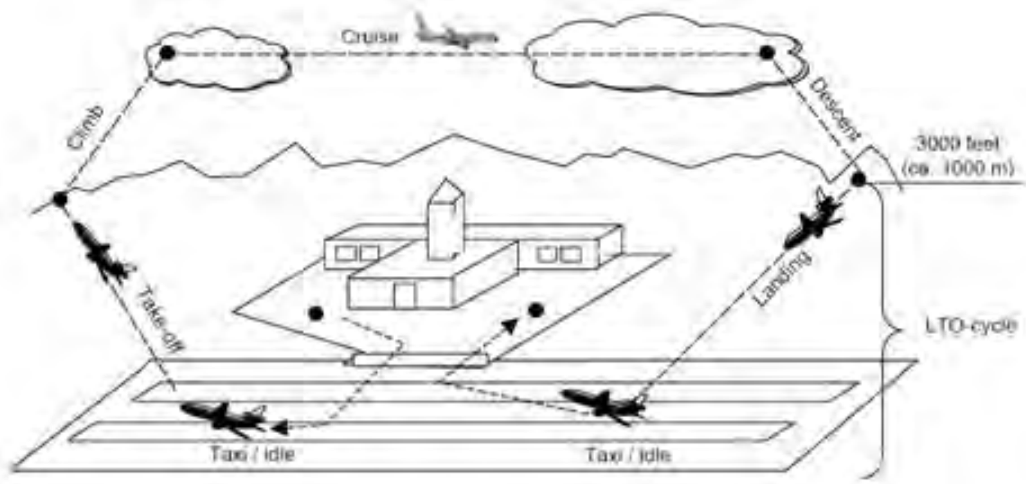


Figure 4.2.1.-2. Standard flight cycle (according to Rypdal, 2001)

Operational LTO time depends on the type of aircraft, the local meteorological conditions and features of the airport. LTO for Zagreb Airport is 30 – 50 minutes.
The average response time assumed for an aircraft of type C is 45 min., According to the following model:

- Access: 4 min.
- Landing: 1 min.
- Taxi in: 2 min.
- Idle (arrival): 2 min.
- Idle (off Ch. Motor, running APU): 18 min.
- Idle (at departure): 8 min.

[17] http://www.zagreb-airport.hr/hr/iz_statistike

- Taxi out: 5 min.
- Takeoff, climbing: 5 min..

The budget included: landing, taxi in, idle, taxi out, take off.

Table 4.2.1.-3. Emissions of pollution parameters for the Airbus A320-200

	CO		NOx		SO_2	
	kg/min	kg/1000kg	kg/min	kg/1000kg	kg/min	kg/1000kg
U (takeoff)	0.11351		3.10258		0.06811	
PE (climbing)	0.0931		2.02745		0.05586	
PR (access)	0.0873		0.27936		0.01886	
PH (prazni hod) ≈ taxi	0.21352		0.04853		0.00655	
APU*		2.05		10.10		-

** The aircraft Airbus A-320 with auxiliary power units (APU) type GTCP36-300 / consumption: 128 kg / h*

Given the typical parameters of pollution emissions (Table 4.2.1.-3), the following can be concluded:

- significant emissions of CO occur during idling and moving around the riding track (taxi),
- significant emissions of NOx occur during take-off and climbing operations, while during other operations they significantly drop,
- emissions of SO2 perform similarly to NOx.

Given the types of aircraft to operate at the airport (Table 4.2.1.-2), in the simulations of air pollution parameters have been used corresponding to aircrafts type Airbus 320-200.
Data on emissions (NOx, CO) from the main engines are taken from Table F-3 (EPA, 1999), while data on emissions (NOx, CO) from the auxiliary power unit (APU) are taken from Tables 9 (EEA, 1995).
Data on particulate matter (PM10) are related to the emissions from the main engines, auxiliary power unit (APU), tires and braking systems. Data on emissions of particulate matter (PM) when operating the main engine they were estimated according to Pehrson, 2005, and amount to:

1. takeoff: 0,52 g/s
2. climb: 0,40 g/s
3. approach: 0,18 g/s
4. idling: 0,08 g/s

Particulate matter (PM10), which is emitted due to tire contact with the runway, and because of the brake system are estimated on the basis of (Morris, 2007) and are as follows: 0.026246 kg / LTO

Modern aircrafts release into the atmosphere 2-10 mg benzo (a) pyrene per minute (LM Shabad, GA Smirnov, 1976). The medium aircraft emission was used in the calculations for the neutral condition of 6 mg BaP / min (see section 3.3.1). For the calculations for the first The phrase the value of 5.4 mg BaP / min. Was used, for 2. Phase 4.8 mg BaP / min., which corresponds to an average reduction of 10% for 2024.g., ie 20% for 2040.

b) Devices on the ground access vehicle - road transport

Since access to the new airport building will be provided through roads, as described in Chapter 1.4 Analysis and forecast of traffic. The main road towards the airport building is the one that connects the eastern bypass of Velika Gorica near the junction Velika Kosnica A3 and the very Velikogorička cesta (currently under construction).

According to current estimates, and the values obtained from automatic counters, the AADT zone of the airport is 7000 vehicles, with the following structure of the traffic flow:

- I. vehicles of 5.5 m: 94.38%
- II. Vehicles of 5.5 m to 9.1 m: 3.61%
- III. Vehicles of 9.1 m to 12.2 m: 1.27%
- IV. Vehicles of 12.2 m to 16.5 m: 0.58%
- V. Vehicles of 16.5 m: 0.14%

According to the projection of the development of the road network in the area of Zagreb airport and the position of the connections to other road network, traffic distribution is estimated from the position of the airport approach (Table 4.2.1. - 4). The structure of the predicted traffic flows is analogous to the above mentioned.

Table 4.2.1.-4. Forecast of traffic volumes within Zagreb airport

year	Evaluated average annual daily traffic		
	entrance D408	entrance A3	Total
2009.	≈ 7.000	-	≈ 7.000
2024.	≈ 5.400	≈ 10.900	≈ 16.300
2040.	≈ 8.700	≈ 17.400	≈ 26.100

The estimates of emissions of NOx, CO and PM10 from road transport vehicles is done on the basis of De Haan & Keller, 2004 (Table A5.1) and Pischinger, 2002 for Euro 4 vehicles, while the estimate of emissions of benzo (a) pyrene (BaP) was performed on the basis of the EMEP / EEA emission guidebook 2009 (Exhaust emissions from road transport, Table 3-16, 3-18 and 3-20).

Taking into consideration the intended structure of vehicles:

- Passenger cars - gasoline: 53%
- Passenger cars - diesel: 42%
- Heavy traffic: 5%

the following (medium) value of emissions (per vehicle) are obtained:

- NOx: 0.414 g/km - PM_{10}: 0.012 g/km
- CO : 0.605 g/km - BaP : 0.479 µg/km

The estimates of emissions of dust particles that are lifted off the road under the influence of strong air turbulent currents due to the passage of vehicles, is calculated based on the measurement of factors PM10 emissions from paved roads (Fitz, 2001; Fitz and Bufalino, 2002).

PM10 emission factor values for different road types are:

- Local road (PGDP < 500): 0.118 g/VKT[18]
- Collector road (PGDP 500 - 10 000): 0.064 g/VKT
- Main road (PGDP 10 000 - 150 000): 0.129 g/VKT
- Highway (PGDP > 150 000): 0.082 g/VKT

c) Energy plant

The mass flow of exhaust gases through one cogeneration block of the plant is 57,000 kg / h and the temperature of the exhaust gases exiting the chimney is 120-180 ° C. Anticipated emissions of harmful substances in the flue gases are:

[18] g/VKT - gram per kilometer of the traveled road of the vehicle (vehicle kilometer traveled)

- max. NOx = 25 ppm ≈ 39 mg/m^3 (for an assumed 50-percent share of NO and NO2)
- max. CO = 60 ppm = 68.7 mg/m^3

According to the projected emissions, both cogeneration blocks will meet the limit emission values (ELVs) in Article 111 *Regulation on emission limit values of air pollutants from stationary sources (OG 21/07, 150/08, 05/09)* - ELVs for small and medium combustion plants using gaseous fuels:

- Nitrogen oxides expressed as NO_2 = 200 mg/m^3
- CO = 100 mg/m^3

Based on the above data, the calculated average mass flows of pollutants influe gases by one block of the cogeneration plant are calculated:

- M_{NOx} = 2.78 kg/h
- M_{CO} = 4.89 kg/h

REFERENCE VALUES OF POLLUTION PARAMETERS

Given the recorded pollution sources as reference parameters for pollution for the assessment on the impact on air quality, NO2, PM10 and benzo (a) pyrene (BaP) were selected. The prescribed limit values of pollution, due to the risk of adverse effects on human health and the environment as a whole, are given in the table below, according to the Regulation on Limit values of pollutants in the air, OG 133/05 (hereafter in this chapter-Regulation)..

Table 4.2.1.-5. Limit value (LV) of selected air quality parameters

(Excerpt from Table 1 - the Regulation on limit values of pollutants in the air, OG 133/05)

Pollutant	Time of averaging	Level of limit value (LV)	Frequency of annual exceedings
NO_2	1 hour	200 µg/m^3	LV should not be exceeded more than 18 times during the year
	24 hours	80 µg/m^3	LV should not be exceeded more than 7 times during the year.
	1 year	40 µg/m^3	-
PM_{10} (I. phase)	24 hours	50 µg/m^3	LV should not be exceeded more than 35 times during the year
	1 hour	40 µg/m^3	-
PM_{10} (II. phase)	24 hours	50 µg/m^3	LV shoud not be exceeded more than 7 times during the year
	1 year	20 µg/m^3	-
Benzo(a)piren	1 year	1 ng/m^3	-

SPATIAL DOMAIN OF MODELS AND SOURCES OF POLLUTION

The figure 4.2.1.-3 shows the spatial domain of the numerical model, measuring 14 x 14 km, with defined sources of pollution. Pollution sources are specially marked within the scope of the operation, especially the main roads in the project's impact zone, in order to do an analysis of relations according to existing procedures and plaOGed roadways.

Figure 4.2.1.-3. Spatial domain of the numerical model that highlights the sources of pollution

SOURCES OF POLLUTION:

a) parts of the operation -Zagreb airport)	**b) the main roads in the affected project zone (GP)**
PR / UZ - approach / takeoff ST - the apron at the terminal - Aircraft idling SL - landing UZ - takeoff / climbing of aircraft P1, P2 - parking lots E - energy plant ZLZ - the main roads in the area ZLZ	D31 - eastern bypass of Velika Gorica (in Construction) D408 - Western approach ZLZ (existing) D30 - Northern bypass of Velika Gorica A11 - Motorway (under construction) A3 - motorway N - planed road (2040.g.)
AADT values are taken from Section 1.4 Analysis and forecast of traffic.	

It should be noted that the analyzed roads will function independently of the project, with note that in the case there is no Zagreb Airport, traffic D30, D31 and D408 would be less intense.

Figure 4.2.1.-4. Scheme of control points in the impact zone of Zagreb airport (K1 - K6: nearest residential objects around Zagreb airport)

The performed experiments and results

Experiments were conducted for the following scenarios:

Experiment	Phase	Parameter of pollution	Source of pollution*
P1-NOx_A	1.phase (2024.)	NOx	ZLZ
P1-NOx_B	1.phase(2024.)	NOx	GP
P1-NOx_C	1.phase(2024.)	NOx	ZLZ+GP
P2-NOx_A	2.phase(2040.)	NOx	ZLZ
P2-NOx_B	2.phase(2040.)	NOx	GP
P2-NOx_C	2.phase(2040.)	NOx	ZLZ+GP
P1-PM10_A	1.phase(2024.)	PM_{10}	ZLZ
P1-PM10_B	1.phase(2024.)	PM_{10}	GP
P1-PM10_C	1.phase(2024.)	PM_{10}	ZLZ+GP
P2-PM10_A	2.phase(2040.)	PM_{10}	ZLZ
P2-PM10_B	2.phase(2040.)	PM_{10}	GP
P2-PM10_C	2.phase(2040.)	PM_{10}	ZLZ+GP
P1-BaP_A	1.phase(2024.)	BaP	ZLZ
P2-BaP_A	2.phase(2040.)	BaP	ZLZ

* ZLZ - parts of the project; GP - the main roads in the area of impact

Determining NOx emissions - first phase (2024. godina)

Table 4.2.1.-6. emission of concentration of Nox at the control points (μg/m^3) for experiments P1-NOx_A, P1-NOx_B i P1-NOx_C

control point	**P1-NOx_A** Sources: ZLZ VU = 1 h	**P1-NOx_B** Sources: GP VU = 1 h	**P1-NOx_C** Sources: ZLZ + GP VU = 1 h
K1	107,23	32,28	126,28
K2	114,60	14,94	126,52
K3	190,77	33,49	179,93
K4	283,62	53,89	288,91
K5	85,83	46,01	125,95
K6	102,16	28,95	112,45

In order to compare the results obtained with the Regulation prescribed limit values (GV) (See Table 4.2.1.-5), an estimate was made based on the concentration of NO_2 based on the assumed ratio: NO_2 / NO_X ≈ 0,4. Thereby the literary data and research in the area of Zagreb were taken into consideration (Šega and Bešlić, 2008; Bešlić and others, 2005a), and the worst case scenario was taken.

Table 4.2.1.-7. Estimation of the emission concentrations of NO_2 in the control points (μg/m^3) for experiments P1-NOx_A, P1-NOx_B and P1-NOx_C

control point	**P1-NOx_A** Sources: ZLZ VU = 1 h	**P1-NOx_B** Sources: GP VU = 1 h	**P1-NOx_C** Sources: ZLZ + GP VU = 1 h
K1	42,89	12,91	50,51
K2	45,84	5,98	50,61
K3	76,31	13,40	71,97
K4	113,45	21,56	115,56
K5	34,33	18,40	50,38
K6	40,86	11,58	44,98

Determining NOx emissions – 2 phase (2040. godina)

Table 4.2.1.-8. NOx emission concentration at the control points (μg/m^3) for experiments P2-NOx_A, P2-NOx_B and P2-NOx_C

control point	**P2-NOx_A** Sources: ZLZ VU = 1 h	**P2-NOx_B** Sources: GP VU = 1 h	**P2-NOx_C** Sources: ZLZ + GP VU = 1 h
K1	142,73	45,19	164,11
K2	152,92	18,88	163,16
K3	228,27	27,45	240,82
K4	374,47	43,03	383,15
K5	128,62	26,29	150,46
K6	148,97	24,07	151,41

Table 4.2.1.-9. Estimation of NO_2 emission concentration at the control points (µg/m^3) for experiments P2-NOx_A, P2-NOx_B and P2-NOx_C

control point	**P2-NOx_A** Sources: ZLZ VU = 1 h	**P2-NOx_B** Sources: GP VU = 1 h	**P2-NOx_C** Sources: ZLZ + GP VU = 1 h
K1	57,09	18,08	65,64
K2	61,17	7,55	65,26
K3	91,31	10,98	96,33
K4	149,79	17,21	153,26
K5	51,45	10,52	60,18
K6	59,59	9,63	60,56

Determining PM_{10} emissions - 1 phase (2024. godina)

Table 4.2.1.-10. PM_{10} emission concentration at the control points kontrolnim točkama (µg/m^3) for experiments P1-PM10_A, P1-PM10_B and P1-PM10_C

control point	**P1-PM10_A** Sources: ZLZ VU = 24 h	**P1-PM10_B** Sources: GP VU = 24 h	**P1-PM10_C** Sources: ZLZ + GP VU = 24 h
K1	5,12	8,16	8,70
K2	8,57	3,94	9,49
K3	9,25	8,36	10,45
K4	8,38	14,17	14,17
K5	5,19	12,54	15,57
K6	5,88	7,28	7,45

Determining PM_{10} emissions - 2 phase (2040. godina)

Table 4.2.1.-11. PM_{10} emission concentration at the control points (µg/m^3) for experiments P2-PM10_A, P2-PM10_B i P2-PM10_C

control point	**P2-PM10_A** Sources: ZLZ VU = 24 h	**P2-PM10_B** Sources: GP VU = 24 h	**P2-PM10_C** Sources: ZLZ + GP VU = 24 h
K1	7,12	14,56	15,42
K2	11,54	5,73	12,85
K3	12,50	8,97	14,43
K4	11,44	14,30	14,30
K5	6,89	13,23	17,03
K6	7,97	7,43	8,72

Determining emissions of benzo(a)pirena - 1 and 2 phase

Table 4.2.1.-12. BaP emission concentration at the control points (ng/m^3) for experiments P1-BaP_A and P2-BaP_A

control point	**P1-BaP_A** Sources: ZLZ VU = 1 year	**P2-BaP_A** Sources: ZLZ VU = 1 year
K1	0,203	0,244
K2	0,509	0,611
K3	0,084	0,101
K4	0,129	0,155
K5	0,239	0,287
K6	0,117	0,140

Note:
Since the airport is the dominant source of benzo (a) pyrene, the analysis results show only the results for Zagreb airport, and not the main roads in the area of impact (GP).

CONCLUSION
The preformed analysis of air quality impacts of building a new passenger terminal of Zagreb Airport was aimed to show the impact of the plaOGed project after realization of the 1. and 2. phase (2024 and 2040). As reference parameters NOx, PM10 and benzo (a) pyrene were selected.
In the performed simulations it was taken into consideration that all types of Airbus A-320, which still gives us a greater load than the real situation. However, the impact of ancillary devices and vehicles (GSE) were not taken into account, so it was assumed that these impacts revoke each other.

Analysis of NOx emission concentration for 1. and 2. phase (graphical appendixes 4.2.1-1a/b/c and 4.2.1- 2a/b/c) revealed the following:

- The highest concentrations were recorded on the take-off of the runway, as the largest NOx emission is from the aircraft engine during takeoff. The loss of contact of the aircraft with the Earth's surface reduces the immediate impact on the surface increasing of concentration of NOx, provided that the contamination remains in the surface layer of the atmosphere to the mixing height (varies seasonally and daily - the average 200 to 900 m) and participates in formation of a ground-level ozone.
- Elements of the project (USS, terminal, associated roads and power plant) forming potential contamination zones of the following radius:
  a) For the first phase: approximately 500 m with Nox concentration values of greater than 200 µg /m3, about 950 m with values higher than 100 µg /m3, about 2700 m with values greater than 50 µg/m3 ... (Graphical appendix 4.2.1-1a)
  b) For 2. phase: approximately 550 ms NOx concentration values greater than 200 g/m3, about 1300 ms values greater than 100 g/m3, about 3700 ms values greater than 75 g/m3 ... (Graphical appendix 4.2.1-2a)
- Roads in the area of impact (A3, A11, D30, D31, D408, plaOGed N) form potential contamination zone as a function of AADT and vehicle structure (Graphical appendix 4.2.1-4.2.1-1b and 2b). The most significant impact is expected from the future highway A11. It should also be noted that the concentration of nitrogen oxides from highways with will be influenced by the proportion of heavy cargo vehicles.

- Regarding the position of Zagreb airport and roads in the area of impact, the cumulative impact will be felt in the 3-5 km radius zone around Zagreb airport. Given the position of the nearby settlements, the strongest negative impact will be on the settlements Mala Kosnica and Petina, near the northeastern edge of the runway. In the close surroundings of the settlement under the impact of Zagreb airport are Pleso, Selnica Šćitarjevska, Bapče and Velika Kosnica, with the note that Selnica and Babče will be under the significant impact of detour D31, and the Velika Kosnica will be under the impact of A3 motorway. In the area of the settlement Velika Gorica and Velika Mlaka will be under the impact of the highway A11 and roads D30 and D31.
- Data in checkpoints indicate prevailing influence of Zagreb airport. Roads that are significant in the context of the cumulative impact are D408 and D30 in K1 and K2, roads D31 and A3 in K3 and K4, and A3 and plaOGed N in K5 and K6.
- Given the wind rose and the nearest impact zones (Pleso settlement, Mala Kosina and Petina), the most unfavorable winds from the direction of N, OGW, with an aOGual incidence of 6% from the direction of the wind that blows from the SW with an aOGual incidence of about 8%.

Based on the assumed ratio: $NO_2/NO_X \approx 0.4$, an estimate of concentration of NO2 was made and the derived values were compared with the prescribed limit values (GV) with respect to human health. Since the *Regulation on Limit values of pollutants in the air (OG 133/05),* GV for NO_2 is 200 g/m3 for the averaging time of 1 h, it can be concluded that the exceedance of GV is right next to the runway. At the points of nearest houses (settlement Mala Kosnica and Petina), exceedence is not expected of the prescribed limit values for NO2. According to that, the share of pollution affected by the subject project and surrounding traffic will be under limits in both phases.

At the location of Zagreb airport, critical levels of NO2 can be exceeded and it is necessary to pay attentio to the health of the workers of Zagreb airport, with a special emphasis on those that are most of the time on the ramp during engine aircraft.

Analysis of emission concentrations of PM10 for 1.and 2.phase (graphical appendixes 4.2.1-3a/b/c and 4.2.1- 4a/b/c) revealed the following:

- The highest concentrations were recorded on the runway and on parts of the future A11 motorway.
- Elements of the project (runway, terminal, associated roads and power plant) form a potential contamination zone of the following radius:
  a) For 1 phase: approximately 200 m with values of PM10 concentrations greater than 30 µg /m^3, about 270 m with values higher than 20 µg /m^3 about 450 m with values greater than 10 µg /m^3 ... (Graphical appendix 4.2.1-3a)
  b) For the second phase: approximately 300 m with values of PM10 concentrations greater than 30 µg /m^3, about 400 m with values higher than 20 µg/m^3, about 800 m with values higher than 10 µg /m^3 ... (Graphical appendix 4.2.1-4a)
- Roads in the area of impact (A3, A11, D30, D31, D408, plaOGed N) form a potential contamination zone under the influence of AADT and vehicle structure (Graphical appendixes 4.2.1-4, 2.1-3b and 4b). The most significant impact is expected from the future highway A11.
- With regard to the position of Zagreb airport and roads in the area of impact, the cumulative impact will be felt in the zone of the radius of 2 km around Zagreb airport. Given the position of the surrounding settlements, the strongest negative impact will be on the settlement Pleso, Mala Kosnica and Petina, although under the prescribed limits of the Regulation.
- Data in checkpoints indicate prevailing influence of Zagreb airport in K2 and K3, the same in K6 and pervasive impact of the roads K1, K4 and K5. Roads that are significant in the context of the cumulative impact are D408 and D30 in the K1 and K2, the roads D31, A3, K3, K4, and A3 and plaOGed N in K5 and K6.

- Given the wind rose values and the nearest impact zone (settlements Pleso, Mala Kosina and Petina), the most unfavorable winds from the directions N, OGW, with an aOGual incidence of 6% and the direction of the wind that blows from the SW with an aOGual incidence of about 8%.

Since the *Regulation on Limit Values of Air Pollutants (OG 133/05)*, LV for PM10 is 50 g/m3 for averaging periods of 24 h, it can be concluded that the exceeding of GV will happen next to the runway. In the surrounding area, the share of pollution under the influence of the subject project will be below the allowable limit values in both phases.

Analysis of emission concentration of benzo (a) pyrene in Phase 1 and 2 (Graphical appendixes 4.2.1-5a and 4.2.1-6a) showed the following:

- The highest concentration was recorded on the runway and the terminal, since the aircrafts during LTO cycles represent the most significant source of pollution. An energy plant does not represent a source of emission of benzo (a) pyrene, while the road traffic will release it, but in significantly lower concentrations from air operations.
- Elements of the project forming a potential contamination zone of the following radius:

  For the 1. phase: about 275 m with BaP concentration values greater than 1 μg/m^3, about 430 m with values greater than 0.5 μg /m^3 ... (Graphical appendix 4.2.1-5a)

  For the 2. phase: approximately 300 m with BaP concentration values greater than 1 μg /m^3, about 500 m with values greater than 0.5 μg /m^3 ... (Graphical appendix 4.2.1-6a)
- With regard to the position of the surrounding villages, the strongest negative impact is on the settlement Pleso (K2). Two times smaller impact on the edges of the settlement Velika Gorica (K1) and Mičevec (K5), while the impact on other settlements in the region is: Petina (K3), Mala Kosnica (K4) Velika Mlaka (K6), 4 to 6 times smaller.
- Regard the aOGual frequency of wind blowing from a given direction, the cloud of pollution from a certain direction of nearby settlements are formed from the following winds:
  - for the settlement Pleso and Velika Gorica: The wind from the directions NW, N and NE (blow with the aOGual frequency of 2%, 4% and 7%, referential)
  - for the area of the settlement Petina: the wind from the direction WSW (9%)
  - for the area of the settlement Mala Kosnica: the wind from the directions SW (8%) and SSW (5%)
  - for the area of the settlement Mičevac: the wind is from the SE (2%) and SE (2%)
  - for the are of the settle Velika Mlaka: The wind from the directions E (6%) and NE (6%)

Since the *Regulation on Limit Values of Air Pollutants (OG 133/05)*, GV for benzo (a) pyrene is 1 ng/m3 during the averaging period of 1 year, with the assumed air traffic, the exceeding of GV can happen in the area of the Zagreb airport. In the nearby area, the proportion of pollution under the influence of the underlying procedure will be under the allowable limits in both phases. However, as the discussed parameter benzo (a) pyrene is an indicator of the presence of PAUs in the air and contributes to the occurrence of malignant diseases, it is essential to minimize its concentration in the entire area, including areas within the Zagreb airport.

* * *

If we compare the emission concentration for the examined parameters in relation to the Regulation on limit values, we conclude that NO2 emissions and benzo (a) pyrene are relevant indicators of risk to human health. The most vulnerable group represent the workers of Zagreb airport, who spend most of their time on the apron during engine operation of the aircraft. As for the surrounding settlements, under the largest impact of Zagreb airport as a source of air pollution are settlements Mala Kosnica and Petina in the immediate vicinity of the northeastern edge of the runwaw, and settlement Pleso on the southern side. However, it should be noted that due to the operation of Zagreb airport, the limit values prescribed by the Regulation on limit values of pollutants in the air will not be exceeded (OG 133/05). Given the trend of making the criteria more severe on allowable emissions in the aviation industry, it is expected that there will be technological advancements in terms of the reduction of emissions from major engine of the aircraft. If we assume that the road vehicles will also reduce emissions of harmful substances in the exhaust gases, we believe that the situation will be made more favorable than in the simulations that are based on the so-called case of the worst scenario.

Table 4.2.1.-13. Impact on air quality during the project use

IMPACT ON AIR QUALITY DURING USE				
PROJECT SEGMENT	CHARACT.	INTENSITY	CHARACTER	DURABILITY
Air traffic	-	1 / 2	DIRECT	DURABLE
Road traffic	-	1	DIRECT	DURABLE
Operation of the energy plant	-	1	DIRECT	DURABLE
Operation of the discharge	/	/	/	/

Given the identified impacts, generally the impact of the plaOGed project on air quality outside the area of Zagreb airport during use is rated as slightly significant negative environmental impact (C). Within the area of Zagreb airport the impact is assessed as significant negative impact on the (working) environment (B), so it is necessary to take into account the health of the workers, with special emphasis on those who spend the most time on the apron during engine operation of the aircraft.

GRAPHICAL APPENDIXES

Appendix 4.2.1-1a. Experiment P1-NOx_A - Immision NOx - 1. faza (2024.g.)
Appendix 4.2.1-1b. Experiment P1-NOx_B - Immision NOx - 1. phase (2024.g.)
Appendix 4.2.1-1c. Experiment P1-NOx_C - Immision NOx - 1. phase (2024.g.)

Appendix 4.2.1-2a. Experiment P2-NOx_A - Immision NOx - 2. phase (2040.g.)
Appendix 4.2.1-2b. Experiment P2-NOx_B - Immision NOx - 2. phase (2040.g.)
Appendix 4.2.1-2c. Experiment P2-NOx_C - Immision NOx - 2. phase (2040.g.)

Appendix 4.2.1-3a. Experiment P1-PM10_A - Immision PM10 - 1. phase (2024.g.)
Appendix 4.2.1-3b. Experiment P1-PM10_B - Immision PM10 - 1. phase (2024.g.)
Appendix 4.2.1-3c. Experiment P1-PM10_C - Immision PM10 - 1. phase (2024.g.)

Appendix 4.2.1-4a. Experiment P2-PM10_A - Immision PM10 - 2. phase (2040.g.)
Appendix 4.2.1-4b. Experiment P2-PM10_B - Immision PM10 - 2. phase (2040.g.)
Appendix 4.2.1-4c. Experiment P2-PM10_C - Immision PM10 - 2. phase (2040.g.)

Appendix 4.2.1-5a. Experiment P1-BaP_A - Immision BaP - 1. phase (2024.g.)
Appendix 4.2.1-6a. Experiment P2-BaP_A - Immision BaP - 2. phase (2040.g.)

4.2.2. Impact on increasing the level of noise

Noise of the energy plant

The energy block (hereinafter "energy plant") intended for the New airport in Zagreb is dislocated approximately 1.2 km of airline west of the building of the new passenger terminal (NPT) and is located along the existing road south of the plot (complex) of Croatia Airlines. The house nearest to the energy block is located at a distance of 175m. The layout area of the plot on which the energy plant is to be located with all accompanying facilities is 50 x 50 m.

In the mentioned energy plant is the concentration of thermo-electrical equipment that can potentially be a source of noise. However, the above mentioned equipment, from which two cogeneration blocks are acoustically most demanding (P=2,8 MW_e) with gas turbines, are delivered in the so-called "low-noise" version, which includes acoustic paneling of the gas turbines and all ancillary aggregates. In addition to these primary measures of protection against noise performed at the factory, the energy plant facility will with secondary measures of acoustic protection minimize noise in the environment. This will be achieved by installing cylindrical absorbers on all functional openings of the energy plant facility adjacent to the outside space (fresh air intake, exhaust of waste air, etc.). If necessary, it is possible to perform interior surface coating of the energy plant with acoustic insulation panels to perform the absorption of noise within the area of the plant.

Air traffic noise

The assessment of impact of Zagreb Airport is made in accordance with the methodology of the development of noise maps specific to the "Regulations on the preparation and content of noise maps and action plans and the method of calculating allowable noise indicators "(OG 75/2009), which follows directly from the Directive 2002/49/EC - "relating to the assessment and management of environmental noise ", as well as the guidelines of the European Commission 2003/613/EC of 06.08.2003," Guidelines on the revised interim computation methods for industrial noise, aircraft noise, road traffic noise and railway noise, and related emission data."
The noise map is made using computer programs and methods of calculating emissions and the propagation of sound (Noise) emitted from known sources of noise in the geographical area of known characteristics. Data on the subject area of the noise mapping include; digital relief model (elevation, contours, turning points), data on construction facilities (buildings, viaducts, walls, etc.) ground cover (grass, concrete, etc.), information on air and road traffic, and meteorological data.
Data for the creation of noise maps imply knowledge of sound power, expressed in dB (A) for individual noise sources, or in dB (A) / m for line noise sources or for surface dB/m2 noise sources with knowledge of the octave spectrum. In addition to these acoustic characteristics, it is necessary to know the time of operation of these sources of noise (day, evening or night). To create a noise map, a validated software package was used designed for making acoustic models of propagation and noise maps Bruel & Kjaer Lima 5.5.0 (June 2011), which fully meets the requirements of Article 13 of the Ordinance on the method of preparation and content of noise maps and action plans, and the maOGer of calculating the permissible noise indicators (OG 75/2009). After the completion of entries and the verification of all data in the specified software package, the calculation is carried on the noise level based on the equations describing the conditions of spreading sound waves in the atmosphere from the noise source. Essential acoustic phenomena that are taken through the calculations are the direction of the source, geometric divergence, absorption of sound waves in the atmosphere, the spread of sound waves near the earth's surface, the appearance of reflection and diffraction of sound waves of various surfaces, the protective effects of the relief elements and objects that make up the barrier of sound waves.
The noise map is a representation of existing and / or predicted state of noise emissions on the observed area, expressed with harmonized noise indicators. The creating of noise maps of Zagreb airport is in accordance with the Croatian legislation, the requirements of the EU

2002/49 and the best professional practice of creating noise maps. The results of the noise maps present a starting point in the management of environmental noise, or give us a picture of environmental burdens with levels of noise coming from the air and road traffic of the Zagreb airport.

For the analysis of the impact of Zagreb Airport, the following input data is used:

Spatial Plan of the City of Velika Gorica - amendments 2008.
Annual report on the level of noise in 2009 - Zagreb Airport
Census of population and households 2011 - Statistical Report, Zagreb, 2011., State Bureau of Statistics, The Republic of Croatia.
geographical data:

- a digital terrain model (elevation, contour lines, turning point)
- ground cover
- Information about the construction facilities (the minimum height of the facility to be taken into the calculation is 4 meters)

Traffic information:

- 2009. 2009- year for the noise level of the current state of air traffic
- 2024- year for noise level of air traffic according to the higher-growth scenario (source: *InterVISTASConsulting Group)*
- 2040- year for noise level of air traffic according to the higher-growth scenario (source: *InterVISTASConsulting Group)*

	2009	2024 (I phase)	2040 (II phase)
total of passengers	2.067.913	5.000.000	8.000.000
annual growth rate (%)*		6,1	4,4
total of aircraft operations	37.435	75.630	100.290
annual growth rate(%)		4,8	3,2

** Cumulative annual growth rate compared to 2009.*

Based on the number of aircraft operations for the typical day, noise maps are made for the Current Status (day, evening and night) and for the assumed scenario of growth in the number of passengers. The targeted number of 5 000 000 passengers according to the higher growth scenario will be reached in 2024, and 8000 000 passengers will be reached in 2040.
From this follows the average daily number of aircraft operations:

- For the year 2009: 103
- For the year 2024: 207
- For the year 2040: 275

fleet structure:
The most prevalent commercial aircraft that conducts operations conducted at the Zagreb airport in 2009 was a regional turbo aircraft Bombardier de Haviland Canada DHC Dash 8 Q400 (or in short Q400), with more than a quarter of all commercial operations. By the frequency of operations the Airbus A318-A321 family follows (for short and medium lines), regional jet Canadair CL-600 RegionalJet CJR-100 and CRJ-700 and Embraer EMB120 turbo-propeller. The series Boeing 737 and ATR 42 can also operate at the Zagreb airport.
These types of aircrafts all together account for about 90% of all movements in 2009. The composition of the fleet this year is similar. Most aircrafts belong to the ICAO Category B and C, although you can find some aircrafts of ICAO Category D (Boeing 757) and E (Boeing 747). According to the input data obtained from the Zagreb airport, the composition of the fleet will not be modified, so the projections of sound maps for the more growth scenario for 2024 (1. Phase) and 2040 (II phase) are

made with the identical composition of the fleet as well as for 2009. This composition of the fleet for the prediction of the noise level of future air traffic can be viewed as a conservative approach, with which the predicted noise levels represent the upper limit that is realistically expected. It is further argued in the following clarification regarding the trends of increasing traffic:

Mid-line connections

The focus in the creation of the regional junction will surely be based on linking new destinations and the introduction of an increased number of aircraft frequencies. Because of the greater coOGectivity of a larger number ofEuropean cities, and analyzing geographic location of the Zagreb airport, these are mostly medium-haul aircrafts A320, A321, B737, etc. According to current knowledge, Airbus in that category of aircraft made a major breakthrough in reducing aircraft noise as evidenced by the development of the A320 Neo aircraft (several times quieter than the current A320) that will surely over time replace the older A320 aircraft fleet. The similar is plaOGed by the company Boeing, which has fully perfected the engines and airfoil on the aircraft type Boeing 737-800. These aircrafts, according to previous analyses make up the largest share of the Zagreb airport and the same trend shoul continue.

Long-line flights

On transatlantic flights certainly the aircraft types A330, A340, B767, B777, B747 should be used. The same arguments as above mentioned apply to these long-line aircrafts. An example of this is the new B787 aircraft that is significantly quieter than aircrafts that are used today, and since 2011 they went into operation. Currently the largest aircraft, the Airbus 380 regardless of the dimensions and 4 engines generate lower noise than smaller aircrafts.

In making the noise maps for the modeling of the existing and plaOGed state, inputs of military aircraft were not available (for security reasons - the military type MIG 21 has a confidential status). Helicopters are very rare (negligible) at Zagreb airport, and most of them come during the day while their impact on the increase of the noise level is minimal, so they are not examined.

Meteorological data:

The list of meteorological data from paragraph 3, Article 22 of Regulations on the maximum allowable noise levels in the environment in which people work and live (OG 145/04).

The study, "The meteorological basis for the study of the environmental impact of a new passenger terminal of Zagreb airport "was made at the State Hydrological Institute, Department of Climatological Research and Applied Climatology, Zagreb, Grič 3 (Class: 920-05/11- 02/53, reg. 554-05-03/04-11-02) by the order of the Institute IGH dd, Zagreb, Janka Rakuše. The first study was prepared by: mr.Sc. Mirta Patarčić

Methodology:

According to the Regulations on the shape and content of noise maps and action plans, and on the way of calculating the allowable noise indicators (OG 75/2009), which defines the computational methods of calculation and assessment of environmental noise, calculation methods used to produce maps of noise of the Zagreb Airport are:

- For air traffic noise: ECAC.CEAC Doc 29 "Report on Standard Method of Computing Noise Contours around Civil Airports "(" Standard Method of calculation Curve - equal level - noise around Civil Airports "), published in 1997 For Computer modeling of flight paths, the segmentation technique is used from Section 7.5 ECAC.CEAC Doc 29
- For road traffic noise: the French national method "NMPB-Routes-96 (SETRA-LCPC-CERT CSTB) "mentioned in" arrêt du 5 mai 1995 relatif au bruit des infrastructures routiéres , Official Journal of May 10th 1995, Article 6. "and the French standard "XPS 31-133".

Regulation:

- Law on Noise Protection (OG 30/2009)
- Ordinance on the establishment of rules and procedures regarding the introduction of operating restrictions related to aircraft noise at airports in the Croatian territory (OG 120/11)
- Ordinance on the preparation and content of noise maps and action plans, and the maOGer of calculation permissible noise indicators (OG 75/2009)
- Ordinance on the maximum permissible noise levels in the environment in which people work and live (OG 145/2004)
- Directive 2002/49 of the European Parliament and of the Council concerning assessment and management of Noise
- European Commission Recommendation 2003/613/EC of computer methods of calculating noise (Air, road, rail traffic, noise and industrial facilities)
- The European Directive 2002/30 (restrictions related to noise management of civilian air ports)

Model results for the noise map of air traffic for 2024 and 2040

The evaluated by noise emissions in open space, was given with regard to the Ordinance on maximum permissible noise levels in the environment in which people work and live (OG 145/04), as the Spatial Plan of the City of Velika Gorica - amendments 2008.
A total of 30 settlements are analyzed; Bapča, Buševec, Črnkovec, Donja Lomnica, Drenje Ščitarjevsko, Gornja Lomnica, Gornje Podotočje, Gradići, Kolibići, Lazi Turopoljski, Lukavec, Mala Kosnica, Mićevec, Mraclin, Novaki Ščitarjevski, Obrezina, Ogulinec, Okuje, Petina, Petrovina Turopoljska, Rakitovec, Sasi, Selnica Ščitarjevska, Staro Čiče, Ščitarjevo, Turopolje, Velika Gorica, Velika Kosnica, Velika Mlaka and Vukovina.
According to the results of the current noise levels, it was determined that these settlements due to exposure to loud noise of Zagreb Airport correspond to the 4th noise zone – Zone of mixed, predominantly commercial purposes with housing, according to Art. 5, the Regulations of the highest permissible noise levels in the environment in which people work and live (OG 145/04), where maximum allowable noise level for the day is 65dB (A) or for the night 50 dB (A).

A detailed presentation of the obtained results for 2024 (Phase 1) and 2040th (Phase 2) is given in the graphical appendixes 4.2.2-1 to 4.2.2.-6. The noise maps are directly related the data which shows the surface of which is affected by noise indicators and analysis of exposure of population that is exposed to exceeded levels of noise indicators, which is expressed in Tables 4.2.2.-4 to.2.2.2-8

According to the calculations for 2024 and 2040 exceedence of daytime noise was recorded in residential areas Donja Lomnica, Mala Kosnica and Petina, while for night noise exceedings were recorded in Donja Lomnica, Mala Kosnicaa, Obrezina, Petina, Selnica, Ščitarjevska and Velika Kosnica. Based on the study results, a choice has been made of reference points in the environment that are proposed to monitor the computational analysis of future conditions and monitoring. The table 4.2.2.-1 describes the noise of the reference points of the individual phases.

Table 4.2.2.-1. Reference points and the noise level obtained based on the model - noise maps

REFERENCE POINT	2009. year			2024. year			2040. year		
	$L_{A,day,evening}$ dB	$L_{A,night}$ dB	$L_{A,den}$ dB	$L_{A,day,evening}$ dB	$L_{A,night}$ dB	$L_{A,den}$ dB	$L_{A,day,evening}$ dB	$L_{A,night}$ dB	$L_{A,den}$ dB
1. Threshold 05	63,5	51,9	63,5	65,7	54,9	65,7	66,8	56,8	66,8
2. Tres. 23	63,0	53,0	63,0	66,3	56,0	66,3	67,4	57,7	67,4
3. Donja Lomnica	61,4	49,1	61,4	64,5	52,1	64,5	65,9	53,9	65,9
4. Obrezina	58,0	47,2	58,0	61,1	50,2	61,1	62,3	51,9	62,3
5. Črnkovec	46,7	36,4	46,7	49,8	39,4	49,8	51,0	41,1	51,0
6. Velika Kosnica	53,2	42,9	53,2	56,3	45,9	56,3	57,5	47,7	57,5
7. Pleso	53,3	42,7	53,3	56,4	45,7	56,4	57,4	47,5	57,4
8. Velika Gorica	48,8	37,5	48,8	51,9	40,5	51,9	52,6	42,3	52,6

GRAPHIC ATTACHMENTS:

Appendix 4.2.2.-1. Noise map of air traffic for the day and evening for the year 2024
Appendix 4.2.2.-2. Noise map of air traffic for the night, for the year 2024
Appendix 4.2.2.-3. Noise map of air traffic for Lden for 2024 year
Appendix 4.2.2.-4. Noise map of air traffic for the day and evening for the year 2040
Appendix 4.2.2.-5. Noise map of air traffic for the night, for the year 2040
Appendix 4.2.2.-6. Noise map of air traffic for Lden for 2040 year

Table 4.2.2.-2. Surfaces of settlements and the estimated number of people living in rural areas who are exposed to overdue indicators of noise levels for air traffic for $L_{day/evening}$ za 2024.

Ord. No	Name of the settlement	Settlement data	Total	L_{night} noise indicator class for 2024											Total excess
				<35 dB(A)	35 - 39 dB(A)	40- 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70-74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
1	Bapče	Settlement surface area (km²)	1,68				0,59	0,32							0,00
		Number of buildings	105												0
		Number of inhabitants	130												0
2	Buševec	Settlement surface area (km²)	4,17												0,00
		Number of buildings	464												0
		Number of inhabitants	889												0
3	Črnkovec	Settlement surface area (km²)	4,62												0,00
		Number of buildings	147												0
		Number of inhabitants	413												0
4	Donja Lomnica	Settlement surface area (km²)	14,93				1,71	1,51	1,43	1,35	0,43				0,43
		Number of buildings	778						209	225	64				64
		Number of inhabitants	1416						380	410	116				116
5	Drenje Ščitarjevsko	Settlement surface area (km²)	2,23				1,33	1,79	3,31	0,03					0
		Number of buildings	147						126	2					0
		Number of inhabitants	202						173	3					0
6	Gornja Lomnica	Settlement surface area (km²)	2,49				0,58	0,38	0,18						0
		Number of buildings	162												0
		Number of inhabitants	582												0
7	Gornje Podotočje	Settlement surface area (km²)	2,93												0,00
		Number of buildings	153												0
		Number of inhabitants	492												0
8	Gradići	Settlement surface area (km²)	1,90				0,34	0,1							0,00
		Number of buildings	622												0
		Number of inhabitants	1808												0
9	Kobilići	Settlement surface area (km²)	1,56												0,00
		Number of buildings	248												0
		Number of inhabitants	520												0
10	Lazi Turopoljski	Settlement surface area (km²)	3,40												0,00
		Number of buildings	43												0
		Number of inhabitants	58												0
11	Lukavec	Settlement surface area (km²)	11,34				0,22	0,1	0,02						0,00
		Number of buildings	535												0
		Number of inhabitants	1136												0
12	Mala Kosnica	Settlement surface area (km²)	1,01				0,01	0,07	0,35	0,35	0,21	0,03			0,24
		Number of buildings	44						9	2	28				28
		Number of inhabitants	49						10	2	31				31
13	Mičevec	Settlement surface area (km²)	6,54				1,99	1,07	0,35	0,19	0,11	0,06			0,17
		Number of buildings	648												0
		Number of inhabitants	1281												0
14	Mraclin	Settlement surface area (km²)	12,93												0,00
		Number of buildings	607												0
		Number of inhabitants	1068												0
15	Novaki Ščitarjevski	Settlement surface area (km²)	2,65				1,15	0,87	0,28						0
		Number of buildings	112						32						0
		Number of inhabitants	165						47						0
16	Obrezina	Settlement surface area (km²)	1,79					0,03	0,9	0,86					0
		Number of buildings	274						57	197					0
		Number of inhabitants	577						120	415					0
17	Ogulinec	Settlement surface area (km²)	3,76												0,00
		Number of buildings	337												0
		Number of inhabitants	296												0

Ord. No.	Name of the settlement	Settlement data	Total	$L_{day/evening}$ noise indicator class for 2024											Total excess
				<35 dB(A)	35 - 39 dB(A)	40 - 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
18	Okuje	Settlement surface area (km²)	4,71												0,00
		Number of buildings	226												0
		Number of inhabitants	467												0
19	Petina	Settlement surface area (km²)	1,84						0,15	1,13	0,56				0,56
		Number of buildings	150						3	41	106				106
		Number of inhabitants	211						4	58	149				149
20	Petrovina Turopoljska	Settlement surface area (km²)	2,63												0,00
		Number of buildings	275												0
		Number of inhabitants	702												0
21	Rakitovec	Settlement surface area (km²)	10,37												0,00
		Number of buildings	247												0
		Number of inhabitants	573												0
22	Sasi	Settlement surface area (km²)	1,67				0,47	0,61	0,56						0,00
		Number of buildings	62												0
		Number of inhabitants	164												0
23	Selnica Sčitarjevska	Settlement surface area (km²)	1,96				0,11	0,85	0,82	0,17					0,00
		Number of buildings	241						21	9					0
		Number of inhabitants	537						47	20					0
24	Staro Čiče	Settlement surface area (km²)	3,02												0,00
		Number of buildings	418												0
		Number of inhabitants	783												0
25	Sčitarjevo	Settlement surface area (km²)	3,79				1,36	1,25	0,94	0,09					0,00
		Number of buildings	243						97	30					0
		Number of inhabitants	440						176	54					0
26	Turopolje	Settlement surface area (km²)	4,64												0,00
		Number of buildings	468												0
		Number of inhabitants	951												0
27	Velika Gorica	Settlement surface area (km²)	31,47				2,15	1,30	0,91	0,65	0,78	0,62	0,57	0,13	2,10
		Number of buildings	5968						32						0
		Number of inhabitants	31341						168						0
28	Velika Kosnica	Settlement surface area (km²)	2,13				0,60	0,75	0,47	0,11					0,00
		Number of buildings	233						54	17					0
		Number of inhabitants	799						185	58					0
29	Velika Mlaka	Settlement surface area (km²)	6,07				0,70	0,53	0,49	0,39	0,33	0,15			0,48
		Number of buildings	1102						9						0
		Number of inhabitants	3326						27						0
30	Vukovina	Settlement surface area (km²)	5,84												0,00
		Number of buildings	453												0
		Number of inhabitants	945												0
	Σ	Settlement surface area (km²)	160,07						11,16	5,32	2,42	0,86	0,57		3,98
		Number of buildings	15512						649	523	198				198
		Number of inhabitants	52321						1338	1020	297				297

YES		Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO		Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
*	**Maximum permitted $L_{day,evening}$ noise immission evaluation levels according to the purpose of the area**	
	Purpose of the area : zone of mixed, mostly residential purpose, $L_{day/evening}$=65 dB	

Table 4.2.2.-3. Surfaces of settlements and the estimated number of people living in rural areas who are exposed overdue indicators of noise levels for air traffic for L_{night} for 2024.

Ord. No	Name of the settlement	Settlement data	Total	L_{night} noise indicator class for 2040											Total excess
				<35 dB(A)	35-39 dB(A)	40- 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	>80 dB(A)	
1	Bapče	Settlement surface area (km²)	1,68			0,25									0
		Number of buildings	105												0
		Number of inhabitants	130												0
2	Buševec	Settlement surface area (km²)	4,17												0,00
		Number of buildings	464												0
		Number of inhabitants	889												0
3	Crnkovec	Settlement surface area (km²)	4,62			0,1									0,00
		Number of buildings	147												0
		Number of inhabitants	413												0
4	Donja Lomnica	Settlement surface area (km²)	14,93			1,35	1,41	1	0,09						1,09
		Number of buildings	778				345	12							12
		Number of inhabitants	1416				628	22							22
5	Drenje Sčitarjevsko	Settlement surface area (km²)	2,23			1,92	2,93								0,00
		Number of buildings	147				78								0
		Number of inhabitants	202				107								0
6	Gornja Lomnica	Settlement surface area (km²)	2,49			0,28	0,06								0
		Number of buildings	162												0
		Number of inhabitants	582												0
7	Gornje Podotočje	Settlement surface area (km²)	2,93												0,00
		Number of buildings	153												0
		Number of inhabitants	492												0
8	Gradići	Settlement surface area (km²)	1,90												0,00
		Number of buildings	622												0
		Number of inhabitants	1808												0
9	Kobilići	Settlement surface area (km²)	1,56												0,00
		Number of buildings	248												0
		Number of inhabitants	520												0
10	Lazi Turopoljski	Settlement surface area (km²)	3,40												0,00
		Number of buildings	43												0
		Number of inhabitants	58												0
11	Lukavec	Settlement surface area (km²)	11,34			0,06									0,00
		Number of buildings	535												0
		Number of inhabitants	1136												0
12	Mala Kosnica	Settlement surface area (km²)	1,01			0,1	0,35	0,35	0,2	0,02					0,57
		Number of buildings	44				7	2	28						30
		Number of inhabitants	49				8	2	31						33
13	Mićevec	Settlement surface area (km²)	6,54			0,94	0,31	0,16	0,1	0,05					0,31
		Number of buildings	648												0
		Number of inhabitants	1281												0
14	Mraclin	Settlement surface area (km²)	12,93												0,00
		Number of buildings	607												0
		Number of inhabitants	1068												0
15	Novaki Sčitarjevski	Settlement surface area (km²)	2,65			0,84	0,19								0,00
		Number of buildings	112												0
		Number of inhabitants	165												0
16	Obrezina	Settlement surface area (km²)	1,79			0,04	1,32	0,43							0,43
		Number of buildings	274				141	82							82
		Number of inhabitants	577				297	173							173
17	Ogulinec	Settlement surface area (km²)	3,76												0,00
		Number of buildings	337												0
		Number of inhabitants	296												0

Ord. No	Name of the settlement	Settlement data	Total	Lnight noise indicator class for 2040											Total excess
				<35 dB(A)	35 - 39 dB(A)	40 - 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
18.	Okuje	Settlement surface area (km²)	4,71												0,00
		Number of buildings	226												0
		Number of inhabitants	467												0
19.	Petina	Settlement surface area (km²)	1,84				0,2	1,15	0,49						1,64
		Number of buildings	150				3	35	112						147
		Number of inhabitants	211				4	49	158						207
20.	Petrovina Turopoljska	Settlement surface area (km²)	2,63												0,00
		Number of buildings	275												0
		Number of inhabitants	702												0
21.	Rakitovec	Settlement surface area (km²)	10,37												0,00
		Number of buildings	247												0
		Number of inhabitants	573												0
22.	Sasi	Settlement surface area (km²)	1,67			0,67	0,42								0,70
		Number of buildings	62												3
		Number of inhabitants	164												8
23.	Selnica Ščitarjevska	Settlement surface area (km²)	1,96			0,91	0,76	0,14							0,14
		Number of buildings	241				17	9							9
		Number of inhabitants	537				38	20							20
24.	Staro Čiče	Settlement surface area (km²)	3,02												0,00
		Number of buildings	418												0
		Number of inhabitants	783												0
25.	Ščitarjevo	Settlement surface area (km²)	3,79			1,21	0,91	0,01							0,01
		Number of buildings	243				172								0
		Number of inhabitants	440				311								0
26.	Turopolje	Settlement surface area (km²)	4,64												0,00
		Number of buildings	468												0
		Number of inhabitants	951												0
27.	Velika Gorica	Settlement surface area (km²)	31,47			1,18	0,83	0,62	0,81	0,54	0,56	0,08			2,61
		Number of buildings	5968				9								0
		Number of inhabitants	31341				47								0
28.	Velika Kosnica	Settlement surface area (km²)	2,13			0,71	0,45	0,01							0,01
		Number of buildings	233				67	19							19
		Number of inhabitants	799				230	65							65
29.	Velika Mlaka	Settlement surface area (km²)	6,07			0,46	0,44	0,36	0,31						0,67
		Number of buildings	1102				2								0
		Number of inhabitants	3326				6								0
30.	Vukovina	Settlement surface area (km²)	5,84												0,00
		Number of buildings	453												0
		Number of inhabitants	945												0
	Σ	Settlement surface area (km²)	160,07			11,02	10,58	4,23	2	0,61	0,56				8,09
		Number of buildings	15512				841	159	140						299
		Number of inhabitants	52321				1676	331	189						520

YES	(green)	meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO	(pink)	does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
*	maximum permitted Lnight noise immission evaluation levels according to the purpose of the area	
	Purpose of the area : zone of mixed, mostly residential purpose, L_{night} =50 dB	

Table 4.2.2.-4. Surfaces of settlements and the estimated number of people living in rural areas who are exposed to overdue indicators of noise levels for air traffic for $L_{day,\ evening}$ 2040.

Ord. No	Name of the settlement	Settlement data	Total	L_{night} noise indicator class for 2040											Total excess
				<35 dB(A)	35 - 39 dB(A)	40- 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70-74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
1	Bapče	Settlement surface area (km^2)	1,68				0,59	0,46							0,00
		Number of buildings	105												0
		Number of inhabitants	130												0
2	Buševec	Settlement surface area (km^2)	4,17												0,00
		Number of buildings	464												0
		Number of inhabitants	889												0
3	Črnkovec	Settlement surface area (km^2)	4,62				1,11	0,34							0,00
		Number of buildings	147												0
		Number of inhabitants	413												0
4	Donja Lomnica	Settlement surface area (km^2)	14,93				1,65	1,46	1,32	1,41	0,71	0,02			0,73
		Number of buildings	778						176	247	83				83
		Number of inhabitants	1416						320	450	151				151
5	Drenje Šćitarjevsko	Settlement surface area (km^2)	2,23				1,12	1,7	3,21	0,61					0,00
		Number of buildings	147						106	24					0
		Number of inhabitants	202						146	33					0
6	Gornja Lomnica	Settlement surface area (km^2)	2,49				0,56	0,4	0,24	0,02					0,00
		Number of buildings	162												0
		Number of inhabitants	582												0
7	Gornje Podotočje	Settlement surface area (km^2)	2,93												0,00
		Number of buildings	153												0
		Number of inhabitants	492												0
8	Gradići	Settlement surface area (km^2)	1,90				0,33	0,12							0,00
		Number of buildings	622												0
		Number of inhabitants	1808												0
9	Kobilići	Settlement surface area (km^2)	1,56												0,00
		Number of buildings	248												0
		Number of inhabitants	520												0
10	Lazi Turopoljski	Settlement surface area (km^2)	3,40												0,00
		Number of buildings	43												0
		Number of inhabitants	58												0
11	Lukavec	Settlement surface area (km^2)	11,34				0,34	0,11	0,04						0,00
		Number of buildings	535												0
		Number of inhabitants	1136												0
12	Mala Kosnica	Settlement surface area (km^2)	1,01					0,03	0,31	0,36	0,27	0,05			0,32
		Number of buildings	44						2	11	28				28
		Number of inhabitants	49						2	12	31				31
13	Mićevec	Settlement surface area (km^2)	6,54				2,09	1,28	0,45	0,22	0,12	0,08			0,2
		Number of buildings	648						3						0
		Number of inhabitants	1281						6						0
14	Mraclin	Settlement surface area (km^2)	12,93												0,00
		Number of buildings	607												0
		Number of inhabitants	1068												0
15	Novaki Šćitarjevski	Settlement surface area (km^2)	2,65				0,97	0,95	0,47						0,19
		Number of buildings	112						51						0
		Number of inhabitants	165						75						0
16	Obrezina	Settlement surface area (km^2)	1,79						0,54	1,24					0,43
		Number of buildings	274						41	213					82
		Number of inhabitants	577						86	449					173
17	Ogulinec	Settlement surface area (km^2)	3,76												0,00
		Number of buildings	337												0
		Number of inhabitants	296												0

Ord. No.	Name of the settlement	Settlement data	Total	$L_{day/evening}$ noise indicator class for 2040											Total excess
				<35 dB(A)	35 - 39 dB(A)	40 - 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
18	Okuje	Settlement surface area (km^2)	4,71												0,00
		Number of buildings	226												0
		Number of inhabitants	467												0
19	Petina	Settlement surface area (km^2)	1,84						0,05	0,92	0,87				0,87
		Number of buildings	150							4	146				146
		Number of inhabitants	211							6	205				205
20	Petrovina Turopoljska	Settlement surface area (km^2)	2,63												0,00
		Number of buildings	275												0
		Number of inhabitants	702												0
21	Rakitovec	Settlement surface area (km^2)	10,37												0,00
		Number of buildings	247												0
		Number of inhabitants	573												0
22	Sasi	Settlement surface area (km^2)	1,67				0,47	0,61	0,59						0,00
		Number of buildings	62						4						0
		Number of inhabitants	164						11						0
23	Selnica Sčitarjevska	Settlement surface area (km^2)	1,96				0,04	0,67	0,96	0,29					0,00
		Number of buildings	241						32	14					0
		Number of inhabitants	537						71	31					0
24	Staro Čiče	Settlement surface area (km^2)	3,02												0,00
		Number of buildings	418												0
		Number of inhabitants	783												0
25	Sčitarjevo	Settlement surface area (km^2)	3,79				1,13	1,27	1	0,25					0,00
		Number of buildings	243						87	62					0
		Number of inhabitants	440						158	112					0
26	Turopolje	Settlement surface area (km^2)	4,64												0,00
		Number of buildings	468												0
		Number of inhabitants	951												0
27	Velika Gorica	Settlement surface area (km^2)	31,47				2,36	1,39	0,96	0,68	0,71	0,71	0,52	0,3	2,24
		Number of buildings	5968						47						0
		Number of inhabitants	31341						247						0
28	Velika Kosnica	Settlement surface area (km^2)	2,13				0,44	0,76	0,53	0,22					0,00
		Number of buildings	233						62	27					0
		Number of inhabitants	799						213	93					0
29	Velika Mlaka	Settlement surface area (km^2)	6,07				0,75	0,52	0,48	0,39	0,33	0,24			0,57
		Number of buildings	1102						14						0
		Number of inhabitants	3326						42						0
30	Vukovina	Settlement surface area (km^2)	5,84												0,00
		Number of buildings	453												0
		Number of inhabitants	945												0
	Σ	Settlement surface area (km^2)	160,07						11,15	6,61	1,26	0,51	0,39		4,93
		Number of buildings	15512						625	602	257				257
		Number of inhabitants	52321						1377	1185	388				388

YES		Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO		Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
*	**Maximum permitted $L_{day,evening}$ noise immission evaluation levels according to the purpose of the area**	
	Purpose of the area : zone of mixed, mostly residential purpose, $L_{day/evening}$=65 dB	

Table 4.2.2.-5 Settlement surface areas and estimated number of inhabitants exposed to excessive air traffic L_{night} for 2040

Ord. No.	Name of the settlement	Settlement data	Total	L_{night} noise indicator class for 2009											Total excess
				<35 dB(A)	35 - 39 dB(A)	40- 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
1	Bapče	Settlement surface area (km²)	1,68			0,46	0,01								0,00
		Number of buildings	105												0
		Number of inhabitants	130												0
2	Buševec	Settlement surface area (km²)	4,17												0,00
		Number of buildings	464												0
		Number of inhabitants	889												0
3	Crnkovec	Settlement surface area (km²)	4,62			0,35									0,00
		Number of buildings	147												0
		Number of inhabitants	413												0
4	Donja Lomnica	Settlement surface area (km²)	14,93			1,39	1,37	1,28	0,31						1,59
		Number of buildings	778				332	19	24						43
		Number of inhabitants	1416				604	35	44						78
5	Drenje Ščitarjevsko	Settlement surface area (km²)	2,23			1,72	3,3	0,4							0,40
		Number of buildings	147				2	76							76
		Number of inhabitants	202				3	104							104
6	Gornja Lomnica	Settlement surface area (km²)	2,49			0,34	0,15								0,00
		Number of buildings	162												0
		Number of inhabitants	582												0
7	Gornje Podotočje	Settlement surface area (km²)	2,93												0,00
		Number of buildings	153												0
		Number of inhabitants	492												0
8	Gradići	Settlement surface area (km²)	1,90			0,03									0,00
		Number of buildings	622												0
		Number of inhabitants	1808												0
9	Kobilići	Settlement surface area (km²)	1,56												0,00
		Number of buildings	248												0
		Number of inhabitants	520												0
10	Lazi Turopoljski	Settlement surface area (km²)	3,40												0,00
		Number of buildings	43												0
		Number of inhabitants	58												0
11	Lukavec	Settlement surface area (km²)	11,34			0,09	0,01								0,00
		Number of buildings	535												0
		Number of inhabitants	1136												0
12	Mala Kosnica	Settlement surface area (km²)	1,01			0,02	0,3	0,35	0,29	0,05					0,69
		Number of buildings	44				5	9	28						37
		Number of inhabitants	49				6	10	31						41
13	Mićevec	Settlement surface area (km²)	6,54			1,24	0,45	0,21	0,11	0,08					0,40
		Number of buildings	648				6								0
		Number of inhabitants	1281				12								0
14	Mraclin	Settlement surface area (km²)	12,93												0,00
		Number of buildings	607												0
		Number of inhabitants	1068												0
15	Novaki Ščitarjevski	Settlement surface area (km²)	2,65			0,95	0,45								0,00
		Number of buildings	112				37								0
		Number of inhabitants	165				55								0
16	Obrezina	Settlement surface area (km²)	1,79				0,61	1,18							1,18
		Number of buildings	274					223							223
		Number of inhabitants	577					470							470
17	Ogulinec	Settlement surface area (km²)	3,76												0,00
		Number of buildings	337												0
		Number of inhabitants	296												0

Ord. No.	Name of the settlement	Settlement data	Total	$L_{day/evening}$ noise indicator class for 2040											Total excess
				<35 dB(A)	35 - 39 dB(A)	40 - 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
18	Okuje	Settlement surface area (km²)	4,71												0,00
		Number of buildings	226												0
		Number of inhabitants	467												0
19	Petina	Settlement surface area (km²)	1,84				0,04	0,89	0,91						1,80
		Number of buildings	150					3	147						150
		Number of inhabitants	211					4	207						211
20	Petrovina Turopoljska	Settlement surface area (km²)	2,63												0,00
		Number of buildings	275												0
		Number of inhabitants	702												0
21	Rakitovec	Settlement surface area (km²)	10,37												0,00
		Number of buildings	247												0
		Number of inhabitants	573												0
22	Sasi	Settlement surface area (km²)	1,67			0,58	0,7								0,00
		Number of buildings	62				3								0
		Number of inhabitants	164				8								0
23	Selnica Sčitarjevska	Settlement surface area (km²)	1,96			0,64	0,96	0,32							0,32
		Number of buildings	241				41	22							22
		Number of inhabitants	537				91	49							49
24	Staro Čiče	Settlement surface area (km²)	3,02												0,00
		Number of buildings	418												0
		Number of inhabitants	783												0
25	Sčitarjevo	Settlement surface area (km²)	3,79			1,25	1	0,3							0,30
		Number of buildings	243				182	61							61
		Number of inhabitants	440				330	110							110
26	Turopolje	Settlement surface area (km²)	4,64												0,00
		Number of buildings	468												0
		Number of inhabitants	951												0
27	Velika Gorica	Settlement surface area (km²)	31,47			1,35	0,95	0,67	0,67	0,68	0,48	0,34			2,81
		Number of buildings	5968				22								0
		Number of inhabitants	31341				116								0
28	Velika Kosnica	Settlement surface area (km²)	2,13			0,74	0,53	0,24	0,01						0,25
		Number of buildings	233				73	47							47
		Number of inhabitants	799				250	161							161
29	Velika Mlaka	Settlement surface area (km²)	6,07			0,47	0,46	0,39	0,35	0,15					0,89
		Number of buildings	1102				9								0
		Number of inhabitants	3326				27								0
30	Vukovina	Settlement surface area (km²)	5,84												0,00
		Number of buildings	453												0
		Number of inhabitants	945												0
	Σ	Settlement surface area (km²)	160,07			11,62	11,29	6,23	2,65	0,96	0,48				10,81
		Number of buildings	15512				712	460	199						659
		Number of inhabitants	52321				1501	944	282						1225

YES		Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO		Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
*	**Maximum permitted $L_{day,evening}$ noise immission evaluation levels according to the purpose of the area**	
	Purpose of the area : zone of mixed, mostly residential purpose, $L_{evening}$=50 dB	

Table 4.2.2.-6 Comparative table of settlement surface areas and estimated number of

Ord. No	Name of the settlement	Settlement surface area in km2	Number of buildings	** Total number of inhabitants per settlement	* 2009 L den noise immission levels in dB(A)	Surface area of the settlement (in km2) affected by excessive noise immission levels in 2009	Number of buildings exposed to excessive noise immission levels in 2009	Estimated number of inhabitants exposed to excessive noise immission levels in 2009	* 2040 L den noise immission levels in dB(A)	Surface area of the settlement (in km2) affected by excessive noise immission levels in 2024	Number of buildings exposed to excessive noise immission levels in 2024	Estimated number of inhabitants exposed to excessive noise immission levels in 2024	* 2040 L den noise immission levels in dB(A)	Surface area of the settlement (in km2) affected by excessive noise immission levels in 2040.	Number of buildings exposed to excessive noise immission levels in 2040.	Estimated number of inhabitants exposed to excessive noise immission levels in 2040
1	Bapce	1,68	105	130	40 do 50				45 do 50				45 do 55			
2	Busevec	4,17	464	889												
3	Crnkovec	4,62	147	413	35 do 50				40 do 50				40 do 55			
4	Donja Lomnica	14,93	778	1416	45 do 65	0,04	0	0	50 do 70	0,43	64	116	50 do 70	0,73	83	151
5	Drenje Scitarjevsko	2,23	147	202	55 do 60	0	0	0	55 do 60	0	0	0	55 do 60	0	0	0
6	Gornja Lomnica	2,49	162	582	35 do 45				40 do 45				40 do 45			
7	Gornje Podotocje	2,93	153	492	<35				<35				<35			
8	Gradici	1,9	622	1808	35 do 50				35 do 50				35 do 50			
9	Kobilici	1,56	248	520	35 do 40				35 do 40				35 do 45			
10	Lazi Turopoljski	3,4	43	58					<35				<35			
11	Lukavec	11,34	535	1136	35 do 45				35 do 50				40 do 50			
12	Mala Kosnica	1,01	44	49	50 do 65	0,07	0	0	55 do 70	0,24	28	31	55 do 70	0,32	28	31
13	Micevec	6,54	648	1281	35 do 65	0,09	0	0	40 do 65	0,17			40 do 65	0,2	0	0
14	Mraclin	12,93	607	1068	<35				<35				<35			
15	Novaki Scitarjevski	2,65	112	165	45 do 55				50 do 60	0	0	0	50 do 60	0	0	0
16	Obrezina	1,79	274	577	55 do 60	0	0	0	55 do 65	0	0	0	60 do 60	0	0	0
17	Oquilinec	3,76	337	296												
18	Okuje	4,71	226	467	<35				<35				<35			
19	Retina	1,84	150	211	55 do 65	0,01	0	0	60 do 70	0,56	106	149	60 do 70	0,87	146	205
20	Petrovina Turopoliska	2,63	275	702	0 do 35				35 do 40				35 do 45			
21	Rakitovec	10,37	247	573					<35				<35			
22	Sasi	1,67	62	164	45 do 55				50 do 55				50 do 60	0	0	0
23	Selnica Scitarjevska	1,96	241	537	45 do 60	0	0	0	50 do 60	0	0	0	50 do 60	0	0	0
24	Staro Cice	3,02	418	783					<35				<35			
25	Scitarjevo	3,79	243	440	50 do 60	0	0	0	50 do 60	0	0	0	55 do 60	0	0	0
26	Turopolje	4,64	468	951					<35				<35			
27	Velika Gorica	31,47	5968	31341	35 do 55				35 do 65	2,1	0	0	35 do 65	2,24	0	0
28	Velika Kosnica	2,13	233	799	45 do 60	0	0	0	50 do 60	0	0	0	50 do 60	0	0	0
29	Velika Mlaka	6,07	1102	3326	35 do 50				40 do 65	0,48	0	0	40 do 65	0,57	0	0
30	Vukovina	5,84	453	945	<35				<35				<35			
	Σ	160,07	1612	52821		0,21	0	0		3,98	198	296		4,93	257	387

YES	(green)	Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO	(pink)	Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
	(yellow)	Settlements which, according to the estimates, will be exposed to excessive noise due to air traffic increase in 2024 and 2040
*	Maximum permitted $L_{day,evening}$ noise immission evaluation levels according to the purpose of the area	
	Purpose of the area : zone of mixed, mostly residential purpose	
**	http://www.dzs. hr/Hrv/censuses/census2011/censusfirstres.htm	

Table 4.2.2.-7 Comparative table of settlement surface areas and estimated number of inhabitants exposed to excessive air traffic L_{night} noise indicators for the years 2009, 2024

Ord. No	Name of the settlement	Settlement surface area in km2	Number of buildings	** Total number of inhabitants per settlement	* 2009 L den noise immission levels in dB(A)	Surface area of the settlement (in km2) affected by excessive noise immission levels in 2009	Number of buildings exposed to excessive noise immission levels in 2009	Estimated number of inhabitants exposed to excessive noise immission levels in 2009	* 2040 L den noise immission levels in dB(A)	Surface area of the settlement (in km2) affected by excessive noise immission levels in 2024	Number of buildings exposed to excessive noise immission levels in 2024	Estimated number of inhabitants exposed to excessive noise immission levels in 2024	* 2040 L den noise immission levels in dB(A)	Surface area of the settlement (in km2) affected by excessive noise immission levels in 2040.	Number of buildings exposed to excessive noise immission levels in 2040.	Estimated number of inhabitants exposed to excessive noise immission levels in 2040
1	Bapce	1,68	105	130	35 do 40				35 do 40				35 do 45			
2	Busevec	4,17	464	889												
3	Crnkovec	4,62	147	413	0 do 35				35 do 40				35 do 45			
4	Donja Lomnica	14,93	778	1416	35 do 55	0,31	12	22	35 do 55	1,09	12	22	35 do 60	1,59	43	78
5	Drenje Scitarjevsko	2,23	147	202	40 do 50	0	0	0	45 do 50	0	0	0	45 do 55	0,4	76	104
6	Gornja Lomnica	2,49	162	582	0 do 0				0 do 35				30 do 35			
7	Gornje Podotocje	2,93	153	492												
8	Gradici	1,9	622	1808	0 do 35				35 do 40				35 do 40			
9	Kobilici	1,56	248	520	0 do 0				0 do 30				0 do 35			
10	Lazi Turopoljski	3,4	43	58												
11	Lukavec	11,34	535	1136	0 do 35				35 do 40				35 do 40			
12	Mala Kosnica	1,01	44	49	40 do 55	0,35	28	31	45 do 55	0,57	30	33	45 do 60	0,69	37	41
13	Micevec	6,54	648	1281	35 do 50	0,19	0	0	35 do 50	0,31			35 do 50	0,4	0	0
14	Mraclin	12,93	607	1068												
15	Novaki Scitarjevski	2,65	112	165	35 do 45				40 do 50				40 do 50	0	0	0
16	Obrezina	1,79	274	577	40 do 50	0	0	0	45 do 55	0,43	82	173	45 do 55	1,18	223	470
17	Ogulinec	3,76	337	296												
18	Okuje	4,71	226	467	<35				<35				<35			
19	Retina	1,84	150	211	50 do 55	0,91	147	207	50 do 60	1,64	147	207	55 do 60	1,8	150	211
20	Petrovina Turopoljska	2,63	275	702												
21	Rakitovec	10,37	247	573												
22	Sasi	1,67	62	164	35 do 45				40 do 45				40 do 50	0	0	0
23	Selnica Scitarjevska	1,96	241	537	40 do 50	0	0	0	45 do 55	0,14	9	20	45 do 55	0,32	22	49
24	Staro Cice	3,02	418	783	<35				<35				<35			
25	Scitarjevo	3,79	243	440	40 do 50	0	0	0	40 do 50	0,01	0	0	45 do 55	0,3	61	110
26	Turopolje	4,64	468	951					<35				<35			
27	Velika Gorica	31,47	5968	31341	35 do 50	2,18	0	0	35 do 55	2,61	0	0	40 do 55	2,84	0	0
28	Velika Kosnica	2,13	233	799	35 do 50	0	0	0	40 do 55	0,01	19	65	40 do 55	0,25	47	161
29	Velika Mlaka	6,07	1102	3326	0 do 50	0,36	0	0	35 do 55	0,67	0	0	35 do 55	0,89	0	0
30	Vukovina	5,84	453	945												
	Σ	160,07	1512	52321		4,3	187	250		7,48	299	520		10,66	659	1224

YES	(green)	Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO	(pink)	Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
	(orange)	Settlements which, according to the estimates, will be exposed to excessive noise due to air traffic increase in 2024 and 2040
*	Maximum permitted $L_{day,evening}$ noise immission evaluation levels according to the purpose of the area	
	Purpose of the area : zone of mixed, mostly residential purpose	
**	http://www.dzs. hr/Hrv/censuses/census2011/censusfirstres.htm	

Table 4.2.2.-8 Comparative table of settlement surface areas and estimated number of inhabitants exposed to excessive air traffic L_{den} noise indicators for the years 2009, 2024 and 2040

Ord. No	Name of the settlement	Settlement surface area in km2	Number of buildings	** Total number of inhabitants per settlement	* 2009 L den noise immission levels in dB(A)	Surface area of the settlement (in km2) affected by excessive noise immission levels in 2009	Number of buildings exposed to excessive noise immission levels in 2009	Estimated number of inhabitants exposed to excessive noise immission levels in 2009	* 2040 L den noise immission levels in dB(A)	Surface area of the settlement (in km2) affected by excessive noise immission levels in 2024	Number of buildings exposed to excessive noise immission levels in 2024	Estimated number of inhabitants exposed to excessive noise immission levels in 2024	* 2040 L den noise immission levels in dB(A)	Surface area of the settlement (in km2) affected by excessive noise immission levels in 2040.	Number of buildings exposed to excessive noise immission levels in 2040.	Estimated number of inhabitants exposed to excessive noise immission levels in 2040
1	Bapce	1,68	105	130	40 do 50				45 do 50				45 do 55			
2	Busevec	4,17	464	889												
3	Crnkovec	4,62	147	413	35 do 50				40 do 50				40 do 55			
4	Donja Lomnica	14,93	778	1416	45 do 65	0,04	0	0	50 do 70	0,43	64	116	50 do 70	0,73	83	151
5	Drenje Scitarjevsko	2,23	147	202	55 do 60	0	0	0	55 do 60	0	0	0	55 do 60	0	0	0
6	Gornja Lomnica	2,49	162	582	35 do 45				40 do 45				40 do 45			
7	Gornje Podotocje	2,93	153	492	<35				<35				<35			
8	Gradici	1,9	622	1808	35 do 50				35 do 50				35 do 50			
9	Kobilici	1,56	248	520	35 do 40				35 do 40				35 do 45			
10	Lazi Turopoljski	3,4	43	58					<35				<35			
11	Lukavec	11,34	535	1136	35 do 45				35 do 50				40 do 50			
12	Mala Kosnica	1,01	44	49	50 do 65	0,07	0	0	55 do 70	0,24	28	31	55 do 70	0,32	28	31
13	Micevec	6,54	648	1281	35 do 65	0,09	0	0	40 do 65	0,17			40 do 65	0,2	0	0
14	Mraclin	12,93	607	1068	<35				<35				<35			
15	Novaki Scitarjevski	2,65	112	165	45 do 55				50 do 60	0	0	0	50 do 60	0	0	0
16	Obrezina	1,79	274	577	55 do 60	0	0	0	55 do 65	0	0	0	60 do 60	0	0	0
17	Oguilinec	3,76	337	296												
18	Okuje	4,71	226	467	<35				<35				<35			
19	Petina	1,84	150	211	55 do 65	0,01	0	0	60 do 70	0,56	106	149	60 do 70	0,87	146	205
20	Petrovina Turopoljska	2,63	275	702	0 do 35				35 do 40				35 do 45			
21	Rakitovec	10,37	247	573					<35				<35			
22	Sasi	1,67	62	164	45 do 55				50 do 55				50 do 60	0	0	0
23	Selnica Šćitarjevska	1,96	241	537	45 do 60	0	0	0	50 do 60	0	0	0	50 do 60	0	0	0
24	Staro Cice	3,02	418	783					<35				<35			
25	Scitarjevo	3,79	243	440	50 do 60	0	0	0	50 do 60	0	0	0	55 do 60	0	0	0
26	Turopolje	4,64	468	951					<35				<35			
27	Velika Gorica	31,47	5968	31341	35 do 55				35 do 65	2,1	0	0	40 do 65	2,24	0	0
28	Velika Kosnica	2,13	233	799	45 do 60	0	0	0	50 do 60	0	0	0	50 do 60	0	0	0
29	Velika Mlaka	6,07	1102	3326	35 do 50				40 do 65	0,48	0	0	40 do 65	0,57	0	0
30	Vukovina	5,84	453	945	<35				<35				<35			
	Σ	160,07	15112	52321		0,21	0	0		3,98	1,98	296		4,93	257	387

YES	(green)	Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO	(pink)	Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
	(orange)	Settlements which, according to the estimates, will be exposed to excessive noise due to air traffic increase in 2024 and 2040
*	Maximum permitted $L_{day,evening}$ noise immission evaluation levels according to the purpose of the area	
	Purpose of the area : zone of mixed, mostly residential purpose	
**	http://www.dzs. hr/Hrv/censuses/census2011/censusfirstres.htm	

POSSIBILITIES FOR THE REDUCTION OF NOISE IMPACTS OF ZAGREB AIRPORT

Noise in the airport zone represents a serious issue for the local population living in the surrounding area. With the expansion of the city, residential neighbourhoods are increasingly approaching the airport zone, making noise in these areas even higher. There have been several programmes to reduce noise pollution:

- take-offs and landings should increasingly take place on runways positioned towards lesser populated areas (if the airport has multiple runways);
- construction of sound barriers and building insulation;
- prohibition of landing for aircraft not complying with noise protection standards
- introduction of the charging of fees based on aircraft noise levels;
- Introduction of operative procedures aimed at noise abatement.

Regardless of whether the issue concerns the noise of aircraft during take-off or landing, or ground based aircraft noise, the local authorities are required to protect the local population in the best possible manner. The principle of protection through operating procedures is most common and can be useful for the purposes of modification of corridors and determination of overpass altitude over uninhabited areas. There are several operative procedures that are used worldwide to reduce noise pollution. Some of the proposed measures to reduce noise are:

- runway improvements;
- shifting runway thresholds;
- giving preference to other air courses;
- terminating procedures during take-off and landing that cause high noise levels
- implementation of new landing procedures (curved line courses);
- Use of reverse thrust to stop aircraft after landing.

In addition to modifications of the take-off and landing procedures, it is possible to implement operating prohibitions that limit or fully prohibit landing of certain types of aircraft at the airport. The adoption of such restrictions must be justified. Operating prohibitions can be partial, global or progressive, and can be divided into two categories:

- operating prohibitions in the sense of prohibiting night flights or upper limits in the movement of high noise aircraft, or
- Prohibition of aircraft with particularly loud technical or performance characteristics.

Further from these prohibitions, there are also ground prohibitions:

- limiting the running of the engine while the aircraft is on the ground;
- specially designated locations for engine testing;
- minimal use of auxiliary power units (APU);
- minimal taxiing time on lanes;
- introduction of sound barriers;
- Aircraft towing.

Landing operating procedures

An analysis of the transport demand at the Zagreb Airport indicates an increase of transport, which will also result in an increase in noise levels. For that reason, a simulation of operating procedures was created that could be used as a possible solution for reducing the noise levels of aircraft at the Zagreb Airport. From the operative segments of landing, the following procedures were examined: low power approach, minimum use of reverse thrust after landing, possibility of shifting the runway threshold, and introduction of the continuous descent arrival (CDA) landing technique. The analysis conducted indicated that use of the approach procedure with minimal use of reduced thrust led to a reduction of aircraft noise exclusively in the areas it flies over at high altitudes upon entry into the Instrument Landing System (ILS). However, there are several negative aspects regarding this procedure and therefore it is not fully justified. The negative aspects of introducing this procedure include: excessive aircraft speed upon entry into the Zagreb Terminal Control Area (TMA) (limitation at 250 kt) - reducing the said speed reduces changes to the aero profile, which generates additional noise; shifting from landing at an angle of 6° to 3° implies adding thrust which generates additional noise; landing from the angle of 6° to the ILS is less comfortable for passengers and requires special crew training and additional aircraft outfitting.

In the use of the procedure of minimal use of reverse thrust after landing, positive aspects include a reduction of aircraft noise upon landing for the settlements surrounding the airport and a more comfortable landing for the passengers. Negative aspects of this procedure include the need to extend runway length if larger aircraft are concerned. Furthermore, without reverse thrust efficient breaking and stopping could be threatened, while the use of reverse thrust on all aircraft models is noisy and increases engine burden. In such a procedure, it is also necessary to consider aircraft safety, which can only be assessed by the captain, and for that reason, reverse thrust is used pursuant to the current conditions in effect at the time of decelerating the aircraft. Practice has proven that some airports have limitations on the use of reverse thrust between the hours of 10:00 pm and 6:00 am.

Another procedure to reduce noise is the shifting of the runway threshold. The positive aspect of this procedure is the reduction of the impact of aircraft noise on inhabited areas before the runway. The negative side would be that moving threshold 05 at Zagreb Airport would reduce the possibility for larger aircraft to use connecting lane D as the exit onto the runway (these would instead using connecting lane E). This would result in increased taxiing time, and with that increased fuel consumption and increased gas emissions. As a result of shifting the threshold for the purpose of reducing noise, individual aircraft would be required upon landing to use reverse thrust to stop for safety reasons, which would result in increased noise. For this procedure, it is necessary to develop special approach procedures, and determine whether the runway is long enough to shift the threshold.

The best approach for reducing noise is implementation of the continuous descent approach (CDA) for landing. The CDA approach allows for maintaining the aircraft at several flight altitudes i.e. delays the start of landing and allows the pilot to descend from cruising altitude until the moment of crossing the glide slope line for the final landing. This approach has reduced levels of noise, fuel consumption and gas emissions towards the settlements in the direct vicinity of the airport.

With the CDA, the aircraft is kept at higher altitudes for longer, as the noise level is significantly reduced when the distance between the source of the noise and the receiver of the noise is increased, even by small distances. In order to apply the CDA procedure, air traffic control should determine the specific or minimal speed of the approaching aircraft and provide the pilot with information about the distance of runway touch points (so that the pilot can ensure the vertical profile of the aircraft). This type of speed control increases the capacity of the runway. The approach control leads the aircraft using the radar vectoring procedure and approves an uninterrupted decent to the level of the inter-approach, such that the level is achieved in the direction of the distance guider of about 8NM to the touch point. Uninterrupted descent to the approved level is carried out at a descent speed of 300 ft/NM (flight path angle of about 3°).

The key factor that allows for the CDA approach landing technique is optimisation of the approach technique, and handling the aircraft with the use of the piloting technique "low engine strength - low drag". In practice, that means that the pilot flies at minimum engine strength for as long as possible, while pulling out the aircraft configuration at the optimal moment so as to reduce flight drag to a minimum. The advantage of the CDA technique is that it can be used for any aircraft, at any airport and in all forms of transport, under the conditions that the pilots are ready and trained for its application.

The use of the CDA technique is a practical example of how an innovative approach can be used to reduce issues of fuel consumption, while also positively affecting the airport environment in terms of noise reduction. The precondition for the widespread use of the CDA technique is the adoption of normative regulations and the appropriate training of pilots

and air traffic controllers.
In order to provide an overview of the advantages in noise reduction between a conventional approach and a CDA approach, a noise map was created for an Airbus 319/320 aircraft approaching Zagreb Airport at threshold 05. The INM program was used with data on the aircraft and pilot procedures to develop the noise map. A simulation at the Zagreb Airport was developed using the INM program and the results of the simulation between a conventional and CDA approach is seen in the noise map (Figs. 4.2.2-1). Keeping the aircraft at a higher altitude and using the continuous descent approach contributes to noise reduction on the ground, though the area covered and total noise are dependent on the aircraft model, i.e. on its engine strength and aerodynamics. For the Airbus 319/320 aircraft, the noise on the noise map from 55 to 60 dB could be significantly reduced upon approach for up to several kilometres.

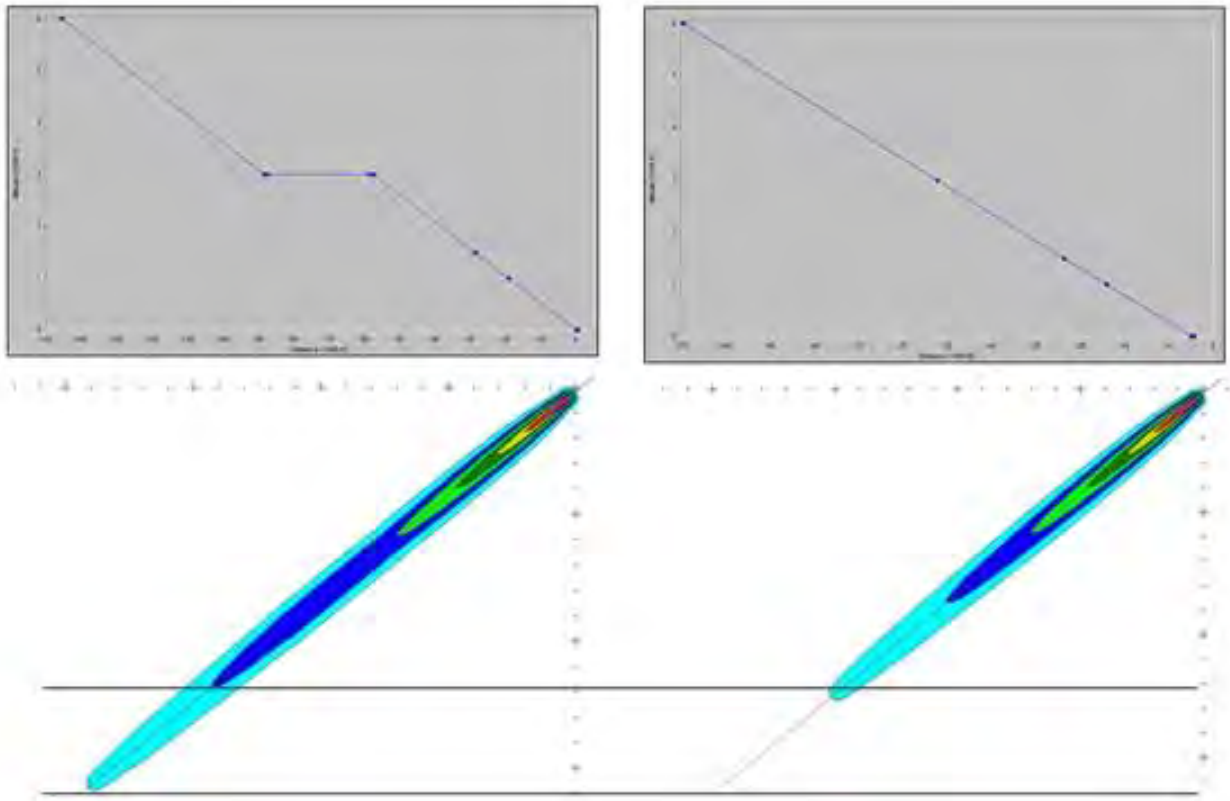


Figure 4.2.2.-1 Simulation of the comparison of a conventional and CDA approach at Zagreb Airport, developed using the INM system

The positive side of this procedure would be a reduction in aircraft noise by 3-12 dB, a continuous 3° descent (more comfortable for passengers), fuel savings, reduced emissions and no need for major aircraft modifications. In some cases, this procedure is already in use at the Zagreb Airport (depending on the decision of the captain and air traffic controller). This procedure is a generally accepted noise reduction procedure at EU airports (e.g. this procedure is in use at Heathrow Airport due to the diversity of traffic, and exceptionally good results have been achieved, with each company using CDA in 80% of landings) and the air traffic control guides the aircraft in such a way so as to avoid populated areas. In that case, it is very important for the air traffic control to provide the pilot with information about the total distance to landing at certain strategic approach points, so that the pilot can adjust the vertical profile. A negative side would be that the air traffic controller would have to give precise data on distance to the runway at each segment (greater time required for each aircraft).

Operative take-off procedures

Noise abatement procedures in take-off differ in relation to conventional take-off procedures in that the engine strength is reduced at 1,500 ft though the aircraft continues to climb at a minimum speed to 3,000 ft. Only at that altitude is the climbing angle reduced and the wing flaps retracted. With this procedure, the aircraft would be able to climb faster to twice the altitude, which ensures noise abatement under the flight course. The impact on fuel consumption is negligible though the gains in noise abatement are very large. The noise map on the ground is shown in Figure 4.2.2-2.

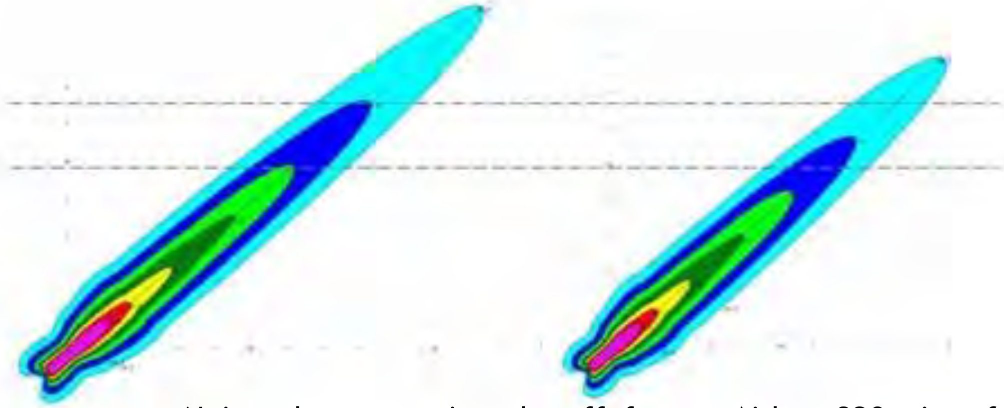


Figure 4.2.2-2 Noise abatement in take-off for an Airbus 320 aircraft - conventional take-off procedure (left) and noise abatement procedure take-off (right)

Introduction of time restrictions at the airport

Each airport has strictly defined time periods during which planes may fly and the noise limits permitted. Initially, these restrictions were directed at the condition and reputation of the airport and were only implemented if they were in the interest of the airport. In the present day, measuring aircraft noise levels and the implementation of restrictions are integral parts of airport functioning. In developed countries, night restrictions have been implemented that either reduce or eliminate noisy operations during the late night hours, when people are most sensitive to noise i.e. between 11 pm and 7 am while the L_{night} lasts.

The simplest solution for airlines in reducing noisy operations is to not fly into countries that have implemented restrictions on aircraft noise. In the current age, all the world airports have introduced restrictions in such a way so as to force air carriers to modernise their fleets or to pay taxes for exceeding noise levels. In the evening hours, these taxes are substantially higher than during daytime hours, and the highest during the night. Therefore, the same aircraft would pay much higher penalties for landing at night, and the consequence was the introduction of a higher number of daytime flights. This type of restriction model could also be applied at the Zagreb Airport if significantly higher noise levels during the night period were to occur due to an increase in transport.

Construction measures for noise protection

An assessment has been given for construction areas in settlements with regard to the Ordinance on the highest permitted noise levels in an environment in which people work and live (OG 145/04). The maximum permitted estimated level of noise immissions for mixed predominantly residential zones is 55 dB (A) by day and 45 dB (A) by night.

Pursuant to the same Ordinance, Article 8 stipulates the highest permitted estimated equivalent noise levels L_{RAeq} in *closed living areas for the same zone as 35 dB (A) by day and 25 dB (A) by night.

**Note: with closed windows and doors.*

According to the Guidelines 89/106/EEC of December 21 1988 and the Construction Act (OG 145/03), noise protection is listed as one of the important requirements for every structure. According to Article 11 of the said Act, “Structures must be designed and constructed in such a way that the sound perceived by a person residing in the structure or in its immediate vicinity is not at such a level that would endanger health and that ensures night time peace and satisfactory conditions for rest and work”. For the above reason, and depending on the type of structure and intended use of the space, the minimum values of sound insulation are defined in line with:

- HRN U.J6.201 (1989) acoustics in construction—technical conditions for the design and construction of buildings, technical requirements for: air sound insulation, impact sound insulation, sound insulation of windows and doors;
- HRN U.J6.151 (1982) acoustics in construction—standard values for the assessment of sound insulation;
- HRN U.J5.153 (1989) acoustics in construction—methods of expressing sound insulation with a single number;
- HRN EN ISO 140-5:1999 Acoustics; measuring sound insulation of buildings and construction elements—Part 5: field measurements of air sound insulation of facade elements and facades (ISO 140-5:1998; EN ISO 140-5:1998)
- DIN 4109 (1989) sound protection in building construction.

Construction protection measures imply the improvement of construction membranes of residential structures. In order to propose passive protection measures, it is necessary to conduct an analysis based on project designs and physical plans of the assessed sound insulation of legally constructed residential buildings lying in zones exposed to excessive noise emissions from air transport.

The assessment of sound insulation is given with regard to the measurements and analysis of results according to the HRN EN ISO 140-5:1999 Acoustics - measuring sound insulation of buildings and construction elements - Part 5: field measurements of air sound insulation of facade elements and facades (ISO 140-5:1998; EN ISO 140-5:1998).

Table 4.2.2-8 Impact on the noise level increase during the project implementation

IMPACT ON NOISE LEVEL INCREASE DURING IMPLEMENTATION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	CONSTANCY
Air traffic	-	3	DIRECT	CONSTANT
Road traffic	-	1	DIRECT	CONSTANT
Power plant operation	-	1	DIRECT	CONSTANT
Drainage system operation	/	/	/	/

Given the identified impacts, the impact of the planned project on increasing the noise level during its implementation was evaluated as **highly significant negative environmental impact (A).**

4.2.3. Impacts on the health of the population

4.2.3.1. Air pollution impact

Research on the impact of the airports on human health perceive recorded and proved impacts of individual pollutants, and correlate risks to which residents in airports surroundings are exposed. Several studies conducted in the region of Amsterdam airport Schiphol (about 50 million passengers in 2011) have shown that air traffic pollutions can not be connected with respiratory problems, the use of drugs to treat allergies and asthma and cardiovascular disease. Also, there was no difference in the incidence of cancer among residents in the area to Schiphol Airport in relation to the inhabitants of one part of Amsterdam. Study conducted in the area of Heathrow Airport, London (approximately 58 million passengers in 1999) also showed no significant increase in chronic respiratory disease within 5 kilometres from the airport, compared with control population in West London.

The recent studies have shown that air quality in major airports can be compared with the air quality of typical urban environments, and in most cases it is better than the air quality near roads with heavy traffic. The results of these analyzes assume that the population is under load, resulting in health risks no greater than the risk inherent to the population of urban areas.

Statements of the inhabitants of Petina Mala Kosnica regarding the effects of aircraft emissions on the local population could not be confirmed by comparing the level of permissible pollution limit values of pollutants in the air (the Regulation on limit values of pollutants in the air (OG 133 / 05). Limit value (LV), in accordance with the Regulation on limit values of pollutants in the air (OG 133/05), is the level below which - on the basis of scientific knowledge -the risk of adverse effects on human health and/or the environment in general does not exist or is at least possible. All defined air pollutions in areas closest to residential buildings today are and will be within allowable limits for the planned phases of increasing traffic.

4.2.3.2 Impact of noise

The increase of air traffic, particularly with the increase of night flights in recent years, represents a significant source of noise, whose impacts on human health may not be ignored. The aircraft is a source of noise that remains at ground level, and this noise is created during take-off, landing and taxiing. This problem is particularly pronounced for airports situated near city neighbourhoods, and the concern of the population living in the vicinity for their own health and safety is no surprise. These concerns are supported by proof of the harmful impacts on noise on health, including sleeping disorders, intolerable noise and cardiovascular diseases. Following from this and from public pressures and environmental protection organisations, maximum permitted levels of aircraft noise during take-off and landing have been prescribed, both at the national and international levels.
As a future Member State of the European Union, the Republic of Croatia has adjusted its laws and regulations to those of the European Union. The adjustment of the legislation relates to the prevention and/or reduction of harmful impacts on human health that are caused from environmental noise. The Noise Protection Act (OG 30/09) was drafted according to the European Union guidelines (Directive 2002/49/EC) that were not fully integrated during the adoption of the previous Noise Protection Act from 2003. Pursuant to the new Act, the development of noise maps is mandatory to give an overview of the existing and/or envisaged state of noise immissions, expressed in the aligned noise indicators L_{den} and L_{night} - acoustic magnitudes for the description of environmental noise associated with the harmful effects of noise on human health. Noise maps also determine the critical zones and prescribe

the adoption of action plans to reduce noise in areas where the permitted values have been exceeded. In making noise maps, detailed information about the airport (runway coordinates, altitude, temperature and humidity), landing and take-off vectors used and the percentages of their use are used. Furthermore, a database with all aircraft divided into groups (commercial, cargo, general aircrafts and military) is used, with the average operations in one day, divided into the periods day, evening and night, as prescribed by the regulations. With the development of noise maps, an overview is obtained into the existing state with regard to the level of environmental noise, and the maps then serve as a starting point in defining measures to prevent increases in emissions or to decrease noise emissions and immissions in the future. The noise map visually presents the noise expansion mechanisms from the site of emissions and the ratios of size, intent and the spatial position of buildings to the noise expansion, which is important in the spatial planning process in urban centres.

Due to the unstoppable spread of cities and the settlement of areas abound airports; the number of complaints about the intolerability of life in those areas is increasing. Scientific research has shown that aircraft noise raises stress levels, anxiety and generally has a negative effect on human health. These negative effects can depend on many factors: the magnitude of the sound and its duration, the direction of flight of the aircraft during take-off and landing, the number and type of operations, operations procedures, time of day and meteorological conditions.

The measurement of noise immissions in the area around the Frankfurt Airport have shown that about 200,000 inhabitants, some living up to 20 km from the airport along the air corridor, are exposed to a continual daily noise level of 55 dB(A) and higher.

Noise acts both directly and indirectly on human health, causing fatigue, a decrease in work capacities, and hindering comprehension, concentration, rest and sleep. Reactions to noise are individual, and depend on the level and frequency of the noise, and the duration of the exposure, and can range from mild and temporary, to permanent damage.

A healthy sense of hearing can hear and differentiate sounds in the frequency range from 16 to 20,000 Hz. The hearing threshold in a person with healthy hearing is from 0-25 dB (A) of intensity. The first phase of hearing damage is the initial acoustic trauma phase, which appears in the frequency area from 4000 Hz. The ear continues to behave normally, but the irritation threshold is objectively increased, as the loss of hearing has occurred in the frequency area higher than the range in which speech is conducted (1000-3000 Hz). The second phase of hearing damage is the hearing impairment phase. Hearing impaired persons have a hearing threshold between 29 and 93 decibels. Negligible hearing impairment appears when the person cannot hear sounds of up to 20 dB, slight impairment (20-40 dB), moderate impairment (40-60 dB), and profound impairment when the person cannot hear sounds between 60-80 dB. Everything about 93 dB (hearing threshold) is considered deafness. If a person is exposed to noise of an intensity of 85 dB (A) or more, there is a likelihood of hearing impairment. Professional hearing impairment and deafness are the most common occupational diseases, with irreversible consequences. Therefore, the permitted noise exposure for workers during an eight hour work day may not, under any circumstance, exceed the maximum permitted level of 85 dB(A) as stipulated by the Ordinance. However, numerous studies have shown that hearing loss is also a dictate of civilisation (electro acoustic devices, firecrackers, concerts). The noise indirectly affects the organs and bodily systems such as the nervous, vascular, and digestive and hormone systems. It can lead to metabolic and endocrinological disorders. It also influences the functioning and execution of daily tasks, and disturbs rest and sleep. It is particularly detrimental to mental functioning and leads to difficulties in concentration, attention spans, mastering new knowledge and causes anxiety and insomnia. Non-auditory health disturbances are the physiological response of the body to stress.

In recent years, the number of night flights has been on the rise, and those surveyed most often note sleeping disturbances as the main problem. Research has been conducted on two groups of people, one living in the direct vicinity of a large airport, and the second living in an ordinary

environment. The results indicated a significant difference between the groups in terms of sleep disorders, a lower quality of life that was seen in the inability to adequately perform daily activities such as listening to the radio or watching television, speaking on the telephone and interpersonal communication (Bronzaft et al., 1998). To sleep well, it is desirable that noise levels not exceed 30 dB (A), and individual sound irritations of 45 dB (A). It has been shown that noise extends the time needed to fall asleep. A minimal level of noise that will awaken a person is from 45 to 50 dB (A). Long-term partial loss of sleep from two to three hours per night has a detrimental impact on the human body, even when there is no subjective feeling of a lack of sleep.
In the psychosocial aspect, continual exposure to noise of 35 dB (A) hinders appropriate human communication and has long-term consequences that are seen in a reduced tolerance to frustration and an increased threshold of reactivity. Even minimal noise levels can cause an increase in anxiety, aggressive and hostile behaviour. These noise effects can be partially explained by the contemporary trend of dehumanisation in interpersonal relationships (Ohrstrom et al.[19]). These changes were particularly pronounced among elderly people. Social and behavioural impacts of noise include changes in daily behaviour patterns (closing windows, not using balconies, turning up the sound on the television or radio), negative changes in interpersonal relations (aggressiveness, hostility) and mood swings.

Noise exceeding 60 dB (A) indirectly affects the stimulation of the sympathetic part of the autonomic nervous system, i.e. the part of the central nervous system that is not dependent on human will and which manages the important vital functions. Increases in noise levels cause an increase in the tonus sympaticus, which causes accelerated heart beat, increase in blood pressure, rapid breathing, increased sweating, disturbances in the digestive organs, particularly the intestines, disturbances in the function of endocrine glands, and even sudden muscle contractions. Exposure to aircraft noise in excess of 50 dB (A) at night increases the risk of hypertension by 20% (Eriksson 2007[20]). The HYENA[21] study conducted among the population (aged 45 to 70 years) living in the vicinity of six European airports showed that levels of night noise from 40-44 dB (A) significantly increased the prevalence of hypertension. This prevalence ranged from 49 to 57%, based on age and gender. Furthermore, the study showed that each increase in the level of night noise by 10 dB (A) increased the prevalence of hypertension by 14%.
Exposure to increased noise levels also impacts the consumption of medicines. According to a Swedish study, exposure to night noise from 40-45 dB (A) increased the consumption of hypertension medication by 27% and 66% in women at noise levels of 46 dB (A) and 61 dB (A), respectively, while in men, an increase in consumption was noted at levels 46 to 61 dB (A) (Swedish study 2005[22]).
Exposure to aircraft noise increases both systolic and diastolic blood pressure by 6.2 mmHg and 7.4 mmHh, respectively, even when the person is asleep and seemingly calm. Hypertension increases the risk of heart disorders, stroke and dementia. The risk of heart attack is 50% greater in people exposed continuously for 15 or more years to noise levels of 60 dB. Therefore, scientists have called for a re-examination of the existing regulations on noise limits. Long-term exposure to traffic noise at an intensity of 60-70 dB(A) can also lead to the above health problems, or can aggravate existing illnesses, such as arthritis, bronchitis and depression (WHO LARES Report, 2004).
Numerous studies have indicated the exposure to low levels of traffic noise, including air traffic, stimulates increased secretion of the stress hormones cortisol, adrenalin and noradrenalin, especially in children living in the direct vicinity of airports. In women whose

[19] Bronzaft et al., 1998
[20] Eriksson 2007
[21] HYENA
[22] Öhrström E, Barregĺrd L, Andresson E, Skĺnberg A, Svensson H, Ăngerheim P. Annoyance due to single and combined sound exposure from railway and road traffic. J Acoust Soc Am 2007;122:2642-2652.

bedrooms were oriented towards busy streets with a relatively high noise level, a greater level of secretion of catecholamine was found in comparison to women who lived in relatively quiet homes. With regard to the economic development of Croatia and Croatia's position as a tourism destination, the expansion of existing airports is both essential and fully justified. Meanwhile, care should be taken of the quality of life of the population living nearer and further from airports. Due to the unstoppable process of urban sprawl and the settlement of areas around airports, there are increasing complaints about the intolerability of life in those areas. These complaints most often relate to irritation, insomnia and impaired communication. The noise at the Zagreb Airport represents a limiting factor in its work and development, as along the outer edges of the airport grounds, settlements are expanding parallel, and often times unplanned, and the number of people exposed to disturbing noise is increasing. The reactions of the population to aircraft engine noise have been strong since the 1960s.

Zagreb Airport is about 20 km from the City of Zagreb, and just south of the airport is the City of Velika Gorica, which has a significant rate of population increase. There are many rural settlements in the direct vicinity of the airport. Based on the developed noise map with the state of air traffic in 2009, Table 4.2.3-1 shows the settlements where noise immissions expressed by indicators have exceeded the permitted upper limits pursuant to the Ordinance on the highest permitted noise levels in an environment in which people work and live (OG 145/04), the assessed population exposed to noise by the classes of noise indicators L_{den} and L_{night}, and the percentage of the population exposed. According to the Ordinance, the permitted level of noise for primarily residential zones is 65 dB(A) during the day and 50 dB(A) at night.

The measured noise levels are expressed as equivalent noise Leq and based on the obtained values, the noise indicator Lden is calculated. Lden (level day-evening-night) relates to the total irritation caused by noise. L_{den} is calculated as the equivalent noise level over 24 hours. Pursuant to the EU Directive on the measurement of noise, L_{den} is the fundamental indicator that is calculated according to the standard time division, with a 12-hour day period (7 am to 7 pm), a 4-hour evening period (7 to 11 pm) and an 8-hour night period (11 pm to 7 am).

Conclusion

With the current and future expansions of the Zagreb Airport, the noise levels measured during the day and night will represent a significant problem for the health and social aspects of the population of the settlements Donja Lomnica, Drenje Ščitarjevo, Mala Kosnica, Obrezine, Petina, Selnica Ščitarjevska, Šćitarjevo and Velika Kosnica. Noise levels from 65 to 69 dB(A) obtained in the simulation models for 2024 and 2040 will affect the population of the settlements Petina and Mala Kosnica, and a large portion of the population of the settlement Donja Lomnica to 2040. Noise levels exceeding 65 dB(A) are considered impermissible for extended exposure by the population (source: World Health Organisation). Noise exceeding 65 dB(A) can cause serious psychological and neuro-vegetative disorders. Therefore, much attention must be dedicated to technical measures that could reduce the exposure of the population to excessive noise immissions, and the possibility of relocating the most threatened population, particularly those in the settlement of Petina.

Table 4.2.2-4 Impact on health during the project implementation

IMPACT ON HEALTH DURING IMPLEMENTATION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	CONSTANCY
Air traffic	-	3	DIRECT	CONSTANT
Road traffic	-	1	DIRECT	CONSTANT
Power plant operation	-	1	DIRECT	CONSTANT
Drainage system operation	/	/	/	/

Given the identified impacts, the impact of the planned project on health during its implementation was evaluated as **highly significant negative environmental impact (B).**

4.2.4. Impacts of the project on water

Drainage of part of the wastewaters at the Zagreb Airport location has been resolved with a separation system and connection to the sewerage system of the City of Velika Gorica. Sanitary wastewater from various structures at the Zagreb Airport, including wastewaters from aircrafts (from sanitary tanks) are collected in collection pits and pumped to the public sewerage system of Velika Gorica. The drainage of runoff waters from roofs and from parts of the aprons (operative and manoeuvring areas envisaged for the preparation of aircraft for the boarding and disembarking of passengers, loading and unloading of cargo and post, fuelling, maintenance and parking) has been resolved by connection to the surface runoff drainage system of the City of Velika Gorica. All runoff waters in the Zagreb Airport area can be considered moderately polluted runoff waters, considering that they may contain particles of oil and fuel as aircraft remain or are parked on the aprons, while runoff waters from manoeuvring areas contain pollutants originating from the exhaust fumes of aircraft engines and are dissolved in precipitation.
Runoff waters are drained from 30% of the operative and manoeuvring areas, i.e. from 155,00 m^2 via pipelines into two treatment plants with a capacity of 40 m^3/h and over one hundred settlers. Within the area of the Zagreb Airport, a system for the measurement of changes in groundwater levels and a system for discovering losses in the potable water pipelines have been installed and regular monitoring and analysis of wastewater has been organised.
The greatest shortcoming in the protection system for water and the water environment is the protection of surface and ground waters along the runway, since the runway does not have a drainage system in place, and instead runoff waters naturally run off into the environment. An aircraft accident in that area would result in a spillage of fuel and its seepage into the ground, while compounds used for de-icing aircraft and de-icing the runway during the winter period today freely seep into the ground.
These impacts are currently present and will not increase with the construction of the new passenger terminal and accompanying structures. However, with the resolution of the drainage and treatment of runoff waters from the transport areas of Zagreb Airport included as an integral part of the planned project, this issue is also resolved. The release of treated water under controlled conditions into the recipient canals (Kosnica, Bapča) or the Sava River have no negative impacts as the guaranteed water quality meets the criteria for release into recipients of the Danube Basin.

Activities taking place inside the passenger terminal and its related facilities will not affect the groundwater quality with respect to the planned waste and drainage water treatment.

Table 4.2.4.-1 Impact on water during the project implementation

IMPACT ON WATER DURING IMPLEMENTATION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	CONSTANCY
Air traffic	-	1	INDIRECT	CONSTANT
Road traffic	-	1	INDIRECT	CONSTANT
Power plant operation	-	1	INDIRECT	CONSTANT
Drainage system operation	+	2	DIRECT	CONSTANT

Given the proposed solution to drainage and treatment of polluted rainwater, flowing freely from the manoeuvring areas into soil and subsoil, the potential impact of the planned project on water during its implementation was evaluated as **positive (P).**

4.2.5. Impact of the project on the soil

Within the zone of impact of the construction and use of the planned project, it is necessary to ensure the conditions for a stable agro-ecosystem that can ensure the appropriate conditions for agricultural production. Though there are currently no clear, reliable and founded data as to the radius within which negative impacts can be expected from roads, a large number of authors list a distance of 100 m from the road edge as the zone within which the predominant share of negative impacts of the road will have on agricultural lands due to the future traffic on the road. Roadside contamination, e.g. by lead or cadmium, is highest along the roadside, and rapidly increases with the distance from the road. At a distance of 200 m, the concentrations of these metals caused by traffic are so low that they fall below limits of detection. Considering that any emissions of harmful compounds into agricultural land can be detrimental to humans, special attention must be focused on all forms of possible pollution to ensure high quality protection of agricultural soils, and with that the agricultural production within the said zone of influence.

The immission of the pollution in agricultural soil should be also expected in the area of landing and takeoff, within the zone of the dominant negative impact on air pollution due to the deposition of particles on the ground. Based on the study "State of soil contamination in the area of Zagreb County" (Romic et al., 2004), a high average content of heavy metals in the wider area of the new terminal ZLZ was determined. In so doing, the Zagreb Airport – amongst the others – is stated as one of the possible major anthropogenic sources.

Table 4.2.5-1 Impact on soil during the project use

IMPACT ON SOIL DURING IMPLEMENTATION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	CONSTANCY
Air traffic	-	2	INDIRECT	CONSTANT
Road traffic	-	1	INDIRECT	CONSTANT
Power plant operation	/	/	/	/
Drainage system operation	/	/	/	/

Given the identified impacts, the impact of the planned project on soil during its implementation was evaluated as **highly significant negative environmental impact (B)**, and it refers to the narrower project area – next to the access road and runway.

4.2.6. Impact of the project on protected areas and areas of the Ecological Network

Considering the distance of the project site from protected areas and areas of the Ecological Network and the objectives to preserve areas of the Ecological Network, it is believed that the project will not have any temporary or permanent impacts during its use on such areas.

4.2.7. Impact of the project on biological diversity

Ornithofauna

With the construction of the project, the intensity of both air and land traffic will be significantly increased. The increased aircraft traffic will increase the level of disturbance that can negatively impact birds in the direct vicinity (buffer zone) of the planned project.

The noise ensuing from increased air traffic during the use phase is the most pronounced factor that can negatively impact the bird population in the use phase. Noise can negatively impact birds by disturbing their communication and/or locating food sources, which can result in reductions of bird abundance in areas exposed to increased noise (Mead, 1987).

Noise can impact the feeding and nesting activities of birds, lead to increased energy losses in cases when birds react to noise disturbance by taking off, in which case they are also more exposed to potential predators. Noise represents environmental pollution that reduces the ability of birds (particularly songbirds) to find a mate, thereby threatening these birds in the in the sense of reduced reproductive abilities and population structures in comparison to similar habitats unpolluted by noise (Habib et al., 2007). reproductive cycle on communication using auditory signals (particularly songbirds), and those species that use hearing for hunting (owls). However, it is difficult to predict the nature and intensity of the reaction of birds to aircraft noise. Research has shown that different species react to noise differently - in some species the reaction is mild and the birds quickly adapt to increased noise, while for other species this is not the case (Manci et al., 1988). Research has shown that many songbirds in forest and grassland habitats are sensitive to noise and in areas with increased noise (such as along motorways), the density of their populations can be reduced (Kaseloo & Tyson, 2004). Many predator species have a relatively high tolerance to aircraft noise and can adapt to aircraft flying overhead, and their populations are oftentimes not significantly negatively affected by this pollution (Grubb & King, 1991).

There are no concrete data that would allow for an assessment of the negative impacts of noise on bird populations in the area surrounding the project area. In order to assess the impacts of this factor on bird populations of special interest for conservation, it is assumed that their abundance in the buffer zone will be reduced by a maximum of about 25% due to increased noise. The increased noise and disturbance for birds during the phases of construction and use of the planned project will not have a significant contribution in the total cumulative effect of disturbances to target species of birds in this area.

Bat Fauna

The increase capacity of the expanded Zagreb Airport will result in a significant increase in the frequency of aircraft flying overhead and, as a result, greater noise produced by these aircraft. The increased frequency of aircraft flying overhead potentially increases the possibility of direct deaths of bats. Considering though that there are no known bat colonies in the general area and that there are no data on migrations or migration routes passing through the study area, the increased flight frequency will not cause increased fatalities of bats due to deaths caused directly by aircraft.

The increased level and quantity of noise generated by the aircraft and its possible negative impacts are assessed, with consideration of the fact that certain bat species use the areas in the direct vicinity of the existing runway for hunting, which suggests the conclusion that noise does bother those species that have acclimated to it and increased noise will not have a negative impact.

The planned expansion of Zagreb Airport will not contribute to a negative cumulative impact neither due to a loss of hunting habitat or due to a loss of shelters.

Mammals

A certain degree of disturbance and pollution already exist as the present airport has been in use for years. However, with the expansion of the airport, the zone of the disturbance will be expanded into new habitats, and an increased intensity of air transport will occur at the airport, which will also increase the degree of disturbance. Given the long-term presence of the air traffic impact in the region, we believe that the mammal fauna will adapt to increased noise levels and that they will not be significantly affected by the planned project.

Amphibians

The construction and use of the new airport will impact the local amphibian fauna to a lesser extent (ponds, channels, woods) due to filling, drying, clearing or extreme pollution. Therefore, it is necessary to focus attention to preservation of the Kosnica Channel and consider it as the link between the habitats cut off by the new access road and the project itself.

Reptiles

Reptiles (snakes and lizards) are most often killed on roads, as these are exothermic organisms that use roads as sources of heat from the surface and from the sun's rays. The number of animals killed increases with road size, vehicle speed and traffic intensity.

Table 4.2.7-1 Impact on biological diversity during the project implementation

IMPACT ON BIOLOGICAL DIVERSITY DURING IMPLEMENTATION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	CONSTANCY
Air traffic	-	1	DIRECT	CONSTANT
Road traffic	-	1	DIRECT	CONSTANT
power plant operation	/	/	/	/
Drainage system operation	/	/	/	/

Given the identified impacts, the impact of the planned project on biological diversity (flora and fauna) during its implementation was evaluated as **highly significant negative environmental impact (C)**.

4.2.8. Impact of the project on cultural and historical heritage

Given the distance of the planned project from the sites of cultural and historical heritage, no significant project impact during its implementation is expected **- no environmental impact (N).**

4.2.9. Impact of the project on the landscape

The arrival of foreign travellers by aircraft at an airport is usually the first contact with that country, and therefore it is important that the airport have a representative appearance. Pursuant to the development plans of the Zagreb Airport, an international urban planning and architecture competition for the new passenger terminal and accompany facilities was held in 2008. The project selected as the best competing project was that by the IGH Institute d.d. (IGH d.d., Neidhardt Architects d.o.o. & Klincl d.o.o. Zagreb) which offered an attractive appearance of the new passenger terminal and urban planning solutions for the approaches to the terminal from the north and south sides. The construction of the new passenger terminal will be the first phase of the execution of the integral solution for the airport complex, as determined by the Zagreb Airport Development Plan. The project can therefore be characterized by having a positive impact on the landscape, as it will contribute to defining the visual identity of Zagreb and the Republic of Croatia.

With regard to the fact that the planned project was designed at the same location as the existing Zagreb Airport and Pleso military air force base, the planned project will not have a significant impact on changing the landscape of the natural and cultural characteristics of the general area, nor will it change the identity of the surrounding rural areas. This is ensured by maintaining a buffer zone of non-construction areas with the existing tall vegetation on the eastern side, which will physically and visually separate the new, planned airport from the existing settlement structures, and ensure spatial integrity and the integrity of the surrounding rural areas.

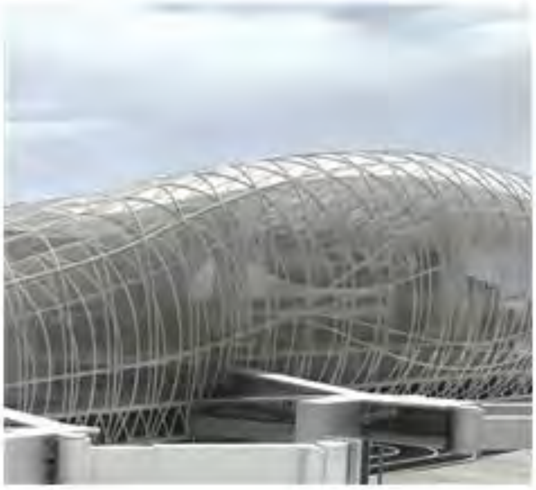
Given the identified impacts, the impact of the planned project on the landscape during its implementation was evaluated as **environmentally positive (P).**

Figure 4.2.9.-1 Spatial depiction of the new passenger terminal of Zagreb Airport (1)

Figure 4.2.9-2 Spatial depiction of the new passenger terminal of Zagreb Airport (2)

Figure 4.2.9-3 Spatial depiction of the new passenger terminal of Zagreb Airport (3)

Figure 4.2.9-4 Spatial depiction of the new passenger terminal of Zagreb Airport (4)



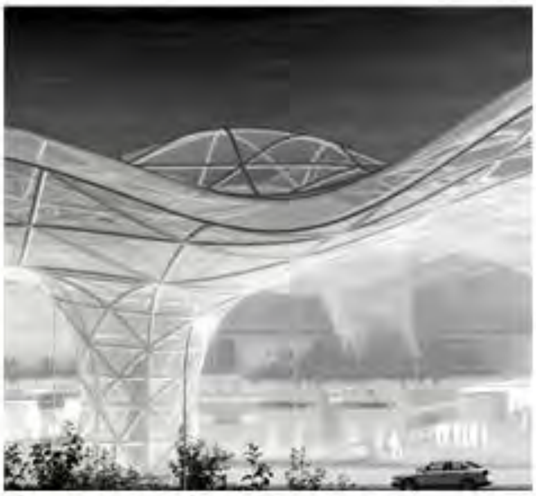


Figure 4.2.9.-5 Spatial depiction of the new passenger terminal of Zagreb Airport (5)

Figure 4.2.9.-6 Spatial depiction of the new passenger terminal of Zagreb Airport (5)

Figure 4.2.9-7 Spatial depiction of the new passenger terminal of Zagreb Airport (7)

4.2.10. Waste generation

During the project implementation phase, the same types of waste occurring to date will continue to be generated, as this is only an expansion project and the present activities of the Zagreb Airport will not change. During the use phase, the positive practice applied to date with regard to waste management will continue. Hazardous and non-hazardous production waste (as listed in Table 1) will be collected separately, stored pursuant to the valid legislation and handed over to the authorised collector for disposal or handling.
Considering the increased capacity of the Zagreb Airport (5,000,000 passengers per year in Phase I, 8,000,000 passengers per year in Phase II), a significant increase in the quantity of waste produced is expected, proportional to the increase in the airport capacity.
Municipal waste will be collected separately and handed over to the authorised collector for disposal. During its work, the Zagreb Airport will organise primarily separation of municipal waste components on site to the greatest extent possible. It is assumed that the dynamics of generating municipal waste will follow the trend of increasing passenger numbers (approx. 0.4 kg/passenger). However, by applying measures to separate waste, it is possible to reduce this to about 0.3 kg/passenger. In Phase I, waste production of about 2000 t/year is assumed, while in Phase II, the estimated production is 2400 t/year.
With the application of the current practices and planned protection measures, there is not expected to be an impact of waste on the environment.

Table 4.2.10-1 Waste creation impact during implementation

WASTE GENERATION IMPACT DURING IMPLEMENTATION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	CONSTANCY
Air traffic	-	1	DIRECT	CONSTANT
Road traffic	-	1	DIRECT	CONSTANT
Power plant operation	-	1	DIRECT	CONSTANT
Drainage system operation	-	1	DIRECT	CONSTANT

The possible impact of the planned project on the waste generation waste during implementation was evaluated as **slightly significant negative environmental impact (C).**

4.2.11. Impacts of light pollution

About light pollution in general
Environmental Protection Act (Official Gazette No. 110/2007), Section III "Environmental components, impacts and burdens" provides a legal framework for the adoption of regulations on protection from light pollution. The need for legislation to regulate this matter was determined as one of the measures within the Economic Recovery Programme, which was initiated by the Croatian Government. Provisions and light pollution management methods are covered by the Law on Protection against light pollution (OG RC 114/11).
Pursuant to the Article 4, Paragraph 1 of the Act on Light Pollution Protection (OG 114/11) " The provisions of this Act are not applied on the emmissions of the light into the environment, which occur due to... signalisation in the air traffic pursuant to the regulations governing air traffic signalization", However, the Article 16 sets forth the compulsory ways of illumination prescribed for the lighting that can cause light pollution; these ways refer, amongst others, to the lighting within air traffic system not covered by a specific regulation on airports". Light pollution is a global problem that affects the entire human population. This, at first glance insignificant problem causes many side effects ranging from unnecessary energy wastage to the harmful effects on humans, animals and the environment in general. The main feature of the light pollution is increase of the night sky brightness caused by artificial light. In short, the nights are getting lighter, which can imply a variety of negative consequences for humans and their environment.

By using currently available technologies, light pollution can be greatly suppressed and controlled – in its entire range - by developing the projects that will insist on modern solutions and lamps, which were selected keeping this on mind.

Possible light pollution components

There are many features of light pollution that can be broken down into essential components of light pollution and less important issues such as confusion in the visual field due to inadequate light source.

Particular attention should be paid to following components of light pollution during road lighting design.

Sky brightness

Sky brightness is the result of natural and man-made reasons. Unlike the light emitted from lamps we can not control natural resources.

The emitted light is divided into 3 components - direct, reflected and absorbed light. Reflected component reflects from the illuminated surface into the atmosphere in an amount that depends on pollution of the atmosphere and weather conditions.

By selecting the properly designed lamp, the planner of the road lighting will try to reduce pollution concerned.

Intrusive light

This kind of light or "intrusive light" usually refers to the outer lighting component that infiltrates the spaces outside the lighting object and disturbs the comfort and health of the local population.

Glare

Visual sensations produced by excessive amounts of light entering the eye; they are divided into three categories:

- Annoying reflections
- Debilitating glare
- Blinding glare.

Colour rendering degree

Less important component, but significant errors due to the introduction of colourful delusion by using a light source with a low colour rendering Ra such as frequently applied source of high-pressure sodium (NaVT), which is to be abandoned in future and replaced by metal halogen light sources (HQI) with Ra ≥ 60th

The goals of protection against light pollution

Environmental protection from light pollution ensures complete preservation of environmental quality, conservation of biological and landscape diversity, rational use of natural resources and energy in the best way for the environment, human health, animal and plant world, as a basic condition for healthy living and sustainable development. Within the principle of protection against light pollution, the new Act will prescribe and verify its use.

Energy efficiency principle:

- By using lights and lamps of higher light efficiency accompanied by smaller energy consumption (lm/W)
- By implementing more efficient regulation and management and monitoring peak power at the same time
- By cheaper maintenance due to the new technologies implementation – LED sources.

Justifiability principle:

- By reasonable status of light – technical facilities construction in a way that the construction benefit of the latter is higher than the adversity of exposure to light pollution – from the social point of view

Optimisation principle:

- Implementation of protective measures that reduce the negative impact of light pollution on humans and environment from all foreseen light sources; the reduction is in an extent which is most reasonable within prescribed limitations.

Limitation principle

- By implementing protective measures in such a manner that the exposure of people and natural environment to the light pollution is lower than legal prescribed values for inoffensive lighting.

Environmental impact

In the case of non-application of project protection measures, the planned expansion could have a negative impact on the population, especially on the population of the neighbouring settlements, as well as from the point of view of light pollution. Therefore, thanks to correct project solutions and planned protective measures, this negative impact shall be reduced to the minimum, legally permissible measure. The consequences of light pollution can be observed as impact on human health and on the feeling of comfort, as well as on the eco-system and particularly on security.

In the event of non-compliance to protective measures, it is possible that due to increased light pollution, there would be some direct and indirect negative impact on people in the immediate vicinity of the project. When speaking about direct implies, we mean the increase in fatigue, difficulties with orientation, increasing incertitude, insufficient quality sleep.

In the event of non-compliance to protective measures, it is possible that due to increased light pollution, there would be negative impacts on insects, birds, amphibians and mammals in the immediate vicinity of the project. These influences can be manifested in different ways, such as: native species of insects may disappear due to "the extended day", atypical insect species may settle and native species of insects may mutate. Light generally attracts insects, so many of them perish near the lighting fixtures, which leads to the emptying of adjacent ecosystems. Fireflies' natural mechanism of seduction and mating is disturbed, so they are gradually changing the location of their residence or even dying in areas which are too lightened.

Furthermore, near the project area, birds lose their orientation during daily and seasonal migrations, they lose time orientations, and atypical species settle by, native species become extinct or fly away. Birds do not nest in lightened areas; migratory birds lose their orientation without the starry sky. Bright lights dazzle them and many of them collide with various buildings and constructions (towers, trees, power lines, etc.). Annually, more birds are killed because of light pollution than other environmental disasters, which has been dramatically confirmed by the disastrous plague of birds caused by the newly built outdoor lighting system at Malpensa Milan airport and this fact was later the subject of many analyzes and studies. Due to hormonal disorders, birds are nesting during autumn, thus the survival possibilities of newborn birds are endangered. Some birds like the disappearance of nights. Thus, there is an explosion in the number of sparrows, starlings, crows, gulls.

Reptiles lose their orientation during migration; they do not visit any more areas which are too lightened. When speaking about mammals, the nocturnal ones suffer because of reduced hunting and feeding time, whereas the daily ones suffer because of reduced time for rest.

As for plants, an unnatural pollination and mutations are possible in the immediate vicinity of the project area, as for aquatic plants, the overproduction is possible in the immediate vicinity of the project area due to the extended process of figuresynthesis. Moreover, when speaking about plants, amplified lightning increases the production of algae in the water, thereby the quality of the water is being reduced. The "extended day" which is caused by unwanted and uncontrolled light, enhances the continuous growth of trees, changes floral samples (which confuses the insects), delays vegetative growth for autumn, causes premature "waking up" from vegetation in spring, causes an increase in leaf size with increased stomatal pores, thus the trees become more threatened in the context of air pollution. Young trees are particularly vulnerable.

Different kinds of sensitivity to unwanted light have been noticed. The most sensitive trees are the following ones: the maple, the beech and the birch, whereas the least sensitive trees are: the ash, the juniper, the spruce, the flank and the oak. A fact to be remembered is that the increased amount of light favours to the rapid growth of weed.

Each used kWh of energy in the domain of light causes the production of: 600g of CO2, 2 g of SO2 and 1.6 g NO.

Badly set illumination disturbs traffic participants. The illumination set along the road must be shadowed cut off. The light is unnecessary scattered into the sky in a number of locations. The part of the luminous beam of a non-adapted lamp blinds the traffic participants (whether it's about choosing a low-quality lamp or about a not adequately set one). Sudden transitions from illuminated to not illuminated areas result in temporary attenuation of vision that can result in accidents.

Heavy dazzle causes driver's reduced attention, which can also result in accidents.

While projecting road illumination, a special attention should be made to the amplification and diminution of contrast in the traffic participants' vision field.

So the road illumination plays the mentioned role as well, where the contrast created during the encountering with other traffic participants that use high-beamed front lights is being reduced by its luminous curtain. In those cases, the perception of the environment is completely lost because of the spotlights of the cars that we encounter. Thereby, these are some eventual traffic obstacles.

The contrast is the most important optical value for all traffic participants, but if it is too big, safety is reduced. Luminaries which are inadequately projected and set can have a negative influence on the security monitoring by disabling the accurate camera functioning in closed-circuit television (CCTV) of objects from Zagreb airport and this point shall require additional attention.

Taking into account the fact that this project covers the extension of the existing Zagreb airport, which is present at this location for numerous years, and provided that the legitimate protection measures shall be applied, a significant effect of the luminous pollution in the immediate vicinity of the project area, in comparison with the existing condition, is not expected.

Table 4.2.11-1 Light pollution impact during the implementation

LIGHT POLLUTION IMPACT DURING IMPLEMENTATION				
PROJECT SEGMENT	FEATURE	INTENSITY	CHARACTER	CONSTANCY
Air traffic	-	1	DIRECT	CONSTANT
Road traffic	-	1	DIRECT	CONSTANT
Power plant operation	/	/	/	/
Drainage system operation	/	/	/	/

The possible impact of the planned project on the waste generation during its implementation was evaluated as **slightly significant environmental impact.**

4.2.12. Impact of the project on economic activities

Air traffic is a very profitable activity that employs a large number of people. Therefore, one of the positive effects of the development of the airport is that with increasing numbers of passengers, the number of jobs for the local population in direct or indirect connection with the Zagreb Airport also increases. In addition to jobs concerning the receipt of passengers and cargo, jobs would also be opened in tourism and hospitality activities, public transport and municipal services and other activities. Another positive impact is the increase of revenues for all activities connected with the airport, and the increase of the overall revenues of the airport itself through airport taxes for aircraft take-off and landings, which will certainly mean better economic contributions for the local community, county and the state.

Table 4.2.12-1 Impact on economic activities during implementation

IMPACT ON ECONOMIC ACTIVITIES DURING IMPLEMENTATION				
PROJECT SEGMENT	**FEATURE**	**INTENSITY**	**CHARACTER**	**CONSTANCY**
Air traffic	+	1	INDIRECT	CONSTANT
Road traffic	-	1	DIRECT	CONSTANT
Power plant operation	+	1	DIRECT	CONSTANT
drainage system operation	+	1	DIRECT	CONSTANT

The possible impact of the planned project on economic activities during its implementation was evaluated as **positive (P).**

4.2.13. Risk assessment in relation to ecological accident

HAZARDS AND RISKS

When assessing the risk of environmental accidents at the airport, the existing hazards that can lead to accidents are to be determined. It is also necessary to evaluate the extent of individual risk. Finally, the analysis includes the identification of risk types and sizes[23] – for people, facilities and environment in respect to individual hazard.

There are following hazard in respect to the airports:

- Risk of fire and/or explosion
- Uncontrolled leakage and emission of hazardous substances into the environment
- The emission of hazardous substances in the air (resulting from the previous two hazards)

Risk of fire and/or explosion

Hazardous substances that can be associated with sources of fire/explosion of the new passenger terminal (NPT) at Zagreb Airport (ZLZ) are as follows:

- Aviation fuel (jet fuel JET A-1 and air-gasoline)
- Liquid fuel for the outstanding work of the boiler s with hot water within the NPT (fuel oil, extra light)
- Fuel for road vehicles and work equipment (diesel)
- Gas fuel for operation of the hot-water boilers (natural gas)
- Hazardous material being transported in airplanes (CARGO)
- Other flammable substances

Physic-chemical properties of hazardous substances that indicate the degree of risk of fire/explosion are listed in the Table 4.2.13-1.

[23] Environmental risks is the size measured by the probability of events occurrence and the potential of the environmental damage that this event may have caused

Table 4.2.13-1 Physic-chemical properties of hazardous substances that indicate the level of risk of fire/explosion.

Substance	CAS-No	Ignition point (^{0}C)	Explosiveness limits (%)	Density on 15^{0}C (kg/m^3)	Data source
Fuel for jet engines JET A-1 (kerosene)	8008-20-6	+38,0 (min)	0,7-50,0	775,0 - 840,0	STL , INA d.d. 50000213.007.08-02 HZT Class: 050-03-01/09-1684 Of 10.06.2009
Aircraft-gasoline TIP 100LL	64741-66-8	-45	1,4-11,5	700-780	STL , INA d.d. 50000213.007.08-01 HZT Class: 050-03-01/08-3354 Of 29.10.2008.
Fuel oil, extra light	68334-30-5	>+55	0,6-6,5	max. 860	STL , INA d.d. 50000206.022.04-01 HZT Class: 050-03-01/08-242, 28.01.2008.
Diesel fuel	68334-30-5	>+55	0,6-6,5	820-845	STL, INA d.d. 50000213.007.08-03 HZT Class: 050-03-01/11-0555, 15.02.2011
Natural gas	74-82-8	-	5-15	0,68	STL , INA d.d. 50000213.007.08-02 HZT, Class: 050-03-01/10-0414 04.02.2010.

Hazardous load Pursuant to the Act on Hazardous Goods Transport OG 79/07, the Ordinance on Conditions and Mode of Transport of Hazardous Goods by Air (OG 39/10) and the Technical instructions for Safe Transport of Dangerous Goods by Air (ICAO Doc 9284-AN/905), hazardous substances are classified as follows: 1. Explosives; 2. Gases; 4.1: Flammable solids, self-reactive substances and insensitive explosives; 4.2: Substances subject to self-combustion; 4.3: Substances which, in contact with water form flammable gases; 5.1: Oxidizing substances; 5.2: Organic peroxides; 6.1: Toxic substances; 6.2: Infectious substances; 7. Radioactive substances; 8. Corrosive substances; 9. Other dangerous goods, not included in other classes criteria.

Aviation fuel

The main causes of fire/explosion are the facilities and activities related to aviation fuel:

- Transportation of the fuel by tankers (tanks with fuel on public roads in direction towards ZLZ, so-called aviation tanks on service roads of the NPT, aviation tanks on location of pouring fuel into the aircraft)
- Storing
  - o Over-ground tanks for jet fuel
  - o Underground tanks for aviation fuel
- Manipulation (pipes, hoses, hydrant system of fuel supply for the needs of NPT) and unloading/loading fuel in tanks for aircraft supply
- Loading fuel in the aircrafts,
- Fuel tanks in aircraft
- Takeoff and landing
- Diversion
- Seismic movements

Today, the aircrafts are filled with the fuel that is stored on the premises of INA Avioservis which is located within the ZLZ's area. For jet fuel there three above-ground tanks: 2 x 1000 m^3 and 1 x 5000 m^3, for a total capacity of 7000 ^{m3} of jet fuel. These days ZLZ has 2 x 1000 m^3 on disposal for its needs, while the 5000 m^3 tank is not in commercial use. The tanks are located in sheltered basins (25 x 25x 1.8 m). For aviation gas, there are storage capacities in five underground tanks with volumes as follows: 3 x 100 m^3 and 50 m^3 x 2 for a total capacity of 400 m^3. There are also underground tanks of diesel fuel and gasoline[24] for road vehicles and mechanisation of the users in ZLZ. Tanks that are not in commercial use are properly maintained.
Tanks of different sizes are used (45, 2 x 60 m^3 for JET A-1 20, 40 and 5 m^3 for AB 100LL). Fuel is supplied by the tankers from Refinery INA Rijeka. The current frequency of fuel supply to ZLZ is in average 160 m^3 per day (5-6 tankers of 30 m^3).

The projection of future demand for fuel is shown in Table 4.2.13-2[25].

[24] Source: Plan of intervention within the environmental protection of Zagrebačka County - Attachments, 2006
[25] Source: Zagreb International Airport Master Plan Update 2008, Chapter 4.2.10.

Table 4.2.13-2 The projection of future fuel demand based on the anticipated density of air traffic after the construction of the NPT.

Year	2010	2015	2020	2025	2030
Aircrafts' movement in the domestic traffic	8.500	10.000	11.200	12.700	14.300
The average number of daily takeoffs	12	14	15	17	20
Average amount of fuel in the aircraft [l]	10.000	10.000	10.000	10.000	10.000
Daily need for fuel; (50% of the aircrafts takes fuel on ZLZ)	58.219	68.493	76.712	86.986	97.945
Aircrafts' movement in the international traffic	39.500	51.600	62.800	70.000	77.200
The average number of daily takeoffs	54	71	86	96	106
Average amount of fuel in the aircraft [l]	25.000	25.000	25.000	25.000	25.000
Daily need for fuel; (50% of the aircrafts takes fuel on ZLZ)	676.370	883.562	1.075.342	1.198.630	1.321.918
Charters movements	700	1.100	1.500	1.800	2.200
Average number of daily takeoffs	1	2	2	2	3
Average amount of fuel in the aircraft [l]	150.000	150.000	150.000	150.000	150.000
Daily need for fuel [l]	143.836	226.027	308,219	369,863	452.055
Total daily need for fuel [l]	878.425	1.178.082	1.460.274	1.655.479	1.871.918
Total daily need for fuel [m^3]	878	1.178	1.460	1.655	1.872
Weekly demand [m^3], rounded-off	6.200	8.200	10.000	11.500	13.000

According to the source mentioned above, it is expected that the week consumption shall exceed the current storage capacity at Zagreb airport (which is 7,400 m^3). With the current capacity, it is possible to ensure the storage for 5 days in 2020. Current aircrafts have lower fuel consumption than they had earlier. Moreover, aircrafts have the opportunity to choose the quantity of aircraft refuelling in some airports (which depends on the price of fuel). All these variables affect future daily and weekly needs for storage capacity, so fuel quantities may be lower than the ones specified in the project. Current requirements for the provision of storage Zagreb airport are at a level of three-day storage, which is ensured by two tanks of 1000 m^3 which are above the ground.

There is another possibility that is taken into account. That is the connection of fuel hydrants to the NPT and aircraft refuelling by using them. Fuel hydrants shall supply all the operating positions. The concessionaire shall be responsible for all modifications and extensions of the existing hydrant system. All existing pipes under the new pavement shall be replaced with new ones. All hydrants shall be supplied from the parallel pipeline. Long, horizontal pipes shall be avoided. Positions for aircrafts of type C shall be equipped with one hydrant. Positions for larger aircrafts of type C shall be equipped with two hydrants. The owner of the central fuel tank shall be responsible for its upgrade or expansion, if it is not otherwise agreed[26].

[26] Source: Technical range, Airport Zagreb, May 2011

Liquid fuel for the energy unit

Natural gas shall be used as the primary fuel for meeting all needs of energy for the full year. Extra light (EL) heating oil and diesel fuel shall be used for work in exceptional conditions (gas shortage, inadequate supply of gas). The capacities of the mentioned alternative sources of fuel can vary greatly, depending on users' desires regarding independent operations of the energy facility. In the 1st phase of energy supply, two underground tanks for extra light fuel oil, with a total volume of 100 m^3 (2 x 50 m^3) shall be constructed. The mentioned capacities shall allow independent boiler operation for water heating for a period of one week with a maximum nominal capacity of 6 MW. Tank capacity can be increased in all phases of construction, depending on customer's preferences in terms of independent work of the energy facility although, in this case, it will be important to plan the underground space in time, as well as the appropriate waterproof basin. In case of difficulties in the supply of gas, it would also be possible to use cogeneration unit in order to meet the maximum demand for thermal energy, and in this case the fuel diesel shall be used[27]. The predicted distance from the NPT energy unit is of approximately 1.2 km west.

In terms of fire/explosion, procedures relating to the supply, storage and use of fuel do not represent such a significant threat as it is the case with manipulation of aircraft fuel (due to the lower frequency of delivery by tankers and underground storage tanks as well as boiler installations).

Regulation on the prevention of major accidents involving hazardous substances (Official Gazette 114/08) sets forth the list and types of hazardous substances present in plants, which can cause a bad accident or may occur in plants during a major accident; the method of determining the quantity of dangerous substances and permitted quantity, and the criteria by which these substances are classified as hazardous. According to the current actual quantities of fuel storage, there is no obligation from the Regulation. If you are planning to expand the storage capacity and taking into account the fuel and other flammable liquids at the location of the project, a threshold quantity of 2.500 tons could be reached when it is necessary to create Alerts on small quantities (Article 12, Annex V of the Regulation) or 25.000 tons of fuel when there is an obligation of developing Safety report. It should be noted that there are two legal entities on location ZLZ are they both fuel in their ownership (INA Avioservisi and ZLZ). For now it is necessary to meet the requirements related to the preparation of the Operative Safety Plan for protection and rescue according to the regulations from Protection and Rescue.

Gas fuel for the power plant

As already mentioned, the natural gas (Hd in range 33100-40200 kJ/m^3) will be used as the primary fuel for meeting the entire energy needs of the full year's level. Maximum gas consumption is estimated at 2400 m^3/h at high pressure (14 bar) for cogeneration (2 cogeneration blocks) and 800 m^3/h at low pressure (1 bar) for heating with boilers. Two potential gas supplier (GPZ-Town Gasworks Zagreb PLINACRO)[27] are taken into consideration.

Gas leakage of damaged pipes can cause an explosion and fire that will continue to spread. Effects on human health due to inhalation of gas without danger to the environment are also possible.

Sources and causes of adverse events can be:

- Uncontrolled digging and deterioration that results in damage to the gas line and pipeline
- Technical errors in the system - defects (defects in the material, corrosion)
- Organisational failures (during the working processes, third parties)
- Diversion and
- Seismic movements.

[27] Source: Technical range, Airport Zagreb, May 2011

These events are extremely rare, hence the risk of such kind of environmental disaster would be very low when observed separately or in a different environment. The level of risk is growing due to the occurrence of domino effect[28] and its impact on other facilities and NPT aircrafts and the potential damage related to the number of people and property.

Hazardous cargo transported in aircrafts (CARGO)
Risk of fire or explosion can occur upon arrival, departure and holding of freight aircraft transporting hazardous materials. This hazard is related to the class 1, 2, 3, 4.1, 4.2, 4.3, 5.1 and 5.2. Mitigating circumstance is that hazardous substances are packed in prescribed and certified containers in excepted quantities. The biggest risk belongs to the class 1 (explosives) and the occurrence of domino effect. A possible cause is the diversion. According to an estimate of the amount of cargo over the years, growth is assumed from the present 7.6 t to 19.6 tons of cargo annually, under the baseline scenario. There is no estimate regarding the amount of cargo which refers to transport of hazardous substances, but we also expect that type of growth[29].

Other flammable substances
In ZLZ, for maintenance of equipment and facilities used substances and mixtures which may cause fire/explosion are used. The same will apply to the NPT. It's about acetylene and other flammable chemicals. Their storage is limited to the Technical base warehouse and their use to workshops on platforms and runways. Plan of Interventions for cases of possible environmental disaster or emergency was developed for ZLZ, as well as the Ordinance on measures and procedures in emergency situations on ZLZ (Emergency Plan)[30]. The above documents should also be prepared for the NPT.

During the project execution
As possible causes of the accident during the construction works there are collisions and impacts on construction machinery objects, damage to vehicles for the fuel transport, damage to existing installations. When performing a new intervention with existing safety measures and adherence to proper operating procedures at the site of construction, the potential risk of an accident is reduced to an acceptable level.

Forecast of the number of passengers and aircrafts after the construction of NPT
For the purposes of assessing the probability of occurrence of accidents related to aircraft, it is necessary to take into account the number of aircrafts that could be found on the project location. In order to assess the level of risk it is necessary to estimate the number of passengers and add the number of employees, visitors and others who may find themselves at the airport. Table 4.2.13-3 provides the forecast for the number of passengers and aircraft throughout a year. Projections of absolute peak hours are made to determine the number of positions needed to accommodate all aircrafts. Tables 4.2.13-4 and 4.2.13-5 provide the forecast for the number of passengers and aircrafts in the peak hour.

Table 4.2.13-3 Forecast for annual movements of passengers and commercial aircrafts under the baseline scenario[31]

Year	2010	2015	2020	2025	2030	2035	2040
Baseline scenarios for the annual number of passengers							
Total	**2.054.437**	**2.894.056**	**3.563.993**	**4.255.740**	**4.890.267**	**5.530.270**	**6.223.300**
Baseline scenario for the annual number of commercial aircrafts							
Total	**31.808**	**42.684**	**49.964**	**56.785**	**62.174**	**67.069**	**72.076**

[28] The domino effect is a series of related effects which, due to the mutual arrangement and proximity of plants or parts of plants or groups of plants and quantity of dangerous substances present in these plants, increase the probability of a major accident or exacerbate the consequences of an accident
[29] Source: TRAFFIC FORECAST, public-private partnership Airport Zagreb - Inter*VISTAS*Consulting Group - Netherlands
[30] Source: Intervention plan in case of a possible environmental disaster or emergency, ZLZ, 2003
[31] Source: TRAFFIC FORECAST, public-private partnership Airport Zagreb - Inter*VISTAS*Consulting Group – Netherlands

Table 4.2.13-4 Projections of absolute peak hour for the aircraft, the baseline scenario[34]

Year	2010	2015	2020	2025	2030	2035	2040
Domestic	6	7	8	9	10	10	11
International	14	19	22	26	28	31	34
Common aviation	8	9	10	11	12	13	14
Cargo	3	4	4	4	5	5	5
Total	**22**	**22**	**26**	**30**	**33**	**36**	**39**

Table 4.2.13-5 Forecast for the number of passengers in project's peak hours, baseline scenario[34]

Year	2010	2015	2020	2025	2030	2035	2040
Total	**986**	**1.486**	**1.822**	**2.152**	**2.461**	**2.752**	**3.061**

Assessment of the probability of ecological disaster in ZLZ

According to data from the annual reports of Annual Safety Review 2010[32] the total number of accidents as well as those with fatal consequences[33] in relation to European airline operators in commercial air traffic has been decreasing. Looking at the ten-year average of the total number of accidents, 15% of them has been fatal for EU operators. Aircraft accidents with fatal consequences for other operators can be considered as uniform. Table 4.2.13-6 shows the fatal accidents relating to EU carriers and other carriers (operators).

Table 4.2.13-6 Overview of the number of fatal accidents relating to EU carriers and other carriers

Period	Number of accidents	Accidents with fatal consequences	Mortality in the air	Mortality on the ground
EU operators 1999-2008 (averaged)	32	5	78	1
EU operators, 2009 (total)	20	1	228	0
EU operators, 2010 (total)	26	0	0	0
Other operators, 2008		50		
Other operators, 2009		39		
Other operators, 2010		46		

The absolute number of aircraft accidents is not a measure that gives the full picture since there are no data on the total number of flights. Therefore, the overview of the number of accidents with fatal consequences in relation to the number of flights is a much better option. The average number of fatal accidents per 10 million flights in the EU and other operators in the period of the last five years amounts to 9 fatal accidents per 10 million flights (probability 9×10^{-7}).

According to the same source[35], aircraft accidents associated with the location of the airport (landing, errors when loading aircraft with fuel and other operations at the airport) do not account for more than 40% of total accidents for the EU operators. According to the source Statistical Summary of Commercial Jet Airplane Accidents, 1959 - 2008, Boeing, the fatal accidents at the stage of take-off, initial rise and the final landing and landing of account for 56% of the accidents.

Correcting the probability regarding the so-called "Accidents on the ground" on the side of sharper criteria ($9 \times 10^{-7} \times 0.56$) we obtain the probability of the accident of 5×10^{-7}. A more precise forecast of accident on ZLZ depends on the number of flights and it is estimated by the expression: **5×10^{-7} x annual number of flights**

[32] Source: Annual safety review 2010, European Aviation Safety Agency, easa.europa.eu

[33] Accident with fatal consequences are those that resulted in at least one death of crew, passengers or other people within 30 days of the accident. (Source: ICAO Annex 13). Fatal accidents often result in a wider scale at the scene so they are taken as a criterion in the assessment of risk.

Table 4.2.13.-7 provides the forecast for accidents throughout the year

Table 4.2.13 -7 Forecast of occurrence of ecological accidents at ZLZ given the increase in traffic over the years

Year	**2010**	**2015**	**2020**	**2025**	**2030**	**2035**	**2040**
Number of flights	31 808	42 684	49 964	56 785	62 174	67 069	72 076
The accident probability x 10^{-2}	1,6	2,1	2,5	2,8	3,1	3,4	3,6
fatal accident probability once in /x years	62,9	46,9	40,0	35,2	32,2	29,8	27,7

The level of expected probability for fatal accidents on ZLZ is in order of 10^{-2}/year, which means that these events might be expected so you need to have to prepare all necessary emergency systems. You should be aware that regardless of the probability of the occurrence of fatal accident every, possible accident carries is accompanied by the risk of an uncontrolled leakage of the fuel into the environment. Although there is no statistical data, descriptions of aircraft accidents cite not only the fuel leakage – more probable are fires. Here is the risk for passengers and aircraft increased, but due to combustion the risk of penetration into soil and environmental pollution are greatly reduced. Fire extension to the surrounding objects is here a hazard.
According to data related to ZLZ and its closer environment, there were accidents in 2001 (0 mortality), 1977 year (0 mortality). In 1976 the airplanes collided and the airplane crashed in the vicinity of Vrbovec (176 deaths) and 1950 (10 deaths).
Detailed analysis of the risk of aircraft accidents is given in section 4.2.14.

Risk analysis related to fire and explosion

For the purposes of risk analysis, the so-called rough analysis was used. The result is the list of sources of risk, assessment of occurrence of accidents together with an assessment of consequences[34]. Table 4.2.12-9 provides data for individual risk facilities with the following contents:
1st column defines the object of observation,
2nd column defines its use in technological terms,
3rd column shows the amounts in the facility,
4th column shows the type of risk, indicating a possible interaction with neighbouring facilities in given situations,
5th column indicates the objects threatened by a particular risk
6th column talks about the manner and consequences of jeopardizing endangered buildings
7th, 8th and 9th column predicts the severity of these consequences for life, environment and property
10th column defines the rate of those consequences,
11th column expresses the probability (probability) of events.

[34] Source: Manual Determining and assessing hazards in local community.

Classification for individual consequence, rate and probability (columns 7-11) include classes 1 - 5 with the following contents (meanings):

Life and health consequences

Class	Features
1. insignificant	occasional insignificant unease
2. limited	several injuries, long-term unease
3. severe	several severe injuries, long-term unease
4. very severe	a few (more than 5) death cases, a few (20) severe injuries, up to 500 evacuated persons
5. disastrous	a few (more than 20) death cases, hundreds of severe injuries, more than 500 evacuated persons

Environmental consequences

Class	Features
1. insignificant	no contamination, localised effects
2. limited	simple contamination, localised effects
3. severe	simple contamination, dispersed effects
4. very severe	complex contamination, localised effects
5. disastrous	very complex contamination, dispersed effects

Effects on property

Class	Total costs of damage (mil. USD)
1. insignificant	<0,5
2. limited	0,5-1
3. severe	1-5
4. very severe	5-20
5. disastrous	>20

Development rate

Class	Features
1. early and clear warning	localised effects/no damage
2.	
3. medium	insignificant spreading/ small damage
4.	
5. without warning	hidden until the effects are fully developed/ direct effects (explosion)

Probability

Class	rough frequency estimate
1. improbable	less than once in 1000 years
2.	once in 100-1000 years
3. very probable	once in u 10-100 years
4.	once in 1-10 years
5. very probable	more often than once a year

A general class is finally assigned to a risk facility, based on the matrix and according to probability assessment for an accident that would be caused by the hazards and seriousness of their consequences:

A - Consequences INSIGNIFICANT
B - Consequences LIMITED
C - Consequences SEVERE
D - Consequences VRLO SEVERE
E - Consequences DISASTROUS

The table 4.2.13-9 provides the risk assessment relating to aircraft accidents(fire/explosion) for the most relevant facilities/activities and substances within the NPT.

The worse case scenario

Although this is not the maximum possible quantity of ZLZ, this event is taken into consideration as it can be located at the position (apron for aircrafts) which would cause dramatic consequences in terms of including a number of people, property and the domino effect.

Location: apron-gate of the NZT
Quantity: 25 m^3 of jet fuel (kerosene)

1. The worst case scenario: vapour cloud explosion, reach: 456 m radius (ultimate pressure of 7 kPa[35])
2. Alternative event: puddle inflammation, reach: Table 4.2.13-8 and Figure 4.2.13.1

Table 4.2.13-8 Ranges of thermal radiation in case of the fire in the aircraft

Thermal radiation level kW/m^2	EFFECTS	Range (m)
47,31	Fireball	79,0
35,59	Spontaneous textile inflammation	91,1
33,49	Spontaneous wood inflammation	93,9
18,84	Steel bents	125,2
12,56	Colour assumes bubbles	153,4
9,63	Equipment requires protection	175,1
5,86	Pain sensation for great number of people	224,5

Data were calculated according to TNT equivalent model[36].

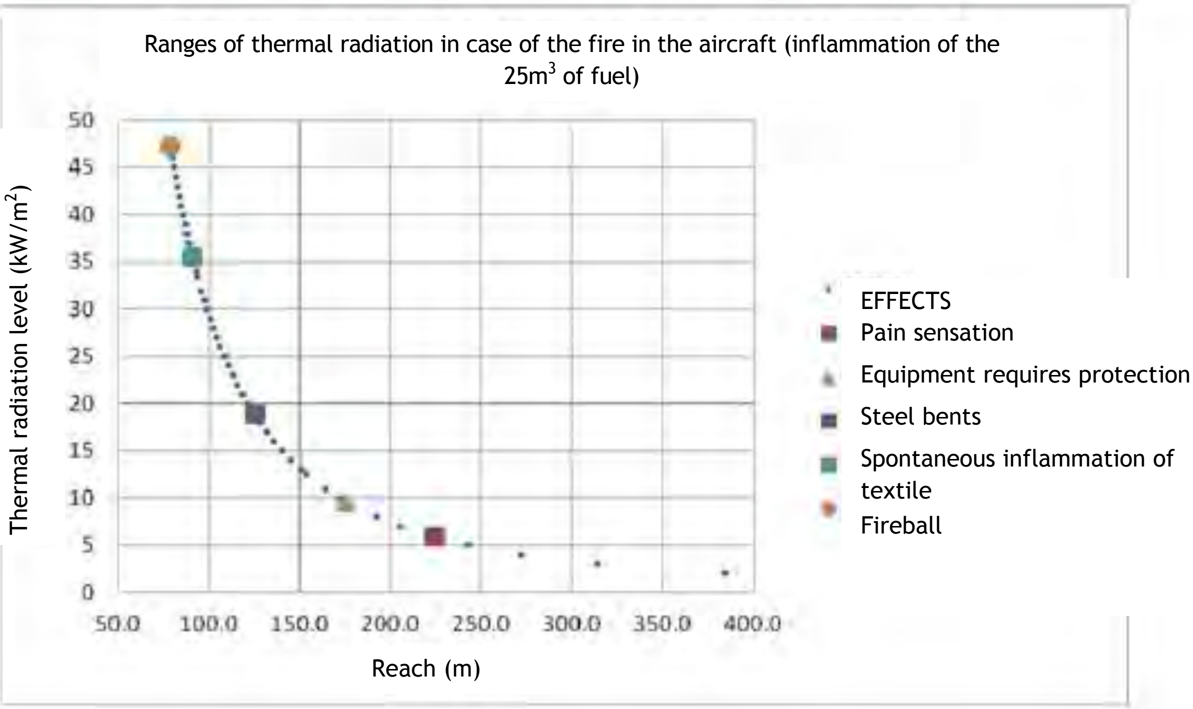


Figure 4.2.13-1 Ranges of thermal radiation in case of aircraft fire (inflammation of the puddle 25 m^3 of fuel)

The domino effect is possible on the apron gate because the range (approx. 130 m) in which the thermal effect is such (approximately 15 kW/m2) that it can cause damage and fuel leakage from another tank (so-called another risk recipient). The following graphic shows the scope for individual events at ZLZ; fire and explosion.

[35] Pressure wave of 7 kPa (0.07 bar) is very improbable to have serious effects on people; may cause property damage, such as partial damage to the houses, which can cause injury to people and shattered windows, whereby flying glass can cause injury to the skin.
[36] Source: APPENDIX AREFERENCES FOR CONSEQUENCE ANALYSIS METHODS

Figure 4.2.13-2 The spatial scope for individual events at the ZLZ site; fire and explosion

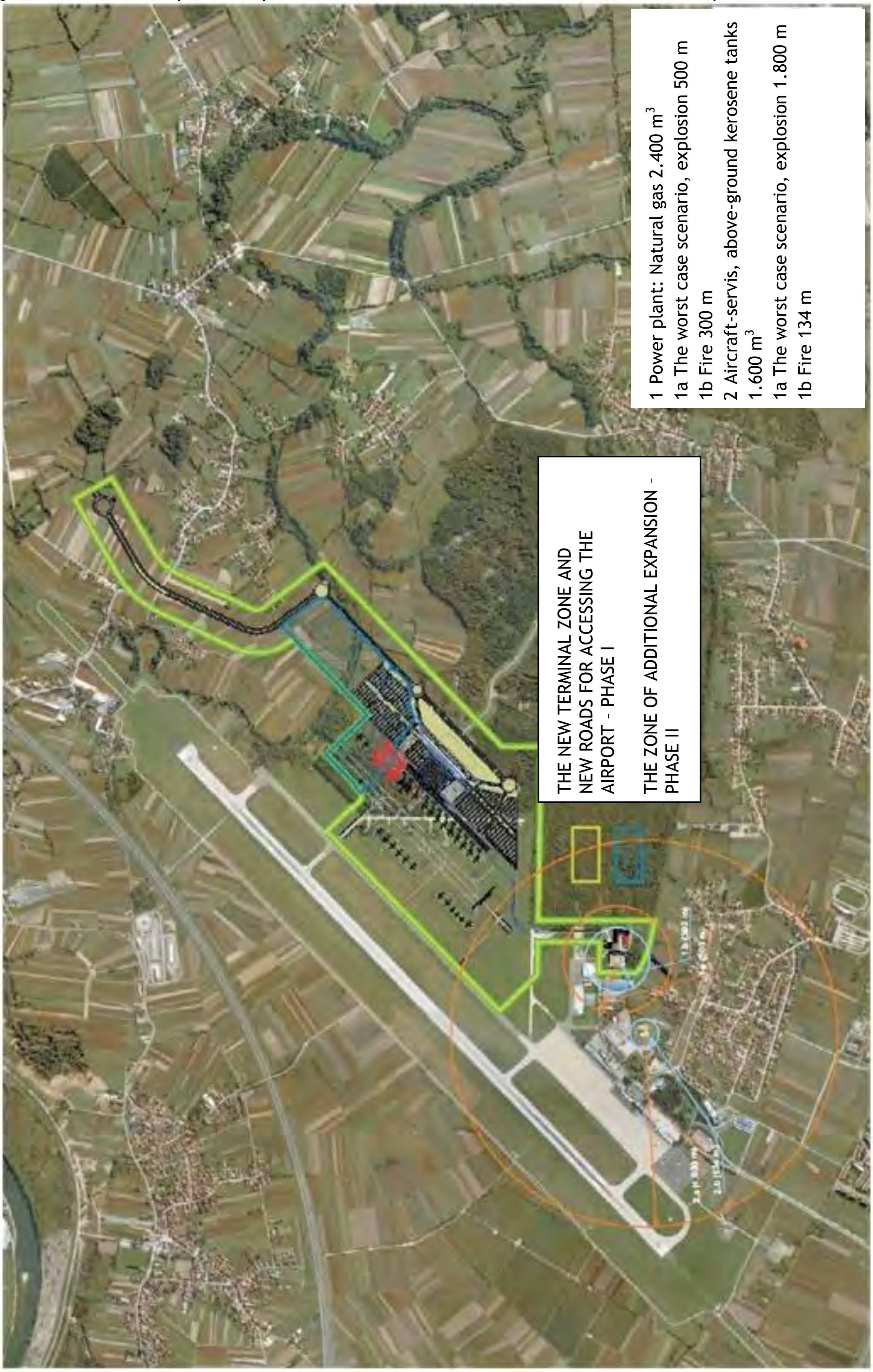
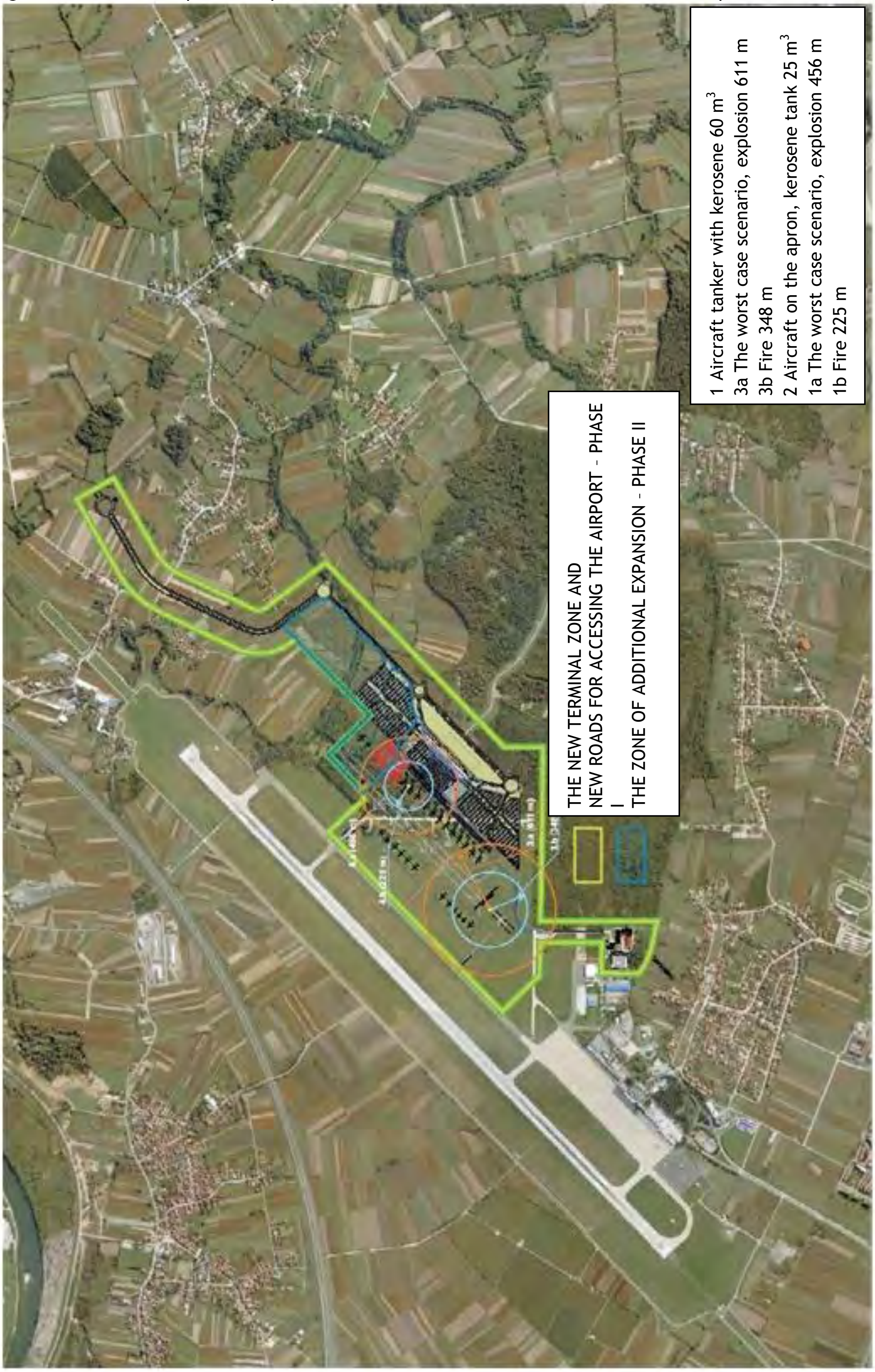


Figure 4.2.13-3 The spatial scope for individual events at the ZLZ site; fire and explosion



L = life
E = environment
P = property

R = rate
L = probability
PR = priority

Table 4.2.13.-9 risk assessment relating to aircraft accidents (fire/explosion) for the most relevant facilities/activities and substances NPT

Facility	Activity	Hazard (quantity)	Risk type	Threatened facility	Consequences	Severity (consequences)				L	P	Remarks
						L	E	P	PR			
1	2	3	4	5	6	7	8	9	10	11	12	13
CURRENT SITUATION INA Avioservis premises Location description: Aircraft service is located within ZLZ. Access to service premises is the extension of public road which connects entrance from direction of Velika Gorica towards facilities within the airport. Aircraft service premises is enclosed with wire and it is near the other objects of the airport The surface of the aircraft service is around 20.000 m^2. Above-ground tanks aircraft tanks 2 x 1000 m^3 (d=12 m, h=8,6 m) The distance between two tanks is 20 m.	Spilling due to : Perforations on armouring, pipes, gaskets rendering, tanks' overloading, corrosion of the substances, operative failures, diversion, earthquakes etc. Tank vans around tanks have dimensions 25 x 25 m, h= 1,8 m. Tanks are loaded up to 80 %. on 82 % alarm sounds 90 % overloading protection activates. Tanks are always loaded in turns.	Kerosene 1600 m^3 (0,8 x 1000 x 2)	- explosion (worst case V= 1600m^3 explosion, reach 1,8 km) - fire (134 m of ultimate radius at the inflammation of the puddle) discharge in the tank van, — fire spreading on other facilities — spreading of the combustion products — domino effect	life: passengers, employees and visitors (includes the existing terminal, but not NPT) , local population of Velika Gorica environment: air, forest and animals property: facilities, vehicles, aircrafts (includes the existing terminal), property of passengers and cargo, private property of population, agricultural land	endangered lives panic, injuries suffocation death environment, spreading of the combustion products, fire centre property material damage to the property of ZLZ and other operators, subcontractors, cargo, passengers and local population	4	2	5	4	1	D	VERY SEVERE consequences, but due to the low probability for the event occurrence (less than once in 1000 years) RISK ACCEPTIBLE Acting: preventive measures integrated in facilities (intake tank) and equipment (installations) , safety systems and fire protection systems, regular maintenance and inspections, proper operative procedures, staff education and planning intervention plan local rescue service/fire department Above-ground tanks are located at least 1,8 km away from the NPT

Facility	Activity	Hazard (quantity)	Risk type	Threatened facility	Consequences	Severity (consequences)				L	P	Remarks
						L	E	P	PR			
1	2	3	4	5	6	7	8	9	10	11	12	13
Gas line, gas station (power plant)	Leakage	Methane Peak quantity per hour 2400 m^3 Spilling due to: Perforations on armouring, pipes, gaskets rendering, tanks overfilling, corrosion of materials, operative failures, diversion, earthquakes etc.	- explosion (worst case: reach 500 m) - fire (reach 300 m), - fire spreading on other facilities - spreading of the combustion products - suffocation	life: employees and people on road, surrounding houses on the edges, environment: air, forest and animals property: facilities, vehicles.	endangered lives panic, injuries suffocation death environment methane spreading spreading of the combustion products,fire centre property damage to the tangible assets of the ZLZ	2	2	2	3	2	B	LIMITED Acting: preventive measures integrated into facilities (maintenance and construction) and equipment , safety and fire protection systems, regular maintenanc e and inspections, proper operative procedures, staff education planning intervention plan local rescue service/fire

Facility	Activity (quantity)	Hazard (quantity)	Risk type	Threatened facility	Consequences	Severity (consequences)				VL	PPR	Remarks
						L	E	P	R			
1	2	3	4	5	6	7	8	9	10	11	12	13
Aircraft tanker for fuel supply for NPT - Anywhere on internal roads or on failures in apron gates	Movement of the aircraft tanker Loading fuel in the aircrafts' tanks Activity takes place on daily basis	Kerosene 1 x 60 m^3 Tanker's rollover, tanker's collision, objects failures in the decanting system, overfilling, operative failures diversion, earthquake	- explosion (worst case: reach: 611 m) - fire (reach: 348 m), fire spreading to other objects - spreading of the combustion products - domino effect	life: passengers (in peak hour 1000-3000), employees (~500) and visitors, people in underground line of railway environment: air, forest and animals property: facilities, vehicles, aircrafts (22-39 according to peak hour), vehicles, passengers and cargo roads	endangered lives panic, injuries suffocation death environment combustion products spreading, fire centre property material damage to the property of ZLZ and other operators, subcontractors, cargo and passengers	4	2	4	3	2	D	VERY SERIOUS consequences, probability (once in 10-100 years) Acting: preventive measures integrated in facilities (construction of facilities and equipment installations), fuel supply by hydrants), safety and fire protection systems, regular maintenance and inspections, proper operative procedures, staff education and intervention plan local rescue service/fire department

Facility	Activity	Hazard (quantity)	Risk type	Threatened facility	Consequences	Severity				V	P	Remarks
						Ž	O	I	B			
1	2	3	4	5	6	7	8	9	10	11	12	13
Fuel tank in the aircraft Anywhere on apron-gates or on the runway	Manipulation on the runway, take-off, activities relating to supplying aircrafts with fuel	Kerosene 1 x25 m3 Failures in decantingsystem,overfilling, operative failures, diversions, eartquake, domino effect imapct	explosion (worst case: reach: 456 m) - fire (reach: 225 m r), fire spreading, to other facilities spreading combustion products, domino effect	life: passengers (in peak hour 1000-3000), employees (>500) and visitors enviroment: air, forest and animals property: facilities, vehicles, aircrafts (22-39 according to peak hour), passengers property and cargo	endangered lives panica, njuries suffocation death enviroment combustion products spreading, fire centre property material damage to the property of ZLZ and other operators, subcontractors, cargo and passengers	4	2	4	3	2	D	VERY SERIOUS consequences, probability (once in 10-100 years) Acting: preventive measures integrated in facilities and equipment (installations, fuel supply by D hydrants), safety and fire protection systems, regular maintenance and inspections, proper operative procedures, staff education and intervention plan local rescue service/fire department

DANGER OF SOIL AND GROUNDWATER POLLUTION

Fuel for aircraft, motor vehicles and liquid fuels (oil) for power plants, apart from the risk of fire/explosion, are - in real terms - danger for the soil and groundwater pollution in case of uncontrolled leakage. The low fuel viscosity facilitates an easy penetration into the soil. The importance of taking this danger in consideration is particularly important due to the fact that the project is located within water wells, while the soil is very porous. Specifically, the project site as well as the current ZLZ is located in the central part of the city aquifer. On the surface level, the spoil is composed of gravel, sand and some sand and siltstone clays. The groundwater, depending on hydrological conditions, is located at the depth between 3.1 and 6.4 m below the surface.

Expanding capacities on the New Passenger Terminal (NPT) increases the need for fuel; therefore, the handling of constantly increasing amounts is expected. All this indicates that the danger of uncontrolled leakage can result in serious pollution of the environment, i.e. soil and groundwater. Sources and actions which may cause leaks are the same as those for the risk of fire/explosion. Comparing the impact on environment between fire and contamination of soil and water, the latter (water) is the most notable. Although the fire is faster occurrence that will most probably be prevented within the shortest period of time and it affects people, property and environment, with pollution of soil and water it is the opposite case. The consequences of penetration into the soil and water pollution are a long-term problem for human health and environment. Recovery procedures are complex and long.

The other chemicals that are used in large quantities on the Zagreb Airport include agents for paths de-icing (Safeway and bio - degradable agents Safeway and Safewing and urea). De-icing location will be equipped with a system for collecting liquids.

Risk analysis regarding soil and groundwater pollution

For the purposes of risk analysis, a matrix with the estimated severity of the consequences and probabilities of occurrence was used[37]. Observed potential adverse event is the worst case that can happen at the source. Assessment of severity of the effects on specific receptor is divided into classes:

The distribution of severity of the consequences to the receptor

Classes	Human health	Soil and water	Ecology	Built environment
Severe	Irrecoverable damage	Abundant soil penetration and significant pollution of the groundwater,	Significant changes to the total number of one or more plant or animal species or ecological systems	Irrecoverable damages on facilities, installations and environment
Limited	Occasional impacts on human health	Limited soil penetration, waste water pollution or low level of groundwater pollution	Changes in the population density for insensitive plant and animal species	Damages on facilities, installations and environment
Weak	Mild short-term health effects	Mild groundwater pollution	Some changes in population density, but without negative impact on the ecological system	Simple restoration on facilities and installations

[37] Source: Environmental Impact Assessement of the Expansion of Bristol International Airport, September 2005, Entec

Insignificant	No measurable effects on human health	No measurable indicators of wastewater pollution	No significant effects on density of population within the environment or ecological system	Very low damages on objects and installation or cleaning only

Probability of event occurrence

Almost improbable	0-5%
Not very probable	5-45%
Probable	45-55%
Very probable	55-95%
Almost definite	95-100% (e.g. it has already happened)

Risk classification matrix

Effect severity					
Severe	Low	Low to medium	Medium to high	Very high	Very high to high
Limited	Insignificant to low	Low	Medium	Medium to high	High
Weak	Insignificant	Low	Low	Low to medium	Medium
Insignificant	Insignificant	Insignificant	Insignificant to low	Low	Low
	Almost impossible	Not very probable	Probable	Very probable	Almost definite

Occurrence probability

Risk class significance

Insignificant	No significant damage (sources and actions are not the potential for significant damages)
Low	Possible slight damage to the receptor
Medium	Mostly local periodic damage. It may be necessary to implement corrective procedures.
High	It is probable that the receptor undergoes significant damage if corrective measures are not implemented
Very high	High probability of serious damage to receptor without appropriate corrective measures

Table 4.2.13.-10 provides a review of the risk assessment of environmental accidents (no fire/explosion) for the most significant sources/activities and substances in ZLZ. Shaded risks are such that they require mitigation measures in order to reduce risk.

Medium to high risk is associated with the supply and maintenance of aircrafts. The construction of the drainage system for collecting fluids that drain from the roads, runway, taxiways and aprons is planned, as well as ensuring an adequate treatment of wastewater before surface water leaves the airport location.

Above-ground fuel tanks, that are used, are set in the tank vans that can accept entire amount of fuel in a manner which allows discharge in the environment. In the event of commissioning the overhead tank of 5000 m^3 or in case of his modifications, prescribed with safety measures will have to be applied.
In the case of construction of the hydrant system for aircraft supply on the NPT, it is also necessary to use the technology and equipment that will prevent discharge in the soil/water (choice of materials, methods of installation, the installation of preventive equipment, additional corrosion protection).

Biodegradable resources Safeway and Safewing and urea are used in ZLZ in order to defrost runways. Some of these resources due to improper use or damages to the tanks can penetrate the soil and threaten groundwater quality. But as these are degradable resources, and urea is used as a fertilizer, the biggest parts of it will biodegrade in the soil, so the risk of possible impacts on groundwater is objectively very small.
A part of negative impacts on the quality of groundwater may occur due to spillage of aviation fuel as the result of aircraft accident. Location of accident can be in location where there are no protected areas and pollution is serious. A similar conclusion applies to the fuel tanks. In this context, fire will reduce the damage from the spill. These dangers are present now, and the construction of the NPT will increase the frequency of manipulation and transport.
Groundwater pollution can occur in the event of leakage of underground tanks and piping of the new power plant.

Table 4.2.13-10 Assessment of the risk of environmental accidents (no fire/explosion) for the most significant sources/activities and substances, NPT

Sources	Substance	Receptors	Way of acting	Type of hazard	Severity of consequences on the receptor	Probability of the event occurrence	Risk classification
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Activities in the airport and maintenance related to aircrafts	All types of fuel, oil, agents for de-icing of the runways (urea), solutions (suspensions), herbicides	Users (workers, passengers, visitors)	Contact with skin, swallowing, breathing in vapour and dust	Harmful to human health	Limited	Less probable	Medium
Roads and parking areas during fuel transportation	Fuels, oil	Users (workers, passengers, visitors)	Contact with skin, swallowing, breathing in vapour and dust	Harmful to human health	Limited	Less probable	Low
		Subcontractors	Contact with skin, swallowing, breathing in vapour and dust	Harmful to human health	Limited	Less probable	Low
		Public	Contact with skin, swallowing, breathing in vapour and dust	Harmful to human health	Limited	Less probable	Low
		Soil	Penetration of hazardous substances, direct contact	Soil pollution	Severe	Probable	Medium to High
		Groundwater	Penetration of hazardous substances	Groundwater pollution	Severe	Probable	Medium to High
		Facilities in the airport	Hazardous chemicals effect, vapours and gases in the air	Hazard to buildings, service equipment and human health	Limited	Less probable	Low
Supply and maintenance of road vehicles	Fuel, oil, chemical agents	Users (workers, passengers, visitors)	Contact with skin, swallowing, breathing in vapour and dust	Harmful to human health	Limited	Less probable	Low

Sources	Substance	Receptors	Way of acting	Type of hazard	Severity of effects on the receptor	Probability for the event occurrence	Risk classification
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
		Subcontractors	Contact with skin, swallowing, breathing in vapour and dust	Harmful to human health	Severe	Less probable	Low to Medium
		Public	Contact with skin, swallowing, breathing in vapour and dust	Harmful to human health	Limited	Less probable	Low
		Soil	Penetration of hazardous substances, direct contact	Soil pollution	Severe	Probable	Medium to High
		Groundwater	Penetration of hazardous substances	Groundwater pollution	Severe	Probable	Medium to High
		Facilities in the airport	Hazardous chemicals effect, vapour and gases in the air	Hazards for buildings, service equipment and human health	Limited	Probable	Medium
Power plant operation	Fuel, oils	Users (workers, passengers, visitors)	Contact with skin, swallowing, breathing in vapour and dust	Harmful to human health	Weak	Slihtly probable	Low
	Fuels in Fuels in tanks	Soil	Penetration of hazardous substances , direct contact	Soil pollution	Severe	Probable	Medium to High
	Fuels in underground tanks	Groundwater	Penetration of hazardous substances	Groundwater pollution	Severe	Probable	Medium to High

CONCLUSION

Hazards of environmental accidents that exist at the present ZLZ are the same as those observed for the observed intervention NPT. The expansion will increase the frequency of actions and quantity of storing dangerous substances.

Hazards and risks associated with fire/explosion of flammable substances were taken into consideration, such as liquid and gas fuel, dangerous cargo and other flammable chemicals used in airports. Serious consequences of fire/explosion are caused by the use of large amounts of fuel for aircrafts, road vehicles and power plants. Their use involves supplying fuel tanks on location ZLZ, storage, handling, and transportation to the aircraft, pouring in the aircraft, aviation fuel tanks, take-off and landing. Among others, the following items were also assesses: probability of an accident relating to fuel discharge from the aircraft, the action scopes and effects on passengers (based on peak hours), environment and property.

All types of fuel are a real danger to the contamination of soil and groundwater in the case of uncontrolled spills. The importance of the consideration of this hazard is particularly important due to the fact that the project is located within the well field, and the soil is very porous.

Analysis of risks associated with these hazards found it necessary to implement technical and organizational measures in accordance with the best available techniques and legislation. This includes forecasting and implementation of security measures at all stages, from development of project documentation, detailed design, equipment supply, works and their future implementation, maintenance and control. Organizational measures are working to develop operational and security procedures, documented monitoring, analysis responsibilities and staff training. This will reduce the risk of accidents to acceptable.

The possible impact of the planned project due to extraordinary events during use was assessed as **slightly significant negative impact on the environment (C).**

4.2.14. Risk Assessment for an aircraft accident

4.2.14.1. Introduction

Safety is conditional and generally a major factor of air transport functioning, including airport operations segment. Safety is a condition, principle and objective of the air traffic control system. Responsibility for the implementation of security measures at airports, especially regarding safety management systems, is inherent to all levels of management in an integrated system of air traffic, as well as to the employees at the airport and implies the organizational, technological and operational implementation of all business processes in a manner and in accordance with the relevant national legal acts based on:

- Standards and recommendations of the International Civil Aviation Organization (ICAO), and
- Directives and regulations of the European Commission (EC).

The content of this paper is to assess security risk in the area of Zagreb airport and its immediate environment on the basis of:

- status of compliance of existing facilities on operational areas with the Zagreb airport with the provisions of Annex 14 of ICAO [1] and the Regulations on airports [2], and
- projections of the need to build a second runway in 30 to 40 years, according to the revised Development Plan of the Zagreb airport (Master Plan) [3], which defines not only the largest annual number of passengers that may be received and dispatched using one (existing) runway (Table 4.2.14-1), but also the dynamics of the five-year growth in passenger traffic by 2030 (Table 4.2.14-2):

Table 4.2.14-1: Planned number of required airport runways (USS) with respect to the total annual number of passengers

PLANNED NUMBER OF THE RUNWAYS	PLANNED TOTAL ANNUAL NUMBER OF PASSENGERS
1	10.000.000
1	15.000.000
2	30.000.000
2	40.000.000

Source: Zagreb International Airport Master Plan Update 2008, Report, Project Airport GmbH, Stuttgart, 2009.

Table 4.2.14-2: Planned annual passenger traffic at the airport in Zagreb until 2030

YEAR	TOTAL PLANNED ANNUAL NUMBER OF PASSENGERS
2010.	2.143.015
2015.	3.261.781
2020.	4.235.952
2025.	5.163.740
2030.	6.038.399

Source: InterVISTASConsulting Group

4.2.14.2. Safety

The ICAO's Handbook of safety management [4] defines Safety as a condition in which the probability of injury to any person or damage has been reduced to an acceptable minimum sequence of systematic and continuous hazard identification) and risk management.

The provisions of the Aviation Act define the obligation to develop the State Safety Programme and the National Aviation Security Plan articulates a Safety Management System as the foundation of the policy of aviation safety.

Safety Management System (SMS) includes integrated organization of the safety management, the incorporation of safety operations in all processes relating to aviation operations. In terms of a proactive approach to security, this results in a systematic, explicit and in details specified risk management process.

ICAO Annexes require implementing of SMS by all operators - providers of services relating to air traffic control (ICAO Annex 11), the airport operators (ICAO Annex 14), airlines (ICAO Annex 6, Part I, II and III), organizations for aviation personnel training (ICAO Annex 1), and aircraft maintenance organizations (ICAO Annex 6, Part I).

At the global level in the field of air traffic control, the implementation of SMS sis standardised by the provisions of ICAO Annex 11 while on a European level the further establishment of SMS is standardized by the Joint Requirements (EC Regulation 2096/2005) of the Single European Sky by which ESARR 3 and ESARR 4 (Eurocontrol Safety Regulatory requirements) requirements for national air traffic control systems (Air navigation Service) are adopted.

Manual on the ICAO Safety Management [4] provides general guidance for the implementation of SMSs that are globally accepted by the aviation community. In accordance with these guidelines, the national regulator (CCAA) has defined a framework for the establishment of an SMS service provider [6].

The International Civil Aviation Organization had standardized the establishment of a safety management system in operative air traffic and established phased implementation of proactive safety management concepts. The scientific theory proactive concept precedes predictive and generative conception of security management, and the instruments of this transition are marked by specificums of certain developmental stages - from the development of a safety culture, through the failures management to risk management system.

The issue of establishing and improving the safety management system in air traffic operations has been further complicated by the lack of standard methodology for metric defining of safety indications, which should be the basis of continuous monitoring and improvement of safety. The methodology of the evaluation and optimization of the safety indications and operative performance in air traffic and applicable software tools are not postulated neither on the regional nor the national level. Therefore, the choice and development of applicable methods for achieving security goals is delegated to the level of the operator. ICAO allows the use of all methods that counteract the implementation frameworks set out in the manual on SMS.

The transition of security management system from the traditional, so-called reactive system to a proactive safety management system is implemented in a way of identifying potential hazards that could endanger the safety analysis of the risks associated with potential hazards, and the application of appropriate procedures for risk management. System for assessing the security situation should include the following elements:

- Procedures for the identification of potential hazards
- Procedures for risk management,
- Continuous monitoring / quality assurance.

Identifying risk is the process of identifying all potential situations that could result in personal injury, partial or complete destruction of equipment and/or any disability relating to proper execution of the function.

Identifying potential hazards is achieved by internal mechanisms for reporting irregularities, programs for monitoring flight data and systems for evaluating the safety of operations.

Risk management procedures are proactively defined activities whose main task is maintaining the proper level of security in situations of potential danger. The basic elements that contain procedures for risk management are:

- Risk Analysis
- Risks Assessment
- Risk Control
- Risk Monitoring.

In order to ensure the effectiveness of proactive measures for security management it is necessary to continually monitor and analyze remedial actions through internal audits.

Dynamics of air traffic development shows the need of introducing a predictive safety management system following the definition of a reference parameter with the acceptable level of safety as a minimum level of security, which also represents the quality of the system and is expressed by safety indicators.

Extraordinary events at the airport

In accordance with section 9.1 of Annex 14 of ICAO [1], and Section 2.1 of the ICAO's Manual on airport services [6], as well as the Article 178 Regulations on airports [2], the airport operator is required to prepare a plan of measures and procedures in case of the following emergency categories:

- Aircraft accident in the area of the airport,
- Aircraft accident outside the airport - near the airport, at a higher distance from the airport - on land; water,
- Malfunction of the aircraft during the flight;
- Unlawful interference with air traffic,
- Sabotage, including the explosive device threat,
- Illegal hijacking of the aircraft,
- a fire at the airport - indoors; outside the building in the open space
- Accident at the airport,
- Event dangerous to public health (for example: an epidemic of infectious disease)
- Natural disaster.

4.2.14.3. AIRCRAFT ACCIDENTS NEAR THE AIRPORT

Share of aircraft accidents in the vicinity of airports statistically refers according to the phases of flight and given the location of the accident in relation to the location of the runway (figures 4.2.14 to 4.2.14-3-10).

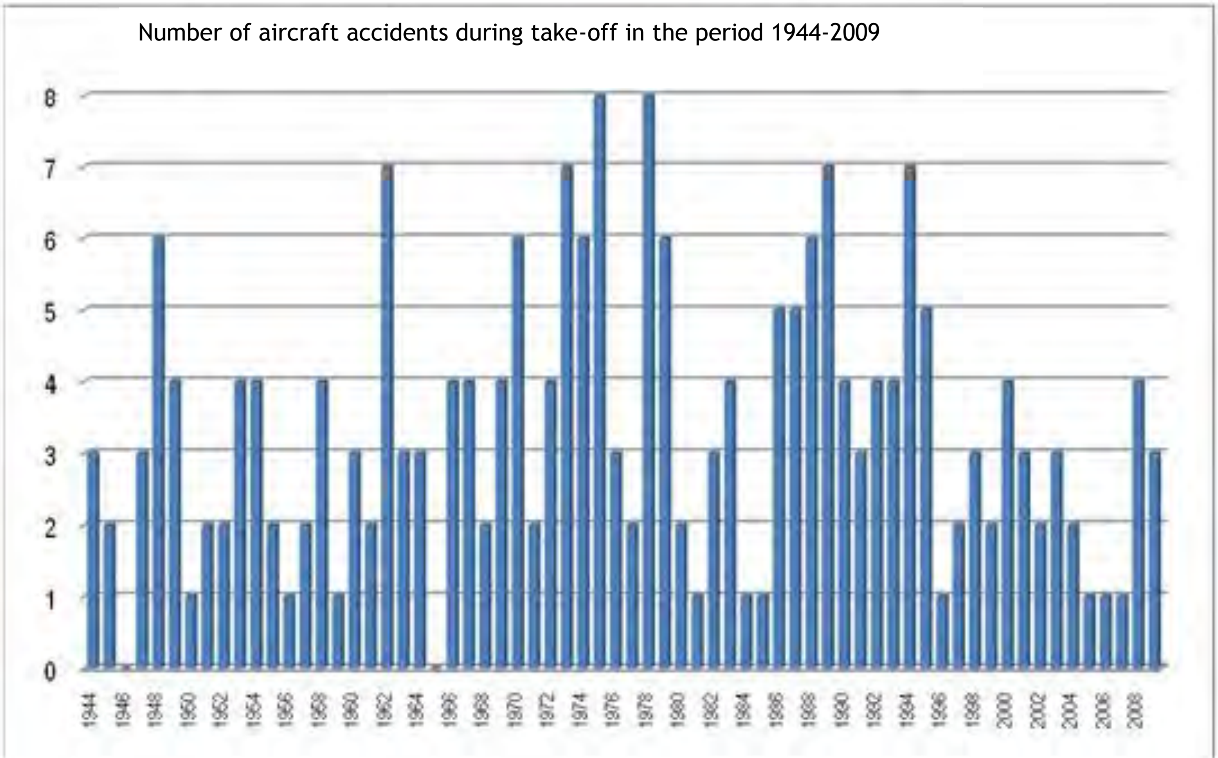


Figure 4.2.14-3: Statistics of aircraft accidents during take-offs, 1944-2008
Source: http://aviation-safety.net/statistics/phase/

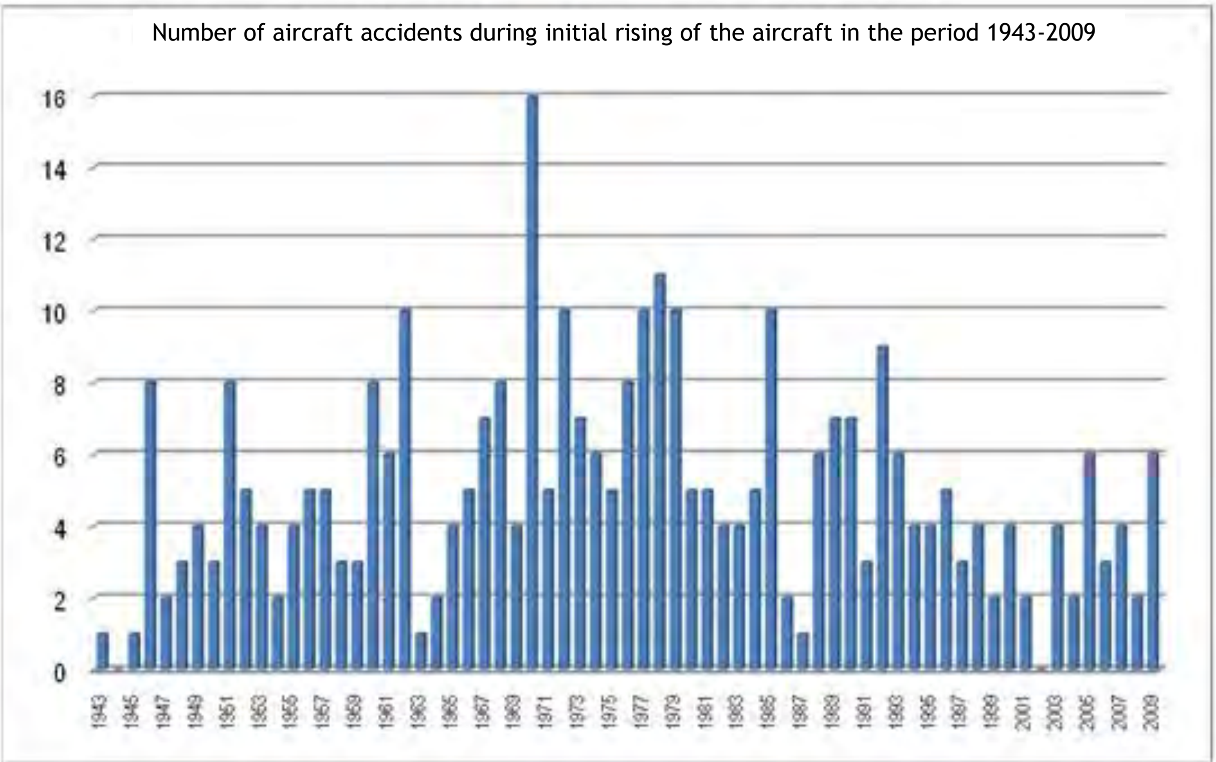
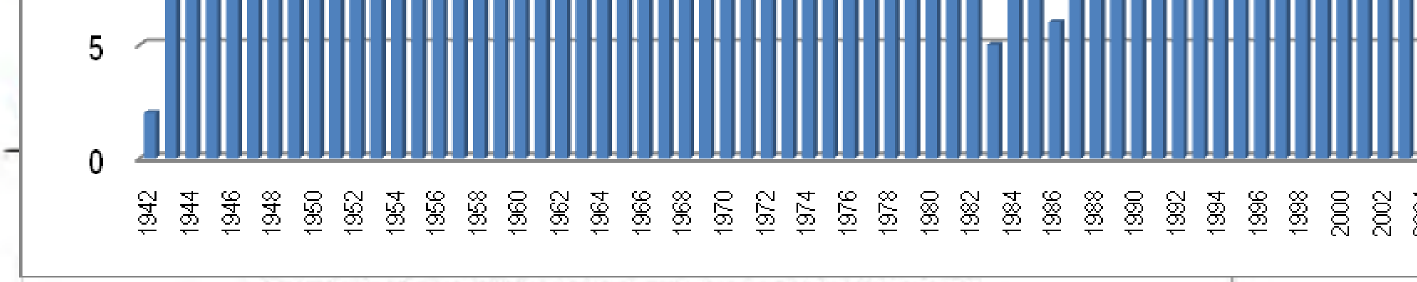


Figure 4.214-4: Statistics of aircraft accidents during take-offs, 1943-2009



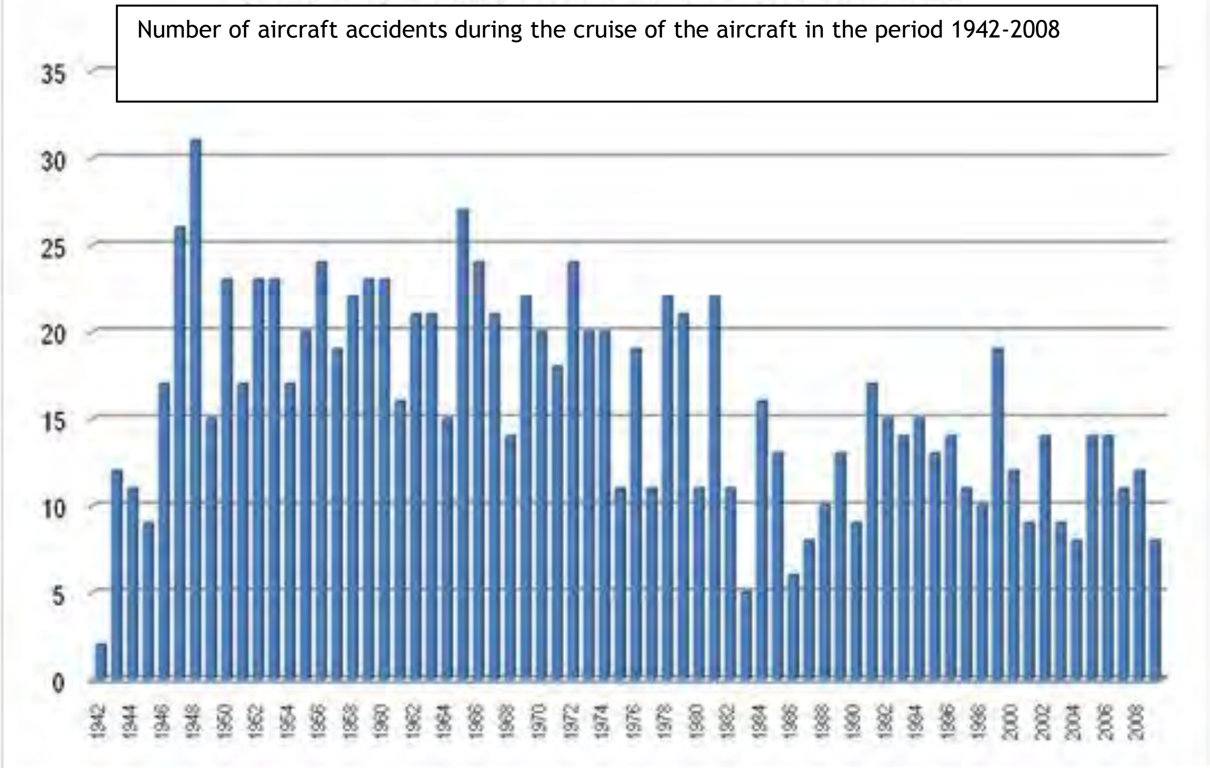


Figure 4.2.14-5: Statistics of aircraft accidents during the cruise of the aircraft, 1942-2008
Source: Ibid.

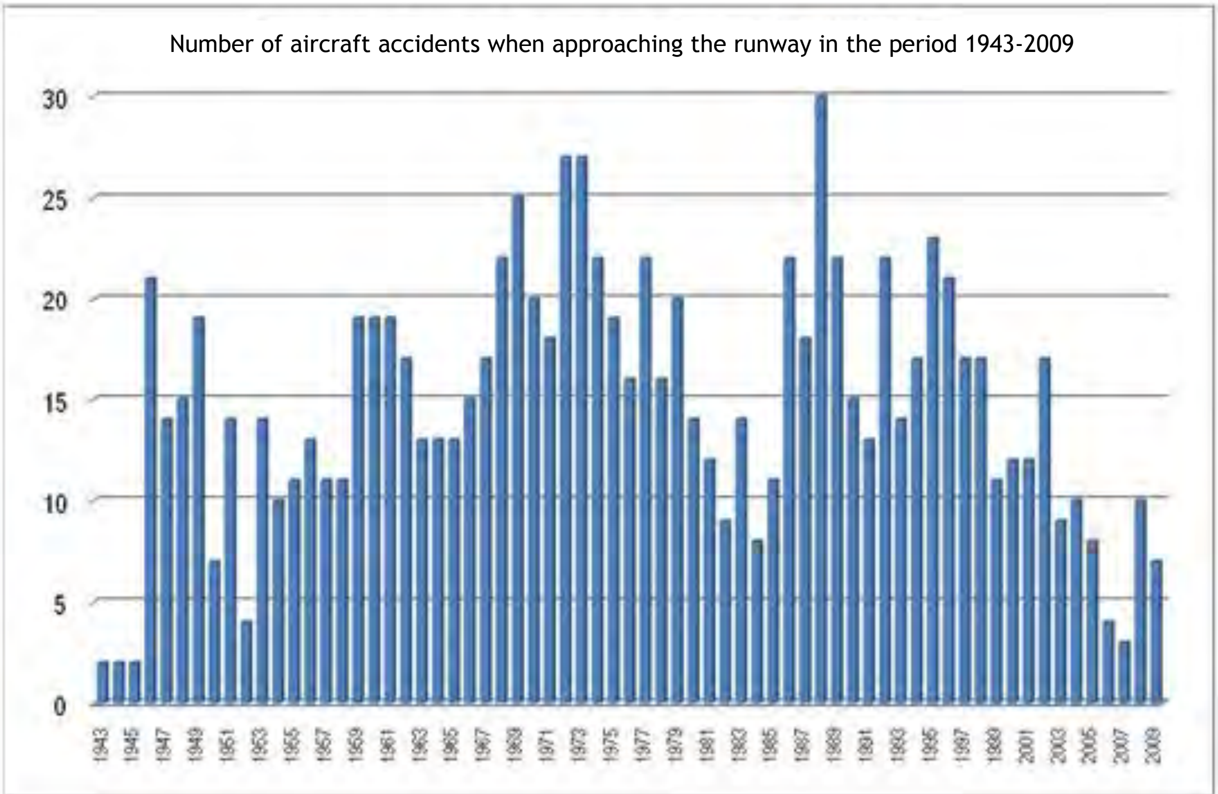


Figure 4.2.14-6: Statistics of the aircraft accidents when approaching the runway, 1943-2009. *Source: Ibid.*

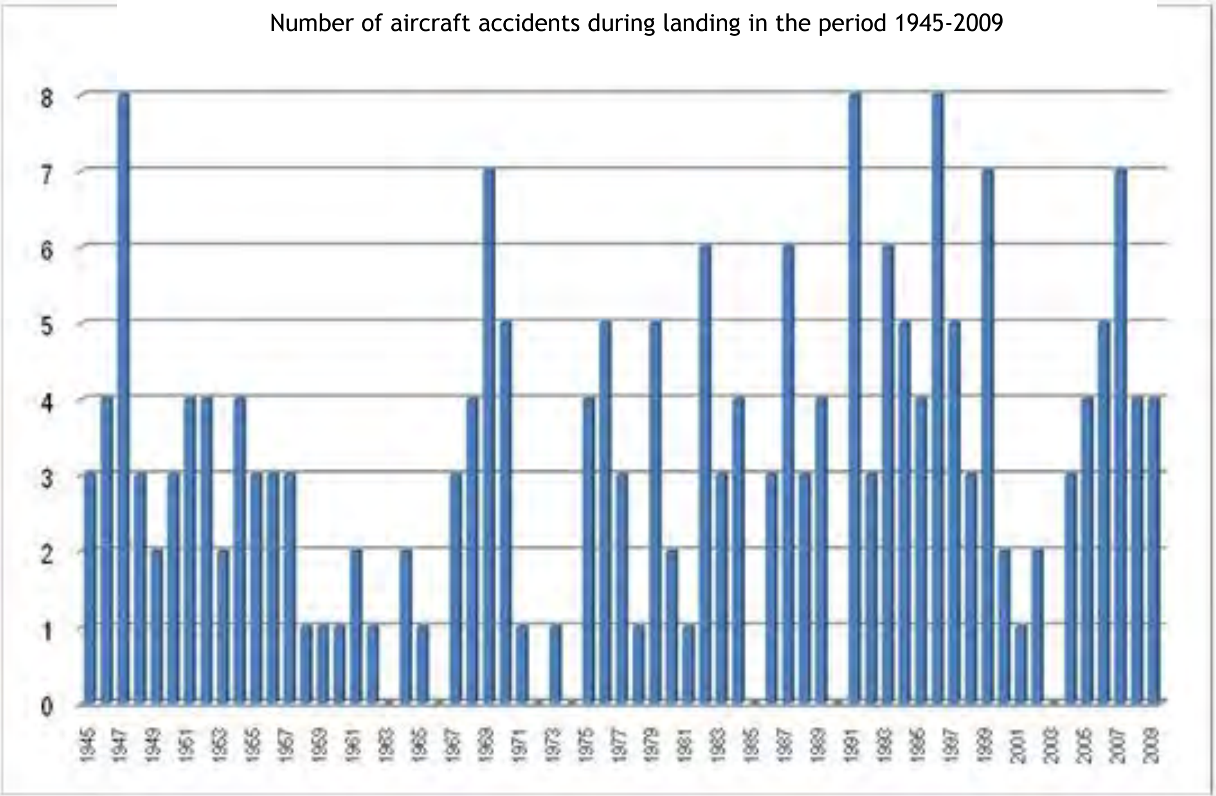


Figure 4.2.14-7: Statistics of aircraft accidents during landing, 1945-2009
Source: Ibid.

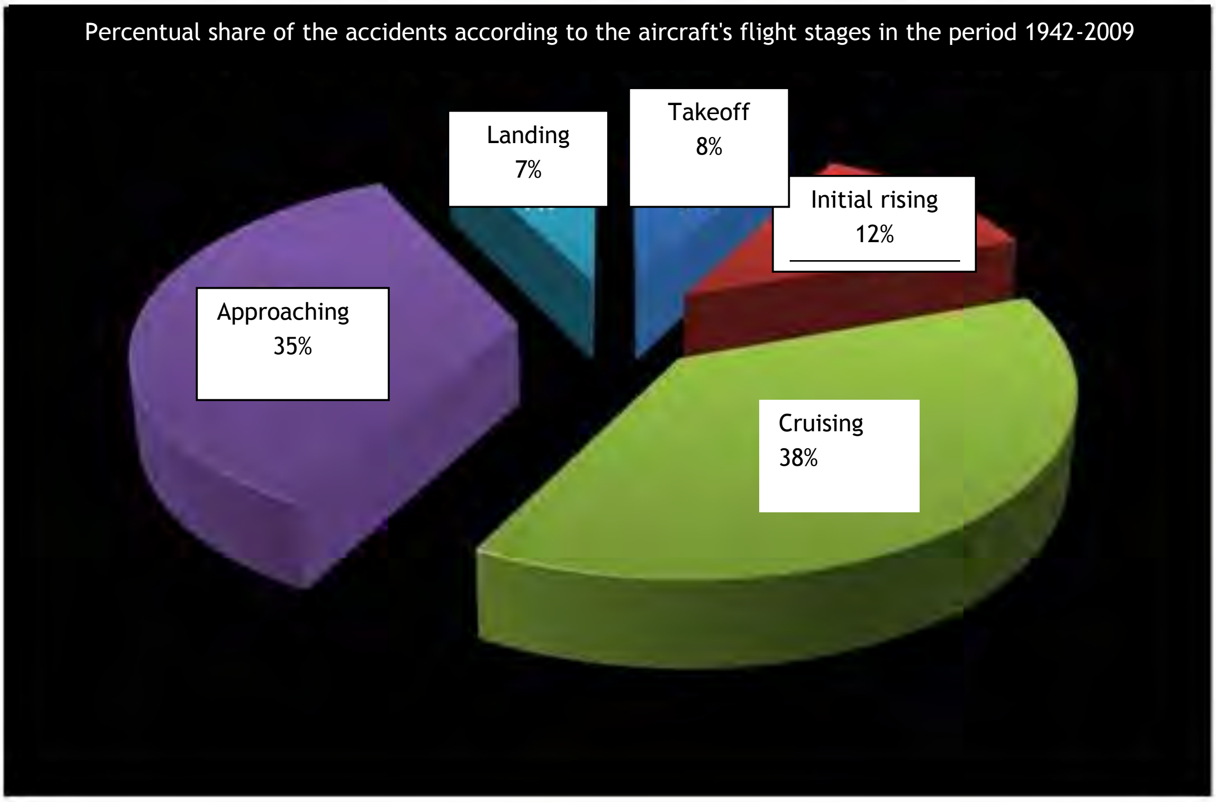


Figure 4.2.14-8: Segmentation of aircraft accidents per flight stages 1942-2009
Source: Ibid.

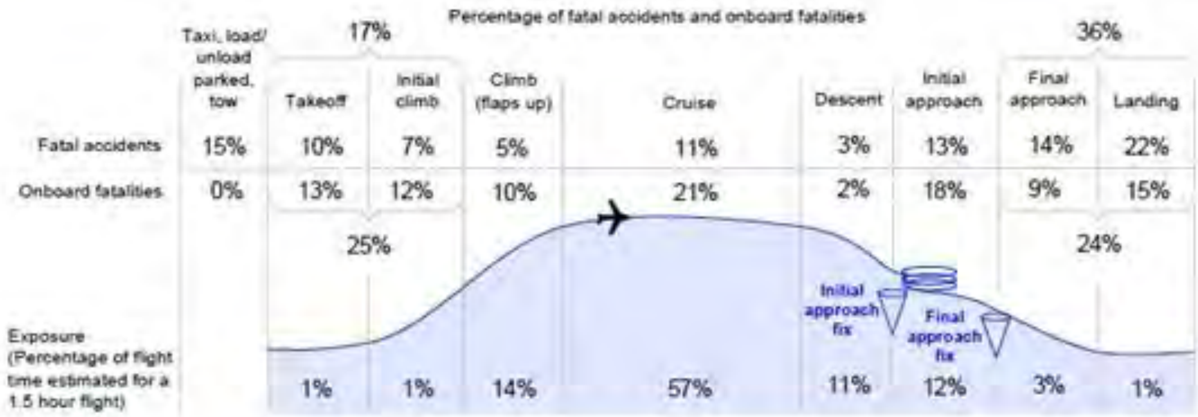


Figure 4.2.14.-9: The distribution of accidents and deaths with regard to phase of the flight, 2001-2010
Source: Boeing Statistical Summary of Commercial Jet Airplane Accidents
http://www.boeing.com/news/techissues/pdf/statsum.pdf

While the data on the percentage of all accidents in the world according to phases of flight, shown in Figures 3-8 differ slightly from the data shown in Figure 4.12.14-9 due to the different time coverage to which these data refer to, it can be concluded that both data sources confirm that most of the accidents occurred in the initial and final phases of flight profile:

- Final approach to the runway and landing (42% in Figure 4.12.14-8 and 36% in Figure 4.12.14-9), and
- Take-off and initial rising (20% 4.12.14-8 and 17% in Figure 4.12.14-9).

Figure 10 shows the results of analysis of the locations of aircraft accidents near runway on a sample of 459 accidents that have occurred till 2008 in the U.S., Canada, Western Europe, Australia, New Zealand and several countries in Asia.

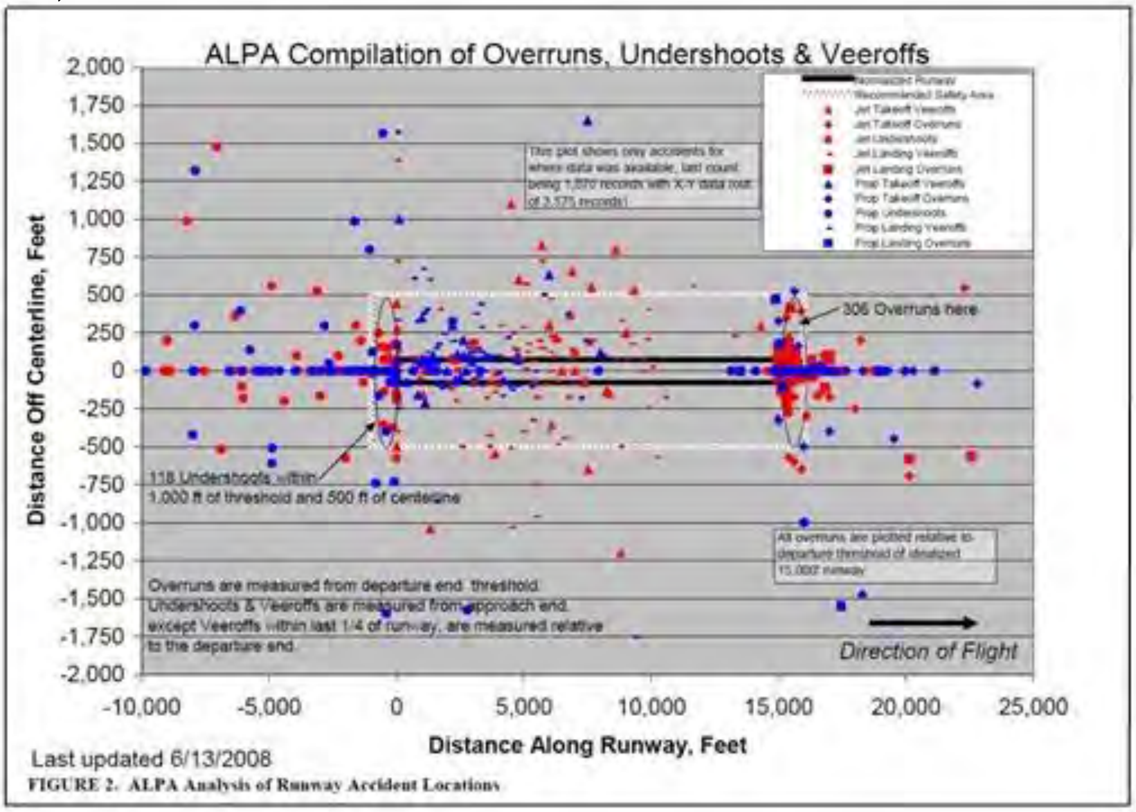


Figure 4.2.14-10: Graph of aircraft accidents relating to the runway
(Source: http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_027AircraftAccidentData.pdf)

The ALPA location analysis of aircraft accidents in relation to the position of the runway, prepared by the Experts at Loughborough University, excluded single-engine aircrafts and aircrafts with a reciprocating engine. The survey covered only the operation of the aircrafts with fixed wings according to FARs (Federal Aviation Rules), 121, 125, 129 and 135, part of the operation of general aviation with fixed wings according to FAR 91, and during which the aircraft:

- hit the surface in front of the runway when landing (Landing Undershoot): 93 recorded cases,
- flew off the runway USS when landing, passing behind the runway (Landing Overrun): 274 recorded cases,
- flew off the runway USS during take-off, passing behind the runway (Take-off Overrun): 92 recorded cases.

Aviation Engineering Department of the Federal Aviation Administration (FAA Airport Engineering Division) keeps a database of 1708 aircraft accidents with the most severe consequences (Table 4.2.14-3) that occurred in the U.S. in the period between 1982 and 2005, and during which the aircraft:

- flew off the runway, passing behind the runway (Overrun Events): 618 recorded cases,
- flew off the runway, turning on the left or the right side (Veeroff Events): 811 recorded cases,
- hit the surface beyond (behind) the runway (Chrashes beyond the Runway End): 279 recorded cases

Table 4.2.14.-3: Categorisation of accidents per aircraft flight stages according to the FAA database

	Aircrafts operations pursuant to FARs				
FLIGHT STAGE	PART 91	PART 121	PART 129	PART 135	OSTALO
Overrun-Arrival	277	76	5	43	2
Overrun-departure	160	19	1	34	1
Veeroff	741	27	-	34	5
Veeroff / Overrun-Arrival	2	-	-	2	-
Crash beyond Runway-Arrival	30	-	-	2	-
Crash beyond Runway-Departure	222	6	1	18	-
TOTAL:	1.432	128	7	133	8

Source: http://onlinepubs.trb.org/onlinepubs/acrp/acrp_rpt_027AircraftAccidentData.pdf

Given the lack of national statistics and databases, in order to identify potential safety hazards and to define the indicators for assessment of the risk of possible accidents or incidents in the Zagreb airport or in its vicinity, specified databases and available research results are used to update the input data in this paper.

This primarily relates to the definition of the operational area and related facilities at the Zagreb airport, and the identification of:

- Conformity of these areas and related facilities with the requirements of ICAO Annex 14 and Regulation on airports, in order to assess the severity of risk, and
- The total number of accidents and incidents that have occurred on the operational areas and associated facilities or in their neighbourhood, in order to assess the probability of risk.

4.2.14.4. Normative measure - public safety zone

The previous section assessed the security risk of the potential negative impact on the immediate surrounding of the Zagreb airport, incurred due to accidents or incidents that occur on the area of the airport and associated surface:

- Basic tracks of the runway (Strip)
- Safety surfaces on the end of the runway (RESA) and
- Clearway.

Risk assessment relating to the potential negative impact on the immediate surrounding of the Zagreb airport, occurred due to accidents or incidents on these surfaces, is required due to the following statistical indication that approximately 70% of all documented accidents in civil aviation happened exactly on the airport manoeuvring area and corresponding primary track of the runway and safety area at the end of the runway (Figure 4.2.14-9). In so doing, the estimated risk is defined within the acceptable limits, based on the fact that the basic track of the runway and safety area at the end of the runway are defined in order to maximize protection of the area in the immediate vicinity of the airport from the negative impact of aircraft accidents that have mostly occurred precisely in this area during the landing or take-off.

However, how can we protect the wider area surrounding the airport, 4-5 kilometres from the runway, on which around 30% of all civil aircraft accidents have happened? With the aim of solutions to this problem, a number of Western European countries defined Public Safety Zones in which the construction of new facilities is completely prohibited and partly limited, in order to minimize the consequences of an aircraft accident. The definition of public safety zones has been developed on assessing the individual risk relating to third parties.

Public safety zones are not defined in Annex 14 of ICAO, and in accordance with this fact they are not defined in the Airports Ordinance, which means that the formal legal definition and protection of these zones in Croatia is not compulsory.

However, based on the fact that most of the developed countries in their legal regulations introduced public safety zones, such as the UK and the Netherlands, this section shall define public safety zone for directions 05 and 23 of the runway at the Zagreb airport, according to the model applied to a sample of airports in the UK (*source: Evans, AW, Foot, PB, Mason, SM, Parker, IG, Slater, K.: Third party risk near airports and Public Safety zone policy, National Air Traffic Services Ltd London, 1997)*.

Individual risk assessment methodology, applied in this study, consists of three main elements:

- Crash Frequency: annual probability of a crash occurring near airport,
- Crash Location Model: the distribution of such crashes with respect to location,
- Crash Consequence Model: the size of the crash area and the proportion of people probable to be killed within this area.

The annual assessment for the Crash Frequency of the airport is the result of multiplying:

- The number of aircraft's activities (landing or take-off) on the specified airport within a calendar year,

- Crash Rate, which is defined as the ratio of the number of accidents and the total number of aircraft operations in a given period (number of accidents/number of operations = crash rate).

Thus, (the annual sum of aircraft operations per groups) x (annual crash rate) = (annual estimate of the crash probability). Methodologically, it is important to group aircrafts by specific categories and calculate the probability of the crash for each group (category) of aircrafts. The sum of the probability of a crash per groups (category) of aircrafts is then divided by the total number of aircraft operations of all groups (categories) in order to obtain the average estimated probability of aircraft accidents (crashes) of all groups together.
The probability of aircraft crashes locations anticipates results of the analysis of all documented locations of aircraft crashes in relation to the position of the runway and associated landing and take-off planes. The study "Third Party Risk Near Airports and Public Safety Zone policy" implements two models:

1. The analysis of 354 aircraft crash locations. where the maximum permitted take-off mass (MTOM) is greater than 4000 kg. The analysis was made by the experts of *National Air Traffic Services Ltd. (NATS)* and it represents a mathematical calculation of probability for the location of future crash, based on the location of 354 analyzed crashes. NATS model implies a division into four categories, so-called *"probability density functions "(pdf)*, which represent the (spatial) distribution of crashes relating to a phase of the flight:
   - ✓ Overruns of the aircrafts due to the inability of stopping during landing (*Landing Overruns*),
   - ✓ Aircraft's crash during landing on the surface in front of the runway (L*anding Non-Overruns*),
   - ✓ *Take-off Overruns*,
   - ✓ *Take-off Non-Overruns*.
2. The AEA analysis of locations of light aircraft accidents where the average maximum permitted take-off mass is less than 2300 kg, adapted for the aircrafts for which the maximum average permitted take-off mass is less than 4000 kg. Given that the AEA analysis model does not distinguish accidents during landing from accidents during take-off stage, it actually presents an analysis of all accidents that occurred during landing and take-off stages.

Within the NATS model, Probability *Density* Function is comprised of two elements:

- Longitudinal Crash Distribution which spreads in the direction of extended centre line of the runway $f_y(y)$,
- Lateral Crash Distribution, which spreads vertically on extended central line of the runway and taking into consideration that it is necessary to determine the distance from the runway threshold, is defined as $f_{x|y}(x,y)$.

In accordance the basic model elements, set in this way, the two-dimensional probability density function) is calculated as follows:
$F(x,y) = f_y(Y)\, f_{x|y}(x,y)$

For each group of accidents, in relation to the flight stage, probability density function algorithm is derived:

Table 4.2.14-4: Aircraft accident during landing on the surface in front of the runway (Landing NonOverrun Crashes)

	$f_{LI}(x,y) = pf_y(y)\ f_{x\|y}(x,y)$		**(y>0)**
	$f_{LI}(x,y) = (1-p)\ f_y(y)\ f_{x\|y}(x,y)$		(y<0)
where	$f_y(Y) = ab\|y\|^{a-1} \exp(-b\|y\|^{a})$	for every	$(y\neq0)$
	$f_{x\|y}(x,y) = gh\|x\|^{g-1}\|y\|^{gc} \exp(-h\|x\|^{g}\|y\|^{gc}) / 2$	for every	$y\neq0,\ x\neq0$

where:

a = 0,636
b = 0,00620
c = -1,006
g = 0,482
h = 3,156
p = 0,306

Source: „Third party risk near airports and public safety zone policy“

Table 4.2.14-5: Aircraft accident upon take-off (Take-off Non-Overrun Crashes)

	$f_{TI}(x,y) = pf_y(y)\ f_{x\|y}(x,y)$		**(y>0)**
where	$f_y(Y) = r \exp(-r\|y\|)$		
and	$f_{x\|y}(x,y) = mn\|y\|^{mc}\|x\|^{m-1} \exp(-n\|y\|^{mc}\|x\|^{m}) / 2$		$x\neq0$
while	$f_{TI}(x,y) = (1-p)\ f_y(y)\ f_{x\|y}(x,y)$		$(y\leq0)$
where	$f_y(Y) = b \exp(-b\|y\|)$		
and	$f_{x\|y}(x) = gh\|x\|^{g-1} \exp(-h\|x\|^{g}) / 2$	for every	$x\neq0$

where:
b = 0.000769
c = -0.534
g = 0.628
h = 0.0367
m = 0.434
n = 0.615
p = 0.597
r = 0.000769

Source: „Third party risk near airports and public safety zone policy“

Table 4.2.1-6: Flying out of aircraft from the runway due to the inability to stop during the landing *(Landing Overrun Crashes)*

	$f_{LO}(x,y) = f_y(y)\ f_{x\mid y}(x,y)$	**(y>0)**
where	$f_y(Y) = y^{a-1}b^a \exp(-by) / \Gamma(a)$	
and	$f_{x\mid y}(x,y) = ghi^{gc}\ \lvert x\rvert^{g-1}\ \exp(-h\lvert x\rvert^{g} y^{gc}) / 2$	

where:

a = 4.306
b = 0.00229
c = 0.558
g = 0.846
h = 0.00145

Izvor: „Third party risk near airports and public safety zone policy“

Table 4.2.14-7: Flying out of aircraft from the runway due to the inability to stop during the take-off (Take-Off Overrun Crashes)

	$f_{TO}(x,y) = p\ f_y(y)\ f_{x\mid y}(x,y)$	**(y>0)**
	$f_{TI}(x,y) = (1-p)\ f_y(y)\ f_{x\mid y}(x,y)$	(y<0)
	$f_y(Y) = y^{a-1}b^a \exp(-by) / \Gamma(a)$	
where, for both cases:		
	$f_y(Y) = b \exp(-b\lvert y\rvert)$	
and		
	$f_{x\mid y}(x,y) = k\ \lvert y\rvert^{c}\ \exp(-k\lvert x\rvert\ \lvert y\rvert^{c}) / 2$	

where, for y>0:

b = 0.00303
c = 0.664
k = 0.000919
p = 0.813

and for y<0:

b = 0.000727
c = -0.312
k = 0.123
p = 0.813

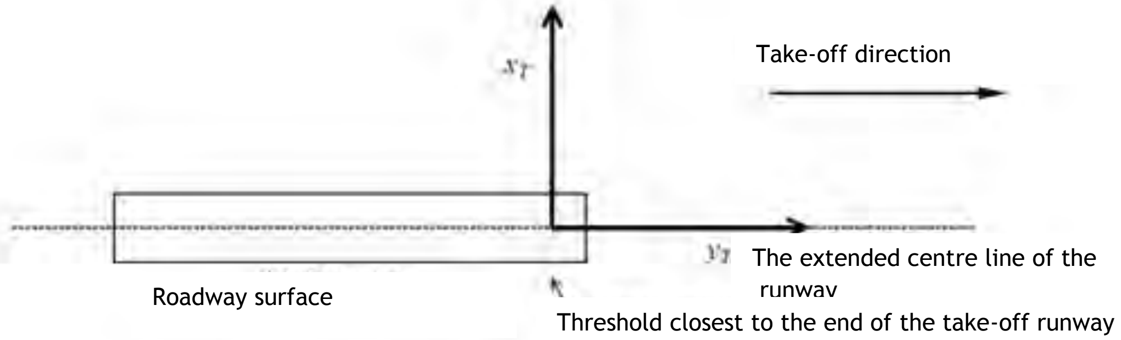
Source: „Third party risk near airports and public safety zone policy“

The AEA model, adjusted for the aircraft with the maximum permissible take-off mass (MTOM) less than 4000 kg, calculates the distribution of accident locations (Probability Density Function) of aircraft as follows:

$$f_{<4.0}(r, \theta) = 0.08 \exp(-r/2.5) \exp(-3\theta/\Pi)$$

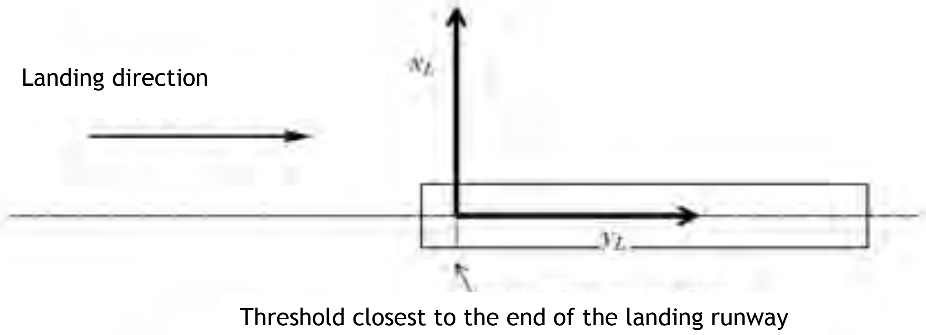
where r is the distance from the end of the runway expressed in kilometres and θ angle relative to the extended centre line of the runway expresses in degrees

The figures 4.2.14-11 and 4.2.14-12. illustrate NATS model and the figure 4.2.14-13 shows graphic AEA distribution model for crash locations.



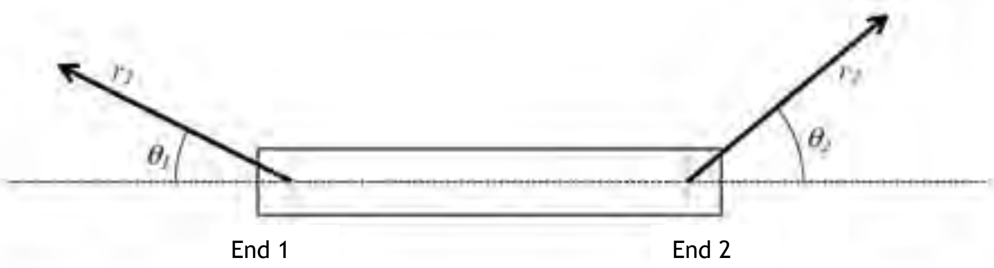
a) COORDINATE SYSTEM DEFINED FOR TAKE-OFF CRASHES

Figure 4.2.14-11: Graphic illustration of the NATS distribution model of aircraft accident sites with MTOM exceeding 4000 kg during take-off
Source: „Third party risk near airports and public safety zone policy“



b) COORDINATE SYSTEM DEFINED FOR LANDING CRASHES

Figure 4.2.14-12: Graphic illustration of the NATS distribution model of aircraft accident sites with MTOM exceeding 4000 kg during landing
Source: „Third party risk near airports and public safety zone policy“



c) COORDINATE SYSTEM DEFINED FOR LIGHT AIRCRAFT CRASHES

Figure 4.2.14-13: Graphic illustration of the NATS distribution model of aircraft accident sites with MTOM exceeding 4000 kg during landing and take-off
Izvor: „Third party risk near airports and public safety zone policy“

The sequential model of the accident, which was developed by the NATS experts, is based on the following assumptions:

- Site area that will be affected by the plane crash is in direct relation to the mass of the aircraft, therefore, the greater the (crashed) aircraft, the greater surface of the crash location of accident,
- All persons who happen to be in that location at the time of the crash will be fatally injured (death).

It is important to emphasize that ultimately defined location of the presumed crash area, given the different categories of aircraft landing and take-off from a particular airport, is caused by the mass (of the category) of the aircraft that have the highest number of operations in the analyzed period. Also, it is important to emphasize that resulting crash model is significantly conditioned by:

- Characteristics of the site, such as degree of urbanization, the presence of the hospitals or schools ... or similar facilities that are intended for great number of people, for which a mathematical calculation assumes high probability that aircraft crashes can happen precisely at this location,
- Number of casualties in previous crashes, on which the model was developed.

The survey *„Third party risk near airports and public safety zone policy“* shows the results of a number of different analysis models of consequential crashes, which were carried out on a different sample of analyzed crashes and which have been developed by the expert teams of RAND, Technica, AEA, NLR and NATS . The most important input data, on which the analysis was conducted, as well as their results, have been updated in the following tables.

Table 4.2.14-8: Analyzed resulting models of aircraft accidents

MODEL	ANALYSED ACCIDENTS NUMBER	FLIGHT PHASE	ROUTE VARIATION
Technica 1990 &1994	Unknown	Take-off	Yes
		Landing	
AEA 1991	121	Take-off	No
		Landing	
RAND 1993	53	No difference	Yes
NLR 1993	181	Take-Off Non Overruns	Yes
		Landing Overruns	
		Landing	
NATS 1996	354	Take-Off Overruns	No
		Take-off	
		Landing Overruns	
		Landing	

Source: „Third party risk near airports and public safety zone policy“

When it comes to specific groups of jet aircraft, the model defines categories based on division authorised by the experts of the Boeing aircrafts manufacturer.

Table 4.2.14-9: Classification of jet aircrafts

CATEGORY	AIRCRAFT TYPE
I	AEROSPATIALE CARAVELLE BAe COMET BOEING 707/720 GENERAL DYNAMICS CV880 GENERAL DYNAMICS CV990 McDONNELL DOUGLAS DC-8
II	BAe (BAC) ONE-ELEVEN BAe (HS) TRIDENT BAe (VICKERS) VC-10 BOEING 727 BOEING 737 100/200 DASSAULT MERCURE FOKKER F28 McDONNELL DOUGLAS DC-9 VFW 614
III	AIRBUS INDUSTRIE A300 BAe/AEROSPATIALE CONCORDE BOEING 747 LOCKHEED TRISTAR McDONNELL DOUGLAS DC-10
IV	AIRBUS INDUSTRIE A310 AIRBUS INDUSTRIE A320/321 AIRBUS INDUSTRIE A330 AIRBUS INDUSTRIE A340 BAe 146 BOEING 737 300/400/500 BOEING 757 BOEING 767 BOEING 777 CANADAIR REGIONAL JET FOKKER 70 FOKKER 100 McDONNELL DOUGLAS MD11 McDONNELL DOUGLAS MD80

Source: „Third party risk near airports and public safety zone policy“

Table 4.2.14-10: Categories (groups) of turbo-prop aircrafts, designed and delivered for the first time after 1970

CATEGORY	AIRCRAFT TYPE
T1	AEROSPATIALE ATR 42 AEROSPATIALE ATR 72 BAe ATP BAe JETSTREAM 31 BAe JETSTREAM 41De HAVILLAND DASH 7De HAVILLAND DASH 8 DORNIER 228 DORNIER 328 EMBRAER BRASILIA - EMB110 EMBRAER BANDEIRANTE - EMB120 FOKKER 50 SAAB 340 SAAB 2000 SHORTS 330 SHORTS 360

Table 4.2.14-11: Categories (groups) of turbo-prop aircrafts, designed and delivered for the first time before 1970

CATEGORY	AIRCRAFT TYPE
T2	BAe (HS) 748 BAe (VICKERS) VANGUARD BAe (VICKERS) VISCOUNT CONVAIR 540/580/600/640 HANDLEY PAGE DART HERALD De HAVILLAND TWIN OTTER FAIRCHILD F27 FAIRCHILD FH227 FAIRCHILD METRO FOKKER F27 GULFSTREAM 1ž LOCKHEED HERCULES LOCKHEED ELECTRA SHORTS SKYVAN

The results of the RAND analysis for 53 crashes are provided in the Tables 4.2.14-12 and 4.2.14.-13.

Table 4.2.14-12: The mortality rate due to the size of the aircraft and flight phase in which the accident occurred

Structure	AIRCRAFT SIZE	FLIGHT PHASE	MORTALITY (M)
Small	Large	Take-off	0, 90
		Landing	0, 75
	Medium	Take-off	0, 40
		Landing	0, 30
	Small	Take-off	0, 20
		Landing	0, 15
Large	Large	Take-off	0, 50
		Landing	0, 40
	Medium	Take-off	0, 30
		Landing	0, 20
	Small	Take-off	0, 10
		Landing	0, 10

Source: „Third party risk near airports and public safety zone policy“

Table 4.2.1.-13: The area of the crash location regarding the angle of the impact, size of the aircraft and flight stage

ANGLE OF IMPACT	AIRCRAFT SIZE	FLIGHT STAGE	AREA (ha)
Large (sharp) angle of the impact	Large	Take-off	5, 18
		Landing	3, 89
	Medium	Take-off	3, 89
		Landing	2, 59
	Small	Take-off	1, 30
		Landing	1, 30
Small (thud) angle of the impact	Large	Take-off	6, 48
		Landing	5, 18
	Medium	Take-off	5, 15
		Landing	3, 89
	Small	Take-off	3, 89
		Landing	2, 59

Source: „Third party risk near airports and public safety zone policy“

Table 4.2.14-14: Table 27: The results of ACARRE analysis of the crash location

REGULAR AND OTHER FLIGHTS	SURFACE AFFECTED BY THE IMPACT (ha)	SURFACE AFFECTED BY THE FIREBALL EFFECT (ha)	SURFACE AFFECTED BY SMALLER FIRES (ha)
Regular flights	0,95	15,0	4,0
Other flights	0,12	0,5	0,3

Source: „Third party risk near airports and public safety zone policy"

Table 4.2.14-15: The results of the Technica analysis of the crash area (surface)

AIRCRAFT SIZE	LANDING CRASH SURFACE (ha)		TAKE-OFF CRASH SURFACE (ha)	
	Great impact angle	Small impact angle	Great impact angle	Small impact angle
Small	0,20	0,26	0,21	0,37
Medium	0,59	0,69	0,66	0,78
Large	1,65	2,58	1,67	2,81
Intercontinental	1,65	2,58	2,10	4,84

Source: „Third party risk near airports and public safety zone policy"

Table 4.2.14-16: The results of the NLR analysis of the crash area (surface)

MORTALITY	AREA (SURFACE)	AFFECTED AREA (m^2/1t MTOM)
0,30	Built area	200
0,30	Open space	250
0,30	Forests and water surfaces	150

Source: "Third party risk near airports and public safety zone policy"

Table 4.2.14-17: The results of the NATS analysis of the crash area (surface)

DIRECTLY OR INDIRECTLY AFFECTED AREA	CALCULATION	R^2
Surface indirectly hit by the aircraft's parts	Log_e (surface [1]) =-8,53+0,80Log_e (MTOM[2])	29%
Surface directly hit by the impact of the aircraft	Log_e (surface [1]) =-6,36+0,49Log_e (MTOM[2])	8%
[1] *surface in hectares (ha)* [2] *weight in kilograms*		

Source: "Third party risk near airports and public safety zone policy"

Table 4.2.14-18: Comparison of calculated surfaces of the location of accidents on the basis of referent analysis

ANALYSIS MODEL	SURFACE AFFECTED BY AN ACCIDENT (ha)
RAND	3,8
ACARRE	2,0
Technica	2,2
NLR	0,9
Eddowes	0,4
NATS	0,6

Source: „Third party risk near airports and public safety zone policy"

Area shown in the previous table (29) is proportional to the number of deaths in the accident of aircraft type B767. The Technica analysis assumes that 50% of all accidents resulted in aircrafts hitting the ground at large impact angle.

Table 4.2.14-19: Crash rate of jet aircrafts produced in the West for a group of so-called first airports and all airports in the world (OAG data)

	GROUP OF FIRST AIRPORTS			ALL AIRPORTS IN THE WORLD		
Aircrafts category	Aircraft operations [1]	Crashes [2]	Crash rate on 1 mil. operations	Aircraft operations [1]	Crashes [2]	Crash rate on 1 mil. operations
I	4.488.656	5	1,114	7.670.788	20	2,607
II - IV	283.378.066	42	0,148	355.975.396	147	0,413

[1] *Number of operations of passenger aircrafts on regular flights in the period from 1979 to 1995 (OAG data base)*
[2] *Total losses in the period between 1979 and 1995 (Airclaims database)*

Source: „Third party risk near airports and public safety zone policy"

Table 4.2.14-20: Crash rate of turbo-prop aircrafts produced in the West for a group of so-called first airports and all airports in the world (OAG data)

	GROUP OF FIRST AIRPORTS			ALL AIRPORTS IN THE WORLD		
Aircrafts category	Aircraft operations (1)	Crashes (2)	Crash rate on 1 mil. operations	Aircraft operations (1)	Crashes (2)	Crash rate on 1 mil. operations
T1	7.777.804	21	0,270	88.758.754	43	0,484
T2	51.814.954	38	0,733	73.546.590	116	1,577

(1) Number of operations of passenger aircrafts on regular flights in the period from 1979 to 1995 (OAG data base)
(2) Total losses in the period between 1979 and 1995 (Airclaims database)

Source: „Third party risk near airports and public safety zone policy“

Table 4.2.14.-21: Summarized accident rate in groups (categories) of aircraft for the so-called group of the first airports

Aircrafts category	Crash rate on 1.000.000 operations of the aircrafts
Category I (jets)	1,114
Category II - IV (jets)	0,148
Jet aircrafts -eastern production	0,930
Jet aircrafts - business type	0,270
Turboprop T1 aircrafts	0,270
Turboprop T2 aircrafts	0,733
Turboprop - non-classified	0,733
So-called Piston- engine aircrafts	3.000
Other non-commercial aircrafts	3.000
Other non-classified aircrafts	3.000

Source: „Third party risk near airports and public safety zone policy“

In accordance with the results of the analysis presented in the previous tables, based on detailed statistical data on the annual number of operations of individual aircraft groups, the assessment was made for the area most likely to be affected by aircraft accident (crash) for five airports in the UK: London Heathrow, London Gatwick, Manchester, Birmingham Leeds and Bradford.

The Figures 4.2.14-14 and 4.2.14-15 show the estimated used geometric shape of the zone, and the pictures 4.2.14- 16 and 4.2.14.- 17 show that area for Heathrow and Birmingham airports.

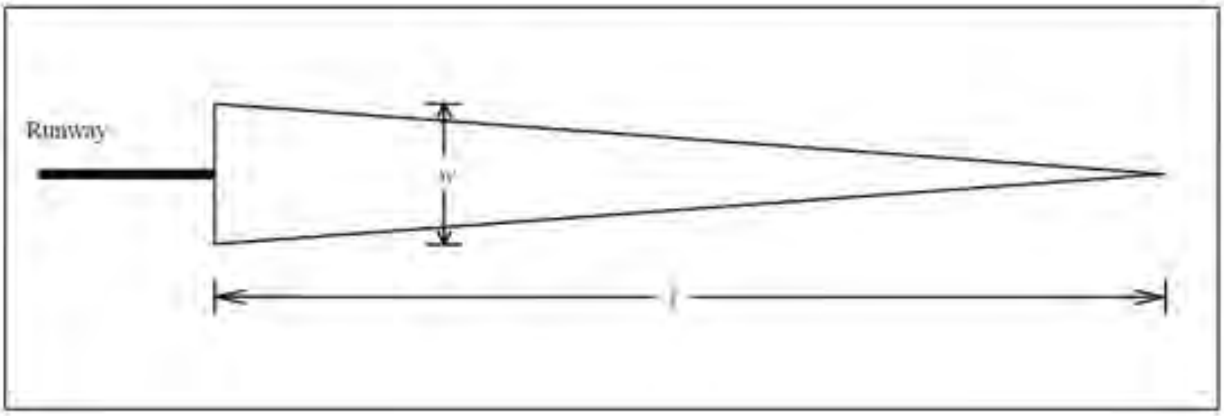


Figure 4.2.14.-14: Geometric presentation of public safety zones

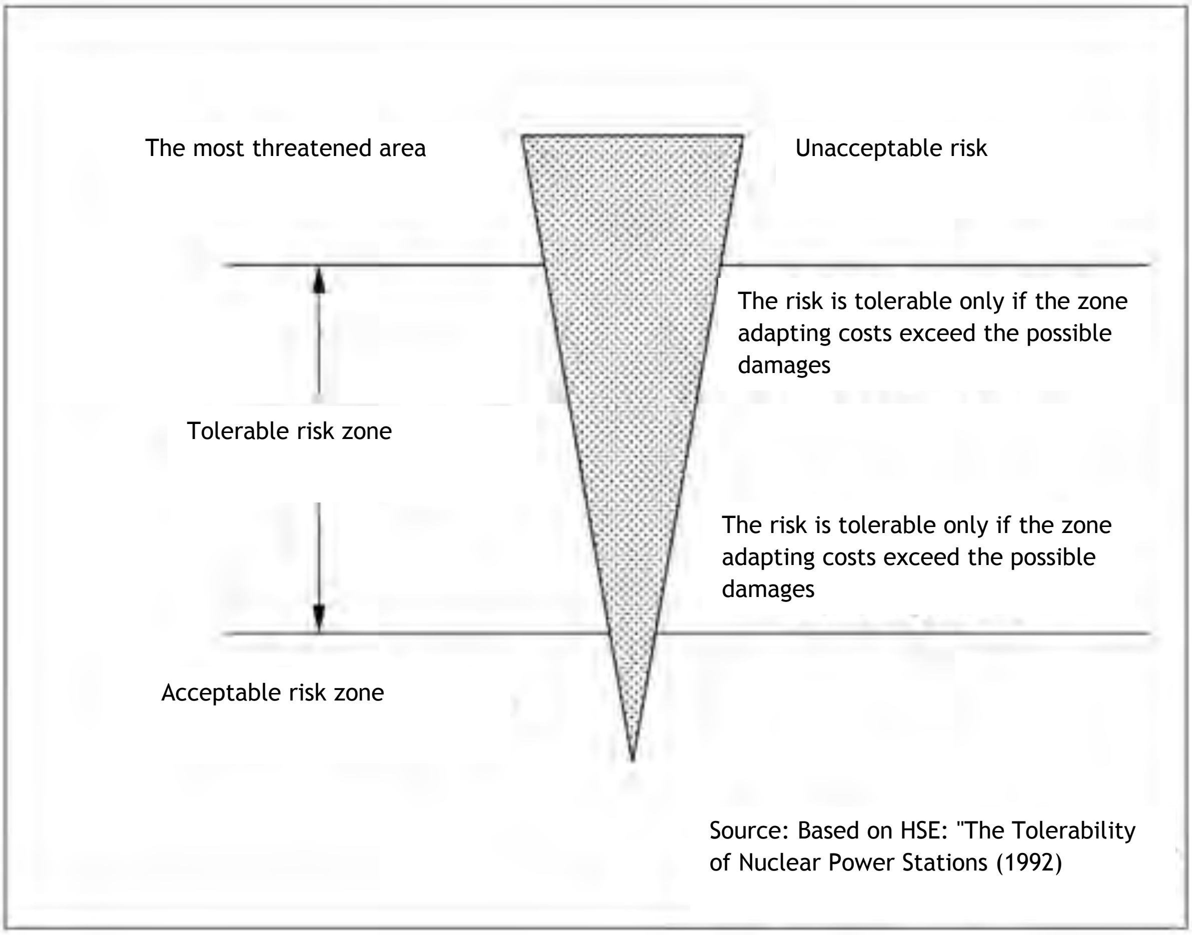


Figure 4.2.14-15: Limits of the unacceptable, tolerable and acceptable risk on the geometric presentation of public safety zones

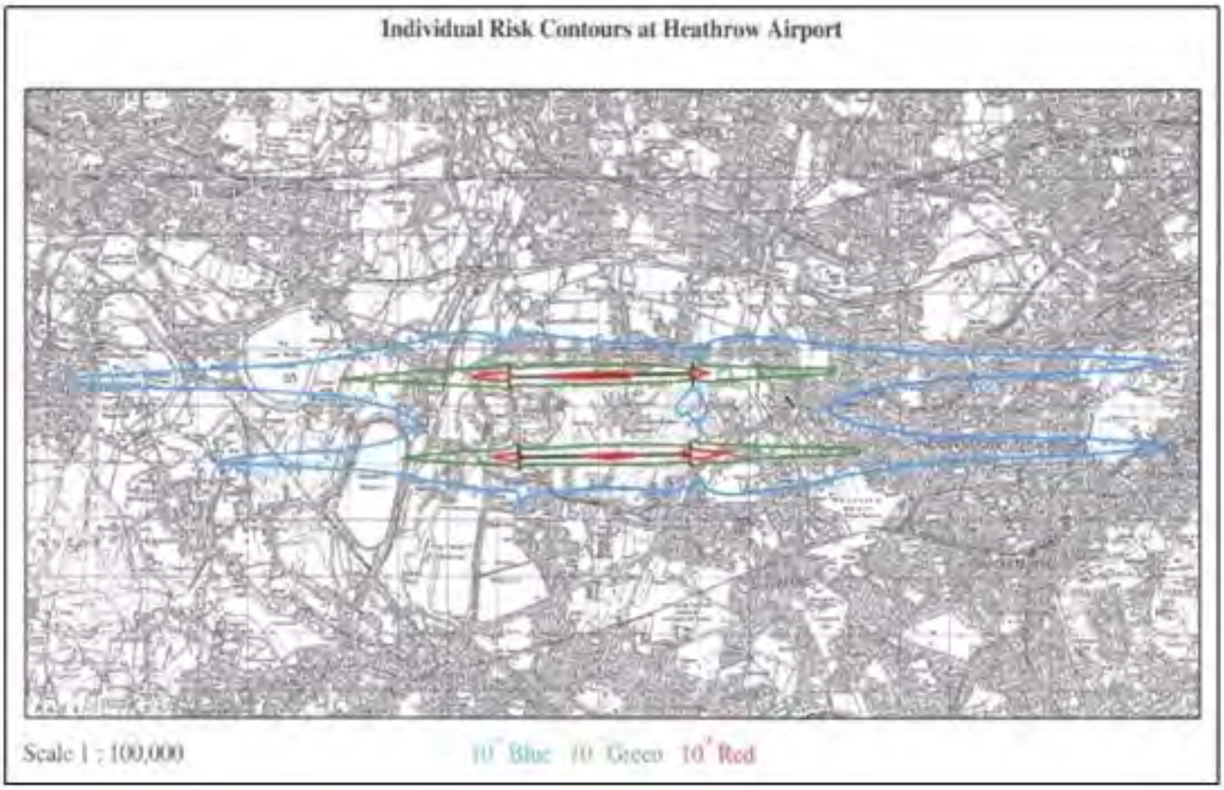


Figure 4.2.14-16: Public safety zone, calculated for two parallel runways at the airport Heathrow

Figure 4.2.14-17: Public safety zone, calculated for two runways that intersect at 90° at the airport Birmingham

Given the fact that the operator of the Zagreb airport is not able to produce statistical data organized in a manner that would allow assessment of areas of public safety zones for the runway in directions 05 and 23, the solution from the scientific paper of the authors Stanislav Pavlina and Matija Bračić, entitled "Impact of airport traffic on urban planning in the vicinity of the airport" (source:http://bib.irb.hr/datoteka/539546.ISEP_LJubljana_conference_final.pdf) was taken as theoretical background. The public safety zone of 2333.33 m in length, measured from the end of the runway and the maximum width of 233.33 m (116.665 mX 2), measured on each side of centre line of the runway (Figure 4.2.14-18) is proposed for the runway 05-23 of the Zagreb Airport.

Figure 4.2.14-18: Proposal for public safety zone for the runway of the Zagreb airport in directions 04 and 22
Source: http://bib.irb.hr/datoteka/539546.ISEP_LJubljana_conference_final.pdf

4.2.14.5. Operational measures

Operational measures for minimising security risks refer to the implementation of the safety management system in operative airport. Croatia has recently passed the legislation, which relates both to the preparation of State Safety Program and the phase implementation of the safety management system and the process is pending. Zagreb airport operator has a relatively developed quality management system, including the environment, while the safety management system is in the postulation stage. Therefore, Insufficiency of the statistical and analytical segment updates, security monitoring and processing of data is more than evident, and it is the same case with the lack of database. Given the normative tendency of transition to a proactive management system which includes monitoring current operational processes and identification of deviations in the latent appearance stages, the highest synergistic effect in this regard would be to establish an integrated safety quality and environment management systems.

The operational measures relating to decrease of security risks are to a large extent analogous or complementary with the measures of decreasing the negative impact of air transport on the environment, as well as with the quality enhancement measures. In this regard, the solutions for the ecological optimization of operations relating to arrivals and departures, such continuous descent approach form a multifunctional solution with the benefits and from the environmental point of view, but also from the standpoint of safety and quality. Moreover, the collaborative decision making is a conceptual solution of the collaboration of the airport, ATM and transport operations with a strong benefits in the sustainable development management.

4.2.14.6. Conclusion

It has been assessed that the security risk of negative impacts on the direct and wider area of the Zagreb Airport caused by an aircraft accident outside the airport area. With consideration that the operative area of the Zagreb Airport is largely aligned with the provisions of Annex 14 of the ICAO and the Ordinance on airports, and is has been defined that based on statistically determined locations of approximately 70% of all civil aircraft accidents, it can be concluded that there would be no serious consequences for the narrow area around the airport in the event of an aircraft incident or accident at the airport or on its operative areas.

With regard to the general area surrounding the airport, and considering the statistic that approximately 30% of all accidents of civil aircraft occur in the general area outside the operative area of the airport, the severity of the consequences of a possible accident depend both on the total mass of the aircraft and on the location of the actual accident. In line with that fact, it is proposed that a public security zone be established for the runway of Zagreb Airport in the directions 05 and 23, and this area should be protected with controlled construction so as to reduce the possible consequences of an aircraft accident to the minimum possible level.

Given that to date has no public safety zone of the Zagreb airport has been established, and that the settlements Petina and Mala Kosnica are partly located in the proposed area of public safety zones for the runway in directions 05 and 23, according to the scientific paper of the authors Stanislav Pavlina and Matija Bračić, we believe that the result of an aircraft accident could lead to serious consequences for the population living in these neighbourhoods. For this reason, we assessed the impact of aircraft accidents during the project implementation as a significant negative effect (B).

4.3. EVALUATION OF THE ENVIRONMENTAL IMPACTS OF THE PROJECT

After the recognition of impacts of all phases and parts of the planned project by individual environmental components, the same are defined by assigning a grade of the significance of the impact in the following manner:

A	Exceptionally significant negative environmental impact
B	Significant negative environmental impact
C	Somewhat significant negative environmental impact
U	Environmental impact cannot be assessed
N	No environmental impact
P	Positive environmental impact

The purpose of this procedure is to determine the environmental components that the planned project impacts most significantly, so as to give these components the greatest attention while defining the necessary protection measures in order to avoid or reduce the recognised impacts. In line with this, particular attention needs to be given to measures to avoid or mitigate the impacts on **increase noise levels, health, soil, air, cultural and historical heritage, transport function and the appearance of an ecological accident.** Table 4.3-1 gives a collective overview of the impacts of the planned project on the environment, during the construction and use phases.

Table 4.3 -1 Overview of the impacts of the project on environmental components

ENVIRONMENTAL IMPACTS OF THE PLANNED PROJECT			
ENVIRONMENTAL COMPONENT	IMPACTS DURING THE PROJECT CONSTRUCTION	IMPACTS DURING THE USE OF PROJECT	
AIR	C	C	B
NOISE	C	A	
POPULATION HEALTH	N	B	
WATER	C	P	
SOIL	C	B	
PROTECTED AREAS	N	N	
FAUNA	C	C	
FLORA	C	N	
FORESTS	C	N	
CULTURAL AND HISTORICAL HERITAGE	B	N	
LANDSCAPE	C	P	
WASTE	C	C	
TRANSPORT FUNCTION	C	N	
LIGHT POLLUTION	N	C	
ECONOMIC ACTIVITIES	N	P	
RISK OF AN ECOLOGICAL ACCIDENT	B	C	
RISK OF AN AIRCRAFT ACCIDENT	N	B	

4.4. POSSIBLE SIGNIFICANT CROSS-BORDER IMPACTS

The project will not cause any significant cross-border impacts.

4.5. DESCRIPTION OF POSSIBLE DEGRADED NATURAL ENVIRONMENTAL VALUES IN RELATION TO POSSIBLE BENEFITS FOR SOCIETY AND THE ENVIRONMENT

The expanded and modernised airport, with its increased traffic and overall offer, will bring with it increased traffic for arrivals and departures, a larger number of vehicles, and larger parking areas. In that sense, foreign airports can serve as very informative examples. In such situations, the overall landscape is urbanised, the natural areas reduced, and the transport corridors for the entry and exit to the airport as a new entity will be from two directions. A new, eastern interchange will be built and will direct traffic towards the city via a new bridge over the Sava River at Mićevec. The surrounding settlements on the eastern side of the airport will suffer certain changes and additional pressures in the form of increased traffic and environmental pollution by traffic in the direct vicinity. The spatial compression of the local population in those areas will increase, as will traffic and traffic noise.

This urbanisation of the airport landscape will be partially “softened” by the landscape development of the new passenger terminal of the Zagreb Airport, as recognised from the proposed project. The current situation contains small green areas, and the development of the new parts will continue in that direction. It is worthwhile mentioning that a motorway, the city bypass segment, runs through part of the settlements to the east and north of the airport and this also delivers noise and a certain level of air pollution into the environment. In these settlements, the negative impacts of the motorway and the runway corridor are compounded and the people in these settlements experience these segments extremely negatively, which is somewhat understandable. There are two sources of pressure on health and the quality of life for these local people and these sources simply increase the negative impression for each of these elements, and this is inevitable.

It is necessary to mention the social and cultural aspects of the possible impacts of the new Zagreb Airport on the local and general environment. The Zagreb Airport will be the point where, in terms of design, function and the style of behaviour, the “world will enter” into nearby Velika Gorica, one of Croatia's ten largest cities, into Zagreb and into Croatia. The airport aims to be a point that will represent both the capital city of Zagreb and the Republic of Croatia. The airport is striving towards the novel, excellent, attractive and cosmopolitan. The surrounding settlements that are part rural and part blue-collar character, with many structures built without permits and many households that live humbly in today's circumstances, are another, different world. The local population, for the most part, does not travel by air and does not use the services of the Zagreb Airport.

In its expanded form, the Zagreb Airport will be a structure of significance for the whole of Croatia. Landing from the world and Europe in Zagreb will no longer mean landing at an old-fashioned and somewhat neglected building. In a ranking of all the world's airports in terms of their functionality, aesthetics and traffic levels, we believe that the Zagreb Airport today would be somewhere in the middle. In its expanded and modernised form, it will certainly move up a few notches on this imagined ranking list.

Meanwhile, the Zagreb Airport has the opportunity to be different from the massive and somewhat inhuman airports around the world, in countries with tens of millions of citizens. It has the opportunity to be more beautiful, better, and more comfortable for travellers. The new ecological solutions of the local environment are in an appreciative ambient. The human dimension, high functionality and morphological values are achievable.

In that sense, the expansion of the Zagreb Airport, the increasing of its capacities, its modernisation and the construction of new content for a more pleasant stay for travellers and visitors will have a positive impact on the state budget of the Republic of Croatia (through the payment of concessions, increased transport, increased tax revenues) and on the self-awareness and pride of its citizens.

4.6. DESCRIPTION OF METHODS USED IN INFLUENCE FORECASTS

Predicting the impact of the underlying project on the environment was conducted in several stages and due to this various forecasting methods were used:

1. Influence matrix

With the aim of defining the precise and user friendly models to determine the potential impacts on the environment, pursuant to the Regulation on Environmental Impact Assessment (Official Gazette 64/08), certain segments of the operation (in stages of construction, use, and after cessation of use) are set in relation to the environmental components and identified by their characteristic (positive or negative impact), strength (weak, moderate or strong impact), character (whether direct, indirect or cumulative impact) and duration (temporary, short-term, medium-term, long-term or permanent impact).

2. *The assessment of the impact's significance*

After the recognition of impacts of all phases and parts of the planned project by individual environmental components, the same are defined by assigning a grade of the significance of the impact in the following manner:

A	Exceptionally significant negative environmental impact
B	Significant negative environmental impact
C	Somewhat significant negative environmental impact
U	Environmental impact cannot be assessed
N	No environmental impact
P	Positive environmental impact

The purpose of this procedure is to determine the environmental components that the planned project impacts most significantly, so as to give these components the greatest attention while defining the necessary protection measures in order to avoid or reduce the recognised impacts.
Assessing the significance of individual impacts on environmental components was conducted by assessments conducted by the experts from relevant fields of science and profession (agronomy, geology, soil science, ecology/biology, forestry, landscape architecture ...).

5 PROPOSAL ON ENVIRONMENTAL PROTECTION MEASURES AND ENVIRONMENTAL MONITORING PROGRAMME

5.1 PROPOSAL ON ENVIRONMENTAL PROTECTION MEASURES AND IMPLEMENTATION PLAN

ENVIRONMENTAL COMPONENTS

Air

1. For extremely dry weather, handling areas and roads should be sprayed with water in order to minimize raising dust particles in the atmosphere and their spreading to the surrounding area.
2. Silos for cement are set during project construction as part of the temporary concrete production plant must have appropriate filters which should to be regularly maintained.
3. Regularly maintain construction machinery.
4. Design a system of aircraft electricity supply for the new passenger terminal. Allow the usage of aircraft APU units only in exceptional situations.
5. Cleanse the air from parts of waste water treatment device in order to prevent the spread of odours.
6. Set up a station for continuous monitoring of air quality in the new passenger terminal.
7. Replace vehicles and equipment under the Ground Support Equipment category at the airport with new ones which are electrically or gas powered, no later than the 1st of May 2020.

Water

8. During the operation of the temporary concrete production plant, for the construction of the project, ensure maximum recycling of concrete waste and industrial waste water from washing concrete mixers.
9. Organize the preparation of asphalt outside the site and deliver it to the site in appropriate vehicles.
10. During building construction, park the machinery on an impervious surface with drainage system as well as with a built-in separator for grease and oil.
11. If the fuel tanks are installed at the construction site, set them in prehensile vessels or they should have two layers.
12. Store petroleum products and lubricants in impervious containers and on impervious surfaces.
13. Topping up oil and fuel as well as doing minor repairs on the working machinery must be done on foreseen, waterproof surfaces which are marked by curbs.
14. Topping up oil and fuel out of the waterproof surface is possible, only with the mandatory use of protective equipment (impervious containers, PVC, PE foil, etc. in order to prevent possible contamination of oil leaking into the environment.
15. Ensure proper disposal of sanitary waste water during construction by using adequate sanitation.
16. As part of project documentation elaboration, analyze the possibility of the usage of the container for water which is collected from the roofs in order to be used for different purposes (watering plants, washing roads and so on).
17. Design the drainage and wastewater treatment system and construct it to be watertight.

18. The snow which is collected from the airport traffic areas must be disposed on foreseen, waterproof surfaces which are connected to the drainage system and to the system of wastewater treatment of Zagreb airport.
19. The drainage of water from the aircraft de-icing/icing protection surface must be designed and constructed in such a way, that the aircraft de-icing agents should be separately gathered and further recycled.
20. Rain water collected from airport traffic areas, which were contaminated by de-icing agents (propylene glycol, formate) must be stored in a retention-equalization tank and treated using the appropriate procedure and discharge it into the recipient.
21. Out of season, the rain water collected from airport traffic areas must be treated in hydrocarbon/sand separators before discharging it into recipients.
22. The drainage of water from the road traffic areas must be designed and constructed with a closed drainage system and with a treatment system.
23. Contaminated rain water collected from road traffic areas which doesn't contain specific de-icing agents (parking zones, roads, etc.) must necessarily be treated in hydrocarbon/sand separators before discharging it into the rainfall drainage system in Velika Gorica town, or into recipients, respectively.
24. All key equipment of the drainage and treatment system must include the installation of the spare capacity in order to avoid uncontrolled overflows into the environment.
25. In the control and measure window of the treatment device, an automated sampler with an key parameter analyzer (TOC, KPK, total nitrogen, total phosphorus) must be installed which, in case of process disturbance, will alarm and announce the manager of the device, as well as will automatically stop the flow into the recipient of the water which was not sufficiently enough treated.
26. In case that it will be needed to remove some of the existing piezometers because of construction works for the new passenger terminal, the new one which will be replaced must be as close as possible to the current location of the existing one.
27. Stop with the use of urea as a de-icing agent at the latest by 01 January 2016. During the transitional period (01 January 2013 - 01 January 2016) the annual rate of consumption reduction is fixed to be 33%. As base consumption, the consumption of the urea in 2011 is fixed to be (100 t of urea). For surfaces and aircraft de-icing, further, it should be continued to use bio-degradable agents which are environmentally acceptable and which do not contain nitrogen concentrations higher than 1%.

Soil

28. In the planning phase for excavation, a location for temporary storage of materials from excavation must be foreseen.
29. Separately collect the humus layer and later use it for landscaping purposes.
30. The excess material from excavation must be delivered to Velika Gorica for their use.

Biological diversity

31. During the 2nd phase of construction, the function of the Kosnica canal must be preserved and it must be regularly maintained.

Landscape

32. As part of the main project, the project for the landscaping design should be done and it should include:

    a) rehabilitation of areas which are intensively affected by construction works for all construction sites and handling areas;

    b) landscaping arrangement of green surfaces of the New passenger terminal at Zagreb airport.

33. The project must include the arrangement of border parts of the terrain in terms of restoration of the indigenous and natural landscapes (wetlands- canals, ponds and groves and hedges).

CULTURAL & HISTORICAL HERITAGE

34. In case of finding any archaeological finds or deposits, all works must be stopped and the competent department for conservation must be announced.
35. Prior to the start of the construction of the 2nd phase, it is obligatory to make a sounding of potential points of archaeological sites in PAL 1-3 settlement, in the zone of direct influence. All findings must be documented and upon finishing researches, they must be submitted to the competent department of conservation.

ENVIRONMENTAL BURDENS

Light pollution

36. Implement environmentally friendly lamps, appliances and equipment that reduce direct emissions of light from the lamps above the horizon.

Protection of population and space regarding the traffic flows

37. During the construction, commercial vehicles must access the site from Zagreb Bypass (A3), the eastern bypass of Velika Gorica and its site and the main access road NPT ZLZ or its site.
38. Within the temporary traffic regulations project during implementation of the project, all points of access to the existing road system must be clearly defined and all collision points secured.
39. Provide circular movement of vehicles within the entire construction zone.
40. Limit the vehicle speed to 30 km/h at the construction site.
41. Repair the damaged sections of roads during construction if damage occurs caused by transport of materials, construction operations or other activities during construction.
42. Start using the new passenger terminal only after obtaining permits for main access road that connects to the eastern bypass of Velika Gorica.
43. Traffic signs should clearly point to the targets in the internal and external network traffic network.
44. Dynamic traffic signs in the location area must indicate free access points and parking capacities.
45. Service and delivery vehicles must adhere to the defined itinerary.
46. Limit the vehicle speed up to 50 km/h on the internal connecting roads.
47. Limit the vehicle speed up to 20 - 30 km/h within parking areas.

Noise

48. Develop strategic noise maps and action plans in order to reduce noise.
49. Adopt measures for noise reduction through Action plan for operating noise reduction - Aircraft Landing and Take-off Protocol, in cooperation with the Croatian air control navigation, in order to reduce the impact of airport traffic noise on the surrounding settlements.
50. Coordinate operational for noise reduction with other operators in the air traffic - providers of transportation and aviation services and the local community covered by the influence of air traffic noise.

51. If the application of operational measures will not show satisfactory results, it is necessary to implement measures to protect passive objects in construction areas that are located in zones exposed to excessive immisions of the air traffic noise.

Waste

52. Regularly conduct and control disposal of waste, i.e. prohibit any temporary or permanent disposal of waste into the surrounding soil during construction.
53. Ensure watertight containers for waste for the purposes of the site.
54. Collect waste separately by type and place of origin and deliver it to authorized collector.
55. Keep proper records of the waste flows.
56. Treat excess biological sludge from the treatment process with the device for waste water treatment to the level that allows disposal.
57. Exceptionally, the excess biological sludge can be processed only to the extent necessary for anaerobic digestion (biogas) if there is an interest in one of surrounding municipal devices for wastewater treatment.
58. Temporarily store treated sludge in a covered and watertight plateau.
59. Give waste matter from the wastewater treatment process (oils and fats, sand, waste screens, etc.) to authorised collectors.

ECOLOGICAL ACCIDENT (DISASTER)

60. At the corporate level, implement safety management systems and quality environmental standards regulated by ICAO documents (Airport Services Manual) and European regulations, particularly in relation to the implementation of EMAS and the ETS system.
61. Establish a public safety zone for the runway of the Zagreb Airport, lines 05 and 23.
62. Underground cisterns of the energy plant for extra light fuel oil, with a total volume of 100 m^3, must have an impervious oil pit.
63. In the case of oil leakage from the transformer power unit in an air-tight pit, remove the leakage cause and give oil to the authorized waste collector.
64. At the construction site, ensure accessories (absorbing materials: sawdust, etc.) for prompt intervention in the event of fuel or oil leakage from the machinery.
65. In the case of soil contamination by fuel, motor oil, antifreeze or other dangerous chemicals, immediately neutralise contaminated area with excavation and give the contaminated soil to the authorized waste collector.

5.2 ENVIRONMENTAL MONITORING PROGRAMME AND IMPLEMENTATION PLAN

Air

1. At the station for monitoring air quality at Zagreb airport (Appendix 5.2 -1), before putting the project into operation, determine the air quality, in order to obtain information about the current state of air quality. During the project, conduct continuous measurements of air quality at the same station, with simultaneous monitoring of meteorological parameters (temperature, pressure, relative humidity, wind direction and speed). Air quality parameters are to be monitored are as follows: carbon monoxide (CO), ground-level ozone, nitrogen oxides (NO_x), expressed as nitrogen dioxide (NO_2), particulate matter PM_{10} and benzo(a)pyrene (BaP) in particulate matter PM_{10}.
2. If monitoring determines exceeding allowable limits, create a plan of measures to prevent further contamination and to monitor the impact of the measures on pollution reduction.
3. Laboratory that will conduct quality measurements must deliver original and validated data on monitoring air quality and report on pollution levels and assessment of air quality to the competent administrative body of the County, City of Zagreb and the town of Velika Gorica, not later than 31st March of the current year for the previous calendar year. These documents are also submitted to the Agency for Environmental Protection.
4. During the trial operation and the use of energy facility, measure NO_2 and CO emissions:

- The first measurement: during the trial and before obtaining a use permit
- Periodic measurements (in the first year of use): 6 individual measurements under operating conditions that can cause the greatest emissions
- Periodic measurements (during usage - after the first year): once a year
- Prepare a report on monitoring according to the *Ordinance on monitoring air pollutants emissions from stationary sources*

Water

5. Analyze samples of groundwater from piezometers and wells for water; fire (Annex 5.2-1). Parameters and frequency will be determined by water permit.
6. Analyze the treated waste water at the outlet of the device for wastewater treatment.
7. Check the impermeability (tightness) of sewage and waste water treatment systems every five years:

- Gravity pipelines and canals - visual (camera),
- Pressure - pressure test,
- Retention basins, etc. – monitoring level changes without inflow.

Soil

8. Soil monitoring should be done during a period of 10 years from the date of release of the new terminal. The soil must be sampled and analyzed each year, once, at the beginning of September, in the arable and sub-arable layers, on locations of agricultural land (Appendix 2). In soil samples the following concentrations should be determined: the concentrations of heavy metals (Cd, Cr, Cu, Hg, Ni, Pb and Zn), total organic carbon (TOC) and the content of polycyclic aromatic hydrocarbons.

Noise

9. Conduct continuous monitoring of noise emissions at the immision checkpoints:

- Measurement point 1: distance from threshold 05 USS-e 306 metres,
- Measurement point: distance from threshold 23 USS-e 307 meters,
- Measurement point 3: settlement Donja Lomnica and
- Measurement point 4: settlement Obrezina.

10. Noise monitoring must be performed each year, from 1. June to 1. October. It is necessary, within this period, to conduct tests for at least fifteen days at each immision checkpoint:

- Measurement point 5: settlement Črnkovec,
- Measurement point 6: settlement Velika Kosnica,
- Measurement point 7: settlement Pleso and
- Measurement point 8: settlement Velika Gorica.

Use the results of noise measurements in the preparation of strategic noise maps and action plans for noise reduction.

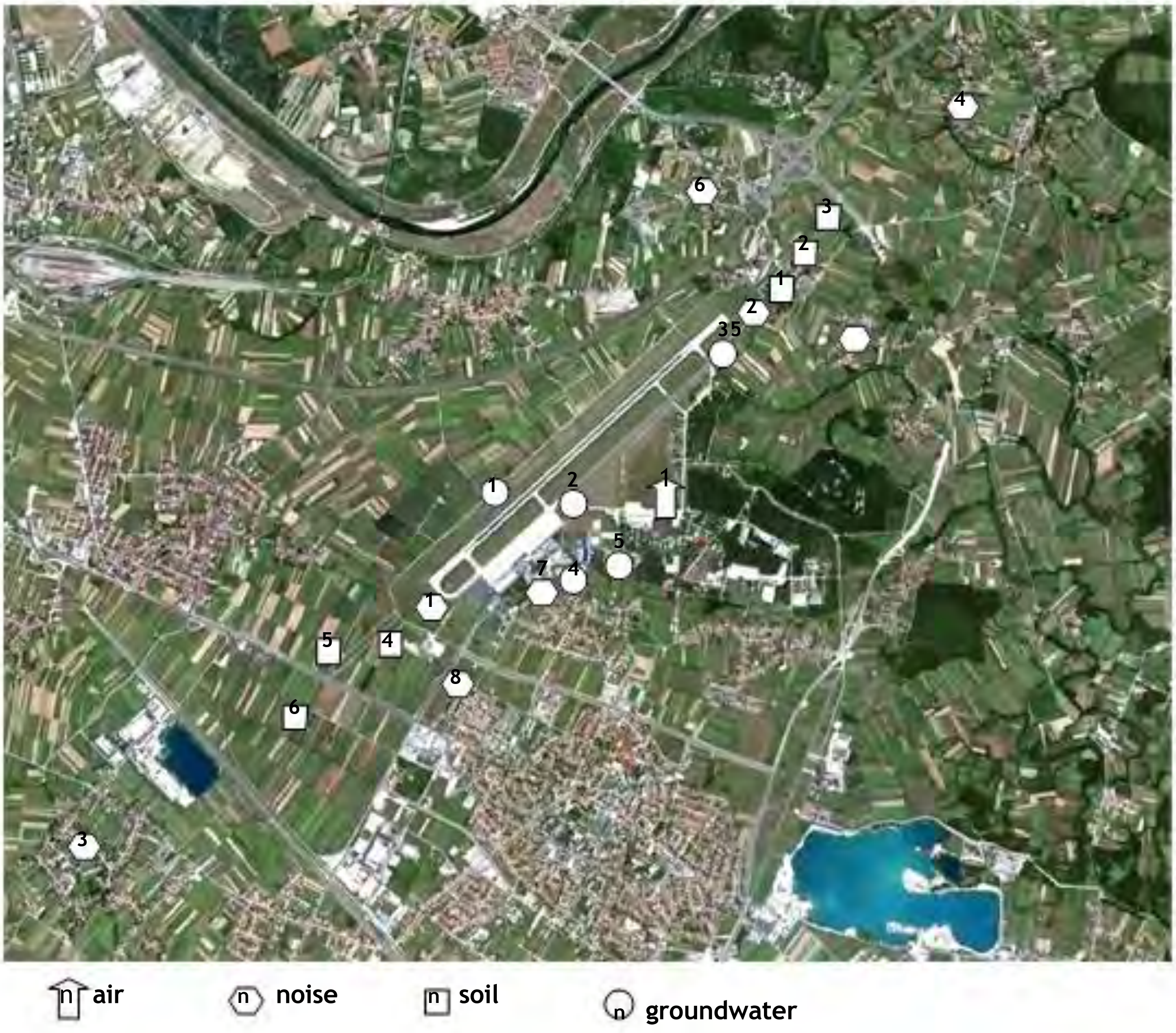


Figure 5.2.-1 Locations for monitoring environmental status

6. PROPOSED ASSESSMENT OF ENVIRONMENTAL ACCEPTABILITY OF THE PROJECT

The process of assessment of the environmental impact is carried out on the basis of the Environmental Impact Study which is a background document that includes all the necessary information, documentation, explanations and descriptions in textual and graphical form, the draft of impact assessment and environmental protection measures in relation to the intervention and environmental monitoring program.

The project holder – during the project implementation and the use of the New passenger terminal of the Zagreb Airport - must apply all measures in order to protect the environment, as well as environmental monitoring program.

The implementation of the planned project of the New passenger terminal of the Zagreb airport, with the application of prescribed environmental protection measures and the implementation of the environmental monitoring program, is evaluated as the procedure that is acceptable for the environment.

7. INDICATION OF ANY DIFFICULTIES

During the preparation of the Study, neither the project holder nor the authorized person encountered any difficulties in terms of technical deficiencies or lack of necessary data for the Study.

8. PROPOSAL FOR THE PLAN OF SUBMITTING THE PROJECT TO THE PUBLIC BEFORE ITS COMMENCMENT AND DURING ITS IMPLEMENTATION

The fundamental assumption of effective communication with the public is the intelligibility of the language and findings used in this communication. Findings of this Environmental Impact Study are to be conveyed to the public in an appropriate and understandable way. Local people must be able to understand these findings since they directly affect their health and quality of life and survival. Basic draft is given below, divided per phases:

1. Stage of development and public debate about the Study - the local public receives initial information on the project through the creation of sociological share on the project. It is also consulted regarding the opinion on the environmental impact of the Zagreb airport. Regulatory procedure of public debate is the perfect time and place for a detailed and clear, democratic communication of the project holder with the local public. Note: Local public expects a well-prepared public communication, preferably organized on the field (where people live - in local boards).
2. Meeting demands of Petina and Mala Kosnica residents, represented by the Local Board of Kosnica for relocation; meeting with the representatives of the local, regional and national authorities, parallel with a public debate on the Study.
3. Communication with the general and competent (expert) public on all issues of project implementation, the establishment and functioning of the professional system of PP and PR of the Zagreb airport under construction;
4. Communication with local public during the project implementation and construction of the New passenger terminal of the Zagreb airport;

9. REFERENCES

9.1. EXPERT GUIDELINES

- Technical Scope (of the New Passenger Terminal at the Zagreb airport), Republic of Croatia, Zagreb Airport,2011
- Conceptual Design of Traffic Surfaces for the New Passenger Terminal at Zagreb airport, Institut IGH, 2011
- Conceptual Design of Water Supply and Drainage System for the New Passenger Terminal of the Zagreb Airport, Institut IGH, 2011
- Conceptual Design of the Power Plant of the New Passenger Terminal of the Zagreb Airport, CTP Projekt, 2011
- Traffic forecast for the Zagreb Airport, InterVISTAS, 2010

9.2. LITERATURE

Meteorology

- Makjanić, B. 1977: Primjena teorije ekstrema u geofizici. Republički hidrometeorološki zavod SR Hrvatske, Zagreb, 87 str.
- Zaninović K, Gajić-Čapka M, Perčec Tadć M, Vučetić M, Milkovć J, Bajić A, Cindrić K, Cvitan L, Katušin Z, Kaučić D, Likso T, Lončar E, Lončar Ž, Mihajlović D, Pandžić K, Patarčić M, Srnec L, Vučetić V. 2008: Klimatski atlas Hrvatske / Climate atlas of Croatia 1961-1990, 1971-2000. Državni hidrometeorološki zavod, Zagreb, 200 str.

Air

- ACRP (2008) Summarizing and Interpreting Aircraft Gaseous and Particulate Emissions Data. ACRP Report 9, Transportation Research Board
- ACA (2011) Annual Report 2010 - 2011, Airport Carbon Accreditation
- ACI (2010) An Outlook for Europe's Airports - Facing the challenges of the 21st century, Airports Council International (ACI Europe)
- Bešlić I, Šega K, Šišović A (2005) Pilot air pollution investigation at Zagreb crossroads, Proceedings of the Third International Symposium on Air Quality Management at Urban, Regional and Global Scales - Volume II, Topcu S, Yardim MF, Bayram A, Elbir T, Kahya C (ur.). Izmir: Altindag Grafik Matbaacilik, 1484 - 1488
- Bešlić I, Šega K, Šišović A, Klaić ZB (2005) PM10, CO and NOx concentrations in the Tuhobić road tunnel, Croatia, Int. J. Environment and Pollution, Vol. 25, Nos. 1/2/3/4, 251 - 262
- Bešlić I, Šega K (2007) Onečišćenje zraka dušikovim dioksidom i lebdećim česticama na nadvožnjaku Slavonske avenije i Radničke ceste u Zagrebu
- Boyle KA (1996) Evaluating Particulate Emissions from Jet Engines: Analysis of Chemical and Physical Characteristics and Potential Impacts on Coastal Environments and Human Health, Transportation Research Record 1517, 1-9
- Byeong-Kyu Lee, Van Tuan Vu (2010) Sources, Distribution and Toxicity of Polycyclic Aromatic Hydrocarbons (PAHs) in Particulate Matter. *U:* Air Pollution, Edited by Vanda Villanyi
- Collins G (2004) Air Quality Modelling Study
- De Haan P, Keller M (2004) Emission Factors for Passenger Cars and Light-duty Vehicles - Handbook Emission Factors for Road Transport (HBEFA) Version 2.1.
- EC (2011) White paper - Roadmap to a Single European Transport Area - Toward a competitive and resource efficient transport system, Brussels, COM (2011) 144 final

- EEA (1995) Technical Data to Support FAA's Advisory Circular on Reducing Emissions from Commercial Aviation
- EKO-MONITORING d.o.o. (2007) Program zaštite i poboljšanja kakvoće zraka u Zagrebačkoj županiji - nacrt
- EMEP/EEA (2009) Emission Inventory Guidebook
- http://www.eea.europa.eu/publications/emep-eea-emission-inventory-guidebook-2009
- EPA (1999) Evaluation of Air Pollutant Emissions from Subsonic Commercial Jet Aircraft
- EPA (2005) Control of Air Pollution From Aircraft and Aircraft Engines; Emission Standards and Test Procedures
- Fitz DR (2001) Measurement of PM_{10} and $PM_{2.5}$ Emission Factors from Paved Roads in California. Final Report to the California Air Resources Board under contract no. 98-723
- Fitz DR, Bufalino C (2002) Measurement of PM_{10} Emission Factors from Paved Roads Using On-Board Particle Sensors. US Environmental Protection Agency 11th Annual Emission Inventory Conference: Emission Inventories-Parntering for the Future.
- GAO/RCED-00-57 (2000) Aviation´s Effects on the Global Atmosphere Are Potentially Significant and Expected to Grow
- Grainger RD, Peters D (200?) AO: 08 Two Independent Studies of Atmospheric Aerosols. I: Hygroscopic Growth and II: Aircraft Emissions
- http://www.atm.ox.ac.uk/group/eodg/mphys_reports/2009_Ansell.pdf
- ICAO (2011) Airport Air Quality Manual, Doc. 9889
- Izvješće o stanju okoliša Zagrebačke županije; Upravni odjel za prostorno uređenje, gradnju i zaštitu okoliša, Odsjek za zaštitu okoliša, 2009.
- Izvješće o provedbi programa zaštite i poboljšanja kakvoće zraka u Zagrebačkoj županiji; Upravni odjel za prostorno uređenje, gradnju i zaštitu okoliša, Odsjek za zaštitu okoliša, 2010.
- Izvještaj o praćenju kakvoće zraka na automatskoj mjernoj postaji Velika Gorica, razdoblje 01.01.2010.-31.12.2010., Dvokut Ecro d.o.o., Zagreb, siječanj 2011.
- Jakovljević I, Žužul S (2011) Policiklički aromatski ugljikovodici u zraku, Arh Hig Rada Toksikol; 62: 357 - 370
- Kumari R, Attri AK, Gurjar BR (2011) Impact of CNG on emissions of PAHs and PCDDa/Fs from the road transport in Delhi, Atmospheric Pollution Research 2, 394 - 399
- Lee LM, Novotny VM, Bartle DK (1981) Analitical Chemistry of Polycyklic Aromatic Compounds. NY: Academic Press
- Morris KM (2007) Emissions from Aircraft - Airframe sources: Tyre and Brake wear
- http://www.cate.mmu.ac.uk/saaq/presentations/Morris.pdf
- Pehrson JR (2005) Aircraft Particulate Matter Emissions. Tansportation Research Board, 84 th Annual Meeting - Session 683
- http://www.trbav030.org/pdf/TRB05Ann_685_j_pehrson.pdf
- Popescu CG (2011) Relation between vehicle traffic and heavy metals content from the particulate matters. Romanium Reports in Physics, Vol. 63, No. 2, 471 - 482
- Program zaštite i poboljšanja kakvoće zraka u Zagrebačkoj županiji; Eko-monitoring d.o.o., 2007.
- Pishinger R (2002) Update of the Emission Functions for Heavy Duty Vehicles in the Handbook Emission Factors for Road Traffic - Final Report. Graz
- Rypdal K (200?) Aircraft emissions
- Shabad LM, Smirnov GA (1976) Aviation and environmental benzo(a)pyrene pollution. IARC Sci. Publ. 13: 53-60

- Steiner S, Božičević J, Kaštela S (2003) Ekološki aspekti zračnog prometa, Naučni skup „Ekološki problemi suvremenog prometa“, Zbornik radova /Čekić, Šefkija (ur.) - Sarajevo: Saobraćaj i komunikacije, Društvo za izdavačku djelatnost, 33-44
- Šega K, Bešlić I (2008) Procjena omjera NO_2/NO_x vezanog uz cestovni promet u Zagrebu
- Šišović A (2000) Policiklički aromatski ugljikovodici u zraku u nas, Arh Hig Rada Toksikol; 51: 89 - 101
- Unique / Swiss (2004) Aircraft NOx - Emissions within the Operational LTO Cycle
- URS Corp. (2003) Hazardous air pollutants (HAPs) associated with aircraft, airports and aviation, Selected Resource Materials Report
- USEPA (1996): Indicators of the Environmental Impacts of Transportation, EPA 230-R-96-009
- http://ntl.bts.gov/lib/6000/6300/6333/indicall.pdf
- WHO - RO for Europe (2000) Air Quality Guidelines for Europe. 2nd ed. Copenhagen

Health

- Öhrström E, Barregĺrd L, Andresson E, Skĺnberg A, Svensson H, Ăngerheim P. Annoyance due to single and combined sound exposure from railway and road traffic. J Acoust Soc Am 2007;122:2642-2652.
- Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and The Committee of the Regions: Air Transport and the Environment Towards Meeting the Challenges of Sustainable Development, COM (1999) 640 final.
- Health impact assessment, Finningley airport, Doncaster Health Authority, 2000
- Public health impact of large airports, Helath Council oft he Netherlands, 1999
- Bridges JW. Report on the effect of air pollution around Heathrow upon human health, Heathrow Terminal5, British Aviation Authority, BAA-822, 1998.
- Bridges JW. The effect of air quality on human health, Heathrow Terminal 5, Proof of evidence, British Aviation Authority, BAA-1476, 1998.
- Longhurst JWS. Systematic solutions for airport air quality. Paper presented at ‘Ecology and Transport: solutions and strategies for reducing the negative effects of traffic on the environment’. Gothenburg, November 1990.
- Municipal Health Service Amstelland-de Meerlanden. Respiratory complaints. In: Report of general physician registry Amstelland-de Meerlanden, registration year 1993-1994, 1995
- Nitsche V, Gottman A. Air pollution studies at Düsseldorf Airport. In: Raper DW, Longhurst JWS, eds, Air pollution and the aviation industry. Report of seminar held at Manchester Airport, 11-12 June 1990, Manchester.
- Staatsen BAM, Franssen EAM, Lebret E. Health Impact Assessment Schiphol Airport
- [Gezondheidskundige Evaluatie Schiphol.]. Bilthoven: RIVM , 1994; (RIVM Rapport 441520003).
- Staatsen BAM, Doornbos G, Franssen EAM et al. Gebruik van ziekenhuisgegevens voor het beschrijven van ruimtelijke patronen in ziekte rondom Schiphol [Usefulness of hospital data to characterise geographical disease patterns in the Amsterdam Schiphol region]. Bilthoven: RIVM , 1998; (RIVM Rapport 441520009).
- Tunnicliffe WS, O’Hickery SPO, Fletcher TJ, et al. Pulmonary function and respiratory symptoms in a population of airport workers. Occup Environ Med 1999; 56: 118-23.
- Visser O, Wijnen JH van, Benraadt J, et al. Cancer incidence in the vicinity of Amsterdam Schiphol in 1988-1993. Ned Tijdschr Geneeskd 1997; 141(10): 468-73.
- Santa Monica Airport Health Impact Assessment, UCLA Medical Center, 2010
- Health Impact assessment, Finningley airport, Doncaster Health Autority, 2000.

- Adamkiewicz G, Hsu HH, Vallarino J, Melly SJ, Spengler JD, Levy IJ. Nitrogen dioxide concentrations in neighborhoods adjacent to a commercial airport: a land use regression modeling study Environ Health. 2010;9: 3.
- Abbey DE, Hwang BL, Burchette RJ. Long-term ambient concentrations of PM10 and airway obstructive disease. Arch Environ Health 1995; 50(2), 135-50.
- Passchier W. et al. Public health impact of large airports. Rev Environ Health. 2000;15:83-96.
- Westerdahl D. et al. The Los Angeles International Airport as a source of ultrafine particles and other pollutants to nearby communities. Atmospheric Environment. 2008;42:3143-3155.

Soil

- Husnjak, S. (2008): Pedologija, interna skripta. Agronomski fakultet Sveučilišta u Zagrebu
- Kovačević, P. i sur. (1972): Tla gornje Posavine. Institut za pedologiju i tehnologiju tla u Zagrebu
- Škorić, A. (1991): Sastav i svojstva tla. Udžbenik, Fakultet poljoprivrednih znanosti u Zagrebu.
- Stanje onečišćenja tala na prostoru Zagrebačke županije (Agronomski fakultet Sveučilišta u Zagrebu, 2004.)

Forests and forestry

- ICAO 2007: Airport Air Quality Guidance Manual, International Civil Aviation Organization
- Bezak K. 2000: Biljni i životinjski svijet u okruženju zračne luke Zagreb.
- Vukelić J., M. Stjepan, Baričević D., Bakšić D., Rosavec R. 2008: Šumska staništa i šumske zajednice u Hrvatskoj, Nacionalna ekološka mreža. Državni zavod za zaštitu prirode, Zagreb.

Geology

- Hrvatski geološki institut, (2009): Hidrogeološka karta 1:300 000 Republike Hrvatske. Zavod za hidrogeologiju i inžinjersku geologiju. Zagreb.
- Basch, O. (1983): Osnovna geološka karta SFRJ 1:100 000. Tumač za list Ivanić Grad, 1-66. Geološki institut, Zagreb.
- Basch, O. (1981): Osnovna geološka karta SFRJ 1:100 000. List Ivanić grad L33-81. Geološki institut, Zagreb.
- Mayer, D. (1980): Kvaliteta i zaštita voda u Hrvatskoj.- Hrv. društvo za zaštitu voda i mora, Zagreb.
- Mayer, D. (1980): Mogućnost zagađenja vodonosnih slojeva kao posljedica hidrodinamičkih značajki na području užeg područja Save u SR Hrvatskoj.- Dokt. disertacija. Sveučilište u Zagrebu.

Hydrogeology

- Bačani, A., Posavec, K., Nakić, Z. Perković, D., Miletić, P., Heinrich-Miletić, M., Parlov, J. & Bazijanec, M. (2005): Elaborat zaštitnih zona vodocrpilišta na području Grada Zagreba - I faza, RGN fakultet, Zavod za geologiju i geološko inženjerstvo, Zagreb.
- Bačani, A. & Posavec, K. (2009): Elaboratu zaštitnih zona vodocrpilišta Velika Gorica. RGN fakultet, Zavod za geologiju i geološko inženjerstvo, Zagreb.
- Basch, O (1983): Osnovna geološka karta M 1:100.000, list Ivanić-Grad, Geološki zavod Zagreb, Sav. geol. zavod Beograd, Beograd
- Basch, O (1983): Tumač osnovne geološke karte M 1:100.000, list Ivanić-Grad, Geološki zavod Zagreb, Sav. geol. zavod Beograd,Beograd.

- Blašković, I. & Dragičević, I. (1988) : Studija prostornog rasporeda i geometrije sedimentnih tijela i njihov utjecaj na hidrogeološke odnose na području lijeve i desne obasle Save of Bregane do Rugvice, RGN fakultet, Zagreb
- Bonacci, O. i Trninić, D. (1986): Analiza uzroka i prognoza promjena vodostaja Save i nivoa podzemnih voda u okolici Zagreba. Vodoprivreda 18, 100-101 (1986/2-3), str. 95-101., Zagreb
- Brkić, Ž. i Biondić, B. (2000): Savski vodonosnik i njegove hidrogeološke značajke. Hidrologija i vodni resursi Save u novim uvjetima, zbornik radova, okrugli stol, Slavonski Brod.
- Jakuš, B. & Bradić, D. (2010): Izvještaj o ispitivanju kakvoće podzemne vode na području Zračne luke Zagreb u 2010. god., Zagrebački holding, Podružnica Vodoopskrba i odvodnja, sektor razvoja i investicija, Odjel razvoja vodoopskrbe, Hidrotehnička istraživanja (2010):, Zagreb
- Miletić, P. i Bačani, A. (1999): EGPV: Izrada bilansa. Book 4, četvrti dio, RGN fakultet, Zagreb.
- Rajer, B. (2000): Environmental Impact Studyizgradnje Zračne like Zagreb, Inženjering za naftu i plin d.o.o., Zagreb
- EGPV - Evidencija i gospodarenje podzemnim vodama Hrvatske (1999): Ujednačavanje baze znanja i grafičke baze za dolinski dio Save. Fond dokumentacije Hrvatskih voda.
- Zračna luka Zagreb .(2008): Izvještaj o zaštiti okoliša 2004.-2007, *www.zagreb-airport.hr/.../20081020065521izvjestajookolisu2007hr.pdf*

Hydrology

- Studija međuutjecaja Prostornim planom Zagrebačke županije predviđenih sadržaja na prostoru Zračne luke Zagreb i vodocrpilišta Črnkovec, EKONERG - Institut za energetiku i zaštitu okoliša, d.o.o., Zagreb, veljača 2005.,
- Environmental Impact StudyHE Drenje, Elektroprojekt d.d., 2006.
- Vodocrpilište Kosnica; Elaborat o zaštitni zonama, Elektroprojekt d.d., 2003.,
- Elaborat Zaštitnih zona vodocrpilišta Velika Gorica (Rudarsko-geološko-naftni fakultet, Zavod za geologiju i geološko inženjerstvo, 2009.).

Ornithology

- BirdLife (2004): Birds in Europe. Population estimates, trends and conservation status. BirdLife Cons. Series no.12.
- BirdLife International (2010) The BirdLife checklist of the birds of the world, with conservation status and taxonomic sources. Version 3. (http://www.birdlife.org/datazone/species/downloads/BirdLife_Checklist_Version_3.).
- Cramp S., Simmons K. E. L., Perrins C. M. (1977-1994) Handbook of the Birds of Europe the Middle East and North Africa, The Birds of the Western Palearctic, Volumes I -IX (Oxford University Press).
- Ćiković, D. (2001): Gustoća populacija i rasprostranjenost vrsta potporodice Picinae u šumskim staništima Središnje Hrvatske. Magistarski rad, Sveučilište u Zagrebu, PMF.
- Fajardo, I. (2001): Monitoring non-natural mortality in the barn owl (Tyto alba), as an indicator of land use and social awareness in Spain. Biological Conservation (2001), 97, 2: 143-149.
- Grubb, T.G., and R.M. King. 1991. Assessing human disturbance of breeding Bald Eagles with classification tree models. Journal of Wildlife Management 55:500-511.
- Habib L., Bayne E.M., Boutin S. (2007): Chronic industrial noise affects pairing success and age structure of ovenbirds Seiurus aurocapilla. Journal of Applied Ecology 44 (1): 176-184.

- Kaseloo, P. A. & Tyson, K.O. (2004) Synthesis of Noise Effects on Wildlife Populations. Washington, DC: U.S. Department of Transportation, Federal Highway Administration. Accessed November 25, 2008. Available at http://www.fhwa.dot.gov/environment/noise/effects/index.htm
- Kralj, J. (2000): Struktura zajednica ptica gnjezdarica šuma hrasta lužnjaka u Hrvatskoj. Doktorska disertacija. PMF, Zagreb. 80 str.
- Manci, K.M., Gladwin, D.N., Villella, R. and M.G. Cavendish, 1988. Effects of aircraft noise and sonic booms on domestic animals and wildlife: A literature synthesis. U.S. Fish and Wildlife Service. National Ecology Research Center, Ft. Collins, CO NERC-88/29. 88 pp.
- Mead, Chris (1987): Birds and Roads Wilderness and Wildlife at Risk. http://www.birdcare.com/bin/shownews/85
- Mužinić, J. (1984): Ptice na zagrebačkom aerodromu Pleso. Bilten društva ekologa Bosne i Hercegovine. Serija B, broj 2: 409-413.
- Radović, D. (1987): Struktura i godišnja dinamika faune ptica rukavca Save kod Zagreba. Diplomski rad, PMF, Zagreb, 75. str.
- Šćetarić, V. (2011): Povezanost svojstava staništa i sastava zajednica ptica higrofilnih travnjaka Hrvatske. Doktorska disertacija. PMF, Zagreb. 127 str.
- Tutiš V., Kralj J., Radović D., Ćiković D., Barišić, S. (u tisku): Crvena Book ptica Hrvatske 2010.
- Tutiš, V., Radović, D., Ćiković, D., Barišić, S., Kralj, J. (2009): Distribution, Density and Habitat Relationships of the Ural Owl Strix uralensis macroura in Croatia. Ardea 97(4):563-570.

Fauna: Bats

- DIETZ , C., O. VON HELVERSEN AND NILL, D. 2009: Bats of Britain, Europe and Northwest Africa. A & C Black, London.
- PAVLINIĆ I., ĐAKOVIĆ M. 2010: Znanstvena analiza dvanaest vrsta šišmiša s Dodatka II Direktive o zaštiti prirodnih staništa i divlje faune i flore za potrebe prijedloga potencijalnih Natura 2000 područja za šišmiše.
- TVRTKOVIĆ N. (ur.) 2006: Crvena Book sisavaca Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode, Republika Hrvatska.

Fauna: mammals

- ANTOLOVIĆ, J., FLAJŠMAN, E., FRKOVIĆ, A., GRGUREV, M., GRUBEŠIĆ, M., HAMIDOVIĆ, D., HOLCER, D., PAVLINIĆ, I., VUKOVIĆ, M. I TVRTKOVIĆ, N. 2006: Crvena Book sisavaca Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode, Zagreb, 127 str.
- BALTIĆ, M., VUKOVIĆ, M. I TVRTKOVIĆ, N. 1997: Zaštita staništa i biološke raznolikosti na području Turopoljskog luga. Hrvatski prirodoslovni muzej. Zagreb.
- KOVAČIĆ, D. 1988: Biologija populacija malih sisavaca u poplavnim šumama hrasta lužnjaka. Magistarski rad, Biološki odsjek PMF-a.
- LEINER, S. 1985: Ishrana sove kukuvije (*Tyto alba* Scop.) u okolici Peščenice (Turopolje) kraj Siska. Šumarski list 5-6, 223-233.
- MEŠTROV, M. i sur. 1986: Ekološka istraživanja u okolici NE Prevlaka.
- Izvještaj o jednogodišnjim istraživanjima 1985/86. Biološki odjel PMF-a, Zagreb 220+78 str.

Fauna: Amphibians

- JANEV-HUTINEC, B. 1997: Zaštita staništa i biološke raznolikosti na području Turopolja. Hrvatski prirodoslovni muzej. Zagreb.
- MEŠTROV, M. i sur. 1986: Ekološka istraživanja u okolici NE Prevlaka.

- Izvještaj o jednogodišnjim istraživanjima 1985/86. Biološki odjel PMF-a, Zagreb 220+78 str.
- OBRADOVIĆ, S. 1995: Morfološka i morfometrijska analiza populacija smeđih žaba iz Turopolja. Diplomski rad, Biološki odsjek PMF-a, 86 str.
- HUTINEC, B., KLETEČKI, E., LAZAR, B., PODNAR LEŠIĆ, M., SKEJIĆ, J., TADIĆ, Z. i TVRTKOVIĆ, N. 2006: Crvena Book vodozemaca i gmazova Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode, Zagreb, 94 str.
- DŽUKIĆ, G., TVRTKOVIĆ, N., LEINER, S. 1981: Vodozemci (Amphibia) Turopolja. Prvi kongres biologa Hrvatske, Zbornik sažetaka priopćenja, str. 169.
- Elaborat "Zaštita stanista i bioloske raznolikosti na području Turopolja" - rezultati prve godine istraživanja; ožujak - studeni 1997. Hrvatski prirodoslovni muzej, Zagreb.
- Elaborat "Zaštita staništa i bioloske raznolikosti Turopoljskog luga" - rezultati druge godine bioloških istraživanja (1998.) Hrvatski prirodoslovni muzej, Zagreb.

Fauna: Reptiles

- JANEV-HUTINEC, B. 1997: Zaštita staništa i biološke raznolikosti na području
- Turopolja. Hrvatski prirodoslovni muzej. Zagreb.
- MEŠTROV, M. i sur. 1986: Ekološka istraživanja u okolici NE Prevlaka. Izvještaj o jednogodišnjim istraživanjima 1985/86. Biološki odjel PMF-a, Zagreb 220+78 str.
- HUTINEC, B., KLETEČKI, E., LAZAR, B., PODNAR LEŠIĆ, M., SKEJIĆ, J., TADIĆ, Z. i TVRTKOVIĆ, N. 2006: Crvena Book vodozemaca i gmazova Hrvatske. Ministarstvo kulture, Državni zavod za zaštitu prirode, Zagreb, 94 str.
- Elaborat "Zaštita stanista i bioloske raznolikosti na području Turopolja" - rezultati
- prve godine istraživanja; ožujak- studeni 1997. Hrvatski prirodoslovni muzej,
- Zagreb.
- Elaborat "Zaštita staništa i bioloske raznolikosti Turopoljskog luga" - rezultati druge godine bioloških istraživanja (1998.) Hrvatski prirodoslovni muzej, Zagreb.

Cultural and historical heritage

- Adamček, J: Agrarni odnosi u Hrvatskoj of sredine 15. do kraja 17. st. Zagreb, 1980.
- Barle, J: Zagrebački arhiđakonat do godine 1642., Zagreb, 1903.
- Barle, J: Povijest turopoljske župe, Zagreb, 1920.
- Buturac,J: Popis župa zagrebačke biskupije of godine 1334., Kulturno povijesni zbornik zagrebačke nadbiskupije, Zagreb 1944.
- Cuvaj, A: Građa za povijest školstva kraljevina Hrvatske i Slavonije of najstarijih vremena do danas, sv I,II,III, Zagreb 1910
- Ćuk, J: Zagrebačka županija oko XIII st., Prigorje 1942.
- Dimitrijević, T. Težak-Gregl, N. Majnarić-Pandžić, Prapovijest, Zagreb, 1998.
- Durman, A: Stotinu hrvatskih arheoloških nalazišta, Zagreb, 2006.
- Fürst, Bjeliš,B: Historijsko - geografska analiza prostornog pojma tradicionalne
- regije Turopolja, Zagreb, 1996.
- Gregl, Z: O jednoj antičkoj cesti u blizini Zagreba, Vijesti muzealaca i Konzervatora Hrvatske XXIX / 1, Zagreb, 1980, 19 - 20.
- Gregl,Z: Rekognosciranja i istraživanja antičkih lokaliteta na području Zagreba 1979. god., Vjesnik Arheološkog muzeja u Zagrebu 3 / XII-XIII, Zagreb, 1980, 244.
- Gregl,Z: Pokušaj rekonstrukcije antičke cestovne mreže na području Zagreba. Iz starog i novog Zagreba VI, Zagreb, 1984., 7-14.
- Gregl,Z: Rimljani u Zagrebu, Zagreb, 1991.
- Jahnz, A: Mjestopisni rječnik kraljevina Hrvatske i Slavonije 1916.
- Klemenc,J: Archaeologische karte von Jugoslavien, Blatt Zagreb, Beograd, 1938.

- Klemenc,F: Predhistorijski i ranohistorijski spomenici na području grada Zagreba, Zagreb, 1939.
- Korenčić, M: Naselja i stanovništvo SR Hrvatske 1857-1971, Djela JAZU, knj.54, Zagreb,1979
- Lakatoš J: Industrija Hrvatske i Slavonije, Zagreb, 1924
- Laszowski, E:Turopolje I, Zagreb 1911.
- Nemeth-Ehrlich, D; Vojvoda, P: Andautonija - Rimsko urbano središte, Zagreb prije Zagreba, Zagreb, 1994., 39-71.
- Nemeth-Ehrlich, D: Ščitarjevo - antička Andautonija, Obavijesti HAD-a XXIII/2, Zagreb, 1991., 52-54
- Nemeth-Ehrlich, D;Kušan Špalj D: Dvije tisuće godina Andautonije; of rimskog grada do arheološkog parka, Zagreb, 2007.
- Radovčić,J; Škoberne Ž:19Zagreb prije početaka, Zagreb, 1989.
- Registar arheoloških nalaza i nalazišta sjeverozapadne Hrvatske, II. dopunjeno izdanje, Bjelovar 1997.
- Simoni,K: Zagreb i okolica u ranom srednjem vijeku, Arheološka istraživanja u Zagrebu i njegovoj okolici (izd. HAD-a 6), Zagreb, 1981.
- Sabljar,V: Mjestopisni riječnik kraljevinah Dalmacije, Hrvatske i Slavonije, Zagreb, 1866.
- Srkulj, S: Hvatska povijest u devetnaest karata, Zagreb
- Szabo,G: Srednjovjekovni gradovi, Zagreb
- Škoberne, Ž: Tragovi starijeg željeznog doba središnje Hrvatske u prostoru između definiranih kulturnih skupina, Ratnici na razmeđu Istoka i Zapada - Starije željezno doba u kontinentalnoj Hrvatskoj, Zagreb, 2004.
- Vikić-Belančić ,B: Etape urbanog razvitka Andautonije i antičko nasljeđe Zagreba, Izdanja HAD 6, Zagreb, 1981.,
- Vikić-Belančić,B; Gorenc ,M: Analiza i valorizacija prirodnog ambijenta naselja Andautonija - Ščitarjevo i prikaz kontinuiteta njegove naseljenosti, Plan uređenja manjeg naselja - Ščitarjevo, 1-2, Zagreb, 1984, 7-17. (umnoženo kao rukopis)
- Vinski-Gasprini, K: Kultura polja sa žarama u sjevernoj Hrvatskoj, Zadar, 1973.
- Konzervatorska podloga za Prostorni plan Zagrebačke županije, Konzervatorski odjel u Zagrebu, 2000.
- Konzervatorska podloga za Prostorni plan Grada Velika Gorica, Konzervatorski odjel u Zagrebu, 2003.
- Konzervatorska podloga za Prostorni plan područja posebnih obilježja Zračna luka Zgareb- vodocrpilište Črnkovec, Konzervatorski odjel u Zagrebu, 2010.
- Konzervatorska podloga za UPU Velika Gorica, Konzervatorski odjel u Zagrebu, 2008.
- Konzervatorska podloga za UPU Velika Mlaka, Konzervatorski odjel u Zagrebu, 2009.
- Konzervatorska podloga za UPU Donja Lomnica, Konzervatorski odjel u Zagrebu, 2009.

Light pollution

- Batinsey, John, "Light Pollution: The Neglected Problem", New Jersey Municipalities, May 1995.
- "An Introduction to Light Pollution", No.28, February, 1990.
- "Exterior Lighting: Glare and Light Trespass", No. 76, September, 1993.
- Recommendations for the Lighting of Roads for Motor and Pedestrian Traffic",Publication CIE 115 - 1995.
- Cinzano P.2001, Light pollution by luminaires in roadway lighting, presented at the Commission Internationale de l, Eclairage, Technical Committee TC4-21 (Interference of light on the astronomical observations), CIE Div.4 meeting, Turin, 28 September - 3 October 2002

- Cinzano, P. 2005, Night Sky Photometry with Sky Quality Meter, ISTIL Int. Rep.9
- Svijetlozagađenje - Ekonomski i Ekološki problem mr.sc. R. Skansi - Interlight Zagreb , 2009.
- Rasvjeta i energetska učinkovitost - Vladimir Kocet Javna rasvjeta 2010. - Crikvenica, HR
- International Dark Sky Association Lighting Guidance - Specifier Bulletin for Lighting Applications
- *Longcore T.2005. Ecological Consequences of Artificial Night Lighting, Island Press, Rich C.*
- *X.D. Li, C.S. Poon, S.C. Lee, S.S. Chung, F. Luk: Waste reduction and recycling strategies for the in-flight services in the airline industry, Resources Consevation and Recycling, 37 (2003) 87-99.*
- *M. Pitt, A. Smith: Waste management efficency at UK airports, Journal of Air Transport Management 9 (2003)103-111*

Noise

- Zračna luka Zagreb - Godišnji izvještaj o razini buke za 2009. godinu
- Prognoza prometa InterVISTASConsulting Group - Nizozemska
- Meteorološka podloga za Studiju o utjecaju na okoliš Novog putničkog terminala Zračne luke Zagreb, studeni 2011.
- Prostorni plan uređenja Grada Velike Gorice - izmjene i dopune 2008.
- Strateška karta buke cestovnog prometa Grada Velike Gorice 2008.
- Strateška karta buke željezničkog prometa Grada Velike Gorice 2008.
- Popis stanovništva, kućanstava i stanova 2011.- Statističko izvješće, Zagreb 2011., Državni zavod za statistiku Republike Hrvatske.
- Pregledni članak „Implementiranje sustava za mjerenje buke na zračnoj luci Zagreb" Izvor: Suvremeni promet, Vol. 25, No. 5, Hrvatsko znanstveno društvo za promet, Zagreb, 2005, str. 356-360.
- Buka zrakoplova u zonama zračnih luka (25.01.2011), mr.sc. Igor Štimac, izvor: www.aerosvijet.com
- A National Aviation Policy - White Paper: Flight Path to the Future, Australian Government, Departmet of Infrastructure and Transport, 2009 (www.infrastructure.gov.au/aviation/nap)
- Štimac, I.,; Vidović, A., Vince, Damir: Implementacija sustava praćenja i analize buke na Zračnoj luci Zagreb, Međunarodni znanstveni skup Ekološki problemi prometnog razvoja, Zbornik radova, Hrvatska akademija znanosti i umjetnosti, Znanstveno vijeće za promet, Zagreb, 2011., p. 265-275.

Aircraft crashes risk assessment

- Aerodromes, Annex 14 to the Convention on International Civil Aviation, Edition 5, International Civil Aviation Organization, Montreal, 2009.
- Pravilnik o aerodromima, OG 64/10
- Zagreb International Airport Master Plan Update 2008, Report, Project Airport GmbH, Stuttgart, 2009.
- Safety Management Manual, Second Edition, Doc. 9859, International Civil Aviation Organisation, Montreal, 2009.
- Airport Services Manual, Part 7: Airport Emergency Planning, Second Edition, Doc. 9137, International Civil Aviation Organisation, Montreal, 1991.
- Implementation of Safety Management Systems, Air Safety Order ASO-2010-04, Croatian Civil Aviation Agency, Zagreb, 2010.
- Pavlin, S.: Arerodromi I, sveučilišni udžbenik, Fakultet prometnih znanosti Sveučilišta u Zagrebu, Zagreb, 2006.

- Pavlin, S., Bračić M.: Utjecaj aerodromskog prometa na prostorno planiranje u okolini zračne luke, ISEP 2011, *Izvor: http://bib.irb.hr/datoteka/539546.ISEP_LJubljana_conference_final.pdf)*
- Evans, A.W., Foot, P.B., Mason, S.M., Parker, I.G., Slater, K.: Third party risk near airports and public safety zone policy, National Air Traffic Service Ltd, London, 1997.

9.3. LIST OF REGULATIONS AND STANDARDS

Environment and nature protection:

- Environment Protection Act (OG 110/07)
- Nature Protection Act (OG 70/05, 139/08)
- The Act on Validation of the Convention on Biological Diversity (OG 6/96)
- The Act on Validation of the European Landscape Convention (OG 12/02)
- The Act on Validation of the Convention on the Conservation of European Wildlife and Natural Habitats (Bern Convention) (OG 6/00)
- The Act on Validation of the Convention on the Conservation of Migratory Species of Wild Animals/Bonn Convention (OG 6/00)
- Regulation on the Assessment of the Environmental Impact (OG 64/08, 67/09)
- Regulation on Proclamation of Ecological Network (OG 109/07)
- Ordinance on habitat types, habitat maps, endangered and rare habitat types and the measures taken to preserve habitat types (OG 7/06, 119/09)

Air:

- Air Protection Act (OG 130/11)
- Regulation on Limit Values of Air Pollutants (OG 133/05)
- Regulation on the Critical Levels of Air Pollutants (OG 133/05)
- Regulation on Ozone in the Air (OG 133/05)
- Regulation on Technical Environmental Standards for Emissions of Volatile Organic Compounds during the Storage and Distribution of Gasoline (OG 135/06)
- Regulation on the Limitation of Emissions of Air Pollutants from Stationary Sources (OG 21/07, 150/08)
- Regulation on Air Quality Monitoring (155/05)
- Regulation on Monitoring Emissions Pollutants into the Air from Stationary Sources (OG 01/06)

Soil:

- Act on Agricultural Land (OG 152/08, 21/10)
- Regulation on the Protection of Agricultural Land from Pollution (OG 32/10)
- Ordinance on the Methodology for Monitoring the Status of Agricultural Land (OG 60/10)
- Ordinance on the Conditions and manner of Use of Charges to be paid for Change of Use of Agricultural Land (OG 87/09, 20/10)

Water:

- Water Act (153/09, 63/11)
- Regulation on Hazardous Substances in Water (OG 137/08)
- Regulation on Water Classification (77/98, 137/08)
- Ordinance on Limit Values for Waste Water Emissions (87/10)
- Ordinance on the Safety of Drinking Water (OG 47/08)
- Ordinance on Sanitary Protection Zones for Water Sources (OG 55/02)
- Decision on the Determination of Sensitive Zones (OG 81/10)
- Decision of the Zagreb County on Drainage for the Area of Velika Gorica (OG

of Zagrebačka County No 4/2007)

- Decision on the Establishment of Sanitary Protection of Drinking Water sources for Kosnica, Stage I (OG of Velika Gorica No 15/2004)
- Program of Measures for Rehabilitation of the Water Environment in the Second and Third Zone for the Protection of Drinking Water Sources for Kosnica, Phase I (OG of Velika Gorica No 13/2007)
- Decision on Protection of Drinking Water Sources for Velika Gorica (OG of Velika Gorica No 8/2010)

Cultural and historical heritage:

- Act on Protection and Preservation of Cultural Heritage (OG, No 69/99, 151/03, 157/03 - correction, 87/09, 88/10 and 61/11)
- The Act on Approval of the European Landscape Convention (OG 12/2002.) UNESCO World Heritage Convention, 1992

Forests and forestry

- Forest Act (OG 140/05)
- Act on Amendments to the Forest Act (OG 82/06)
- Act on Amendments to the Forest Act (OG 129/08)
- Ordinance on Forests Restructuring (OG 111/06)
- Ordinance on Amendments of the Ordinance on the Forests Restructuring (OG 141/08)
- Ordinance on Monitoring the Damages of Forest Ecosystems (OG 067/2010)

Geology and hydrogeology

- Ordinance on Determination of Sanitary Protection Zones (OG 55/02)
- Decision on Protection of the Water sources Stara Loza, Sašnjak, and Žitnjak, Ivanja Reka, Petruševec,Zapruđe and Mala Mlaka, OG of the City of Zagreb, No 9 from 19th July 2007
- Decision on Determining Sanitary protection Zones for the Water source "Kosnica, Phase I " (OG of Velika Gorica No 15/2004.
- Ordinance on Determining Sanitary Protection Zones for the Water Sources ("Official Gazette", No 55/02)
- Ordinance on the Safety of Drinking Water (OG No 47/08).
- Ordinance on Hazardous Substances in Water (OG 137/2008)

Waste

- Waste Act OG 178/04, 153/05, 111/06, 60/08, 87/09)
- Ordinance on the Terms and Conditions of Waste Disposal, Categories and Operational Requirements for Landfills *(*OG, No 117/2007)
- Regulation on Categories, Types and Classification of Waste with Catalogue of Waste and List of Hazardous Waste (OG 50/05, 39/09)

Light Pollution

- Act on Protection against Light Pollution (OG 114/011)
- HRN EN 13 201 Croatian (European) Norm for road lighting
- HRN EN 12 464 Croatian (European) Norm for indoors lighting.

Noise

- Air Traffic Act (OG 132/08, 84/11)
- Act on the Airports (OG 19/98, 14/11)
- Regulation an Aircrafts' flying (OG 75/06)
- Regulation on the Establishment of Rules and Procedures Regarding the Introduction of Operational Restrictions on Aircraft Noise at Airports on the Territory of the Republic of Croatia (OG 120/11)
- Decree on Working Hours of the Airport for the Public Air Traffic (OG 36/11)

- Decree on Air Traffic Routes (Lines) (OG 82/93)
- Commission Recommendation 2003/613/EC concerning the guidelines on the revised interim computation methods for industrial noise, aircraft noise, road traffic noise and railway noise, and related emission data.
- Directive 2002/30/EC of the European Parliament and of the Council of 26 March 2002 on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Community airports
- Act on Protection against noise (OG 30/09)
- Ordinance on the Shape and Content of Noise Maps and Action Plans and on the Calculation Method for Allowed Noise Indicators (OG 75/2009)
- Ordinance on Maximum Permissible Noise Levels in the Environment in which People Work and Live (OG 145/04)
- For road traffic noise: French national calculation method »NMPB-Routes-96 (SETRA-CERTU-LCPC-CSTB)«, stated in "Arrété du 5 mai 1995 relatif au bruit des infrastructures routiéres, Official gazette from 10th May 1995, Article 6" and in French norm »XPS 31-133«.
- ECAC.CEAC Doc. 29 "Report on Standard Method of Computing Noise Contours around Civil Airports", edition 1997. In order to model a flying path, segmentation technique from the section 7.5 ECAC.CEAC Doc. 29 is used
- HRN EN ISO 9613-2: "Acoustics -- Attenuation of sound during propagation outdoors -- Part 2: General method of calculation"
- HRN EN ISO 8297 "Acoustics -- Determination of sound power levels of multi-source industrial plants for evaluation of sound pressure levels in the environment -- Engineering method"
- HRN EN ISO 3744 "Acoustics -- Determination of sound power levels and sound energy levels of noise sources using sound pressure -- Engineering methods for an essentially free field over a reflecting plane"
- HRN EN ISO 3746 "Acoustics -- Determination of sound power levels of noise sources using sound pressure -- Engineering method in an essentially free field over a reflecting plane"

Traffic and construction

- Act on Spatial Planning and Construction (OG, No 76/07, 38/09 and 55/11).
- Act on Road Traffic Safety (OG, No 67/08)
- Act on Amendments to the Act on Road Traffic Safety (OG 74/11)
- Roads Act (OG No 84/11)
- Standardisation Act (OG No 55/96; 163/03)
- Act on Fire Protection (OG 92/2010)
- Act on Protection at Work (OG No 59/96, 94/96, 114/03, 86/08, 75/09)
- Regulation on Traffic Signs, Equipment and Road Signalisation (OG No 33/05; Correction OG No 64/05; Amendments OG No 155/05, 14/11)
- Ordinance on Essential Requirements by which the Public Roads outside the Villages and Their Elements Must Comply from the Traffic Safety Point of View (OG No 110/01)
- Ordinance on Requirements for Design and Construction of Connection and Access to a Public Road (OG No 119/07)
- Ordinance on Type and Content Public Roads Projects (OG No 53/02)
- Guidelines for Remote Routing and Managing Traffic flow (Hrvatska uprava za ceste, June 2000)
- Ordinance on Marking Highways, Their Chainage, the Number of Exits and Joints, Names of Exits and Joints and Rest Areas (OG No 73/2003)
- Rules and Technical Requirements for Public Roads Patrolling (OG No 11/199)
- Technical Regulation for Concrete Structures (OG No 139/09, Amendments in OG No 14/2010, Amendments in OG No 125/2010)
- Technical Requirements for Steel Structures (OG No 112/08, Amendments in OG No125/2010),

- General Technical Conditions for Road Works, Book I - VI (Zagreb, December 2001 Hrvatske ceste - Hrvatske autoceste),
- Ordinance on the requirements for fire fighting approaches (OG No 35/94, 55/94);

ENVIRONMENTAL IMPACT STUDY

NEW ZAGREB AIRPORT PASSENGER TERMINAL

- SUMMARY

INSTITUT IGH, d.d. Janka Rakuše 1, 10000 Zagreb, CROATIA Tel:+3851 6125 413 Fax:+3851 6125 405 igh@igh.hr www.igh.hr

INSTITUT IGH, d.d.
IGH Hydrotechnics, Geotechnics and Ecology
10 000 ZAGREB, J.Rakuše 1

Ordering Party:	ZRAČNA LUKA ZAGREB d.o.o.
Study Title:	ENVIRONMENTAL IMPACT STUDY FOR THE NEW ZAGREB AIRPORT PASSENGER TERMINAL
Study Level:	FINAL VERSION
Project Number:	81010-467/11
Book:	II Environmental Impact Study - Summary
Responsible Development Manager:	Domagoj Vranješ, MSc Land Arch, Univ Spec Oecoing
Director:	Ivan Krstanović, MSc Civil Eng
Conceptual Design Team for the New Zagreb Airport Passenger Terminal:	academician Branko Kincl, KINCL d.o.o. academician Velimir Neidhardt, NEIDHARDT ARHITEKTI d.o.o. PhD Jure Radić, INSTITUT IGH d.d.
Collaborators:	PhD Aleksandra Anić Vučinić - waste management MSc Indira Aurer Jezerčić (Institute of Safety Research and Development) -accident situations Davor Barać, MSc Civil Eng -site's geotechnical features MSc Ivan Barbić, MSc Civil Eng - NPT Airport Zagreb project coordination Ena Bićanić, MSc Land Arch - coordination and layout preparation Erol Čičić, MSc Mech Eng - light pollution Hrvoje Damić, MSpec Civil Eng - noise inventory prof.dr.sc. Jagoda Doko Jelinić (School of Medicine University of Zagreb, School of Public Health „Andrija Štampar“) - health impact assessment PhD Miodrag Drakulić, MSc Mech Eng (CTP Projekt d.o.o.) - project description/energetics MSc Biserka Dumbović Bilušić, MSc Arch Eng - cultural heritage

Zlatko Franolić, MSc Eng - noise inventory

Zoran Golob, MSc Biotech Eng (TEH Projekt Kemo d.o.o.) - alternative solutions for polluted rainwater treatment

Draško Holcer MSc Eng (Croatian Natural History Museum) - fauna: mammals

Ines Horvat, MSc Arch Eng - spatial planning analysis PhD Stjepan Husnjak - soil

MSc Slobodan Kljaić, MSc - traffic analysis MSc Stjepan Kralj, MSc Civil Eng - project description/ traffic solution

PhD Vladimir Lay - sociological analysis

Mato Lujić, MSc Civil Eng - project description/water supply and sewage system

Darija Maletić Mirko, MSc Arch Eng - spatial planning analysis

PhD Darko Mayer - hydrogeology

Natalija Mavar, MSc Arch Eng - spatial planning analysis Vanja Medić, MSc Biol Ecol Eng - flora, habitats and protected areas

MSc Mirta Patarčić (Meteorological and Hydrological Service) -meteorological data

Marija Pašalić, MSc Spat. Plan. - settlements and population

PhD Igor Pavlinić, (Croatian Natural History Museum) - fauna: mammals, fauna: bats

PhD Natalija Pavlus, MSc Biol Ecol Eng, PhD - ecological network

MSc Zlatko Perović - air quality, air pollution model

PhD Ivan Pilaš - forests and forestry

PhD Martina Podnar (Croatian Natural History Museum) - fauna: amphibians, fauna: reptiles

PhD Božo Prtoljan - geology

Vanda Sabolović, MSc Eng Land Arch - landscape PhD Sanja Steiner - project description/operative area of Zagreb Airport, aircraft accident risk assessment

MSc Željko Štromar, MSc Civil Eng - noise protection Dinko Tvrtković, MSc Mech Eng - project description/ refined products pipeline

PhD Vesna Tutiš - ornithofauna

Amelio Vekić, MSc Arch - cultural heritage

Place and date: Zagreb, October 2012

COPY No.

REVISION E

Study content - comprehensive list of books

CONTENTS OF THE BOOK II - SUMMARY OF THE ENVIRONMENTAL IMPACT STUDY:

1 PROJECT DESCRIPTION

1.1 REASONS FOR PROJECT PROPOSAL

The existing Zagreb Airport infrastructure and physical planning are not sufficient for further traffic development. It is, therefore, deemed necessary to expand airside and landside capacities and to upgrade ramp handling capacities in order to provide for the anticipated traffic requirement increase.

In December 2010 InterVISTAS Consulting Group confirmed the Zagreb Airport forecast for the period 2011-2040. New project parameters were developed based on the analysis of the 30th peak hour which will enable the construction of the new terminal per phases.

The above mentioned project envisages the Zagreb Airport capacity increase to 5 million passengers in Phase I, i.e. 8 million passengers annually in Phase II. The project encompasses the construction of the passenger building and external traffic area with access roads and other infrastructure in Phase 1 and their subsequent expansion in Phase II. The future Concessionaire is ultimately responsible (as defined under the Concession Agreement) for ensuring terminal capacities of 8 million passengers and reaching at least C level service not later than 15 years after the hand-over date.

One of the steps in obtaining the location permit for the project is the development of the Environmental Impact Assessment. The Environmental Impact Assessment (hereinafter referred to as: EIA) evaluates the impact of the proposed project on the environment while taking into account potential adverse effects and approving environment protection measures in order to reduce the adverse effects to the minimum and preserve environment quality to the highest extent possible. The adopted environment protection measures are included into the project documentation for obtaining location and construction permits.

The EIA development is mandatory pursuant to Art. 3 Annex I of the Regulation on environmental impact assessment (Official Gazette 64/08, 67/09) i.e. for: 13. Construction of an airport with a runway of 2 100 m or more in length.

1.2.PROJECT SCOPE AND MAIN FEATURES

The subject of the study is the following:

1 The construction of the new passenger terminal (NPT) with all necessary connections to the infrastructure network

2 The construction of the airside traffic areas of the NPT:
- Apron-gate area
- Rapid exit taxiway
- Pathways
- Aircraft de-icing area

3 The construction of the landside traffic areas of the NPT:
- Airport ground access roads
- Parking lots (for taxis, buses and vehicles of passengers and employees)

4 The construction of a power plant with a connection to the gas network

5 The construction of a system for drainage and treatment of the contaminated storm and sanitary waste water of Zagreb airport having two options:

Option 1: The connection to a public network system and waste water treatment by connection to Velika Gorica system for waste water treatment

Option 2: Waste water treatment at Zagreb airport

6 The reconstruction of the runway and of taxiway in terms of the construction of the drainage system contaminated storm water. The runway shall not be extended neither shall another runway be built.

7 The reconstruction of the existing apron-gate area in terms of the connection to the drainage of the contaminated storm water to a new collective drainage and water treatment system.

For purposes of the new passenger terminal, it will be needed to build a new access road which shall connect the NPT with the eastern bypass of Velika Gorica, which is currently under construction. The influence of the construction and use of the mentioned access road is discussed in this study.

The aircraft fuel provision, as an important part of the functional and technological airport complex is also analysed in terms of possible environmental impact. Since the aircraft fuel is stored in the facility which is not owned by Zagreb airport, but on the location of INA Aviation service in Zagreb which operates and has all necessary permits, there have not been proposed any environmental protection measurements for the mentioned facility.

The existing terminal building, as well as all other facilities at Zagreb airport, which are also the subject of the concession agreement, will retain their current function, and as such they are not the subject of consideration within this study. It should be mentioned that all existing facilities at Zagreb airport have use permits and will be used in the future in accordance with their purpose.

1.2.1 Current situation at Zagreb Airport

The project scope area for the construction of the New Passenger Terminal at the Zagreb Airport (hereinafter referred to as: ZLZ) covering a total surface of around 1.3 km^2 (area under concession 3.2 km^2), is located north of the town of Velika Gorica, close to the Zagreb Airport.

Photo 1.2.1.-1 View of the existing Zagreb Airport

The project location is situated in the Zagrebačka County on the territory of Velika Gorica in the cadastre municipalities of: Pleso, Mičevec and Kosnica.

In autumn 1959 the passenger building and platform were built and the Pleso Airport was opened for passenger traffic. The Zagreb Airport commenced its operations on 20 April 1962. The then concrete runway was 2500 m in length, and the passenger terminal covered an area of 1000 m^2. The platform had a capacity for five smaller aircrafts. In the first year of its operation the Zagreb Airport recorded 78,041 passengers, 633 tons of cargo in 5,206 aircraft rotations. Four years later, in 1966 a new passenger building was built with a surface of 5,000 m^2, the runway was renovated and extended reaching now 2,860 m and the platform was upgraded to 60.000 m^2. In addition, a new management building with the control tower was constructed. In that year the airport changed its name to “Zagreb Airport”. The next significant renovation followed in 1974 when the Zagreb Airport was closed for this reason for two months. The runway was reconstructed and extended to 3,259 m, radio navigation devices were upgraded and the equipment modernized. Due to a frequent traffic increase in 1984 a new phase was introduced covering the upgrade of the existing facilities but also construction of new ones. That year the Customs office and international freight forwarding agency, cargo terminal and a new fire fighting station commenced their operations. The passenger building was upgraded to 11.000 m^2. In 1986 additional work was performed on the platform of 30.000 m^2 and the runway was modernized.

Today ZLZ disposes of a runway of 3,252 m in length and 45 m in width and together with the curb it covers a surface of 60 m. The runway thresholds are made of concrete, and the middle part is made of asphalt.

The existing passenger terminal building has two levels on the landside. An area of 2,140 m^2 is used as an arrival and departure lobby. There are two lounges, one for international passengers

(865 m^2) and the other for domestic passengers (505 m^2). Passenger control and baggage areas cover the surface of 250 m^2 (plus 315 m^2 for immigration control/arriving passengers) and 1.420 m^2, respectfully. There are 18 terminal exits and 18 passenger and baggage check-in desks. The common area of 2,640 m^2 is situated on the ground floor. In addition there are 597 parking lots for terminal users.

The 91st Pleso Air Force Base is situated in the eastern part of the Zagreb Airport and in addition to transport aircraft and helicopters it also disposes of a MiG 21bisD fighter squadron. It also houses the Croatian Air Force and Air Defence headquarters.

Prior to Croatian independence the Zagreb Airport was the main transit and transfer airport on the territory of the former Yugoslavia, with the largest traffic reached in 1979, greater than 1,9 million passengers a year, out of which approx. 0.4 million were transit passengers (passengers continuing their journey on the same flight) and approx. 0.8 million were transfer passengers (passengers changing their flight), 37 thousand civil aircraft operations and dozens of thousands of military aircraft operations annually.

After Croatian independence in war time the traffic volume decreased significantly and in 2007 it reached a figure of 1,992,455, i.e. 2 million passengers.

Considering its physical characteristics the ZLZ manoeuvring area and apron can handle all aircraft types used today in civil aviation. However, not all elements of airport areas meet international and domestic regulations. At ramp handling wide body aircraft penetrate an obstacle limitation surface with their tails.

The Zagreb Airport represents a rare example in Europe in which the capital city airport is also an air force base and one runway is used both for civil and military purposes.

It should be emphasized that the position of the Zagreb Airport is, in principle, non-favourable considering the potentially negative impact on some aspects of the environment, particularly with regard to the possible contamination of groundwater that represents drinking water reserves, intended for public water supply to a city of Velika Gorica and the entire eastern part of the Zagreb County. However, due to the fact that no other suitable location is found or planned and that it was decided that the Zagreb Airport continues to develop at its present location, the only thing left is to protect vulnerable segments of the environment from the negative effects of this procedure with means of enhanced protection measures.

1.2.2 New passenger terminal construction objectives at Zagreb Airport

The airport capacity expansion concept is based on the following criteria:
Minimum requirements for the new terminal:

- handling of 5 million passengers annually (Phase I)
- handling of 8 million passengers annually (Phase II)
- minimum level of service C
- The existing security protocol for the public and passengers

Minimum airside requirements:

- 70% of international aircraft (in the peak period) have to be connected to the exit (through air bridges)
- 30% of international aircraft and domestic passengers can use the existing apron
- A new apron needs to be constructed in front of the new terminal for the purpose of ensuring the above capacity. The new apron should have a double Code C taxi lane / single Code E lane and two taxiway connections for access to the military taxiway F
- New rapid exit taxiway
- New airside service road has to link the existing and the new apron
- De-icing area has to be equipped with a drainage system
- Sufficient number of parking lots for taxis, buses and vehicles of passengers and employees

1.2.3 CONSTRUCTION OF NEW PASSENGER TERMINAL AT ZAGREB AIRPORT PER PHASES

According to the procedure for the development of technical documentation for the new terminal at the Zagreb Airport the entire programme needs to be realized in two phases. The realization of each phase is based on traffic forecasts and minimum requirements.
A part of the passenger building and external traffic areas with access roads and other infrastructure (water pipeline, drainage and power supply) shall be realized in Phase 1. Phase 2 refers to the increase in the carrying capacity with respect to the anticipated air traffic increase and includes the expansion of the terminal building, apron and parking areas.

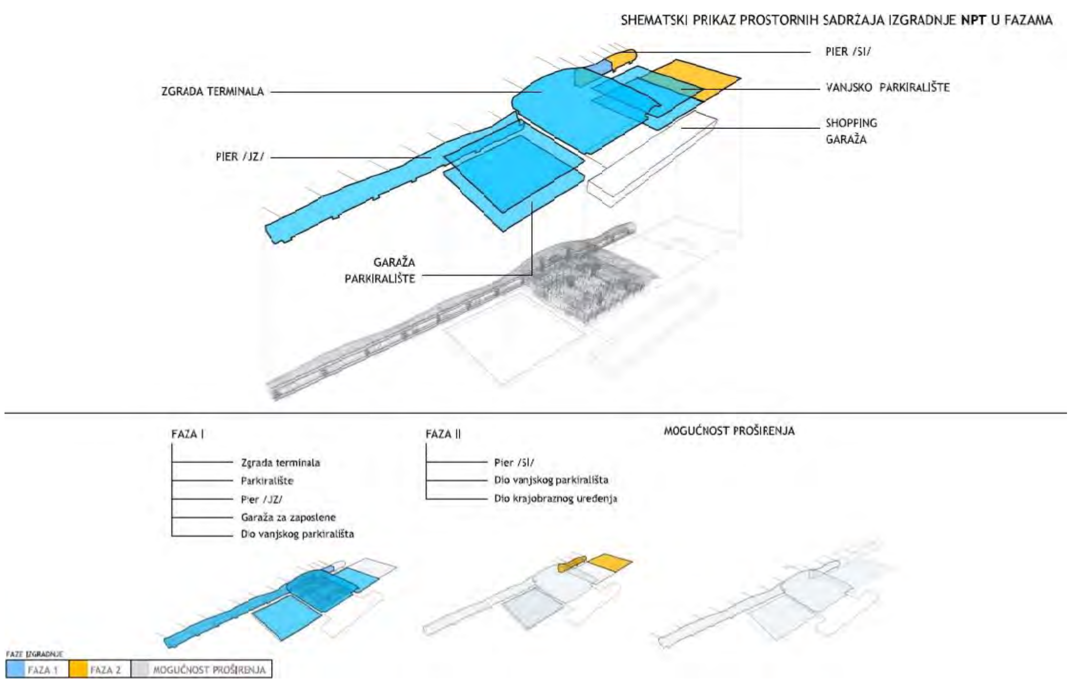


Photo 1.2.3.-1 Construction of New Passenger Terminal at Zagreb Airport per Phases
<SHEMATSKI PRIKAZ PROSTORNIH SADRŽAJA IZGRADNJE NPT U FAZAMA = ILUSTRATION OF NTP FACILITY CONSTRUCTION PER PHASE
ZGRADA TERMINALA = TERMINAL BUILDING; VANJSKO PARKIRALIŠTE = OUTSIDE PARKING AREA, GARAŽA = GARAGE; JZ = SW; SI = NE
FAZA = PHASE, Garaža za zaposlene = Employees´ garage; Dio vanjskog parkirališta = Part of outside parking area;
Dio krajobraznog uređenja = Part of landscape design; MOGUĆNOST PROŠIRENJA = EXPANSION POSSIBILITY>

Phase 1 work duration: maximum of 3 years
Phase 2 work duration: maximum of 2 years

The commencement of works in Phase 2 is scheduled for 2022.

FIGURES:
Photo 1.2.3.-1 Project location - scale 1: 25.000.
Photo 1.2.3.-2 Cadastral survey - scale 1: 10 000 Photo 1.2.3.-3. Situation 1: 10 000

1.3.NEW PASSENGER TERMINAL FACILITIES AND TECHNOLOGY AT ZAGREB AIRPORT

1.3.1 New terminal

The new terminal shall consist of:

- One main terminal complex (the main building), which encompasses the central landside facilities for domestic and international passengers as well as airside facilities for domestic and international passengers. The main building will house ground handling facilities for domestic and international operations, including: curb part, check-in, handing over, security check and control of baggage sent to the baggage area.
- Two airside passenger ramp halls for departing, arriving and transfer passengers, which will be connected with the main terminal.

Main building

The new terminal has been designed for 5 MPA (million of passengers annually), which is is a minimum requirement for keeping the C level of the service.
In Phase II the terminal will be expanded to 8 MPA.

Basement level - It contains all technical installations, baggage make-up system with automated make-up of outgoing baggage, situated 6 meters (-6) below the ground level. Incoming baggage is transferred from the apron through the tractor and trolley system, and then by way of ramps with a slope of 6.5% to the baggage make-up zone.
It is used for the following departure passenger types: domestic, international (non-Schengen) and international (Schengen). The project proposes a possibility of a shopping centre at this level.
We also discussed the possibility of eliminating this level and moving installations planned at this level to higher levels.

Arrival level - Includes business exists for departing passengers. It includes immigration control, baggage claim area, and customs office and arrivals hall. It is designed at the ground floor level. It is used for the following types of arriving passengers: domestic, international (non-Schengen) and international (Schengen).

Transfer level

The handling area for passengers arriving from an air bridge includes security check, passport control, lounges for transfer passengers and airline desks.
It is used for the following transfer passenger types:

- International (Schengen) for domestic flights
- International (non-Schengen) for domestic flights
- Domestic for international (Schengen)
- Domestic for international (non-Schengen)
- International (Schengen) for international (non-Schengen)
- International (non-Schengen) for international (Schengen)
- International (Schengen) for international (Schengen)
- International (non-Schengen) for international (non-Schengen)

Departure level

It is situated at 9.6m and connected, through the departure curb with a slope of 6%, with the arrival level. It consists of a landside hall, check-in area, emigration, and security and departure halls.
It is used for the following arrival passenger types: domestic, international (non-Schengen), international (Schengen) and all types of transfer passengers.

Restaurant and visitor levels (optional areas)
The restaurant level would be useful for incorporating small food and beverage units (F&B) and commercial offices. It is situated at 14.4.m, including lounges, with a view of the apron and Zagreb panorama.
The visitor level is located above the restaurant level and it should offer food and beverages, with a view of the outside and inside area.

1.3.2 NPT airside

The construction of the airside area in front of the new terminal provides for a neat organization with sufficient area and flexibility in order to meet the needs for aircraft parking area after the completion of the terminal construction.

Airside stands
A new apron shall be built in order to accommodate all aircraft stands necessary for the fleet expected at the Zagreb Airport. Fleet variations are possible so that the plan for the apron, as well as gradual development, takes into account such a possibility.
Based on the forecast by InterVISTAS Consulting Group on the absolute peak hour in 2024 on the basis of the high traffic growth scenario 11 aircraft stands will be required for handling 70% of international aircraft in the peak period.
During the First Phase, 30% of the needs for stands shall be met (for international aircrafts) at the existing apron in front of the existing terminal.
The airside apron plan foresees a double code C taxiway and one code E taxiway. This will enable code C aircraft to get around one another without interrupting other operations (i.e. aircraft push-out).
Because of allowing the aircrafts to land from both sides of the western ramp, there is the possibility of moving the building approximately 30m in the direction of the runway.

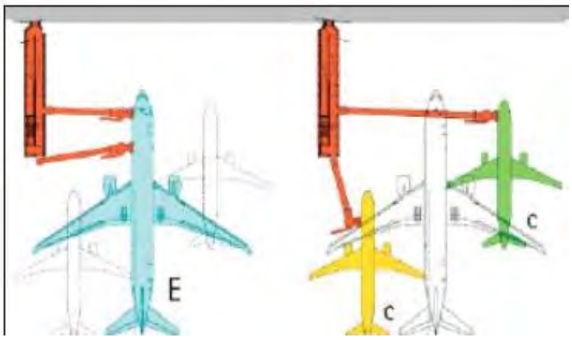


Photo 1.3.2.-1 Flexible use of type E aircraft or two type C aircraft enabling optimum flexibility and efficient use of the available apron area.

Rapid exit taxiway
In order to increase the runway capacity, a rapid exit taxiway needs to be constructed. The exact location of the rapid exit taxiway depends on the key type C aircraft. The taxiway will be located on the opposite side of the access roads to the apron in order to achieve the maximum taxiway capacity.
Apron taxiways
Two taxiways will connect the new terminal apron with the code F taxiway in order to ensure aircraft operation flexibility.

De-icing area/Waiting area
The plan includes a de-icing platform. The best location for a de-icing area is next to the edge of the runway 05. The de-icing area should be built near the end of the runway 05 because 90% of traffic takes place on this runway. In addition, a separate de-icing fluid drainage system or a drainage system closing valve should be used in order to separate fluids from precipitation. The waiting area will be built at the apron edge, on the eastern or western side of the terminal. Some other location, such as the future expansion of the code F taxiway to the end of the runway 23, might represent a good location because this area is rarely used (10% of traffic).
Airside road
An integrated airside road system between the building and aircraft stands should be ensured. Passenger buses for domestic services will use the same road system together with special-purpose lanes next to the road which serve as resting area. The entire road system has been organized in a simple way and designed for safe and orderly operations.

1.3.3 NPT landside

A new access for arriving passengers will be provided on the ground floor by way of a new arrival curb. An access for departing passengers will be ensured through construction of a departure curb with a ramp. Traffic can be two-way on the ground floor and one-way at the departure level. Both outside yards enable access to taxi and buses.

1.3.4 Traffic solution

<u>WIDER ROAD NETWORK</u>
Taking into account the entire settlement of the traffic issue and access to the ZLZ New Passenger Terminal, the existing and planned road network in the surrounding area have been analysed in depth.
The above research was conducted within the "Spatial and traffic study of the road and railway traffic in the wider area of the City of Zagreb", IGH Zagreb, 2008/2009.
On the basis thereof complete traffic solutions have been proposed, out of which the building solutions per stage and phase can be developed as parts of the future comprehensive solution.
From the perspective of traffic planning, the location in question of the future airport is situated in a general environment with natural or man-made obstacles, such as the highway and the existing runway NW, Velika Gorica S and SE, well field, bypass route and a number of rural settlements E.
The future access to the new airport building will be ensured through roads (and in the future phase through railway, but this is not the subject matter of this Environment Impact Assessment) with direct links to the inner city centre. The main access road to the airport building is the road connecting the eastern Velika Gorica bypass a bit more to the south from the Velika Kosnica junction on the A3 highway and across the NPT traffic area access avenue (internal roads).
The eastern Velika Gorica bypass (1-currently under construction) is a link between the A11 highway Zagreb-Sisak and the A3 highway, the Zagreb bypass, i.e. a link across the Domovinski bridge to the city centre (main railway station, Zrinjevac square, Jelačić square).
The existing access road from the Velikogorička road (SW) shall remain an access to the existing terminal, and in Phase 1 it shall also be a service road to the new passenger terminal.
The access road route has been determined by the Velika Gorica Spatial Plan.

<u>NPT ACCESS ROAD</u>
According to the Decision on the Velika Gorica Spatial Plan (Velika Gorica Official Gazette 10/06), figure No. 1 "Area use and purpose", the access road from the eastern Velika Gorica bypass to the Zagreb Airport scope boundary has been entered into the “state road” category, with a corridor of 100 m in width.

The scope area, i.e. the planned access road route is crossed by the local road L-31154 (V. Mlaka (Ž 3109) - Mićevec - M.Kosnica - Selnica Ščitarjevska (Ž 3068) with asphalt road overlay. According to the plan the access road will have two roadways, each with 2 lanes, separated by a median, for calculation speed of 60 km/h. Both side roadways have 7.0 m between the SW roadway and cycle path a median is planned with 1.4 m in width. Next to the 2-meter cycle path there is a 1.6-meter sidewalk and a 1.5-meter median (curb). In addition to the SE roadway, a 1.50-meter median (curb) is planned, as well. Bicycle and pedestrian path should be separated by vertical or horizontal signalisation. This conceptual design establishes the construction of the local road 31154 crossing over the access road to the new passenger terminal at the Zagreb Airport (in km 0+709,25 km).

1.3.5 Energy supply and distribution

The energy block, which will be used for the new passenger terminal at Zagreb airport, is planned to be situated at about 1 km west from the new passenger terminal, next to the existing road, on the southern side of Croatia Airlines terrain (complex). Taking into account the fact that the location of the energy block at this moment is not defined yet, there is a possibility to relocate it closer to the New passenger terminal building.
The terrain, on which the power plant, its equipment and accessories will be placed, has approximately 50 x 50 m. The power plant will be connected with the positions of the end users through the installation channel.
The new passenger terminal at Zagreb airport will get thermal, cooling and a part of the electrical energy from the trigeneration power plant. Throughout the year, they plan to use natural gas as the primary fuel because of its energy efficiency as well as because of its properties related to transport and environmental protection. The architectural scheme proposes as well the use of solar photovoltaic systems in order to produce electricity. Solar panels are placed on the solid parts of the roof. Similar systems are successfully used at the Munich airport.
The proposed energy supply system has the basic attributes of the "green" concept because it uses:

- Highly efficient trigeneration system that significantly reduces fuel consumption compared to conventional energy production by separated processes of reduced gas emissions
- The natural gas as "the cleanest fossil fuel," regarding the possibility of environmental pollution
- The bio-gas as an alternative solution in the future exploitation

Photovoltaic elements as optional solution for the production of electricity and covering the basic needs of the system for emergency situations during power failures and during changes in the mode of electrical energy supply.

1.3.6 Fuel supply and treatment

The principle of aircraft fuel provision for the new passenger terminal at Zagreb airport shall be continued as it has been practised so far, so the aircraft fuel shall be delivered from INA Aviation service storehouse to aircrafts by tanker aircrafts. Aircraft fuel provision from the storehouse to aircrafts by means of product lines has also been considered as being an option, but the construction of such systems is proved to be functional and economically feasible only at airports with a traffic which is more than 10 million passengers a year.

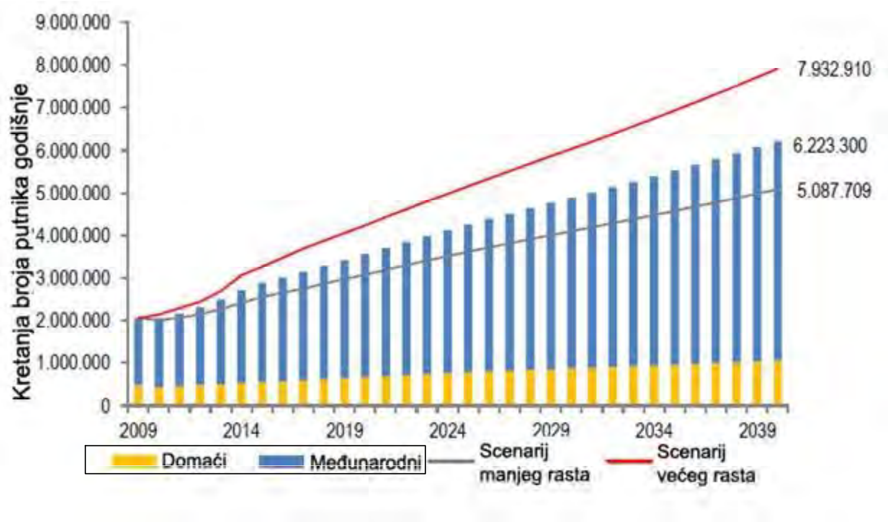
1.4 AIR TRAFFIC FORECAST

For the purpose of the project development in question, the Croatian Government has decided to engage the private sector in the financing, designing, construction, management and maintenance of the new passenger terminal and related infrastructure at the Zagreb Airport and management and maintenance of the existing Zagreb Airport. In order to reach these goals the Expert commission on the concession of the new passenger terminal at Zagreb appointed InterVISTAS Consulting Group the consulting service provider for the transaction that will ultimately result in a contract concluded with a private operator.
The consulting company has carried out traffic volume projection for the 30-year period: 2010-2040 In addition to the base scenario (also deemed the most probable traffic development scenario), high and low growth scenarios have been developed for the purpose of presenting the traffic volume range that can be expected. The high and low growth scenarios differ from the base scenario with respect to the expected economy growth, development of Croatia Airlines as a domestic carrier and favourable EU accession impact.
Forecast has been prepared for various traffic elements: passenger flows, aircraft movements and freight volume. In addition to annual aggregate values, peak hour forecasts have also been prepared for passenger and aircraft movement. While annual traffic movements have been primarily used as input values for the financial analysis, the peak hour forecasts have been used as input values for the capacity analysis. With respect to the flows of millions of passengers annually (MAP), the traffic volume is expected to grow from 2 MAP to 5.1 MAP according to the low traffic volume scenario, 6.2 MAP under the base scenario and 7.9 MAP according to the high traffic volume scenario.

<u>Air traffic forecast results</u>

		2009	2010	2015	2020	2025	2030	2035	2040
Low-Growth Scenario	Domestic	479,706	423,303	532,378	630,937	726,369	800,839	872,870	951,379
	International	1,582,536	1,593,510	2,024,773	2,453,334	2,891,396	3,297,347	3,703,303	4,136,330
	Total	**2,062,242**	**2,016,813**	**2,557,151**	**3,084,271**	**3,617,765**	**4,098,186**	**4,576,172**	**5,087,709**
	*ann. gr.rate**		*-2.2%*	*3,7%*	*3.7%*	*3.6%*	*3.3%*	*3.1%*	*3.0%*
Base Scenario	Domestic	479,706	434,157	555,022	670,072	783,403	873,037	960,625	1,057,000
	International	1,582,536	1.620,280	2,339,034	2,893,920	3,472,337	4,017,231	4,569,645	5,166,300
	Total	**2,062,242**	**2,054,437**	**2,894,056**	**3,563,993**	**4,255,740**	**4,890,267**	**5,530,270**	**6,223,300**
	*ann. gr.rate**		*-0.4%*	*5.8%*	*5.1%*	*4.6%*	*4.2%*	*3,9%*	*3.6%*
High-Growth Scenario	Domestic	479,706	445,011	580,423	727,041	876,488	997,888	1,118,959	1,254,719
	International	1,582,536	1,698,004	2,681,358	3,508,911	4,287,252	5,040,511	5,822,466	6,678,191
	Total	**2,062,242**	**2,143,015**	**3,261,781**	**4,235,952**	**5,163,740**	**6,038,399**	**6,941,425**	**7,932,910**
	*ann. gr.rate**		*3.9%*	*7.9%*	*6.8%*	*5.9%*	*5.2%*	*4.8%*	*4.4%*

** compound annual growth rate in comparison to 2009*



Base Scenario

Source: InterVISTASConsulting Group
<Kretanja broja putnika godišnje = Passenger number p.a.; Domaći = Domestic; Međunarodni = International; Scenarij manjeg rasta = Low-growth scenario; Scenarij većeg rasta = High-growth scenario>

2 PROJECT SOLUTION POSSIBILITIES

Since the subject matter of the Environmental Impact Assessment, i.e. minimum technical requirements for the New Passenger Terminal at the Zagreb Airport, is defined by the Technical Scope (Republic of Croatia, Zagreb Airport, 2011), 2011), special project solution possibilities with respect to the New Passenger Terminal location selection or the building design have not been considered.

The solution to the problem regarding the precipitation surface drainage is of great importance for the acceptability of the existing and the planned environmental project. Data on the means used and their quantities indicate a possible negative impact on underground waters, which needs to be prevented by constructing an adequate drainage and water treatment system. Global practices have been analysed with respect to the settlement of this issue, as well as technical and technological possibilities, which will be later considered in detail, compared on the basis of costs and benefits and analysed based on their technical and economic aspects; one possibility will be chosen at the end.

Option A - the waste water treatment at Zagreb airport
The waste water treatment at Zagreb airport includes:

- Collection and treatment of sanitary and sewage wastewater, which includes pre-treatment and the third degree biological treatment throughout the year,
- Collection, retention and the third degree biological purification of storm water which was contaminated by de-icing agents during the de-icing season. During off season, the de-icing of storm water is treated in a hydrocarbon/sand separator,
- Collection and treatment of highly loaded waste water which contains de-icing agents. Waste water is gradually dosed into the biological degree of treatment throughout the year. This waste water can be treated in other ways as well:
- By recycling or by its use in anaerobic digestion and denitrification, if there is any interest and there are capacities of connection to a larger public device,
- Collection and treatment of storm water, which is not polluted by special defrosting agents, is purified in the hydrocarbon/sand separator.

Option B - The waste water treatment at Velika Gorica waste water treatment system (WWTS)
The waste water treatment at Velika Gorica wastewater treatment system includes:

- Collection of sanitary and sewage waste water, its treatment at Velika Gorica waste water treatment system throughout the year,
- Collection and retention of storm water which was contaminated by de-icing agents during the de-icing season, as well as its treatment at Velika Gorica waste water treatment system. During off season, the de-icing of storm water is treated in a hydrocarbon/sand separator.
- Collection of highly loaded waste water which contains de-icing agents. This waste water is treated by recycling or by its use in anaerobic digestion and denitrification, if there is any interest and there are capacities of connection to a larger public system.
- Collection and treatment of storm water, which is not polluted by special defrosting agents, is purified in the hydrocarbon/sand separator.

It is possible to conclude that both options in terms of their impact on the environment can be reduced to acceptable and legally permissible frames. In accordance with the solutions discussed above, new measures of protection of the environment have been elaborated. Taking into account the fact that the option of treatment of polluted store water of Zagreb airport by connection to the municipal public device depends on the construction of the new device for treatment (because the existing one does not meet capacity requirements), finally they selected the solution A for the treatment of polluted storm water at Zagreb airport.

3 LOCATION DESCRIPTION AND ENVIRONMENT DATA

3.1 DATA PROVIDED IN SPATIAL PLANNING DOCUMENTS

The respective decision on the new passenger terminal at the Zagreb Airport is in compliance with the Zagrebačka County Spatial Plan (Zagrebačka County Official Gazette No. 3/02, 8/05, 8/07, 4/10 and 10/11), Velika Gorica Spatial Plan (Velika Gorica Official Gazette No. 10/06 and 6/08) and the Spatial Plan of Areas with Special Characteristics Črnkovec - Zagreb Airport *(Draft plan for public debate)* with respect to the new passenger terminal and accompanying facilities. For the purpose of reaching the optimum spatial and technical solution regarding this road and the road junction at the connection point with the projected eastern Velika Gorica by-pass, the projected route of the access road to the New Passenger Terminal at the Zagreb Airport partially deviates from the route projected by the County Spatial Plan, Velika Gorica Spatial Plan and Draft Spatial Plan of Areas with Special Characteristics Črnkovec - Zagreb Airport.

METEOROLOGICAL AND CLIMATE CHARACTERISTICS

The Zagreb Airport is located in the continental Croatia, with moderate continental climate. Over the year it is entirely situated in the circulation belt over the middle latitudes, in which atmosphere is characterized by frequent and intensive changes in weather conditions over the year. They are caused by travelling low or high pressure systems, often similar to whirls with several hundreds and thousands in diameter. During the cold period of a year stationary anticyclones are predominant with fog or low cloud and very weak currents. Summer is characterized by baric fields with small pressure gradient with predominant mild wind, but unstable atmosphere stratification. Turbulent air mixing is strong, convection clouds develop with possible showering. Spring is characterized by rapidly moving cyclones (cyclones and valleys) resulting in frequent and sudden weather changes; rain interchanges with non-precipitation periods.

3.3 AIR QUALITY

Pursuant to the Air Protection Act (OG 178/04, 60/08) the Zagrebačka County passed the Air Protection and Quality Improvement Programme in the Zagrebačka County (Zagrebačka County Official Gazette No. 33/07) and in 2010 the Administrative Department for Physical Planning, Construction and Environment Protection - Environment Protection Section developed the first Report on the Implementation of the Air Protection and Quality Improvement Programme for the period from 2008 to 2010. The data were collected from municipalities and towns in the Zagrebačka County, utility companies, the National Protection and Rescue Directorate, data from the air protection and quality improvement programme in the Zagrebačka County, the Cadastre of the Emissions into the Environment, Environmental Pollution Register, Croatian Bureau of Statistics and air quality data from the Velika Gorica automatic monitoring station. Data from recent studies, documents and projects were also used.

According to Table 4.2 of the Report, the key issues for the area of Velika Gorica are the state road D-30, Zagreb Airport, quarry and concrete plant in Novo Čiće, main wastewater treatment system (sludge dewatering area, HEP fuel-oil station, Žura Light Metal Foundry in Čička Poljana, Solidum wood processing industry in Kušanec and Mraclinska Dubrava landfill. It is stated that the citizens mostly complained about the above pollution sources, but were generally satisfied with air quality.

An automatic air quality monitoring station (NO_2, SO_2, H_2S, benzene, PM_{10}, O_3, CO) was built in the very centre of Velika Gorica. The monitoring results obtained in 2009[1] indicated that the concentrations were low and did not exceed the limit values under the Regulation on Limit Values of Pollutants in Air (OG 133/05) and Regulation on Ozone in Air (OG 178/04) and the surrounding air was of the I. category (C < LV) under the Air Protection Act (OG 178/04, 60/08).

At the end of the Report it was concluded that the air quality in the Zagrebačka County was good, but that it was necessary to conduct continuous monitoring of the air quality with respect to road traffic increase, emission of air pollutants from processing and industrial plants and boiler stations. According to the Report, the current situation regarding monitoring of potential air pollutants did not meet the requirements and it was, therefore, necessary to undertake appropriate measures in order to prevent uncontrolled and illegal emission of pollutants in air and to carry out systematic air protection in cooperation with all public authorities, associations and citizens.

ZERO STATE IN THE AREA OF ZAGREB AIRPORT

In the area of the Zagreb Airport there are no monitoring data regarding the concentration of air pollution parameters. An impact assessment of ZLZ and main roads to the air quality was therefore made, considering the 2009 and 2010 data on air and road traffic. Simulations were carried out by way of the ISC-AERMOD View software for 3-D air dispersion modelling (US Environmental Protection Agency).

If we compare immission concentrations for both monitored parameters in relation to the legally stipulated LVs, we can conclude that the situation regarding airborne particulate matters is significantly more favourable and that NO_2 represents the actual pollution measure and hazard indicator with respect to human health. The critical situation takes place in case of peak when LV is exceeded in the immediate vicinity of the runway. As regards the surrounding area, the pollution share under the ZLZ impact is within acceptable values.

3.4 NOISE LEVEL

3.4.1 Airport Noise in General

European airports have a long tradition in managing environmental noise. The first environmental noise monitoring, introduced into the noise management system, was conducted around 30 years ago - the Frankfurt Airport in 1964 and Schiphol airport (Amsterdam) in 1976.

The Ordinance on the Establishment of Rules and Procedures with regard to the Introduction of Noise-Related Operating Restrictions at Croatian Airports (OG 120/11) is currently in effect in the Republic of Croatia. This Ordinance contains provisions in line with the Directive 2002/30/EC of the European Parliament and of the Council 2002/30/EZ of 26. March2002 on the Establishment of Rules and Procedures with Regard to the Introduction of Noise-Related Operating Restrictions at Community Airports (OJ, L 85, 28. 3. 2002). An aircraft in flight, particularly when landing and taking off, represents a significant noise source. This problem is particularly significant at airports in the vicinity of urban areas. Many factors affect the impact of aircraft noise on humans. Aircraft engine is the single most significant point at which noise can be minimized. That is why in 1969 the U.S. Federal Aviation Administration (FAA) adopted regulations requiring commercial

[1] Source: Report on monitoring air quality in Velika Gorica, 2010

aircraft to meet noise standards. Within the Federal Acquisition Regulation (FAR) the FAA established three categories for jet aircraft. Stage 1 jets, such as the original Boeing 707s and McDonnell-Douglas DC-8s, are the oldest and noisiest aircraft. Stage 2 jets, such as 727s, 737-200s, Tupolev 134 and 154, and DC-9s, later DC-8s and Boeing 707s, as well as Fokker 28, are noisy aircraft. Stage 3 jets such as 737-300s, 757s, A319s, MD-80s, Fokker 70s and 100s are jets flying today.
The aircraft noise issue was regulated by the ICAO standards (International Civil Aviation Organisation) in Annex 16, Volume I, Aircraft Noise. This was based on the FAR, Part 36. In addition to defining terms regarding aircraft noise, Annex 16, Volume I of the ICAO stipulated the maximum noise level during take-off and landing for all aircraft categories, depending on their mass and engine number. It also sets forth the methods for noise measuring, thus establishing the measurement and data processing procedure, as well as the measurement requirements.

The European Parliament adopted a number of directives regulating the noise management area, as well as the establishment of measures and procedures with regard to noise-related operating restrictions at airports. In April 202 a new directive on aircraft noise entered into force, which prohibits the landing of the so called "noisy" aircraft referred to in Chapter 2, Annex 16 of the ICAO at EU airports. Aircraft which meet the requirement referred to in Chapter 2 of the Annex to a smaller extant can fly within the EU with a special permit. A jet aircraft without noise certificate is not allowed to fly unless it is a government aircraft or an emergency airplane or an aircraft used for marking historical flights. Airports enter into contracts with airlines on aircraft landing predominantly during daytime; airport working hours during night are limited, etc. All EU member states have developed their national Noise Reduction Programme consisting of:

- Stipulated landing and take-off procedures in order to minimize the aircraft noise impact,
- Air navigation control procedures enabling an aircraft to directly reach a specific altitude and keeping an arriving aircraft at an altitude until it comes close to the airport,
- Publication of noise monitoring results and noise maps.

Since 1970 Europe has ratified twenty-odd various directives on noise-related issues covering equipment construction, motor vehicles and aircraft. In June 2004 the European Commission adopted the "European Environment and Health Action Plan 2004-2010" obligatory for implementation by all member states. They hereby undertook to conduct research, monitoring and measurement of adverse effects with respect to the environment. Within the national framework the Republic of Croatia has regulated aircraft noise by way of an Act restricting the obligation of noise monitoring to airport operators. It has set forth the obligation to establish aircraft noise protection areas with respect to measurement results, in which noise level equivalent exceeds 67 dB (A), i.e. 75 dB (A).
Aircraft categories allowed to land at Croatian airports have been established under the Ordinance on Rules of the Air (OG 75/06) and have to have appropriate noise certificates for all civil jet aircraft operating within the Croatian airspace. Civil jets referred to in Chapter 2 Annex 16 of the ICAO can operate at Croatian airports only if they meet noise requirements. Aircraft pilots are also obliged to adhere to the procedures stipulated by the Ordinance regarding noise reduction when taking off or landing. The Noise Protection Act has stipulated noise protection measures on mainland, in water or air, as well as the supervision over measure implementation for the purpose of preventing or reducing noise and eliminating the hazards for human health. The Act provisions do not refer to the protection measures obligatory under air traffic international conventions, treaties and

standards. In the Republic of Croatia there is no consistent and rational traffic policy on environment protection. There is also a lack of a number of implementing regulations which would elaborate on the Act provisions. In accordance with the European practice, the Noise Reduction Programme should be developed at the national level.

3.4.2 Noise Monitoring Results So Far

The Zagreb Airport has implemented the aircraft noise measurement system for the purpose of achieving two goals. First, one should use measurement to obtain insight into the noise values and establish the impact area on the population living in the immediate vicinity of the airport. The second goal is linked to the international and domestic legal obligation according to which all airports must comply with EU regulations.

The continuous noise monitoring system has been implemented at the Zagreb Airport. It consists of three fixed and one mobile noise monitoring terminals (NMT). The fixed NMTs at the Zagreb Airport are located as follows:

- NMT 1 and NMT 2 stations measure noise on the runway thresholds No. 05 and 23.
    - NMT 1 is located approx. 306 m from the runway threshold No. 05
    - NMT 2 is located approx. 307 m from the runway threshold No. 23
- NMT 3 Tower is located on the management building (next to the control tower) - used for measuring noise on the apron
- NMT Mobile - placed on locations depending on the needs for measuring aircraft noise - currently located in Donja Lomnica (fire fighting station)

The two fixed measurement devices are located near the runway thresholds Nos. 05 and 23. The third fixed devices is located near the apron, and the location of the forth one is determined based on the data collection need. The mobile device has its own feed and can, therefore, be taken to any location around the airport. In order to monitor the accuracy of noise measurement at Zagreb, a computerized Zagreb Airport noise map is developed annually regardless of the data measured. The following data are used for this: the runway threshold coordinates, altitude, temperature and humidity. In addition, a database with all aircraft grouped into categories is used (commercial, freight, generally civil, military) and the operation average per day, for the day, evening and night periods (L_{den}) pursuant to the Noise Protection Act (OG 30/09).

Table 3.4.2.-1 Monitoring terminal data per month in 2009

L_{den} (dB)		Month											
Code	Location	1	2	3	4	5	6	7	8	9	10	11	12
NMT 1	Threshold 05	65.7	66.7	67.2	66.3	6 .6	67.6	69.6	70.0	68.8	x	x	x
NMT 2	Threshold 23	59.6	60.3	59.8	59.8	62.3	61.8	64.1	63.2	60.8	62.5	63.5	62.3
NMT 3	Tower	75.7	76.3	76.3	76.8	77.2	77.4	77.7	77.6	77.3	77.3	75.6	75.4
NMT 4	D. Lomnica	57.5	57.3	60.3	61.4	62.5	62.1	64.1	64.6	64.0	64.5	58.4	57.6

x terminal under repair

In the course of 2009 and 2010 noise level measurements were conducted on 4 locations. The two fixed measurement devices NMT1 and NMT2 were located near the runway thresholds 05 and 23, the third device NMT3 was located on the management building (apron) and the fourth mobile device in Donja Lomnica (near the fire fighting station). The fixed devices for noise measurement were placed within the airport zone due to the required infrastructure availability and many factors, such as areas with the highest noise exposure, vicinity to the runway threshold, smooth sound dispersion without obstacles towards the microphone, accompanying infrastructure and the network for proper functioning of the measurement devices.
The noise level measured was expressed as equivalent noise level L_{eq}. The noise indicator L_{den} was calculated based on the obtained values.

L_{den} (level day-evening-night) is the noise indicator. It refers to the total irritation caused by noise. L_{den} is a calculation of the equivalent noise level over 24 hours. Pursuant to the Noise Protection Act (OG 30/09) L_{den} is the main noise indicator calculated according to the standard time division into the 12-hour day period (from 7 a.m. to 7 p.m.), 4-hour evening period (from 7 p.m. to 11 p.m.) and 8-hour night period (from 11 p.m. to 7 a.m.). L_{den} measurements are carried out over the year. A noise map was drawn up based on L_{den}. It formed the basis for action plan noise maps for the purpose of noise reduction, further physical planning and zoning of the area around the airport.

Threshold 05 location
The noise levels measured on the threshold 05 location, where NMT 1 was placed, expressed as equivalent noise levels L_{eq} per month in 2009 varied from 62.8 dB(A) to 66.5 dB(A). The noise level above the limit (65 dB(A)) expressed as equivalent noise level L_{eq} was recorded in May, July, August and September. The highest noise level was recorded in July. The noise increase is a result of the increased number of operations due to seasonality and different flight schedule (IATA winter and summer schedules).
The values calculated for L_{den} per month in 2009 varied from 65.7 dB(A) to 70.0 dB(A). The L_{den} noise level exceeded 65 dB(A) during all 9 months in which measurements was taken. The recorded L_{eq} level per day in 2009 varied from 57.1 dB(A) to 76.2 dB(A). Daily L_{den} noise levels varied from 60.0 dB(A) to 84.3 dB (A) and exceeded the allowed values for a significant number of days.
Measurements on the threshold 05 location were not taken throughout 2010 due to the NTM1 breakdown.

Threshold 23 location
On the threshold 23 location (NMT2) the recorded L_{eq} and L_{den} levels were below 65 dB. The L_{eq} and L_{den} levels stated per day in 2009 exceeded 65 dB(A) only during several days. In 2010 m measurements were taken only at the end of the year due to the terminal breakdown. The recorded values did not deviate from the 2009 data, which meant that they were below 65 dB(A). The placement of the terminal on this location and noise measurement was important because places Selnica, Petrina, Mala Kosnica and Velika Kosnica were located in the vicinity of the airport and in the take-off corridor which could be in danger upon aircraft take-off from the Zagreb Airport.

The third fixed device (NMT3) monitored the exposure of employees and passengers to noise. According to the measurement results the highest L_{eq} and L_{den} levels were recorded on this location. The L_{eq} values reached 70 dB (A), a varied from 72.3 dB(A) to 73.9 dB(A). The L_{den} values were higher and varied from 75.4 dB(A) to 77.7 dB(A) as well as daytime noise levels per days. The noise level was higher due to continuous operating processes relating to vehicles used for ramp handling and aircraft power feeding system (APU of its own system installed on the aircraft of GPU (Ground Power Supply)).

Donja Lomnica
The data obtained from the mobile NTM4 station placed in Donja Lomnica indicated that the recorded noise equivalent levels L_{eq} (dB) and L_{den} were below 65 dB(A) in 2009. The recorded values for L_{eq} varied from 54.8 dB(A) to 60.2 dB(A), and for L_{den} from 57.3 dB(A) to 64.5 dB(A).

In addition, in July 2009 and 2010 the noise level on the area of Donja Lomnica was compared. Following the landing ban for stage 2 aircraft (such as Tupolev 154) due to a high noise level, daily average L_{eq}, L_{den} and background noise L_{eback} decreased in 2010. However, for all days the L_{den} value was ≥ 55 db(A), while the recorded L_{eq} values were a bit lower.

3.4.3 Methodology for Zagreb Airport Noise Mapping

The noise mapping methodology is set forth in the "Ordinance on the Preparation Methods and Content of Noise Maps and Action Plans and on the Allowed Noise Indicator Calculation Methods" (OG 75/2009) as is a direct result of the Directive 2002/49/EC - "Relating to the assessment and management of environmental noise", as well as the Commission Recommendation 2003/613/EC of 6 August 2003 concerning "Guidelines on the revised interim computation methods for industrial noise, aircraft noise, road traffic noise and railway noise, and related emission data.

A noise map is developed by using computation methods for emission calculations and sound (noise) propagation emitted from known noise sources in a geographical area of known characteristics. The data on the noise map area include the following: digital relief model (elevations, contour lines, and break lines), data on construction facilities (buildings, viaducts, walls, etc.), terrain surfaces (grass, concrete, etc.), data on air and road traffic and meteorological data.

Noise mapping data include data on sound power in dB(A) for respective noise sources, i.e. in dB (A)/m for line noise sources or dB/m2 for surface noise sources together with the octave band spectrum. In addition to the above acoustic characteristics, it is important to know the operation time of these noise sources (day, evening or night).

The noise map was developed using a verified program package intended for the development of acoustic propagation models and noise maps called Bruel & Kjaer LimA 5.5.0 (June 2011), which fully meets the requirements referred to in Article 13 of the Ordinance on the Preparation Methods and Content of Noise Maps and Action Plans and on the Allowed Noise Indicator Calculation Methods" (OG 75/2009). Upon entering and verifying all the data in the above program package the noise level calculation is performed based on a number of equations describing conditions for sound wave expansion in the atmosphere from the noise source. Relevant acoustic elements included in the calculations as source direction, geometric divergence, absorption of sound waves in the atmosphere, sound waves spreading near the ground, sound wave reflection and diffraction from various surfaces, protective effects from relief elements and facilities which form an obstacle to the spreading of sound waves.

The noise map shows the existing and/or anticipated noise immission on the monitored location, expressed through harmonized noise indicators. The Zagreb Airport noise map is in accordance with Croatian regulations, requirements under EU guidelines 2002/49 and best professional practices for the development of noise maps. The noise map results represent a starting point for environmental noise management, i.e. they provide for an overview of the noise burden level in the environment caused by air and road traffic at the Zagreb Airport.

The objective of the 2009 noise map was to establish the "zero situation", i.e. show noise indicator levels with respect to air traffic for places around the Zagreb Airport. The results were stated in the air traffic noise map in figures for all time periods $_{Lday,\ evening}$, L_{night} and L_{den}.

The 2009 air traffic noise map was developed based on the average of 103 daily operations according to the data obtained from InterVISTAS Consulting Group and on referent aircraft types (Bombardier de Haviland Canada DHC Dash 8 Q400, Airbus A318-A321s, Canadair CL-600 RegionalJet CJR- 100 and CRJ-700, Embraer EMB120, Boeing 737 and ATR 42).

Discrepancies at control points of digital model receiver immission, in comparison to the Zagreb Airport Noise Monitoring Terminal show that an acoustic model modelled in such a way represents an accurate model of the actual situation. The reason for discrepancies at immission control points and increased values at the Zagreb Airport measurement stations in relation to the values obtained through the acoustic model is in the operations of MIG 21 military aircraft. Due to the secrecy of their flight schedule, these aircraft were not included in the noise map, but the measurement stations registered the noise immission levels and their values were added to the NMT aggregate value.

While making the noise maps not only for the existing modelling, but for the planned state as well, there were not available any input data of military aircrafts (for security reasons - military MIG 21 has the status of confidentiality). Helicopters rarely flow (can be ignored) at Zagreb airport, and most of them fly during the day, whereby their impact on the increase in the noise level is minimal.
The noise indicator calculation was made on a 10x10 m grid at the altitude of 4 m using the Bruel & Kjaer LimA 5.5.0. program package for the development of acoustic propagation models and noise maps.

3.4.4 Results for 2009 Air Traffic Noise Map

The assessed immission noise level in the open space was provided in accordance with the Ordinance on the maximum permitted noises levels in the environment in which people work and live (OG 145/04), as well as the Velika Gorica Spatial Plan - 2008 amendments. A total of 30 settlements have been analysed: Bapče, Buševec, Črnkovec, Donja Lomnica, Drenje Ščitarjevsko, Gornja Lomnica, Gornje Podotočje, Gradići, Kobilići, Lazi Turopoljski, Lukavec, Mala Kosnica, Mićevec, Mraclin, Novaki Ščitarjevski, Obrezina, Ogulinec, Okuje, Petina, Petrovina Turopoljska, Rakitovec, Sasi, Selnica Ščitarjevska, Staro Čiče, Ščitarjevo, Turopolje, Velika Gorica, Velika Kosnica, Velika Mlaka and Vukovina.

According to the gathered results of the current noise levels, it was determined that these settlements correspond to the fourth noise zone due to noise exposure from Zagreb airport – the Zone of mixed, predominantly for commercial purposes with housing, according to Article 5 of the Book of regulations on the maximum permissible noise levels in the environment in which people work and live (the Official Gazette 145/04), where the maximum permissible noise level during the day is 65dB (A) and during the night is 50 dB (A). In accordance with this criterion, the assessment on the noise emission in the outdoors was given.

A detailed overview of the 2009 results has been given in Figures 3.4.-1, 3.4.-2, 3.4.-3. Noise maps are directly linked to the data showing the surface covered by noise indicators as well as the population exposure analysis with respect to exceeded noise indicator levels, as shown in Table 3.4.4.-1 for L_{den} and Table 3.4.4.-2 for L_{nighth}.

According to the analysis of the current situation, there has not been recorded any exceeding of daytime noise. On the other hand, there was recorded some exceeding in Donja Lomnica, Mala Kosnica and Petina.

Graphic appendices

Figure 3.4.-1 Noise map of air traffic during the day and evening for 2009
Figure 3.4.-2 Noise map of air traffic during the night for 2009
Figure 3.4.-3 Noise map of air traffic for L_{den} for 2009

Table 3.4.4.-1 Settlement surface areas and estimated number of inhabitants exposed to excessive air traffic L_{den} noise indicator levels for 2009

Ord. No.	Name of the settlement	Settlement data	Total	L_{den} noise indicator class for 2009											Total excess
				<35 dB(A)	35 - 39 dB(A)	40- 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
1	Bapče	Settlement surface area (km²)	1,68				0,53	0,03							0,00
		Number of buildings	105												0
		Number of inhabitants	130												0
2	Buševec	Settlement surface area (km²)	4,17												0,00
		Number of buildings	464												0
		Number of inhabitants	889												0
3	Crnkovec	Settlement surface area (km²)	4,62				0,47								0,00
		Number of buildings	147												0
		Number of inhabitants	413												0
4	Donja Lomnica	Settlement surface area (km²)	14,93				1,62	1,44	1,46	0,83	0,04				0,04
		Number of buildings	778						212	205					0
		Number of inhabitants	1416						386	373					0
5	Drenje Ščitarjevsko	Settlement surface area (km²)	2,23				1,66	2,86	1,21						0,00
		Number of buildings	147						126						0
		Number of inhabitants	202						173						0
6	Gornja Lomnica	Settlement surface area (km²)	2,49				0,45	0,27	0,04						0,00
		Number of buildings	162												0
		Number of inhabitants	582												0
7	Gornje Podotočje	Settlement surface area (km²)	2,93												0,00
		Number of buildings	153												0
		Number of inhabitants	492												0
8	Gradići	Settlement surface area (km²)	1,90				0,21								0,00
		Number of buildings	622												0
		Number of inhabitants	1808												0
9	Kobilići	Settlement surface area (km²)	1,56												0,00
		Number of buildings	248												0
		Number of inhabitants	520												0
10	Lazi Turopoljski	Settlement surface area (km²)	3,40												0,00
		Number of buildings	43												0
		Number of inhabitants	58												0
11	Lukavec	Settlement surface area (km²)	11,34				0,12	0,05							0,00
		Number of buildings	535												0
		Number of inhabitants	1136												0
12	Mala Kosnica	Settlement surface area (km²)	1,01				0,01	0,27	0,36	0,30	0,07				0,07
		Number of buildings	44						9	28					0
		Number of inhabitants	49						10	31					0
13	Mićevec	Settlement surface area (km²)	6,54				1,44	0,55	0,24	0,12	0,09				0,09
		Number of buildings	648												0
		Number of inhabitants	1281												0
14	Mraclin	Settlement surface area (km²)	12,93												0,00
		Number of buildings	607												0
		Number of inhabitants	1068												0
15	Novaki Ščitarjevski	Settlement surface area (km²)	2,65				1,00	0,57							0,00
		Number of buildings	112												0
		Number of inhabitants	165												0
16	Obrezina	Settlement surface area (km²)	1,79					0,37	1,42						0,00
		Number of buildings	274						242						0
		Number of inhabitants	577						510						0
17	Ogulinec	Settlement surface area (km²)	3,76												0,00
		Number of buildings	337												0
		Number of inhabitants	296												0

Ord. No.	Name of the settlement	Settlement data	Total	L_{den} noise indicator class for 2009											Total excess
				<35 dB(A)	35 - 39 dB(A)	40 - 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79	> 80 dB(A)	
18	Okuje	Settlement surface area (km²)	4,71												0,00
		Number of buildings	226												0
		Number of inhabitants	467												0
19	Petina	Settlement surface area (km²)	1,84						0,75	1,07	0,01				0,01
		Number of buildings	150						3	147					0
		Number of inhabitants	211						4	207					0
20	Petrovina Turopoljska	Settlement surface area (km²)	2,63												0,00
		Number of buildings	275												0
		Number of inhabitants	702												0
21	Rakitovec	Settlement surface area (km²)	10,37												0,00
		Number of buildings	247												0
		Number of inhabitants	573												0
22	Sasi	Settlement surface area (km²)	1,67				0,56	0,77	0,04						0,00
		Number of buildings	62												0
		Number of inhabitants	164												0
23	Selnica Sčitarjevska	Settlement surface area (km²)	1,96				0,53	1,03	0,37						0,00
		Number of buildings	241						29						0
		Number of inhabitants	537						65						0
24	Staro Čiče	Settlement surface area (km²)	3,02												0,00
		Number of buildings	418												0
		Number of inhabitants	783												0
25	Sčitarjevo	Settlement surface area (km²)	3,79				1,28	1,06	0,34						0,00
		Number of buildings	243						127						0
		Number of inhabitants	440						230						0
26	Turopolje	Settlement surface area (km²)	4,64												0,00
		Number of buildings	468												0
		Number of inhabitants	951												0
27	Velika Gorica	Settlement surface area (km²)	31,47				1,51	1,04	0,73	0,61	0,78	0,51	0,39		1,68
		Number of buildings	5968												0
		Number of inhabitants	31341												0
28	Velika Kosnica	Settlement surface area (km²)	2,13				0,74	0,57	0,27						0,00
		Number of buildings	233						62						0
		Number of inhabitants	799						213						0
29	Velika Mlaka	Settlement surface area (km²)	6,07				0,59	0,51	0,42	0,35	0,27				0,27
		Number of buildings	1102												0
		Number of inhabitants	3326												0
30	Vukovina	Settlement surface area (km²)	5,84												0,00
		Number of buildings	453												0
		Number of inhabitants	945												0
	Σ	Settlement surface area (km²)	155,43					7,65	3,28	1,26	0,51	0,39			2,16
		Number of buildings	15512					810	380						
		Number of inhabitants	52321					1590	611						

YES	(green)	Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO	(pink)	Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
*	Maximum permitted L_{den} noise immission evaluation levels according to the purpose of the area	
	Purpose of the area : zone of mixed, mostly residential purpose, L_{den}=65 dB	

Table 3.4.4.-2 Settlement surface areas and estimated number of inhabitants exposed to excessive air traffic L_{night} noise indicator levels for 2009

Ord. No.	Name of the settlement	Settlement data	Total	L_{night} noise indicator class for 2009											Total excess
				<35 dB(A)	35 - 39 dB(A)	40- 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
1	Bapče	Settlement surface area (km²)	1,68			0,01									0,00
		Number of buildings	105												0
		Number of inhabitants	130												0
2	Buševec	Settlement surface area (km²)	4,17												0,00
		Number of buildings	464												0
		Number of inhabitants	889												0
3	Crnkovec	Settlement surface area (km²)	4,62				0,47								0,00
		Number of buildings	147												0
		Number of inhabitants	413												0
4	Donja Lomnica	Settlement surface area (km²)	14,93			1,37	1,28	0,31							0,31
		Number of buildings	778												0
		Number of inhabitants	1416												0
5	Drenje Ščitarjevsko	Settlement surface area (km²)	2,23			3,30	0,40								0,00
		Number of buildings	147				78		126						0
		Number of inhabitants	202				107		173						0
6	Gornja Lomnica	Settlement surface area (km²)	2,49												0,00
		Number of buildings	162												0
		Number of inhabitants	582												0
7	Gornje Podotočje	Settlement surface area (km²)	2,93												0,00
		Number of buildings	153												0
		Number of inhabitants	492												0
8	Gradići	Settlement surface area (km²)	1,90			0,15									0,00
		Number of buildings	622												0
		Number of inhabitants	1808												0
9	Kobilići	Settlement surface area (km²)	1,56												0,00
		Number of buildings	248												0
		Number of inhabitants	520												0
10	Lazi Turopoljski	Settlement surface area (km²)	3,40												0,00
		Number of buildings	43												0
		Number of inhabitants	58												0
11	Lukavec	Settlement surface area (km²)	11,34			0,01									0,00
		Number of buildings	535												0
		Number of inhabitants	1136												0
12	Mala Kosnica	Settlement surface area (km²)	1,01			0,30	0,35	0,29	0,06						0,35
		Number of buildings	44				7	28							28
		Number of inhabitants	49				8	31							31
13	Mićevec	Settlement surface area (km²)	6,54			0,45	0,21	0,11	0,08						0,19
		Number of buildings	648												0
		Number of inhabitants	1281												0
14	Mraclin	Settlement surface area (km²)	12,93												0,00
		Number of buildings	607												0
		Number of inhabitants	1068												0
15	Novaki Ščitarjevski	Settlement surface area (km²)	2,65			0,45									0,00
		Number of buildings	112												0
		Number of inhabitants	165												0
16	Obrezina	Settlement surface area (km²)	1,79			0,61	1,18								0,00
		Number of buildings	274				223								0
		Number of inhabitants	577				470								0
17	Ogulinec	Settlement surface area (km²)	3,76												0,00
		Number of buildings	337												0
		Number of inhabitants	296												0

Ord. No.	Name of the settlement	Settlement data	Total	L_{night} noise indicator class for 2009											Total excess
				<35 dB(A)	35 - 39 dB(A)	40 - 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79	> 80 dB(A)	
18	Okuje	Settlement surface area (km^2)	4,71												0,00
		Number of buildings	226												0
		Number of inhabitants	467												0
19	Petina	Settlement surface area (km^2)	1,84			0,04	0,89	0,91							0,91
		Number of buildings	150				3	147							15
		Number of inhabitants	211				4	207							211
20	Petrovina Turopoljska	Settlement surface area (km^2)	2,63												0,00
		Number of buildings	275												0
		Number of inhabitants	702												0
21	Rakitovec	Settlement surface area (km^2)	10,37												0,00
		Number of buildings	247												0
		Number of inhabitants	573												0
22	Sasi	Settlement surface area (km^2)	1,67			0,70									0,00
		Number of buildings	62												0
		Number of inhabitants	164												0
23	Selnica Sčitarjevska	Settlement surface area (km^2)	1,96			0,96	0,32								0,00
		Number of buildings	241				26								0
		Number of inhabitants	537				58								0
24	Staro Čiče	Settlement surface area (km^2)	3,02												0,00
		Number of buildings	418												0
		Number of inhabitants	783												0
25	Sčitarjevo	Settlement surface area (km^2)	3,79			1,00	0,22								0,00
		Number of buildings	243				104								0
		Number of inhabitants	440				188								0
26	Turopolje	Settlement surface area (km^2)	4,64												0,00
		Number of buildings	468												0
		Number of inhabitants	951												0
27	Velika Gorica	Settlement surface area (km^2)	31,47			0,95	0,67	0,67	0,68	0,49	0,34				2,18
		Number of buildings	5968												0
		Number of inhabitants	31341												0
28	Velika Kosnica	Settlement surface area (km^2)	2,13			0,53	0,24								0,00
		Number of buildings	233				52								0
		Number of inhabitants	799				178								0
29	Velika Mlaka	Settlement surface area (km^2)	6,07			0,46	0,38	0,36							0,36
		Number of buildings	1102												0
		Number of inhabitants	3326												0
30	Vukovina	Settlement surface area (km^2)	5,84												0,00
		Number of buildings	453												0
		Number of inhabitants	945												0
	Σ	Settlement surface area (km^2)	155,43			11,29	6,14	2,65	0,82	0,49	0,34				5,81
		Number of buildings	15512					838	187						190
		Number of inhabitants	52321					1641	260						264

YES		Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO		Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
*	Maximum permitted L_{night} noise immission evaluation levels according to the purpose of the area	
	Purpose of the area : zone of mixed, mostly residential purpose, L_{night}=50 dB	

3.5 GEOLOGICAL CHARACTERISTICS

Zagreb Airport is situated to the southeast of Zagreb, 17 km from the city core. It is bordered to the north by the Lučko-Ivanja Reka motorway bypass and the Sava River, and to the south by the Zagreb-Sisak state road, the Pleso settlement and the City of Velika Gorica. It covers about 300 ha of terrain on which all infrastructure and traffic structures are situated. The location of Zagreb Airport is situated on a part of the Sava River plain that stretches between an upland area, formed by the Medvednica highlands, and the hill country of Vukomerička Gorica. With regard to tectonics (based on the legend of geological map M 1:100000, Zagreb sheet) the area belongs to the structural unit know as the Zagreb Depression, which forms a part of the tectonic unit know as the Sava Tertiary Basin. The Zagreb Depression is bordered by major border faults along border terrace segments of the Stupnik and Zagreb terraces, and has been filled with deposits of Plioquaternary and Quaternary age. Tectonic activity in the Younger Pliocene was, namely, the final stage in the formation of the tectonic fabric and in the geomorphologic shaping of the relief of this and the broader Pannonian area. The further raising of the highland massif of Medvednica and the Samoborsko Gorje rendered them a source area for clastic material for the deposition of fluvial-lake and proluvial sediments of the molasse-foothills type. On the surface these deposits are found on the Stupnik terrace in the narrow area from Rakitje to Obrež. They consist of unsorted gravel, granulometrically diverse sands and clays in a mutually irregular alteration. Less frequently there are interbeds of sandstone and conglomerates within these deposits. Pronounced limonitisation is present in individual deposition columns with interbeds of limonite zone, sandstone with limonitic cement of centimetre thicknesses and limonitic concretions. Clays are found in the form of thin interbeds and lens, and are sometimes carbonaceous. In other parts of the area they are covered by younger, predominately alluvial sediments of Quaternary age. As a result the terrain in the broader area of Zagreb Airport is constructed of clastic deposits of Quaternary age that differ from one another by their origin, which has caused differences in the mineralogical and granulometric composition.

3.6 GROUNDWATER

The Airport is situated to the south of Zagreb, in the central part of the Zagreb aquifer, and covers about 300 ha. The terrain in the subsurface section of the Airport area is constructed of alluvium of the second (middle) Sava terrace (a_2), and of floodplain sediment (ap) only in the far north-eastern section. The lithological composition of the terrain in the area foreseen for the construction of the new Zagreb Airport passenger terminal is consistent with the description of the wider area hereinafter presented. The most relevant data in this regard has been gained by the drilling of 3 structural bores closest to the location of the future passenger terminal. In conclusion, the greatest part of the determined water quality parameters were found in very low concentrations, i.e. significantly below the maximum permitted quantities stipulated in the Ordinance on sanitary quality of drinking water (Official Gazette 47/2008). The criteria set out in that ordinance were not met in groundwater samples that are bacteriologically contaminated (UBB, UK, faecal streptococcus, sulphite reducing clostridia), and in samples that had a noticeable smell (three samples from piezometer ZLZ-5), that contained ammonia (1 sample from piezometer ZLZ-2 and 4 samples from piezometer ZLZ-4) and nitrates (1 sample from piezometer ZLZ-2) in concentrations above the maximum permitted quantities. A potential causative agent for the presence of ammonia could be a urea-organic compound with the chemical formula $(NH_2)_2CO$ used to de-ice runways and also as an artificial fertiliser. As the greatest concentration of ammonia was established in a water sample from piezometer ZLZ-4 taken on 27 May 2010 it is very likely that the urea used for de-icing can be ruled out as the causative agent of the contamination of groundwater. Therefore, the contamination is most likely the result of the agricultural production that is present in the wider area of the airport and a poor-quality or damaged system for the evacuation of sewage (for example in the case of piezometer ĆDP-10/3 located in the Pleso settlement) and cannot be attributed to the activities and structures of Zagreb Airport.

3.7 SURFACE **WATER**

Pursuant to the Decision on the borders of catchment areas (Official Gazette 81/10), the entire area of Zagreb County belongs to the Danube River catchment, i.e. the area from which all waters drain, as surface or groundwater, into the Danube River. The major watercourses with very large catchment areas in the Danube River catchment area are, along with the Danube River itself, the Drava, Mura, and Sava, Kupa and Una rivers and their numerous tributaries.
The Danube River catchment area has been divided pursuant to the Decision on the borders of subcatchment areas, small catchment areas and sectors (Official Gazette 97/10) into the Sava River subcatchment area and the Drava and Danube river sub-catchment area. The Plan area in question is situated in the Sava River sub-catchment area, i.e. in the Zagrebačko prisavlje small catchment area, the territory of which includes the City of Zagreb and a part of Zagreb County (the cities of Jastrebarsko, Samobor, Sveta Nedelja, Velika Gorica, Zaprešić and the municipalities of Bistra, Brdovec, Dubravica, Jakovlje, Klinča Sela, Krašić, Kravarsko, Luka, Marija Gorica, Orle, Pisarovina, Pokupsko, Pušća, Rugvica, Stupnik and Žumberak).
In the wider area of the project the major watercourses are the Sava River and the Odra River, which have been classified as waters of the first order pursuant to the Decision on the list of waters of the first order (Official Gazette 79/10). There are also smaller watercourses among the surface waters in the area under observation: Kosnica, Bapče, Želin, Ribnica and Savišće, and the standing water, i.e. Lake Novo Čiče near the settlement of Novo Čiče.
At the upper sections of the courses of the Kosnica and Ribnica streams the channel is filled only during rainy periods and during periods of high groundwater levels and high water levels in the Sava River. However, as a result of a continuing trend of the lowering of groundwater levels, both of these watercourses, in particular that of the Kosnica, dry up in the upstream part of their course. This effect is less prominent in the Ribnica watercourse as it cuts somewhat deeper into the terrain. Streams only form a few kilometres to the southeast, in an area that is hypsometrically lower than the area of the Kosnica pump site, where these watercourses collect groundwater, and they drain into the Odra River around the settlement of Novo Čiče, together with smaller watercourses (Želin, Bapče, Siget and Stara Lomnica). Somewhat upstream from its confluence with the Odra River, at the Jagodno settlement, the Kosnica stream had a maximum flow of 1.18 m^3/s in the period from 1979 to 1982, while the Ribnica stream had an almost identical flow (1.12 m^3/s). It is evident from this that, as a result of the long-term lowering of the water level in the Sava River and of groundwater levels, the Kosnica and Ribnica watercourses do not have a significant influence on hydrological relations in the area of the Kosnica pump site.
A rainfall drainage system has been partially constructed in the inner area of the City of Velika Gorica, and rainfall water is drained in the Želin, Bapče or Kosnica and Stara Lomnica watercourses. The Odra River is the terminal, common natural receptacle of rainfall water from the Plan area in question. Rainfall water is collected in the inner area of the City of Velika Gorica through a network of open canals, i.e. the former Odra field amelioration canals, and drain into the Želin stream. The rainfall water of the Pleso settlement and of Zagreb Airport are gravitationally collected and drained via the Pleški canal into the Bapče and Kosnica watercourses.

3.8 PEDOLOGICAL CHARACTERISTICS

A pedological map has been created to provide a description of the current state of soil characteristics in the wider area affected by the project. This map was produced on the basis of an existing pedological map of Zagreb County on a 1:100,000 scale. Table 3.8-1 shows the legend of this pedological map with a surface inventory. An analysis and processing of the produced pedological map and its legend has established the appearance of several types of soil.

Table 3.8.-1: Legend of the pedological map of the wider project area

Cartographic soil unit		
No.	**Name and composition of systematic units**	**Surface, ha**
1	Rendzina on alluvial gravel and sand Eutric brown on a Holocene deposit Semigley (alluvial field) carbonaceous	1273,6
2	Eutric brown on a Holocene deposit Luvisol typical	429,6
3	Semigley (alluvial field) carbonaceous Alluvial gley and non-gley carbonaceous Marsh gley hypogley, mineral	1397,4
4	Marsh gley hypogley, mineral, carbonaceous Marsh gley amphigley, mineral, carbonaceous	51,5
	Semigley (alluvial field) carbonaceous and non-carbonaceous	
5	Alluvial carbonaceous, middle deep and deep loamy Alluvial carbonaceous gley, deep and very deep	26,6
6	Marsh gley hypogley, mineral, carbonaceous Marsh gley amphigley, mineral, carbonaceous	26
7	Settlement	27,6
8	Water surfaces	41,1
Total		3273,4

3.9 PROTECTED AREAS

There are no protected natural values in the area covered by the project under the Nature Protection Act.
In the wider area the following natural values have been recognised and proposed in the Zagreb County Physical Plan, The City of Velika Gorica Physical Development Plan, and the Municipality of Orle Physical Development Plan for protection under the Nature Protection Act (Official Gazette 70/05, 139/08):

1 IN THE CATEGORY OF PARK FORESTS:
The oak grove alongside Zagreb Airport (Velika Gorica)
2 IN THE CATEGORY OF SIGNIFICANT LANDSCAPES:
The source area of the Odra River (Velika Gorica, Orle)
3 IN THE CATEGORY OF PARK ARCHITECTURE MONUMENTS:
The park around the parish church of St Martin in Ščitarjevo (Velika Gorica)
4 IN THE CATEGORY OF NATURE MONUMENTS
The penduncupate oak along the slope of the Sava embankment at Bukevje (Orle)

3.10 **ECOLOGICAL NETWORK**

In the vicinity of the planned operations, within a distance of 10 km, there are two areas of the Croatian ecological network which is important for birds: **Turopolje - HR1000003 and HR1000002 Sava near Hrušćica (with surrounding gravels).** The edge parts of both areas are located within a distance of less than 5 km from the border of the operation area. There is the area of the ecological network **HR200116 Sava** at a distance of about 3 km.
The acceptability of the planned project to the ecological network was the subject of the Prior Acceptability Assessment Study for the new Zagreb Airport passenger terminal on the ecological network. The study was conducted by the Institut IGH d.d. in January of 2012. A certificate was received from the Ministry for the Environmental and Nature Protection (CLASS: 612-07/12-01/0064, UR: 517-12-4 from 28. February 2012) - **the planned project shall have no significant effect on the goals of the preservation and integrity of the ecological network area**.

3.11 BIODIVERSITY

The area covered by the project to construct a new Zagreb Airport passenger terminal, of a total area of 1.3 km^2, is situated to the north of the City of Velika Gorica, in the immediate vicinity of Zagreb Airport.
Based on the map of habitats in the Republic of Croatia the predominant habitats in the project area are mosaics of cultivated areas that occupy about 46% of the total surface area covered by the project. Intensively tilled land accounts for about 0.6%, while forests of mixed oak-hornbeam and only hornbeam occupy about 5.6% of the total project area. A significant amount (about 40%) is occupied by infrastructure areas. The remainder consists of village areas (outlying sections of the Petina and Selnica Ščitarjevska settlements) that occupy about 4.1% and municipal residential areas that make up about 1.5% of the total area covered by the project.
A tour of the project area established that many parcels (plough fields and mowing meadows) are currently abandoned (about 25% of the total area). They are in various states of vegetation succession, and many are already in the state of low-growing scrub (figure 3.11.1.).

Figure 3.11.1 Abandoned plough fields and mowing meadows at the project location in various phases of vegetation succession.

The Kosnica canal passes through the area covered by the project in a length of about 600 m. given that the canal dries up at times, and that is banks are regularly mown, there is no developed marsh vegetation or reed along its course (figure 3.11.2.) and it has very little, practically negligible, value as a habitat for water and marsh habitat birds.

Figure 3.11.2 The dry bed of the Kosnica canal. The banks of the canal are regularly mown.

The buffer zone (the immediate vicinity of the project zone, i.e. a belt of 1 km around the bounds of the project) covers the same habitats as the project area itself. In this zone too (figure 3.11.1.-1) the most prevalent habitats are mosaic village landscapes (35% of the total area of the buffer zone). However, the share or intensively cultivated plough fields in the buffer zone is much greater (about 21%), and the infrastructure areas much smaller (21%) than in the area covered by the project. Forests of mixed oak and hornbeam and only hornbeam occupy about 7% of the total area of the buffer zone.

3.12 CULTURAL AND HISTORICAL HERITAGE

The cultural heritage conservation report for the needs of the Zagreb Airport—New Passenger Terminal Environmental Impact Assessment treats the cultural and historical heritage within the bounds of the project area zone and in its immediate vicinity. The observed area falls under the administration of the City of Velika Gorica and the settlements of Bapče, Velika Kosnica, Pleso and Selnica Ščitarjevska. The methodology and content of the conservation report is harmonised with the Ordinance on environmental impact assessment (Official Gazette 59/00, 136/04, 85/06) and the Act on the Protection and Preservation of Cultural Objects. The data in the conservation report is based on relevant literature, on the records of cultural objects at the Ministry of Culture and competent museum institutions and on the results of a survey of the terrain. The results of the conservation report are found in the integral Environmental Impact Assessment.
A part of the access road is located in the archaeological zone Andautonia and during the field survey they found eight potential archaeological sites that should be investigated before works start.

3.13 LANDSCAPE VALUES

The integral experience of a given area, i.e. its landscape, is determined by the basic physico-geographic elements; in particular the relief, waters, vegetation cover, and depends on anthropogenic influences.
The location of the project is situated within cultivated areas and urban landscapes. The anthropogenic influence is the major factor in creating this landscape and emerged over many centuries of the activity of societal and economic factors upon nature. As a result of human activity there is an ongoing reduction in landscapes in their natural form and the natural landscape undergoes changes and degradation and is transformed into a cultivated and urban landscape. The basic impression and experience of the landscape is that of a flatland area, agriculturally cultivated, of gentle relief dynamics, dominated by Zagreb Airport, the Pleso Air Force base and the surrounding settlements.

The landscape structure of the observed area was analysed through an understanding of the target use of the land and of its surface vegetation, relief characteristics and visual qualities. A structural analysis of the immediate project location identifies the existing Zagreb Airport and Pleso Air Force Base, the City of Velika Gorica and Lake Čiče as the dominant spatial elements, while the other recognisable elements of the landscape are settlements, agricultural areas and roads that together form a picture of the landscape characteristic of the area.

The anthropogenic spatial structures present include settlements with their accompanying infrastructure and agricultural areas, which dominate the area covered by the project. There are only traces of natural elements in the area covered by the project, only the odd grove. Settlements are situated traditionally as lines running along road corridors and contiguous with agricultural areas. The settlements are dominated by traditional architecture and there are no structures whose dimensions or style departs from the context of the local architecture and rural landscape. The traditional way of life based on crop farming and farming in general has been retained to the present day. Agricultural areas create a mosaicked structure of horizontally alternating cultures. The mosaic structure of agricultural areas is only visible from the air, and is could be said as such that the area, from a human perspective, is not abundant in significant perceptual values.

The most prominent linear element in the space, besides roads, are formed by the former armlets of the Sava River, now dried up, prominent by their hydrophilic vegetation that, along with sporadic patches of forest cover, creates the basic dynamic of this largely static landscape. The linear character of the armlets is further emphasised by agricultural areas placed perpendicular to the former watercourses, whereby water was, along with the lowland relief, the basic determinant element in the formation of the landscape.

The cited elements alternate in the area of the location under consideration, creating a landscape without exceptional value, but with individual elements and a spatial organisation that should be retained in the future.

3.14 SETTLEMENTS AND POPULATION

Significant areas of building zones in settlements have been designated as undeveloped area for the future expansion of building zones. In most cases, during the period from 1985 to 2004, these areas were not covered by new construction, rather significant areas have been developed outside of designated building zones, which indicate that settlements are expanding in other directions. On the other hand, as a result of the long-term reservation of space for the needs of the expansion of Zagreb Airport, building zones have not been designated for four independent statistical settlements (Mala Kosnica, Petina, Selnica Ščitarjevska and Bapče), and for a part of the Črnkovec settlement. Regardless of the ban on construction and the planned relocation of the settlements during the period from 1985 to 2004 the settlements still exist and have seen further development. The population fell in the period from 2001 to 2011 in the settlements of Bapče, Mala Kosnica and Petina, there was a small growth registered in the settlement of Selnica Ščitarjevska and a large increase in the number of inhabitants was registered in Črnkovec (see Table 3.14.-2.: Population, households and residential units).

The existing settlements of Mala Kosnica and Petina are, based on the relevant physical development planning documentation, situated within the area for the development of Zagreb Airport, within which the formation of building zones is not permitted, and for the existing settlements a consolidation to relocation regime is established. In the settlement consolidation to relocation regime the planning of essential traffic and municipal infrastructure is permitted and the reconstruction of existing buildings, all pursuant to the conditions established in the City of Velika Gorica Physical Development Plan (Official Gazette of the City of Velika Gorica 10/06, 6/08). The depicted conditions and restrictions in this area are essential because of the immediate vicinity of the runway and other Airport structures to the cited settlements, i.e. because of a permanent and immediate danger and numerous negative effects these structures have on the inhabitants of these settlements, and to secure the possibility of the further expansion of the Airport within this area.

3.15 ECONOMIC ACTIVITIES

Agriculture

On the construction site of the Zagreb Airport and the access road, agricultural land covers 54.7 ha or 35.6% of the relevant area.

Forestry

All forests and forest land in the wider area of the Zagreb Airport are well-maintained with the exception for forests in the immediate vicinity of the runway, which are located in a fenced-off area. Forests in the narrower area of the Zagreb Airport mainly belong to the category of special-purpose forests for the needs of the Croatian Army. Forests in the wider area under the impact of the Zagreb Airport belong to two economic units that form part of the Forest Office Velika Gorica; on the upper south-western edge the economic unit „Savski vrbaci“ is located, and the economic unit Turopoljski lug is located as a continuation of its south-eastern part.

Hunting

The scope of the project covers the area of the Common Forest Ground „Črnkovec“ (No. 38, total area 3.460 ha). In this area, the most common species of game are the following: roe deer (Capreolus capreolus), wild boar (Sus scrofa), European hare (Lepus europaeus), pheasant (Phaisanus colchicus), common quail (Coturnix coturnix), mallard (Anas platyrhynchos), Eurasian woodcock and grey partridge. Hunting is predominantly a sports-recreational activity, but there is an increasing trend of its development towards hunting tourism.

Tourism

The area in question has an exceptional tourist potential because of its location in the central part of the Zagreb County and its administrative border with the City of Zagreb, as well as because of its favourable traffic position and, in the first place, its rich natural and cultural-historical resources. The use of this potential depends on the traffic accessibility and availability of information to tourists, and on the level of equipment of tourist resources. Equipment of tourist resources encompasses a set of characteristics that make a certain resource a tourist attraction, and includes its preservation, possibility of its promotion, accessibility to public, the presence of indications, well-positioned signposts, availability of information and promotional material. Out of tourist resources in this area, cultural heritage should be specially pointed out - cultural and historical monuments dating from the times of antiquity, through Middle Ages to our times. The unique value of Turopolje are wooden churches and chapels and noblemen's manors which represent the greatest achievements of the national baroque architecture in the area of Northern Croatia. Then, there are also natural resources - especially valuable and recorded landscapes along the Sava and Odra rivers, providing the possibility for excursion-related, recreational, hunting and fishing tourism. The sports-recreational potential of the Čiče Lake should also be stressed. The great number of tourist resources, however, is still in disharmony with the level of their equipment for tourism, which has to be one of important goals for the future development of this area.

3.16 SOCIOLOGICAL ANALYSIS

Introductory note

The objective of the sociological analysis was to investigate the impact of the Zagreb Airport on the neighbouring settlements (above all Petina and Mala Kosnica) and on local population and their quality of life in the immediate vicinity of the Zagreb Airport. The problem is the intensity and the characteristics of the noise and air pollution from air traffic. The special planning documents foresee relocation of the population as the permanent and long-term solution of the problem, and reconstruction until relocation as a short-term solution.

In 2000 the author made a sociological analysis for the Environmental Impact Study of the Zagreb Airport (Inženjering za naftu i plin, Zagreb, 2000). Twelve years later we can say that there are no significant differences in basic elements. As the consequence of the expansion and modernisation at the Zagreb Airport and the planned increase in air traffic, the pressure on the local community will grow. Therefore, this sociological analysis puts an emphasis on this problem.

Results of field research

The sociological analysis "came down" among the local citizens in the area south-east of the Airport. While working on the sociological analysis, and based on the experience gained during the field research during the elaboration of the same analysis for Environmental Impact Study of the Zagreb Airport in 1999 - 2000, we considered it useful to refresh our insight into fundamental problems from the point of view of people daily affected by the flight of airplanes and the operation of the Airport. We organised a presentation of the project of the New Zagreb Airport Terminal for the local population[2].

The meeting with the citizens of Velika and Mala Kosnica, Petina, Črnkovec, Bapča and Selina was held on 27 October 2011 at the Kosnica Firehouse, 100 metres from the beginning of the eastern part of the Airport corridor and the runway. The purpose of this meeting, to which about 80 people responded, was to inform the citizens on behalf of the Institut IGH which prepared the study about its impact on the environment. The selected representatives of community offices Kosnica, Črnkovec, Bapča and Selnica were also present. We collected their inquiries and opinions.

The second meeting was held on 10 November 2011 at the same place, to which citizens of Petina and Mala Kosnica were invited; at the first meeting it was established that these two settlements are most endangered by environmental pollution or, more precisely, by air and noise pollution. The response was also great.[3] During the initial communication with citizens, inquiries and questions were mainly revolving about a certain number of issues and observations, of which we are here stating the most important ones.

1 Depending on from where they came, the participants were sharply divided into two groups. The first group consisted of those from more distant settlements, and the second group was from the most endangered settlements of Petina and Mala Kosnica. The first group stated that they wanted to receive a certain ecological annuity. There was even a proposal (T.A.) of HRK 1,500 monthly per household! A small price for lots of suffering! In addition, a former pilot of JAT and Croatialines (S.P.), who understands well how airplanes pollute the environment and which are realistic environmental annuities for citizens in the vicinity of airports in the world, gave examples of compensation in the amount of DEM 900 annually to households over-flown by airplanes at low altitudes in Stuttgart, Germany. The citizens of Mala Kosnica and Petina considered such proposals ridiculous and out of place since that amount of money cannot solve their problems. A number of participants stated that the only solution to the problem is complete relocation, about which there has been much talk for many years, and an equitable financial compensation for houses, house plots and farm buildings. A part of these buildings was constructed illegally after 1975. The prevailing standpoint is that the compensation should be given for all buildings such as they are regardless of the illegal status of some of them.

[2] In the organisation of the meeting we were assisted by the community office Kosnica. We would like to use this opportunity to thank the young and agile managerial teams of the community office headed by Goran Miličević for their help in the organisation of the meeting and for carrying out a survey in the settlements of Petina and Mala Kosnica.

[3] The minutes of both meetings were made by Mario Radoš, the secretary of the community office Kosnica. We thank them for their efforts on the preparation of this sociological analysis. See: http://www.mo-kosnica.hr/

In conclusion, the representatives of local public are divided into two groups with respect to their reaction to the impact of the Zagreb Airport on the local environment and it is not reasonable to put all of them into the same basket. The solution of this problem should go in the direction of differentiated and precise treatment of this reaction. Full attention should be given to the request of citizens of Petina and Mala Kosnica for relocation as the only appropriate solution of the exceptionally negative impact on their environment. Problems related to the negative impact on the environment (air pollution and noise) in settlements more distant from the Airport exist, but are much less intense.

2 Representatives from the settlements in the vicinity of the Airport pointed out that the expansion of the Airport would result in the increased air and road traffic in the vicinity of their settlements. If the overall situation with the environment is now bad, they ask themselves what the situation will be in these new circumstances. They expressed their fear from bigger and, according to them, also noisier airplanes.

3 The authors of the Environmental Impact Study were requested to make a noise map for these settlements. The representatives pointed out that for these settlements it was being said that the noise amounted to maximum values of 70 - 75 dB, but they are sure that the noise reaches more decibels. During low landings of bigger airplanes, i.e. in individual specific situations, the noise is deafening and upsets the nerves and the entire body, not only ears. The value of about 70 dB is an average value that has no relation to the reality of life, the representatives say. They are touched on the raw and disturbed by extreme peak noise values, and not by average values, and they feel them on their skin. To sum up this topic, it was pointed out that noise should be measured daily and continuously in this area and that only such a method would give true results.

4 The representatives pointed out that air is polluted by airplanes taking off and landing and that an offensive smell can be felt. They ask (Ž.H.): „How much harmful substances, heavy metals, are contained in a ton of fuel? What is it that falls on the ground and enters our lungs when fuel is burnt at low speeds during airplane taking off and landing?“ They stated that whatever they plant in their gardens, nothing grows.

5 In addition to this type of disruption of the environment, problems with occasional interruptions of TV signal were also mentioned. When listening to radio programmes they sometimes hear conversations of pilots that over-fly their villages.

6 Several representatives stated that in most households of Petina and Mala Kosnica somebody died of cancer, a grandmother or children or both father and mother. It was stated (Ž.H) that in a part of Petina in 18 households only three persons died of natural causes, and all other people died of cancer. The representatives attribute this situation to air pollution and inhalation of gases and solid particles generated during the flight of airplanes. Some people mentioned sad examples from their own families. Examples of younger people falling ill and undergoing treatment for cancer were mentioned.

7 The representative of the community office Črnkovec (M.Ć.) said that the Spatial Plan of Velika Gorica is currently in the process of the fourth revision and that the plan foresees relocation of the entire settlements of Petina and Mala Kosnica. According to him, this is an admission of the fact that there are no conditions for life there. It is foreseen that the settlements of Črnkovec, Selnica and Bapča will develop in the vicinity of the new Zagreb Airport.

General critical attitude of the citizens present and of the local public is clear. Nobody is against the expansion and modernisation of the Zagreb Airport, but there is great dissatisfaction and upset, even the sense of being wronged, by many years of neglect of the health of people and of the environment in the immediate surroundings of the Airport on its south-eastern side. It was especially stressed that the competent authorities of the city of Velika Gorica to which these settlements belong were very negligent in solving this problem. The citizens are unanimous in considering that the time of the expansion of the Airport is the right moment to make certain moves that would rescue local citizens from very low quality of the environment and an overall low quality of life in this area.

Living conditions in the settlements of Petina and Mala Kosnica

The settlements of Petina and Mala Kosnica, located in the immediate vicinity of the Airport, especially close to its corridor for taking off and landing and its runway on the eastern side, were partly formed a long time ago as parts of the villages of the same name, and were partly constructed during the last 3-4 decades. The inhabitants of these settlements are mostly natives. Only around 25% or around 20 households in Petina belong to immigrants and in Mala Kosnica there is only one family of immigrants.

Any construction was prohibited in these settlements by law since 1975 and all buildings that were constructed from then on were constructed illegally. The status of temporariness hovers over these families, people, houses, and there is no certainty about the relocation. In such conditions they cannot plan the future of new generations and cannot be on an equal footing with other citizens. A certain number of houses are not even connected to the municipal sewer and water supply system.

There has been talk about relocation with representatives of community offices from these settlements since as far as 1967. At that time, three families living in a location unfavourably positioned with respect to the then Airport were „relocated by the state", and several families received compensation of allegedly 500.000 dinars of that time.

For many years have these settlements had an unenviable status of places where construction is prohibited, and the life is permanently temporary. The Spatial Plan of the City of Velika Gorica which has been continuously revised for years foresees relocation of the inhabitants of these settlements. However, relocation never takes place. There is not even serious talk about it. The City of Velika Gorica shows a certain neglect of this issue. The inhabitants say „We are a blind gut to Velika Gorica". In the "Spatial Plan of the Area with Special Characteristics (PPPPO) Črnkovec and Zagreb Airport" from October 2011 these settlements are mentioned in principle as places that should be relocated, and "the prohibition of forming new and expansion of the existing construction sits and THE ESTABLISHED REGIME OF RECOVERY UNTIL RELOCATION" is operatively notified.[4]

About 200 families live here, in Petina there are about 50 buildings, mainly houses on house plots and with farm buildings, and in Mala Kosnica there are about 25 households, a total of about 75. Further analysis of air and noise pollution in Chapters 4.2.1 and 4.2.2 shows that these two settlements are most endangered by the activities of the Airport, in the first place by airplanes flying in close proximity of residential and other buildings.

An inhabitant of Mala Kosnica 12, said during the survey in November 2011: „Move us as soon as possible while we are still alive!". An immigrant from Bosnia from Mala Kosnica 9 writes „I live in a noisy, environmentally unhealthy zone. 400 metres behind my house there is a motorway, 150 metres in front of my house there is a corridor for airplane taking off and landing. The noise causes me heart palpitations. Even now this is an unbearable place to live in ". An inhabitant of Petina sends a message: "It is now difficult to live with traffic as it is because of the noise and stench. And how will it be when air traffic becomes more intense."

At the second meeting on 10 November 2011 health problems and environmental issues in these two settlements were discussed. Arguments about unbearable noise and polluted air were repeated, numerous examples were given. The focus was placed on the proposal by several inhabitants that these two settlements should be relocated. Opposing voices were few.

At the proposal of citizens, it was agreed that a small survey will be conducted among the inhabitants of Petina and Mala Kosnica. The author created the survey questions in accordance with the proposals of the participants of the meeting. The questions were: 1. settlement; 2. Owner of the household - owner of the flat, house plot, owner of the farm building; 3. Do you want to be relocated in the next few years from this area into another area of your choice under the condition that you receive a just and appropriate compensation for your house and housing plot ? (yes or no); 4. What type of compensation do you consider appropriate for you and your household (money, indemnity house and housing plot at a chosen location, indemnity flat)? 5. Has anyone in your family died of cancer since 1960? State the degree of kinship and the year of death?

The survey was conducted in the period from 15 October to 30 November 2011 by visiting the households. The intention was to survey all inhabitants of these two settlements. A small number of

[4] See: SPATIAL PLAN OF THE AREA WITH SPECIAL CHARACTERISTICS - ČRNKOVEC ZAGREB AIRPORT, II Mandatory Annexes, Proposal of the plan for public dispute, Summary for the public, p. II, 8 - 6. Bureau for Physical Planning of the Zagreb County, October 2011

households did not want to respond to the survey. The survey was responded by 20 owners of households in Mala Kosnica and by 47 in Petina, a total of 67 households in which about 200 people live.

The analysis of answers gave the following picture.

1 Almost all surveyed inhabitants of Mala Kosnica and Petina want to move out. Three people out of 46 surveyed in Petina do not want to leave, and 1 out of 20 surveyed in Mala Kosnica. One inhabitant said „I would rather not move“, but, out of concern for his health, he is willing to leave.

2 Almost all households own a residential building, house plot and a farm building. Only a few households do not have a farm building. A part of buildings built after 1975 do not have building licence since construction was prohibited by law in this area according to plans.

3 Almost the only form of the compensation wanted is payment in money under the condition that a just and appropriate compensation is received for the abandoned house, housing plot and farm buildings. 45 inhabitants out of 46 from Petina and 17 out of 20 from Mala Kosnica opted for this. In addition, one surveyed inhabitant of Petina would like to receive an indemnity flat, and one household in Mala Kosnica, in addition to money, would accept an indemnity flat as a possibility.

4 In almost all households somebody died of cancer. In Kosnica, in a total of 20 households, a total of 19 deaths from cancer were recorded. In Petina, in a total of 46 households, a total of 35 deaths from cancer were recorded. People talk about their closest relatives, grandmothers, grandfathers, fathers, mothers, mothers-in-law, fathers-in-law, sisters and brothers who died of lung, stomach and breast cancer. Especially striking is the example of a 19-year old boy affected by liposarcoma, the case of a sister suffering from cancer, and the case of a person who had a tumour but underwent surgery in 2009 and at the moment if free from any health problems.

Conclusion

It is necessary to solve urgently the problem of inhabitants of Petina and Mala Kosnica where all included parties must reach an agreement on the model of relocation of the endangered population as soon as possible.

4 DESCRIPTION OF THE ENVIRONMENTAL IMPACT OF THE PROJECT DURING THE CONSTRUCTION AND USE OF THE PROJECT

4.1 ENVIRONMENTAL IMPACT DURING THE CONSTRUCTION OF THE PROJECT

4.1.1 Impact on air quality

During the construction phase of the Zagreb Airport passenger terminal there will be dust produced as result of terrain works (especially during the dry period), the loading and offloading of earth, the movement of cargo vehicles on earthen surfaces and the like. Pursuant to the current regulation (Regulation on limit values of pollutants in air, Official Gazette 133/05) the limit value for PM_{10} is 50μg/m^3 for a 24-hour sampling period.
There will also be an increase in exhaust fume emissions as a result of the work of heavy excavation machinery, the loading and removal of excavated material and other machinery (compacters, finishers, rollers etc.). Besides the impact on the project location, there will be additional burdening of all local, county and state roads along which traffic will run. This impact will be of a temporary nature.
Given the scale of the project and the spatial situation of the location itself, it can be concluded that, with the application of protective measures, the construction of the project in question will be acceptable for the environment with regard to the impact on the air.

4.1.2 Impact on increased noise levels

During construction on the terrain classic construction machinery will be used that, as a rule, produces noise in excess of the 80dB level. Means of transport and human activity are also sources of noise. The increased noise level at the project location is unavoidable, of a temporary nature and represents an impact of short duration, significant at the actual project location.

4.1.3 Impact on water

During civil engineering construction the top, humus layer of soil is removed to a depth of some thirty centimetres, which facilitates the percolation of possible pollutant fluid discharges to groundwater. Given that a wide array of construction machinery is used in this work there is a potential threat of the discharge of motor oils, fuels and antifreeze. This may occur as a result of machine operator negligence, breakdowns (such as the bursting of pipes on the hydraulic parts of machinery) or damage (fuel tank, crankcase and radiator rupture).
Possibly contaminated material (such as unwashed gravel and sand with the remains or organic substances) built into road, parking lot and apron beddings or water soluble isolation materials may have an impact on the quality of groundwater.
Work that falls under the category of building construction presents a much lesser potential threat to groundwater.

4.1.4 Impact on soil

As a result of the reallocation of the land for the construction of the planned structure, the most significant impact is in the reallocation of agricultural land and the loss of soil on the route of the access roads. The area of the New Passenger Terminal is situated on the area of the Pleso military base, and as a result the reallocation of this area is not considered significant with regard to the loss of agricultural land.

4.1.5 Impact of the project on biological diversity

The planned project will cause a complete change, i.e. loss of existing habitats in the project zone. Given that the total area of the project is small (about 1.3 km^2) and that it, for the most part, covers mosaicked habitats on which widely prevalent and numerous species live, we feel that the possible impact of the project on flora and fauna is negligible.

Our evaluation is that the planned project will not have a significant negative impact on species of particular significance to nature protection.

4.1.6 Impact of the project on cultural and historical heritage

Potential archaeological localities PAL1-PAL3 in the Andautonija archaeological zone are directly threatened by the future construction. The density of existing archaeological finds in the proximity of the construction of the airport new passenger terminal indicates the possible discovery of new localities that have not been determined by this field survey.

4.1.7 Impact of the project on the landscape

The construction of a new passenger terminal is planned on an anthropogenically affected area next to the location of the existing airport and on the site of a military base. The location in question is not characterised by significant landscape value. A negative visual impact can be expected during the construction of the project as a result of the presence of machinery, equipment and construction material in the project area. The impact is of short duration and characteristic for the duration of the construction of the project.

4.1.8 Creation of waste

Non-hazardous and hazardous waste will be produced during the construction of the project from the remnants of construction material and packing material and as municipal waste resulting from the work and presence of people at the construction site. The disposal of waste at the project location may result in an unfavourable impact on the environment as a whole. Material will be excavated during the construction of the project, a part of which will be used for landscaping green areas, and a part of which will be transferred to an authorised collector for further disposal. Given the size of the project the collection of waste will be organised within the area covered by the project as provided for by law. A significant impact of waste on the quality of the environment is not expected in this phase of the realisation of the project. Waste management for all types of waste that will be created during its use must be provided for pursuant to valid legislation and subordinate regulations that regulate the management of individual categories of waste.

4.1.9 Impact on the population and the area in regard to traffic flows

An increase in the frequency of the transport of materials and machinery at the construction site may result in the change in the state of traffic, which can be avoided by the timely regulation of traffic.

4.1.10 Ecological accident risk evaluation

The risk of an ecological accident during the construction of a new Zagreb Airport passenger terminal for the most part pertains to accidents and mishaps during construction work. Good engineering practice during the execution of construction operations, and during the design phase will reduce the possibility of these events that would, given the sensitive nature of the area in question, potentially cause significant problems.

4.2 ENVIRONMENTAL IMPACT DURING THE USE OF THE PROJECT

4.2.1 Impact on air quality

Besides the increase in space, the expansion of the airport implies an increased number of aircraft and a greater number of passengers requiring transport to the airport, which automatically means an increase in road traffic. Together with the various activities that take place at the airport itself and around it, this will have an additional impact on air pollution. During the use phase of the project air pollution related the work of Zagreb Airport will be created from exhaust fumes.

The sources of gas emitters are:

- Aircraft (main and auxiliary engines)
- Ground machinery (aircraft and baggage tugs, fuel trucks, service and other vehicles)
- Access vehicles (vehicles operated by passengers, employees, passenger transporters and other people using the airport)
- Energy facilities

a) Aircrafts

Aircrafts may be divided into three types based on their purpose and the frequency of their use, size and operational profile: commercial, civilian and military.

For the project in question we are (primarily) interested in commercial aircraft for the transport of passengers and cargo. The operation of the motors of these aircraft create high temperature exhaust fumes and particles that leave jet motors and mix with the surrounding air.

As it has been previously explained, this process takes place for the most part in the tropopause zone (8-12 km above the earth's surface), with a predominantly negative effect in the form of releasing greenhouse gases (CO_2 and water vapour). Despite the fact that air traffic has a global impact, when considering the impact of the project in question on air quality we focused on the activities that will take place within the airport and in its immediate vicinity. The subject of the impact assessment was the ground level layer of the atmosphere in the so-called mixing zone[5], which corresponds to the vertical column of air from the earth's surface to the mixing altitude.

Besides the main motors, additional sources of pollution from large aircraft are auxiliary motors (Auxiliary Power Unit—APU), which serve to start the main motor during aircraft departure. After that they supply the aircraft with electrical energy and provide ventilation. The auxiliary motors also turn the generator and provide the power required for the electrical generation unit when the main motors are off (while the aircraft is grounded). If the airport has its own power system and source of air ventilation the aircraft can couple with these (after docking). During aircraft operations of landing, take-off and movement within the airport, the auxiliary motor creates the exhaust fumes created by larger machinery (HC, CO, NOx, and SO2).

b) Ground machinery and access vehicles

Motor vehicles emit pollutants into the atmosphere through exhaust pipes during the combustion of fuel, and a certain quantity of fuel is emitted by the evaporation of fuel from tanks, evaporation from machines that supply motors with fuel and the evaporation of lubricants from the crankcase. The composition and quantity of emissions depends on the type of vehicle (automobile, bus, tractor/tug…), the type of fuel used and the speed of the vehicle.

There are about 150 hazardous and poisonous organic and inorganic compounds in the exhaust fumes of automobile engines, the most significant of which are CO, NOx, SO_2, dust particles and

[5] Mixing zone—the layer of the earth's atmosphere in which the chemical reactions of pollutants can have a significant effect on the ground level concentration of pollutants. According to the EPA the height of the mixing zone is 900 m, although it is in many cases significantly less (EPA, 1999).

other substances. Research to date has shown that the emission of pollutants drops sharply with the distance from the source, as a rule following a logarithmic function, such that at a distance of 10-35 m it amounts to only 20% of the source values.
As a result of the construction of the project in question the sources of pollution from traffic routes will be machinery on the ground (tugs for aircraft and baggage, fuel tankers, service and other vehicles) and access vehicles (vehicles operated by passengers, employees, passenger transporters and other persons using the airport).

c) Power plant
There will be 2 power plant blocks for the production of electrical and thermal energy, including cooling within the energy plant building *(CHCP—Combined Heat, Cooling and Power)*. With the use of *Dry Low Emissions* technology and natural gas as the fuel, the exhaust fumes will contain NOx and CO.

EXHAUST FUME COMPONENTS
Given the cited sources of air pollution, the most significant components of exhaust fumes that will be emitted during the operation of the airport are as follows:

- **Carbon (IV) oxide - CO_2** ➢ a colourless gas essential to life on Earth—the product of breathing and vital to photosynthesis. An increased concentration of CO_2 in the atmosphere has an impact on an increase in the greenhouse effect and is manifested through the heating of the troposphere and cooling of the stratosphere. The normal concentration in the atmosphere is 0.039%. Anthropogenic impacts burdening the atmosphere are created as a result of the complete combustion of fossil fuels. It should be noted that of all types of traffic, road traffic is the source of the emission of 80% of CO_2. There is no technology to reduce CO_2 in the process of the combustion of fossil fuels, but this can be achieved by the development of more fuel efficient means of transport, the use of alternative fuels or other forms of transport (such as rail transport).

- **Carbon (II) oxide - CO** ➢A toxic, flammable gas created as a result of the incomplete combustion of substances containing carbon (such as fossil fuels). Unlike in closed spaces, it is not harmful to humans in open areas as it converts to CO_2 in contact with oxygen. It can be almost entirely removed by the use of catalytic converters in motor vehicles.

- **Nitrogen oxides - NOx** ➢ Created in the process of combustion at high temperatures. The high temperature and pressure present in an aircraft motor encourages a reaction between atmospheric nitrogen and oxygen, for the most part during takeoff and climbing, when motor temperatures are at their highest. NO is created first, requiring an atom of oxygen during and immediately after combustion, followed by the production of NO_2 during combustion with excess oxygen present.

  Since 1996 the ICAO (International Civil Aviation Organisation) has tightened standards for aircraft motors, and more stringent standards are expected in the future. Nitrogen oxides are toxic and can produce ozone[6] in reaction with oxygen in the surface layer and in the troposphere, while in the stratosphere its impact is in reducing the concentration of ozone. NO_2 is the most toxic - it causes inflammation of the throat, windpipe and bronchia accompanied by headaches and coughing. It penetrates the lung very quickly where it bonds with haemoglobin creating compounds that block the work of the lungs. In combination with CO it can be lethal.

[6] Ozone can irritate the respiratory system, induce coughing, irritate the throat and/or create an uncomfortable sensation in the chest. Further, ozone can reduce lung functions and hamper deep breathing (breathing is quicker and shallower than normal). Ozone can also exacerbate asthma, cause pneumonia, and irreversibly impair lung functions. People who work in the open air, people with respiratory diseases, asthmatics and children are especially prone to the effects of ozone. Ozone is also detrimental to plants (reduced yields and productivity).

– **Hydrocarbons - HC** ➢The chief component of jet fuel. The incomplete combustion of fuel in motors during "slow" operation causes the emission of uncombusted hydrocarbons, some of which are toxic (such as polycyclic aromatic hydrocarbon - PAH).

  Polycyclic aromatic hydrocarbons (PAH) with two or three aromatic rings are stable in the gaseous phase, whereas PAHs having more than three aromatic rings can be found in the air and are generally linked to particles. Researches have found direct connection between PAH exposure and lung cancer diseases (Chang and others, 2006).

  The benzopyrene (BaP) is often used as an indicator of the PAH presence in food and in air (Lee and others, 1981, WHO 2000). The toxicity of other PAHs is transformed into the toxicity equivalent factors (TEFs) of BaP, in order to evaluate their relative toxicity (Byeong-Kyu and Van Tuan, 2010). BaP mostly contributes to the apparition of malignancies, followed by DahA, Ind. and BbF[7] (Pufulete and others, 2004).

– **Sulphur (IV) oxide** - SO2 ➢ Chiefly responsible for the creation of acid rain, as SO2 oxidises with oxygen in the air creating SO3, which in contact with water transitions to sulphuric acid. The emission of SO2 is proportional to the quantity of combusted fuel and the concentration of sulphur in the fuel.

– **Water vapour - H20** ➢ Vapour condenses, creating trails that are sometimes visible behind aircraft at high altitudes. The emission of H20 from aircraft is proportional to the quantity of combusted fuel. Data indicates that there is a relation between the condensation core in the trail and the formation of cirrus, which most likely contribute to the greenhouse effect. Air traffic, therefore, contributes to the creation of water vapour, but the contribution of the airport itself is negligible.

– **Particulate matter - PM** ➢A wide range of various chemical and physical substances. For the most part these are discrete particles that exist in a condensate phase (liquid or solid) and are divided based on aerodynamic radius into several size classes: PM (primarily < 40 µm), PM10 (< 10 µm), PM2.5 (< 2.5 µm).

  They are generally composed of sulphates, nitrates, chlorides, ammonium compounds, organic carbon, elementary carbon and metals. The combustion of coal, oil, diesel, petrol, wood… produces emissions that contribute to the creation of suspended particulate matter. Aircraft engines emit NOx, which reacts in the atmosphere by forming secondary $PM_{2.5}$. Suspended particles may remain in the atmosphere for days or weeks and can travel through the atmosphere for hundreds or thousands of kilometres. With regard to land sources of pollution, the component of coarse dust is deposited for the most part in the direct vicinity (10 - 30 m), while fine dust is transported greater distances. The distribution direction of dust clouds depends on the dominant wind direction.

  In relation to other hazardous emissions, suspended particulate matter (PM) has the most dangerous impact on human health. If they are smaller than 10 µm their harmful effects are manifested by their retention in lungs, and can cause bronchitis and other disorders. In this regard the detrimental impact of aircraft on human is increased as most of the emitted particles are smaller than 2.5 µm ($PM_{2.5}$). Dust with particles greater than 10 µm in size represent less of a hazard to people, but can be a significant hazard for vegetation, depending on the type of dust. The effect on coniferous plants is more unfavourable than on deciduous plants, given that deciduous plants naturally eliminate the harmful effects by shedding their leaves.

  About 80% of PM_{10} suspended particles in urban areas are emitted by road traffic as a result of friction and incomplete combustion (Popescu, 2011).

[7] DahA - Dibenz[a,h]anthracene
Ind - Indeno(1,2,3-cd)pyrene
BbF - Benzo[b]fluoranthene

Other environmental impacts related to the deposition of NOx and suspended particles: acid aggregations, water eutrophication, ozone damage to plants, restricted visibility.

- **Heavy metals** ➢ Very hazardous because of their characteristic long persistence in soil and accumulation in living organisms. Sources of emission are: stationary (industry, households), mobile (traffic), natural (volcanic eruptions, forest fires) and accidents. Road traffic vehicles (as one of the major sources) for the most part emit zinc, copper and lead, and smaller quantities of nickel and cadmium. Heavy metals are emitted in the form of suspended particles. Lead is a significant burden to the environment, although it should be noted that emissions have been significantly reduced since unleaded petrol was introduced.

AIR POLLUTION SIMULATION

Simulations were conducted using ISC-AERMOD View software for a 3D modelling of air dispersion (US Environmental Protection Agency) to determine the impact on air quality. The emission of pollutants is estimated on the basis of meteorological conditions, characteristic sources of pollution and the configuration of the terrain.

The analysis of the impact on air quality of the New Passenger Terminal at Zagreb Airport had the goal of demonstrating the effect on the planned project upon the realisation of the 1st and 2nd phases (2024 and 2040). Concentrations of NO_x and PM_{10} were taken as reference parameters.

The simulations conducted assumed that all aircraft were of the Airbus A-320 type, which provides a somewhat greater weighting than the real state. However, we did not take into consideration the impact of auxiliary machinery and vehicles (GSE) and as such it is assumed that these impacts will mutually cancel each other out.

Analysis of NOx emission concentrations for the 1st and 2nd phases demonstrated the following:

- The greatest concentrations were registered on the takeoff section of the runway, given that the greatest emission of NOx from aircraft motors is, in fact, during takeoff. With the loss of aircraft contact with the surface of the Earth, the immediate impact on the surface concentration of NOx is reduced, but the contamination remains in the ground level layer of the atmosphere up to the mixing altitude (varies by season and daily - on the average 200 to 900 m) and participates in the formation of ground level ozone.

- Elements of the project (runway, terminal, accompanying roads and power plants) form a potential pollution zone of the following radiuses:
  a) For Phase 1: about 500 m with NOx concentrations values in excess of 200 μg/m^3, about 950 m with values in excess of 100 μg/m^3, about 2,700 m with values in excess of 50 μg/m^3
  b) For Phase 2: about 550 m with NO_x concentrations values in excess of 200 μg/m^3, about 1,300 m with values in excess of 100 μg/m^3, about 3,700 m with values in excess of 75 μg/m^3

- Roads in the project impact zone (A3, A11, D30, D31, D408, and planned N) form a potential pollution zone depending on the PGDP and structure of vehicles. The most significant impact is expected from the future A11 motorway. In this regard one should bear in mind that the key impact on the concentration of nitrogen oxides from roadways will come from the share of heavy cargo vehicles.

- Roads in the project impact zone (A3, A11, D30, D31, D408, and planned N) form a potential pollution zone depending on the PGDP and structure of vehicles. The most significant impact is expected from the future A11 motorway. In this regard one should bear in mind that the key impact on the concentration of nitrogen oxides from roadways will come from the share of heavy cargo vehicles.

- Given the position of Zagreb Airport and of the roadways in the project impact zone, the cumulative impact will be felt in a zone with a radius of 3 to 5 km around Zagreb Airport. Given the position of surrounding settlements the most prominent negative impact will be on the settlements of Mala Kosnica and Petina, in the immediate vicinity of the northeast edge of the runway. Other settlements most impacted by Zagreb Airport include Pleso, Selnica Ščitarjevska, Bapče and Velika Kosnica, and we should point out that the D31 bypass will have a significant impact on Selnica and Bapče, and the A3 motorway on Velika Kosnica. The impact of the A11 motorway and of the D30 and D31 roads will have a dominant impact on the areas of the settlements of Velika Gorica and Velika Mlaka.

- Data in control points indicate the predominant impact of Zagreb Airport. Traffic routes that are significant in the context of a cumulative impact are the D408 and D30 roads in K1 and K2, the D31 and A3 in K3 and K4 and the planned N road in K5 and K6.

- Given the values measured from a weathervane and the closest impact zone (the settlements Pleso, Mala Kosnica and Petina), the least favourable winds are from the N, NNW with an annual frequency of 6% and from the SW direction, which blows with an annual frequency of about 8%.

Based on the assumed ratio: NO_2/NO_x = 0.4, an estimate of NO_2 concentrations was made and the results produced were compared with stipulated limit values with regard to human health. Given that according to the *Regulation on limit values of pollutants in air, Official Gazette 133/05)*, the limit value for NO_2 is 200 µg/m^3 for an averaging period of 1hr, it can be concluded that the limit value will be exceeded immediately along the runway. Considering the health of people in nearby settlements, the critical zone will be the nearest houses in the settlements of Mala Kosnica and Petina; it should be noted that the LV prescribed by law is expected to be exceeded. Therefore, the share of pollution caused by the impact of the project in question will be within acceptable limits during both phases.

At the Zagreb Airport location itself the critical NO_2 level may be exceeded; therefore it is necessary to take care of the health of the ZLZ's employees, with special emphasis on those employees who spend most of their time on the open, next to the apron gate.

Analysis of PM_{10} emission concentrations for the 1st and 2nd phases demonstrated the following:

- The greatest concentrations were registered on the runway and on parts of the future A11 motorway.
- Elements of the project (runway, terminal, accompanying roads and power plants) form a potential pollution zone of the following radiuses:
  a) For Phase 1: about 200 m with PM_{10} concentrations values in excess of 30 µg/m^3, about 270 m with values in excess of 20 µg/m^3, about 450 m with values in excess of 10 µg/m^3
  b) For Phase 2: about 300 m with PM_{10} concentrations values in excess of 30 µg/m^3, about 400 m with values in excess of 20 µg/m^3, about 800 m with values in excess of 10 µg/m^3
- Roads in the project impact zone (A3, A11, D30, D31, D408, and planned N) form a potential pollution zone depending on the PGDP and structure of vehicles. The most significant impact is expected from the future A11 motorway.
- Given the position of Zagreb Airport and of the roadways in the project impact zone, the cumulative impact will be felt in a zone with a radius of 2 km around Zagreb Airport. Given the position of surrounding settlements the most prominent negative impact will be on the settlements of Pleso, Mala Kosnica and Petina, although quite a bit less than in the case of the NO_x parameters.
- Data in control points indicate the predominant impact of Zagreb Airport in K2 and K3, equal in K6 and with a predominant impact of traffic routes in K1, K4 and K5. Traffic routes that are significant in the context of a cumulative impact are the D408 and D30 roads in K1 and K2, the D31 and A3 in K3 and K4 and A3 and the planned N road in K5 and K6.
- Given the values measured from a weathervane and the closest impact zone (the settlements Pleso, Mala Kosnica and Petina), the least favourable winds are from the N, NNW with an annual frequency of 6% and from the SW direction, which blows with an annual frequency of about 8%.

Given that according to the Regulation on limit values of pollutants in air, Official Gazette 133/05), the limit value for PM_{10} is 50 µg/m^3 for an averaging period of 24hr, it can be concluded that the limit value will be exceeded immediately along the runway. In the surrounding area, the share of pollution caused by the impact of the project in question will be within acceptable limits during both phases.

The analysis of benzopyrene concentration immission for the 1st and 2nd phases has demonstrated the following:

- The greatest concentrations were registered on the runway and on terminal areas, because aircrafts, during their LTO (Landig/Take off) cycle, are a major source of pollution. The power plant is not a source of benzopyrene emission, whereas the road traffic emits it in much lower concentrations in comparison with aircraft operations.

- The elements of the project form a potential pollution zone that has following radiuses:

  For the 1st phase: about 275 m, with BaP concentration values higher than 1 ng/m^3, about 430 m values higher than 0,5 ng/m^3

  For the 2nd phase: about 300 m, with BaP concentration values higher than 1 ng/m^3, about 500 m values higher than 0,5 ng/m^3

- When speaking about the position of the nearby villages, the most pronounced negative impact is observed in the settlement of Pleso (K2). The impact on the peripheral part of Velika Gorica (K1) and Mičevec (K5) settlements is twice lower, whereas the impact on other settlements in the region: Petina (K3), Mala Kosnica (K4) and Velika Mlaka (K6) is 4 - 6 times lower.
- Speaking about the annual frequency of wind blowing from a given direction, the cloud of pollution in the direction of nearby settlements is formed by the following winds:
  - for Pleso and Velika Gorica settlement area: the wind from NNW, N and NNE (blow with an annual frequency of 2%, 4% and 7%, respectively)
  - for Petina settlement area: the wind from WSW (9%)
  - for Kosnica settlement area: the wind from SW (8%) and SSW (5%)
  - for Mičevac settlement area: the wind from SSE (2%) and SE (2%)
  - for Velika Mlaka settlement area: the wind from the E (6%) and NE (6%)

Since according to the *Regulation on Limit Values of Air Pollutants (the Official Gazette 133/05)*, the limit value for benzopyrene is 1 ng/m3 during the averaging period of 1 year, with an assumed air traffic, it is possible an exceeding of the limit value in Zagreb airport.
In the nearby areas, the proportion of pollution shall be within the limits of acceptability under the influence of mentioned operations. However, as the discussed parameter of benzopyrene is an indicator of the presence of PAHs in the air and contributes to the apparition of malignant diseases, it is important to minimize its concentration in the whole area, including the area within Zagreb airport.

* * *

If we compare the emission concentrations in both of the parameters under consideration in relation to the limit values stipulated by law, we can conclude that the situation with regard to suspended particles is after all quite favourable, and that NO_2 and benzopyrene represent the real measure of pollution and indicator of threats to human health. The most endangered group are the employees of the TLZ who spend most of their time on the open (apron gate). However, it should be noted that the share of pollution caused by the impact of the project in question is within acceptable limits and LVs prescribed by law will not be exceeded.
Given the trend to tighten emissions criteria in the aviation industry it is to be expected that there will be technological advances in the form of emissions reductions from the main aircraft motor. If we also assume that there will be a reduction of the emission of hazardous components in the exhaust fumes of road vehicles, the situation will be more favourable than in the simulations.

4.2.2 Impact on increased noise levels

An evaluation of the impact of Zagreb Airport traffic was made pursuant to the methodology of drafting noise maps as per the Ordinance on the method of preparation and content of noise maps and action plans and on the method of calculating limit values of noise indicators (Official Gazette 75/2009), which directly follows from Directive 2002/49/EC – "Relating to the assessment and management of environmental noise", and European Commission recommendation 2003/613/EC of 6 August 2003 on "Guidelines on the revised interim computation methods for industrial noise, aircraft noise, road traffic noise and railway noise, and related emission data".
Noise maps are produced using computation methods to calculate sound (noise) emission and propagation emitted from known sources of noise in a geographic area of known characteristics. Data on the area in question for the production of a noise map include: a digital relief model (elevations, contour lines, and break lines), data on structures (buildings, viaducts, walls and the like), terrain cover (grass, concrete and other), data on air and road traffic and meteorological data.
Data for the production of a noise map assume a knowledge of the sound level as expressed in dB(A) for individual sources of noise, i.e. in dB(A)/m for linear sources of noise or db/m^2 for surface sources of noise with a knowledge of the octave spectrum. Besides the cited acoustic characteristics, the working time of the cited sources of noise must be known (day, evening or night). Bruel & Kjaer LimA 5.5.0 (June 2011), a validated program package targeted to the construction of acoustic propagation models and noise maps, was used to produce a noise map that entirely meets the requirements set out in article 13 of the Ordinance on the method of preparation and content of noise maps and action plans and on the method of calculating limit values of noise indicators (Official Gazette 75/2009). Upon the entry and verification of all data into the cited program package a noise level computation is conducted on the basis of a series of equations that describe the conditions of the propagation of sound waves from sources of noise in the atmosphere. Key acoustic phenomenon that are taken through the computation are the orientation of the source, geometric divergence, the absorption of sound waves in the atmosphere, the propagation of sound waves close to the surface of the earth, the reflection and diffraction of sound waves from various surfaces, the protective effects of elements of the relief and structures that present an obstacle to the propagation of sound waves.
A noise map depicts the existing and/or foreseen noise emission situation in an observed area, expressed in harmonised noise indicators. The production of the Zagreb Airport noise map is in accordance with the legal regulations of the Republic of Croatia, the requirements of EU guideline 2002/49 and the best expert practice in the production of noise maps. The results of the noise map are an initial point of reference in managing environmental noise, i.e. they provide us with a picture of the load on the environment from the levels of noise that originate from the air and road traffic of Zagreb Airport.

The following entry data was used to produce an analysis of the impact of Zagreb Airport traffic:
City of Velika Gorica Physical Development Plan - 2008 amendments
2009 Annual Noise Level Report - Zagreb Airport
2011 Census of Population, Households and Dwellings - Statistical Report, Zagreb 2011, Croatian Bureau of Statistics, Republic of Croatia.
Geographic data:
- Digital terrain model (elevations, contour lines, break lines)
- Terrain cover
- Data on structures (the minimum height of structures considered in the calculation is 4 metres)

Traffic data:
- Year 2009 for noise levels of the existing air traffic situation
- Year 2024 for air traffic noise levels based on a greater growth scenario (source: *InterVISTASConsulting Group*)

– Year 2040 for air traffic noise levels based on a greater growth scenario (source: *InterVISTASConsulting Group*)

	2009	2024 (Phase 1)	2040 (Phase 2)
Total passengers	2,067,913	5,000,000	8,000,00
Annual growth rate (%)*		6,1	4,4
Total aviation operations	37,435	75,630	100,290
Annual growth rate (%)		4,8	3,2
*Cumulative, annual rate of growth in relation to 2009.			

Noise maps were produced for existing conditions (day, evening, night) and the assumed scenario of a growth in the number of passengers based on the number of aviation operations for a characteristic day. According to the scenario of greater growth the target number of 5,000,000 passengers will be reached in 2024 and of 8,000,000 passengers in 2040.

This gives us an average daily number of aviation operations:
- In 2009: 103
- In 2024: 207
- In 2040: 275

<u>Fleet structure</u>:
The commercial aircraft with the most frequent operations at Zagreb Airport in 2009 was the regional turboprop Bombardier de Havilland Canada DHC Dash 8 Q400 (abbreviated Q400), accounting for over a quarter of all commercial operations. This is followed in terms of operational frequency by the Airbus A318-A321 Family (for short and medium routes), the Canadair CL-600 Regional Jet CJR-100 and CRJ-700, and the Embraer EMB120 turboprop. The Boeing 737 and ATR 42 series also operate at Zagreb Airport.
About 90% of all traffic in 2009 is accounted for by these aircraft types. The fleet composition is similar this year. Most of the aircraft belong to the ICAO Category B and C, although there are some aircraft from the ICAO Category D (Boeing 757) and E (Boeing 747). Based on the entry data received from Zagreb Airport the fleet composition will not change, and the noise map projections for the greater growth scenario for 2024 (Phase 1) and 2040 (Phase 2) were made with an identical fleet composition to that in 2009. This fleet composition for noise level projections of the future air traffic can be seen as a conservative approach, where the projected noise levels represent the upper limits of realistic expectations. This is further supported by the following explanation related to traffic increase trends:
Mid-haul lines
The emphasis in creating a regional hub will certainly be based on the linking of new destinations and the introduction of an increased aircraft frequency. As a result of the linking of a greater number of European cities, and based on an analysis of the geographic location of Zagreb Airport, this pertains primarily to aircraft of the mid-range type, the A320, A321 and B737. Based on current knowledge Airbus has made significant steps forward in this category in terms of aircraft noise reduction, evidenced by the development of the A320 Neo aircraft (several times quieter than the current A320), which over time will certainly replace the older A320 aircraft fleet. There are similar plans at the Boeing company, which has entirely improved the motors and aerodynamic profile on aircraft of the Boeing 737-800 type. These aircraft according to current analysis make up the greatest share at Zagreb Airport and this trend should continue.
Long-haul lines
For transoceanic flights the aircraft used would certainly be of the A330, A340, B767, B777 and B747 types. The same arguments cited above are valid for these long-haul aircraft. An example of this is the new B787 aircraft, which is significantly quieter than aircraft currently in use, and began exploitation in 2011. The currently largest aircraft, the Airbus 380, regardless of its size

and 4 motors, generates a lower level of noise than do smaller aircraft currently flying to Zagreb Airport.

While making the noise maps not only for the existing modelling, but for the planned state as well, there were not available any input data of military aircrafts (for security reasons - military MIG 21 has the status of confidentiality). Helicopters rarely flow (can be ignored) at Zagreb airport, and most of them fly during the day, whereby their impact on the increase in the noise level is minimal, that's why they were not examined.

Meteorological data:
The list of meteorological data pursuant to paragraph 3, article 22 of the Ordinance on maximum permitted noise levels in an environment in which people work and live (Official Gazette 145/04).
The Meteorological Report for the Zagreb Airport—New Passenger Terminal Environmental Impact Assessment was produced by the Croatian Meteorological and Hydrological Service, Department of Climatology Research and Applied Climatology, Zagreb, Grič 3 (Class: 920-05/11-02/53, filing no. 554-05-03/04-11-02) as requested by the Institut IGH d.d., Zagreb, Janka Rakuša 1. The study was compiled by Mirta Patarčić MSc.

Methodology:
Pursuant to the Ordinance on the method of preparation and content of noise maps and action plans and on the method of calculating limit values of noise indicators (Official Gazette 75/2009), which defines the computation methods for calculating and evaluating environmental noise, the calculation methods used to compile the Zagreb Airport noise map were

- For air traffic noise: ECAC.CEAC Doc. 29 Report on Standard Method of Computing Noise Contours around Civil Airports, 1997 edition. For computer modelling of flight paths the segmentation technique described in section 7.5 ECAC.CEAC Doc. 29 is used.
- For road traffic noise: the French national computation method NMPB-Routes-96 (SETRA-CERTU-LCPC-CSTB), cited in "Arrété du 5 mai 1995 relatif au bruit des infrastructures routiéres, Official Gazette of 10 May 1995, article 6," and in the French standard "XPS 31-133."

Regulations:

- Noise Protection Act (Official Gazette 30/2009)
- Ordinance on the establishment of rules and procedures with regard to the introduction of noise-related operating restrictions at Croatian airports (Official Gazette 120/11)
- Ordinance on the method of preparation and content of noise maps and action plans and on the method of calculating limit values of noise indicators (Official Gazette 75/2009)
- Ordinance on maximum permitted noise levels in an environment in which people work and live (Official Gazette 145/04)
- European Parliament and Commission Directive 2002/49 relating to the assessment and management of environmental noise
- European Commission recommendation 2003/613/EC on noise computation methods (aircraft, road traffic, railway and industrial noise)
- European Directive 2002/30 (restrictions related to noise management at civil airports)

Results of the model for a noise map of air traffic in 2024 and 2040

An assessment of open-air noise emission levels is given based on the Ordinance on maximum permitted noise levels in an environment in which people work and live (Official Gazette 145/04), and on the City of Velika Gorica Physical Development Plan—2008 amendments. A total of 30 settlements were analysed; Bapče, Buševec, Črnkovec, Donja Lomnica, Drenje Ščitarjevsko, Gornja Lomnica, Gornje Podotočje, Gradići, Kobilići, Lazi Turopoljski, Lukavec, Mala Kosnica, Mićevec, Mraclin, Novaki Ščitarjevski, Obrezina, Ogulinec, Okuje, Petina, Petrovina Turopoljska, Rakitovec, Sasi, Selnica Ščitarjevska, Staro Čiče, Ščitarjevo, Turopolje, Velika Gorica, Velika Kosnica, Velika Mlaka and Vukovina.
Permitted noise levels in open-air spaces based on the purpose of the area are established pursuant to article 5 of the Ordinance on maximum permitted noise levels in an environment in which people work and live (Official Gazette 145/04). Given that the purpose of building zones is not defined in detail at the level of the physical development plan, from which building zones have been taken, the criteria taken for all building zones shall be for the highest permitted evaluation noise emission levels for the 4^{th} noise zone—the one of mixed, predominantly residential purpose. In accordance with this, the highest permitted daytime noise level is 65dB(A), and 50dB(A) for night time.

A detailed diagram of the results yielded for 2024 (Phase 1) and 2040 (Phase 2) is provided in the Graphical Appendixes 4.2.2.-1 to 4.2.2.-6. Data showing the surface covered by noise indicators and an analysis of the exposure of the population to excessive noise indicator levels is directly related to noise maps, as shown in tables 4.2.2.-1 to 4.2.2.-8.
According to the calculation for 2024 and 2040 the following settlements are within the zone for which a noise emission level evaluation was yielded in excess of the permitted levels: Donja Lomnica, Mala Kosnica and Petina (night) and Donja Lomnica, Mala Kosnica, Obrezina, Petina, Selnica Šćitarevska and Velika Kosnica.

Based on the study results, the choice of reference points in the environment has been made. These points are proposed for monitoring during the computational analysis of future conditions and monitoring.

GRAPHICAL APPENDIXES:
Appendix 4.2.2.-1 Air traffic noise map for day and evening in 2024
Appendix 4.2.2.-2 Air traffic noise map for night for 2024
Appendix 4.2.2.-3 Air traffic noise map for L_{den} for 2024
Appendix 4.2.2.-4 Air traffic noise map for day and evening for 2040
Appendix 4.2.2.-5 Air traffic noise map for night for 2040
Appendix 4.2.2.-6 Air traffic noise map for L_{den} for 2040

Table 4.2.2.-2 Settlement surface areas and estimated number of inhabitants exposed to excessive air traffic $L_{day/evening}$ noise indicator levels for 2024

Ord. No.	Name of the settlement	Settlement data	Total	$L_{day/evening}$ noise indicator class for 2024											Total excess
				<35 dB(A)	35 - 39 dB(A)	40- 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
1	Bapče	Settlement surface area (km²)	1,68				0,59	0,32							0,00
		Number of buildings	105												0
		Number of inhabitants	130												0
2	Buševec	Settlement surface area (km²)	4,17												0,00
		Number of buildings	464												0
		Number of inhabitants	889												0
3	Crnkovec	Settlement surface area (km²)	4,62				0,97	0,16							0,00
		Number of buildings	147												0
		Number of inhabitants	413												0
4	Donja Lomnica	Settlement surface area (km²)	14,93				1,71	1,51	1,43	1,36	0,43				0,43
		Number of buildings	778						209	225	64				44
		Number of inhabitants	1416						380	410	116				116
5	Drenje Ščitarjevsko	Settlement surface area (km²)	2,23				1,33	1,79	3,31	0,03					0,00
		Number of buildings	147						126	2					0
		Number of inhabitants	202						173	3					0
6	Gornja Lomnica	Settlement surface area (km²)	2,49				0,58	0,38	0,18						0,00
		Number of buildings	162												0
		Number of inhabitants	582												0
7	Gornje Podotočje	Settlement surface area (km²)	2,93												0,00
		Number of buildings	153												0
		Number of inhabitants	492												0
8	Gradići	Settlement surface area (km²)	1,90				0,34	0,10							0,00
		Number of buildings	622												0
		Number of inhabitants	1808												0
9	Kobilići	Settlement surface area (km²)	1,56												0,00
		Number of buildings	248												0
		Number of inhabitants	520												0
10	Lazi Turopoljski	Settlement surface area (km²)	3,40												0,00
		Number of buildings	43												0
		Number of inhabitants	58												0
11	Lukavec	Settlement surface area (km²)	11,34				0,22	0,10	0,02						0,00
		Number of buildings	535												0
		Number of inhabitants	1136												0
12	Mala Kosnica	Settlement surface area (km²)	1,01				0,01	0,07	0,35	0,35	0,21	0,03			0,24
		Number of buildings	44						9	2	28				28
		Number of inhabitants	49						10	2	31				31
13	Mićevec	Settlement surface area (km²)	6,54				1,99	1,07	0,35	0,18	0,11	0,06			0,17
		Number of buildings	648												0
		Number of inhabitants	1281												0
14	Mraclin	Settlement surface area (km²)	12,93												0,00
		Number of buildings	607												0
		Number of inhabitants	1068												0
15	Novaki Ščitarjevski	Settlement surface area (km²)	2,65				1,15	0,87	0,28						0,00
		Number of buildings	112						32						0
		Number of inhabitants	165						47						0
16	Obrezina	Settlement surface area (km²)	1,79					0,03	0,90	0,86					0,00
		Number of buildings	274						57	197					0
		Number of inhabitants	577						120	415					0
17	Ogulinec	Settlement surface area (km²)	3,76												0,00
		Number of buildings	337												0
		Number of inhabitants	296												0

Ord. No.	Name of the settlement	Settlement data	Total	$L_{day/evening}$ noise indicator class for 2024											Total excess
				<35 dB(A)	35 - 39 dB(A)	40 - 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
18	Okuje	Settlement surface area (km^2)	4,71												0,00
		Number of buildings	226												0
		Number of inhabitants	467												0
19	Petina	Settlement surface area (km^2)	1,84						0,15	1,13	0,56				0,56
		Number of buildings	150						3	41	106				106
		Number of inhabitants	211						4	58	149				149
20	Petrovina Turopoljska	Settlement surface area (km^2)	2,63												0,00
		Number of buildings	275												0
		Number of inhabitants	702												0
21	Rakitovec	Settlement surface area (km^2)	10,37												0,00
		Number of buildings	247												0
		Number of inhabitants	573												0
22	Sasi	Settlement surface area (km^2)	1,67				0,47	0,61	0,56						0,00
		Number of buildings	62												0
		Number of inhabitants	164												0
23	Selnica Sčitarjevska	Settlement surface area (km^2)	1,96				0,11	0,85	0,82	0,17					0,00
		Number of buildings	241						21	9					0
		Number of inhabitants	537						47	20					0
24	Staro Čiče	Settlement surface area (km^2)	3,02												0,00
		Number of buildings	418												0
		Number of inhabitants	783												0
25	Sčitarjevo	Settlement surface area (km^2)	3,79				1,36	1,25	0,94	0,09					0,00
		Number of buildings	243						97	30					0
		Number of inhabitants	440						176	54					0
26	Turopolje	Settlement surface area (km^2)	4,64												0,00
		Number of buildings	468												0
		Number of inhabitants	951												0
27	Velika Gorica	Settlement surface area (km^2)	31,47				2,15	1,30	0,91	0,65	0,78	0,62	0,57	0,13	2,10
		Number of buildings	5968						32						0
		Number of inhabitants	31341						168						0
28	Velika Kosnica	Settlement surface area (km^2)	2,13				0,60	0,75	0,47	0,11					0,00
		Number of buildings	233						54	17					0
		Number of inhabitants	799						165	58					0
29	Velika Mlaka	Settlement surface area (km^2)	6,07				0,70	0,53	0,49	0,39	0,33	0,15			0,48
		Number of buildings	1102						9						0
		Number of inhabitants	3326						27						0
30	Vukovina	Settlement surface area (km^2)	5,84												0,00
		Number of buildings	453												0
		Number of inhabitants	945												0
	Σ	Settlement surface area (km^2)	155,43						11,16	5,32	2,42	0,86	0,57		3,98
		Number of buildings	15512						649	523	198				198
		Number of inhabitants	52321						1338	1020	297				297

YES – Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)

NO – Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)

* **Maximum permitted $L_{day/night}$ noise immission evaluation levels according to the purpose of the area**

Purpose of the area : zone of mixed, mostly residential purpose, L_{day}=65 dB

Table 4.2.2.-3 **Settlement surface areas and estimated number of inhabitants exposed to excessive air traffic L_{night} noise indicator levels for 2024**

Ord. No	Name of the settlement	Settlement data	Total	L_{night} noise indicator class for 2024											Total excess
				<35 dB(A)	35 - 39 dB(A)	40 - 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70-74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
1	Bapče	Settlement surface area (km²)	1,68			0,25									0,00
		Number of buildings	105												0
		Number of inhabitants	130												0
2	Buševec	Settlement surface area (km²)	4,17												0,00
		Number of buildings	464												0
		Number of inhabitants	889												0
3	Črnkovec	Settlement surface area (km²)	4,62			0,10									0,00
		Number of buildings	147												0
		Number of inhabitants	413												0
4	Donja Lomnica	Settlement surface area (km²)	14,93			1,35	1,41	1,00	0,09						1,09
		Number of buildings	778				345	12							12
		Number of inhabitants	1416				628	22							22
5	Drenje Šćitarjevsko	Settlement surface area (km²)	2,23			1,92	2,93								2,93
		Number of buildings	147				78								78
		Number of inhabitants	202				107								107
6	Gornja Lomnica	Settlement surface area (km²)	2,49			0,28	0,06								0,06
		Number of buildings	162												0
		Number of inhabitants	582												0
7	Gornje Podotočje	Settlement surface area (km²)	2,93												0,00
		Number of buildings	153												0
		Number of inhabitants	492												0
8	Gradići	Settlement surface area (km²)	1,90												0,00
		Number of buildings	622												0
		Number of inhabitants	1808												0
9	Kobilić	Settlement surface area (km²)	1,66												0,00
		Number of buildings	248												0
		Number of inhabitants	520												0
10	Lazi Turopoljski	Settlement surface area (km²)	3,40												0,00
		Number of buildings	43												0
		Number of inhabitants	58												0
11	Lukavec	Settlement surface area (km²)	11,34			0,06									0,00
		Number of buildings	535												0
		Number of inhabitants	1136												0
12	Mala Kosnica	Settlement surface area (km²)	1,01			0,10	0,35	0,35	0,20	0,02					0,57
		Number of buildings	44				7	2	28						30
		Number of inhabitants	49				8	2	31						33
13	Mićevec	Settlement surface area (km²)	6,54			0,94	0,31	0,16	0,10	0,05					0,31
		Number of buildings	648												0
		Number of inhabitants	1281												0
14	Mraclin	Settlement surface area (km²)	12,93												0,00
		Number of buildings	607												0
		Number of inhabitants	1068												0
15	Novaki Šćitarjevski	Settlement surface area (km²)	2,65			0,84	0,19								0,19
		Number of buildings	112												0
		Number of inhabitants	165												0
16	Obrezina	Settlement surface area (km²)	1,79			0,04	1,32	0,43							0,43
		Number of buildings	274				141	82							82
		Number of inhabitants	577				297	173							173
17	Ogulinec	Settlement surface area (km²)	3,76												0,00
		Number of buildings	337												0
		Number of inhabitants	296												0

Ord. No	Name of the settlement	Settlement data	Total	L_{day} noise indicator class for 2024											Total excess
				<35 dB(A)	35 - 39 dB(A)	40 - 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
18	Okuje	Settlement surface area (km²)	4,71												0,00
		Number of buildings	226												0
		Number of inhabitants	467												0
19	Petina	Settlement surface area (km²)	1,84				0,20	1,15	0,49						1,84
		Number of buildings	150				3	35	112						147
		Number of inhabitants	211				4	49	158						207
20	Petrovina Turopoljska	Settlement surface area (km²)	2,63												0,00
		Number of buildings	275												0
		Number of inhabitants	702												0
21	Rakitovec	Settlement surface area (km²)	10,37												0,00
		Number of buildings	247												0
		Number of inhabitants	573												0
22	Sasi	Settlement surface area (km²)	1,67			0,67	0,42								0,00
		Number of buildings	62												0
		Number of inhabitants	164												0
23	Selnica Šćitarjevska	Settlement surface area (km²)	1,96			0,91	0,76	0,14							0,14
		Number of buildings	241				17	9							9
		Number of inhabitants	537				38	20							20
24	Staro Čiče	Settlement surface area (km²)	3,02												0,00
		Number of buildings	418												0
		Number of inhabitants	783												0
25	Šćitarjevo	Settlement surface area (km²)	3,79			1,21	0,91	0,01							0,01
		Number of buildings	243				172								0
		Number of inhabitants	440				311								0
26	Turopolje	Settlement surface area (km²)	4,64												0,00
		Number of buildings	468												0
		Number of inhabitants	951												0
27	Velika Gorica	Settlement surface area (km²)	31,47			1,18	0,83	0,62	0,81	0,54	0,56	0,08			2,61
		Number of buildings	5968				9								0
		Number of inhabitants	31341				47								0
28	Velika Kosnica	Settlement surface area (km²)	2,13			0,71	0,45	0,01							0,01
		Number of buildings	233				67	19							19
		Number of inhabitants	799				230	65							65
29	Velika Mlaka	Settlement surface area (km²)	6,07			0,46	0,44	0,36	0,31						0,67
		Number of buildings	1102				2								0
		Number of inhabitants	3326				6								0
30	Vukovina	Settlement surface area (km²)	5,84												0,00
		Number of buildings	453												0
		Number of inhabitants	945												0
	Σ	Settlement surface area (km²)	155,43			11,02	10,58	4,23	2,00	0,61	0,56				18,06
		Number of buildings	15512				841	159	140						1140
		Number of inhabitants	52321				1676	331	189						2196

YES	(green)	Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO	(pink)	Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
*	Maximum permitted L_{day} noise immission evaluation levels according to the purpose of the area	
	Purpose of the area: zone of mixed, mostly residential purpose, L_{day}=50 dB	

Table 4.2.2.-4 **Settlement surface areas and estimated number of inhabitants exposed to excessive air traffic $L_{day/evening}$ noise indicator levels for 2040**

Ord. No.	Name of the settlement	Settlement data	Total	$L_{day/evening}$ noise indicator class for 2040											Total excess
				<35 dB(A)	35 - 39 dB(A)	40- 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
1	Bapče	Settlement surface area (km²)	1,68				0,59	0,48							0,00
		Number of buildings	105												0
		Number of inhabitants	130												0
2	Buševec	Settlement surface area (km²)	4,17												0,00
		Number of buildings	464												0
		Number of inhabitants	889												0
3	Crnkovec	Settlement surface area (km²)	4,62				1,11	0,31							0,00
		Number of buildings	147												0
		Number of inhabitants	413												0
4	Donja Lomnica	Settlement surface area (km²)	14,93				1,65	1,46	1,32	1,41	0,71	0,02			0,73
		Number of buildings	778						1,76	247	63				83
		Number of inhabitants	1416						320	450	151				151
5	Drenje Ščitarjevsko	Settlement surface area (km²)	2,23				1,33	1,70	3,21	0,61					0,00
		Number of buildings	147						106	24					0
		Number of inhabitants	202						146	33					0
6	Gornja Lomnica	Settlement surface area (km²)	2,49				1,12	0,40	0,24	0,02					0,00
		Number of buildings	162												0
		Number of inhabitants	582												0
7	Gornje Podotočje	Settlement surface area (km²)	2,93												0,00
		Number of buildings	153												0
		Number of inhabitants	492												0
8	Gradići	Settlement surface area (km²)	1,90				0,33	0,12							0,00
		Number of buildings	622												0
		Number of inhabitants	1808												0
9	Kobilići	Settlement surface area (km²)	1,56												0,00
		Number of buildings	248												0
		Number of inhabitants	520												0
10	Lazi Turopoljski	Settlement surface area (km²)	3,40												0,00
		Number of buildings	43												0
		Number of inhabitants	58												0
11	Lukavec	Settlement surface area (km²)	11,34				0,34	0,11	0,04						0,00
		Number of buildings	535												0
		Number of inhabitants	1136												0
12	Mala Kosnica	Settlement surface area (km²)	1,01					0,03	0,31	0,38	0,27	0,05			0,32
		Number of buildings	44						2	11	28				28
		Number of inhabitants	49						2	12	31				31
13	Mićevec	Settlement surface area (km²)	6,54				2,09	1,28	0,45	0,22	0,012	0,08			0,17
		Number of buildings	648												0
		Number of inhabitants	1281												0
14	Mraclin	Settlement surface area (km²)	12,93												0,00
		Number of buildings	607												0
		Number of inhabitants	1068												0
15	Novaki Ščitarjevski	Settlement surface area (km²)	2,65				0,97	0,95	0,47						0,00
		Number of buildings	112						51						0
		Number of inhabitants	165						75						0
16	Obrezina	Settlement surface area (km²)	1,79					0,03	0,54	1,24					0,00
		Number of buildings	274						41	213					0
		Number of inhabitants	577						80	440					0
17	Ogulinec	Settlement surface area (km²)	3,76												0,00
		Number of buildings	337												0
		Number of inhabitants	296												0

Ord. No.	Name of the settlement	Settlement data	Total	$L_{day/evening}$ noise indicator class for 2040											Total excess
				<35 dB(A)	35 - 39 dB(A)	40 - 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
18	Okuje	Settlement surface area (km^2)	4,71												0,00
		Number of buildings	226												0
		Number of inhabitants	467												0
19	Petina	Settlement surface area (km^2)	1,84						0,05	0,92	0,87				0,87
		Number of buildings	150							4	146				146
		Number of inhabitants	211							6	205				205
20	Petrovina Turopoljska	Settlement surface area (km^2)	2,63												0,00
		Number of buildings	275												0
		Number of inhabitants	702												0
21	Rakitovec	Settlement surface area (km^2)	10,37												0,00
		Number of buildings	247												0
		Number of inhabitants	573												0
22	Sasi	Settlement surface area (km^2)	1,67				0,47	0,61	0,59						0,00
		Number of buildings	62												0
		Number of inhabitants	164												0
23	Selnica Sčitarjevska	Settlement surface area (km^2)	1,96				0,04	0,67	0,96	0,29					0,00
		Number of buildings	241						32	14					0
		Number of inhabitants	537						71	31					0
24	Staro Čiče	Settlement surface area (km^2)	3,02												0,00
		Number of buildings	418												0
		Number of inhabitants	783												0
25	Sčitarjevo	Settlement surface area (km^2)	3,79				1,13	1,27	1,00	0,25					0,00
		Number of buildings	243						87	62					0
		Number of inhabitants	440						158	112					0
26	Turopolje	Settlement surface area (km^2)	4,64												0,00
		Number of buildings	468												0
		Number of inhabitants	951												0
27	Velika Gorica	Settlement surface area (km^2)	31,47				2,36	1,39	0,96	0,68	0,71	0,71	0,52	0,30	2,24
		Number of buildings	5968						47						0
		Number of inhabitants	31341						247						0
28	Velika Kosnica	Settlement surface area (km^2)	2,13				0,44	0,76	0,53	0,22					0,00
		Number of buildings	233						62	17					0
		Number of inhabitants	799						213	58					0
29	Velika Mlaka	Settlement surface area (km^2)	6,07				0,75	0,52	0,48	0,39	0,33	0,24			0,57
		Number of buildings	1102						14						0
		Number of inhabitants	3326						42						0
30	Vukovina	Settlement surface area (km^2)	5,84												0,00
		Number of buildings	453												0
		Number of inhabitants	945												0
	Σ	Settlement surface area (km^2)	155,43						11,15	6,61	3,01	1,10	0,52		4,93
		Number of buildings	15512						825	602	257				257
		Number of inhabitants	52321						1377	1185	388				399

YES	(green)	Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO	(pink)	Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
*	**Maximum permitted L_{day} noise immission evaluation levels according to the purpose of the area**	
	Purpose of the area : zone of mixed, mostly residential purpose, $L_{day/evening}$=65 dB	

Table 4.2.2.-5 **Settlement surface areas and estimated number of inhabitants exposed to excessive air traffic L_{night} for 2040**

Ord. No	Name of the settlement	Settlement data	Total	L_{night} noise indicator class for 2040											Total excess
				<35 dB(A)	35-39 dB(A)	40- 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	>80 dB(A)	
1	Bapče	Settlement surface area (km²)	1,68			0,46	0,01								0,01
		Number of buildings	105												0
		Number of inhabitants	130												0
2	Buševec	Settlement surface area (km²)	4,17												0,00
		Number of buildings	464												0
		Number of inhabitants	889												0
3	Crnkovec	Settlement surface area (km²)	4,62			0,35									0,00
		Number of buildings	147												0
		Number of inhabitants	413												0
4	Donja Lomnica	Settlement surface area (km²)	14,93			1,39	1,37	1,28	0,31						2,96
		Number of buildings	778				332	19	24						375
		Number of inhabitants	1416				604	35	44						683
5	Drenje Sčitarjevsko	Settlement surface area (km²)	2,23			1,72	3,30	0,40							3,70
		Number of buildings	147				2	76							78
		Number of inhabitants	202				3	104							107
6	Gornja Lomnica	Settlement surface area (km²)	2,49			0,34	0,15								0,15
		Number of buildings	162												0
		Number of inhabitants	582												0
7	Gornje Podotočje	Settlement surface area (km²)	2,93												0,00
		Number of buildings	153												0
		Number of inhabitants	492												0
8	Gradići	Settlement surface area (km²)	1,90			0,03									0,00
		Number of buildings	622												0
		Number of inhabitants	1808												0
9	Kobilići	Settlement surface area (km²)	1,56												0,00
		Number of buildings	248												0
		Number of inhabitants	520												0
10	Lazi Turopoljski	Settlement surface area (km²)	3,40												0,00
		Number of buildings	43												0
		Number of inhabitants	58												0
11	Lukavec	Settlement surface area (km²)	11,34			0,09	0,01								0,01
		Number of buildings	535												0
		Number of inhabitants	1136												0
12	Mala Kosnica	Settlement surface area (km²)	1,01			0,02	0,30	0,35	0,29	0,05					0,99
		Number of buildings	44				5	9	28						42
		Number of inhabitants	49				6	10	31						47
13	Mićevec	Settlement surface area (km²)	6,54			1,24	0,45	0,21	0,11	0,08					0,85
		Number of buildings	648				6								6
		Number of inhabitants	1281				12								12
14	Mraclin	Settlement surface area (km²)	12,93												0,00
		Number of buildings	607												0
		Number of inhabitants	1068												0
15	Novaki Sčitarjevski	Settlement surface area (km²)	2,65			0,95	0,45								0,45
		Number of buildings	112				37								37
		Number of inhabitants	165				55								55
16	Obrezina	Settlement surface area (km²)	1,79				0,61	1,18							1,79
		Number of buildings	274				223								223
		Number of inhabitants	577				470								470
17	Ogulinec	Settlement surface area (km²)	3,76												0,00
		Number of buildings	337												0
		Number of inhabitants	296												0

Ord. No	Name of the settlement	Settlement data	Total	L_{night} noise indicator class for 2040											Total excess
				<35 dB(A)	35 - 39 dB(A)	40 - 44 dB(A)	45 - 49 dB(A)	50 - 54 dB(A)	55 - 59 dB(A)	60 - 64 dB(A)	65 - 69 dB(A)	70 - 74 dB(A)	75 - 79 dB(A)	> 80 dB(A)	
18	Okuje	Settlement surface area (km²)	4,71												0,00
		Number of buildings	226												0
		Number of inhabitants	467												0
19	Petina	Settlement surface area (km²)	1,84				0,04	0,29	0,91						1,2
		Number of buildings	150					3	147						150
		Number of inhabitants	211					4	207						211
20	Petrovina Turopoljska	Settlement surface area (km²)	2,63												0,00
		Number of buildings	275												0
		Number of inhabitants	702												0
21	Rakitovec	Settlement surface area (km²)	10,37												0,00
		Number of buildings	247												0
		Number of inhabitants	573												0
22	Sasi	Settlement surface area (km²)	1,67			0,58	0,70								0,70
		Number of buildings	62				3								0
		Number of inhabitants	164				8								0
23	Selnica Šćitarjevska	Settlement surface area (km²)	1,96			0,64	0,96	0,32							0,32
		Number of buildings	241				41	22							22
		Number of inhabitants	537				91	49							49
24	Staro Čiče	Settlement surface area (km²)	3,02												0,00
		Number of buildings	418												0
		Number of inhabitants	783												0
25	Šćitarjevo	Settlement surface area (km²)	3,79			1,25	1,00	0,30							0,30
		Number of buildings	243				182	61							61
		Number of inhabitants	440				330	110							110
26	Turopolje	Settlement surface area (km²)	4,64												0,00
		Number of buildings	468												0
		Number of inhabitants	951												0
27	Velika Gorica	Settlement surface area (km²)	31,47			1,35	0,95	0,67	0,67	0,68	0,48	0,34			2,84
		Number of buildings	5968				22								0
		Number of inhabitants	31341				116								0
28	Velika Kosnica	Settlement surface area (km²)	2,13			0,74	0,53	0,24	0,01						0,25
		Number of buildings	233				73	47							47
		Number of inhabitants	799				290	161							161
29	Velika Mlaka	Settlement surface area (km²)	6,07			0,47	0,46	0,39	0,35	0,15					0,89
		Number of buildings	1102				9								0
		Number of inhabitants	3326				27								0
30	Vukovina	Settlement surface area (km²)	5,84												0,00
		Number of buildings	453												0
		Number of inhabitants	945												0
	Σ	Settlement surface area (km²)	160,07			11,62	11,29	6,23	2,65	0,96	0,48				10,91
		Number of buildings	15612				935	237	199						6959
		Number of inhabitants	52321				1970	474	222						1226

YES		Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO		Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
*	Maximum permitted L_{night} noise immission evaluation levels according to the purpose of the area	
	Purpose of the area : zone of mixed, mostly residential purpose, L_{night}=50 dB	

Table 4.2.2.-6 Comparative table of settlement surface areas and estimated number of inhabitants exposed to excessive air traffic $L_{day,\ evening}$ noise indicators for the years 2009, 2024 and 2040

Ord. No	Name of the settlement	Settlement surface area in km²	Number of buildings	**Total number of inhabitants per settlement	* 2009 L day,evening noise immission levels in dB(A)	Surface area of the settlement (in km²) affected by excessive noise immission levels in 2009	Number of buildings exposed to excessive noise immission levels in 2009	Estimated number of inhabitants exposed to excessive noise immission levels in 2009	* 2024 L day,evening noise immission levels in dB(A)	Surface area of the settlement (in km²) affected by excessive noise immission levels in 2024	Number of buildings exposed to excessive noise immission levels in 2024	Estimated number of inhabitants exposed to excessive noise immission levels in 2024	* 2040 L day,evening noise immission levels in dB(A)	Surface area of the settlement (in km²) affected by excessive noise immission levels in 2040.	Number of buildings exposed to excessive noise immission levels in 2040.	Estimated number of inhabitants exposed to excessive noise immission levels in 2040
1	Bapče	1,68	105	130	40 - 50				45 - 50				45 - 55			
2	Buševec	4,17	454	839												
3	Črnkovec	4,62	147	413	35 - 50				40 - 50				40 - 55			
4	Donja Lomnica	14,93	778	1416	45 - 65	0,04	0	0	50 - 70	0,43	44	116	50 - 70	0,73	83	151
5	Drenje Šćitarjevsko	2,23	147	202	55 - 60	0,00	0	0	55 - 60	0,00	0	0	55 - 65	0,00	0	0
6	Gornja Lomnica	2,49	162	582	35 - 45				40 - 45				40 - 45			
7	Gornje Podotočje	2,93	153	492	≤35				≤35				≤35			
8	Gradići	1,90	622	1808	35 - 50				35 - 50				35 - 50			
9	Kobilići	1,56	248	520	35 - 40				35 - 40				35 - 45			
10	Lazi Turopoljski	3,40	43	58					≤35				≤35			
11	Lukavec	11,34	535	1136	35 - 45				35 - 50				40 - 50			
12	Mala Kosnica	1,01	44	49	50 - 65	0,007	0	0	55 - 70	0,24	28	31	55 - 70	0,32	28	31
13	Mićevec	6,54	648	1281	35 - 65	0,09			40 - 65	0,17			40 - 65	0,20	0	0
14	Mraclin	12,93	607	1068	≤35				≤35				≤35			
15	Novaki Šćitarjevski	2,85	112	165	45 - 55				50 - 60	0,00	0	0	50 - 60	0,00	0	0
16	Obrezina	1,79	274	577	55 - 60	0,00	0	0	55 - 65	0,00	0	0	60 - 65	0,00	0	0
17	Ogulinec	3,76	337	296												
18	Okuje	4,71	226	457	≤35				≤35				≤35			
19	Petina	1,84	150	211	55 - 65	0,01	0	0	60 - 70	0,56	106	149	60 - 70	0,87	146	205
20	Petrovina Turopoljska	2,63	275	702	0 -35				35-40				34 - 45			
21	Rakitovec	10,37	247	573					≤35				≤35			
22	Sasi	1,67	62	164	45 - 55				50 - 55				50 - 60	0,00	0	0
23	Selnica Šćitarjevska	1,96	241	537	45 - 60	0,00	0	0	50 - 65	0,00	0	0	50 - 65	0,00	0	0
24	Staro Čiče	3,02	418	783					≤35				≤35			
25	Šćitarjevo	3,79	243	440	50 - 60	0,00	0	0	50 - 65	0,00	0	0	55 - 65	0,00	0	0
26	Turopolje	4,64	468	951					≤35				≤35			
27	Velika Gorica	31,47	5968	31341	35 - 55				35 - 65	2,10	0	0	35 - 65	2,24	0	0
28	Velika Kosnica	2,13	233	799	45 - 60	0,00	0	0	50 - 65	0,00	0	0	50 - 65	0,00	0	0
29	Velika Mlaka	6,07	1102	3326	35 - 50				40 - 65	0,48	0	0	40 - 65	0,57	0	0
30	Vukovina	5,84	453	945	≤35				≤35				≤35			
	Σ	180,07	16612	62821		0,21	0	0		3,58	198	296		4,93	257	387

YES	(green)	Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO	(pink)	Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
	(orange)	Settlements which, according to the estimates, will be exposed to excessive noise due to air traffic increase in 2024 and 2040
*	Maximum permitted $L_{day,evening}$ noise immission evaluation levels according to the purpose of the area	
	Purpose of the area : zone of mixed, mostly residential purpose, Lday, evening=65 dB	
**	http://www.dzs.hr/Hrv/censuses/census2011/censuslistres.htm	

Table 4.2.2.-7 **Comparative table of settlement surface areas and estimated number of inhabitants exposed to excessive air traffic L_{night} noise indicators for the years 2009, 2024 and 2040**

Ord. No	Name of the settlement	Settlement surface area in km²	Number of buildings	** Total number of inhabitants per settlement	* 2009 L night noise immission levels in dB(A)	Surface area of the settlement (in km²) affected by excessive noise immission levels in 2009	Number of buildings exposed to excessive noise immission levels in 2009	Estimated number of inhabitants exposed to excessive noise immission levels in 2009	* 2024 L night noise immission levels in dB(A)	Surface area of the settlement (in km²) affected by excessive noise immission levels in 2024	Number of buildings exposed to excessive noise immission levels in 2024	Estimated number of inhabitants exposed to excessive noise immission levels in 2024	* 2040 L night noise immission levels in dB(A)	Surface area of the settlement (in km²) affected by excessive noise immission levels in 2040.	Number of buildings exposed to excessive noise immission levels in 2040.	Estimated number of inhabitants exposed to excessive noise immission levels in 2040
1	Bapče	1,68	105	130	35 - 40				35 - 40				35 - 45			
2	Bušeuec	4,17	454	889												
3	Črnkovec	4,62	147	413	0 - 35				35 - 40				35 - 45			
4	Donja Lomnica	14,93	778	1416	35 - 55	0,31	12	22	35 - 55	1,09	12	22	35 - 60	1,69	43	78
5	Drenje Šćitarjevsko	2,23	147	202	40 - 50	0,00	0	0	45 - 50	0,00	0	0	45 - 55	0,40	76	104
6	Gornja Lomnica	2,49	162	582	0 - 0				0 - 35				30 - 35			
7	Gornje Podotočje	2,93	153	492												
8	Gradići	1,90	622	1808	0 - 35				35 - 40				35 - 40			
9	Kobilići	1,56	248	520	0 - 0				0 - 30				0 - 35			
10	Lazi Turopoljski	3,40	43	58												
11	Lukavec	11,34	535	1136	0 - 35				35 - 40				35 - 40			
12	Mala Kosnica	1,01	44	49	40 - 55	0,35	28	31	45 - 55	0,57	30	33	45 - 60	0,69	37	41
13	Mičevec	6,54	648	1281	35 - 50	0,19	0	0	35 - 50	0,31			35 - 45	0,40	0	0
14	Mraclin	12,93	607	1068												
15	Novaki Šćitarjevski	2,65	112	165	35 - 45				40 - 50				40 - 50	0,00	0	0
16	Obrezina	1,79	274	577	40 - 50	0,00	0	0	45 - 55	0,43	82	173	45 - 55	1,18	223	470
17	Ogulinec	3,76	337	296												
18	Okuje	4,71	226	467	≤35				≤35				≤35			
19	Petina	1,84	150	211	50 - 55	0,91	147	207	50 - 60	1,64	1,47	207	55 - 60	1,20	150	211
20	Petrovina Turopoljska	2,63	275	702												
21	Rakitovec	10,37	247	573												
22	Sasi	1,67	62	164	35 - 45				40 - 45				40 - 50	0,00	0	0
23	Selnica Šćitarjevska	1,96	241	537	40 - 50	0,00	0	0	45 - 55	0,14	9	20	45 - 55	0,32	22	49
24	Staro Čiče	3,02	418	783	≤35				≤35				≤35			
25	Šćitarjevo	3,79	243	440	40 - 50	0,00	0	0	40 - 50	0,01	0	0	45 - 55	0,30	61	110
26	Turopolje	4,64	468	951												
27	Velika Gorica	31,47	5968	31341	35 - 50	2,18	0	0	35 - 55	2,51	0	0	40 - 55	2,84	0	0
28	Velika Kosnica	2,13	233	799	35 - 50	0,00	0	0	40 - 55	0,01	19	65	40 - 55	0,25	47	161
29	Velika Mlaka	6,07	1102	3326	0 - 50	0,36	0	0	35 - 55	0,67	0	0	35 - 50	0,29	0	0
30	Vukovina	5,84	453	945												
	Σ	180,07	1612	62821		4,80	187	280		7,43	288	6,20		10,88	868	1224
YES		Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)														
NO		Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)														
		Settlements which, according to the estimates, will be exposed to excessive noise due to air traffic increase in 2024 and 2040														
*	Maximum permitted L_{night} noise immission evaluation levels according to the purpose of the area															
	Purpose of the area : zone of mixed, mostly residential purpose, L_{night} = 50 dB															
**	http://www.dzs.hr/Hrv/censuses/census2011/censustirstres.htm															

Table 4.2.2.-8 Comparative table of settlement surface areas and estimated number of inhabitants exposed to excessive air traffic L_{den} noise indicators for the years 2009, 2024 and 2040

Ord. No	Name of the settlement	Settlement surface area in km²	Number of buildings	** Total number of inhabitants per settlement	* 2009 Lden noise immission levels in dB(A)	Surface area of the settlement (in km²) affected by excessive noise immission levels in 2009	Number of buildings exposed to excessive noise immission levels in 2009	Estimated number of inhabitants exposed to excessive noise immission levels in 2009	* 2024 Lden noise immission levels in dB(A)	Surface area of the settlement (in km²) affected by excessive noise immission levels in 2024	Number of buildings exposed to excessive noise immission levels in 2024	Estimated number of inhabitants exposed to excessive noise immission levels in 2024	* 2040 Lden noise immission levels in dB(A)	Surface area of the settlement (in km²) affected by excessive noise immission levels in 2040.	Number of buildings exposed to excessive noise immission levels in 2040.	Estimated number of inhabitants exposed to excessive noise immission levels in 2040
1	Bapče	1,68	105	130	40 - 50				45 - 50				45 - 55			
2	Bušvec	4,17	464	889												
3	Črnkovec	4,62	147	413	35 - 50				40 - 50				40 - 55			
4	Donja Lomnica	14,93	778	1416	45 - 65	0,04	0	0	50 - 70	0,43	64	116	50 - 70	0,73	83	151
5	Drenje Šćitarjevsko	2,23	147	202	55 - 60	0,00	0	0	55 - 60	0,00	0	0	55 - 65	0,00	0	0
6	Gornja Lomnica	2,49	162	582	35 - 45				40 - 45				40 - 45			
7	Gornje Podotočje	2,93	153	492	≤35				≤35				≤35			
8	Gradići	1,90	622	1808	35 - 50				35 - 50				35 - 50			
9	Kobilići	1,56	248	520	35 - 40				35 - 40				35 - 45			
10	Lazi Turopoljski	3,40	43	58					≤35				≤35			
11	Lukavec	11,34	535	1136	35 - 45				35 - 50				40 - 50			
12	Mala Kosnica	1,01	44	49	50 - 65	0,07	0	0	55 - 70	0,24	28	31	55 - 70	0,32	28	31
13	Mičevec	6,54	648	1281	35 - 65	0,09	0	0	40 - 65	0,17			40 - 65	0,20	0	0
14	Mraclin	12,93	607	1068	≤35				≤35				≤35			
15	Novaki Šćitarjevski	2,65	112	165	45 - 55				50 - 60	0,00	0	0	50 - 60	0,00	0	0
16	Obrezina	1,79	274	577	55 - 60	0,00	0	0	55 - 65	0,00	0	0	60 - 65	0,00	0	0
17	Ogulinec	3,76	337	296												
18	Okuje	4,71	226	467	≤35				≤35				≤35			
19	Petina	1,84	150	211	55 - 65	0,01	0	0	60 - 70	0,56	106	149	60 - 70	0,87	146	205
20	Petrovina Turopoljska	2,63	275	702	0 - 35				35 - 40				35 - 45			
21	Rakitovec	10,37	247	573					≤35				≤35			
22	Sasi	1,67	62	164	45 - 55				50 - 55				50 - 60	0,00	0	0
23	Selnica Šćitarjevska	1,96	241	537	45 - 60	0,00	0	0	50 - 65	0,00	0	0	50 - 65	0,00	0	0
24	Staro Čiče	3,02	418	783					≤35				≤35			
25	Šćitarjevo	3,79	243	440	50 - 60	0,00	0	0	50 - 65	0,00	0	0	55 - 65	1,25	149	270
26	Turopolje	4,64	468	951					≤35				≤35			
27	Velika Gorica	31,47	5968	31341	35 - 55				35 - 65	2,10	0	0	40-65	2,24	0	0
28	Velika Kosnica	2,13	233	799	45 - 60	0,00	0	0	50-60	0,00	0	0	50-60	0,00	0	0
29	Velika Mlaka	6,07	1102	3326	35 - 50				40-65	0,48	0	0	40-65	0,57	0	0
30	Vukovina	5,84	453	945	≤35				≤35				≤35			
	Σ	180,07	1612	62821		0,21	0	0		3,98	198	296		4,98	267	387

YES	(green)	Meets the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
NO	(pink)	Does not meet the requirements of the Ordinance on the maximum permitted noise levels in an environment in which people work and live (OG 145/04)
	(orange)	Settlements which, according to the estimates, will be exposed to excessive noise due to air traffic increase in 2024 and 2040
*	Maximum permitted $L_{day,evening,night}$ noise immission evaluation levels according to the purpose of the area	
	Purpose of the area : zone of mixed, mostly residential purpose	
**	http://www.dzs.hr/Hrv/censuses/census2011/censustries.htm	

POSSIBILITIES FOR THE REDUCTION OF NOISE IMPACTS OF ZAGREB AIRPORT

Noise in the airport zone represents a serious issue for the local population living in the surrounding area. With the expansion of the city, residential neighbourhoods are increasingly approaching the airport zone, making noise in these areas even higher. There have been several programmes to reduce noise pollution:

- take-offs and landings should increasingly take place on runways positioned towards lesser populated areas (if the airport has multiple runways);
- construction of sound barriers and building insulation;
- prohibition of landing for aircraft not complying with noise protection standards
- introduction of the charging of fees based on aircraft noise levels;
- introduction of operative procedures aimed at noise abatement.

Regardless of whether the issue concerns the noise of aircraft during take-off or landing, or ground based aircraft noise, the local authorities are required to protect the local population in the best possible manner. The principle of protection through operating procedures is most common and can be useful for the purposes of modification of corridors and determination of overpass altitude over uninhabited areas. There are several operative procedures that are used worldwide to reduce noise pollution. Some of the proposed measures to reduce noise are:

- runway improvements;
- shifting runway thresholds;
- giving preference to other air courses;
- terminating procedures during take-off and landing that cause high noise levels
- implementation of new landing procedures (curved line courses);

use of reverse thrust to stop aircraft after landing.

In addition to modifications of the take-off and landing procedures, it is possible to implement operating prohibitions that limit or fully prohibit landing of certain types of aircraft at the airport. The adoption of such restrictions must be justified. Operating prohibitions can be partial, global or progressive, and can be divided into two categories:

- operating prohibitions in the sense of prohibiting night flights or upper limits in the movement of high noise aircraft, or
- prohibition of aircraft with particularly loud technical or performance characteristics.

Further from these prohibitions, there are also ground prohibitions:

- limiting the running of the engine while the aircraft is on the ground;
- specially designated locations for engine testing;
- minimal use of auxiliary power units (APU);
- minimal taxiing time on lanes;
- introduction of sound barriers;
- aircraft towing.

Landing operating procedures

An analysis of the transport demand at the Zagreb Airport indicates an increase of transport, which will also result in an increase in noise levels. For that reason, a simulation of operating procedures was created that could be used as a possible solution for reducing the noise levels of aircraft at the Zagreb Airport.

From the operative segments of landing, the following procedures were examined: low power approach, minimum use of reverse thrust after landing, possibility of shifting the runway threshold, and introduction of the continuous descent arrival (CDA) landing technique.

The analysis conducted indicated that use of the approach procedure with minimal use of reduced thrust led to a reduction of aircraft noise exclusively in the areas it flies over at high altitudes upon entry into the Instrument Landing System (ILS). However, there are several negative aspects regarding this procedure and therefore it is not fully justified.

These negative aspects include: excessive aircraft speed upon entry into the Zagreb Terminal Control Area (TMA) (limitation at 250 kt) - reducing the said speed reduces changes to the aero profile, which generates additional noise; shifting from landing at an angle of 6° to 3° implies adding thrust which generates additional noise; landing from the angle of 6° to the ILS is less comfortable for passengers and requires special crew training and additional aircraft outfitting.
In the use of the procedure of minimal use of reverse thrust after landing, positive aspects include a reduction of aircraft noise upon landing for the settlements surrounding the airport and a more comfortable landing for the passengers. Negative aspects of this procedure include the need to extend runway length if larger aircraft are concerned. Furthermore, without reverse thrust efficient breaking and stopping could be threatened, while the use of reverse thrust on all aircraft models is noisy and increases engine burden. In such a procedure, it is also necessary to consider aircraft safety, which can only be assessed by the captain, and for that reason, reverse thrust is used pursuant to the current conditions in effect at the time of decelerating the aircraft. Practice has proven that some airports have limitations on the use of reverse thrust between the hours of 10:00 pm and 6:00 am.
Another procedure to reduce noise is the shifting of the runway threshold. The positive aspect of this procedure is the reduction of the impact of aircraft noise on inhabited areas before the runway. The negative side would be that moving threshold 05 at Zagreb Airport would reduce the possibility for larger aircraft to use connecting lane D as the exit onto the runway (these would instead using connecting lane E). This would result in increased taxiing time, and with that increased fuel consumption and increased gas emissions. As a result of shifting the threshold for the purpose of reducing noise, individual aircraft would be required upon landing to use reverse thrust to stop for safety reasons, which would result in increased noise. For this procedure, it is necessary to develop special approach procedures, and determine whether the runway is long enough to shift the threshold.
The best approach for reducing noise is implementation of the continuous descent approach (CDA) for landing. The CDA approach allows for maintaining the aircraft at several flight altitudes i.e. delays the start of landing and allows the pilot to descend from cruising altitude until the moment of crossing the glide slope line for the final landing. This approach has reduced levels of noise, fuel consumption and gas emissions towards the settlements in the direct vicinity of the airport.
With the CDA, the aircraft is kept at higher altitudes for longer, as the noise level is significantly reduced when the distance between the source of the noise and the receiver of the noise is increased, even by small distances. In order to apply the CDA procedure, air traffic control should determine the specific or minimal speed of the approaching aircraft and provide the pilot with information about the distance of runway touch points (so that the pilot can ensure the vertical profile of the aircraft). This type of speed control increases the capacity of the runway. The approach control leads the aircraft using the radar vectoring procedure and approves an uninterrupted decent to the level of the inter-approach, such that the level is achieved in the direction of the distance guider of about 8NM to the touch point. Uninterrupted descent to the approved level is carried out at a descent speed of 300 ft/NM (flight path angle of about 3°).
The key factor that allows for the CDA approach landing technique is optimisation of the approach technique, and handling the aircraft with the use of the piloting technique “low engine strength - low drag”. In practice, that means that the pilot flies at minimum engine strength for as long as possible, while pulling out the aircraft configuration at the optimal moment so as to reduce flight drag to a minimum. The advantage of the CDA technique is that it can be used for any aircraft, at any airport and in all forms of transport, under the conditions that the pilots are ready and trained for its application.
The use of the CDA technique is a practical example of how an innovative approach can be used to reduce issues of fuel consumption, while also positively affecting the airport environment in terms of noise reduction. The precondition for the widespread use of the CDA technique is

the adoption of normative regulations and the appropriate training of pilots and air traffic controllers.
In order to provide an overview of the advantages in noise reduction between a conventional approach and a CDA approach, a noise map was created for an Airbus 319/320 aircraft approaching Zagreb Airport at threshold 05. The INM program was used with data on the aircraft and pilot procedures to develop the noise map. A simulation at the Zagreb Airport was developed using the INM program and the results of the simulation between a conventional and CDA approach is seen in the noise map (Figs. 4.2.2-1). Keeping the aircraft at a higher altitude and using the continuous descent approach contributes to noise reduction on the ground, though the area covered and total noise are dependent on the aircraft model, i.e. on its engine strength and aerodynamics. For the Airbus 319/320 aircraft, the noise on the noise map from 55 to 60 dB could be significantly reduced upon approach for up to several kilometres.

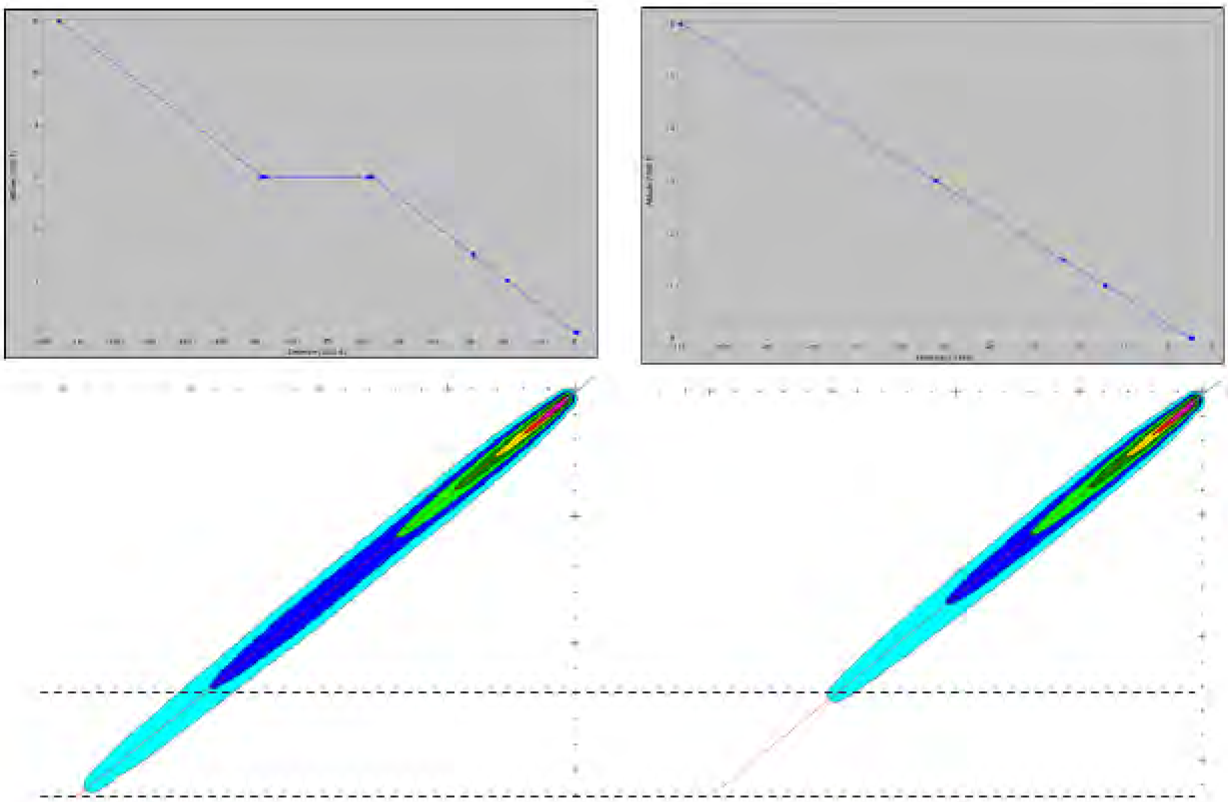


Photo 4.2.2.-1 Simulation of the comparison of a conventional and CDA approach at Zagreb Airport, developed using the INM system

The positive side of this procedure would be a reduction in aircraft noise by 3-12 dB, a continuous 3° descent (more comfortable for passengers), fuel savings, reduced emissions and no need for major aircraft modifications. In some cases, this procedure is already in use at the Zagreb Airport (depending on the decision of the captain and air traffic controller). This procedure is a generally accepted noise reduction procedure at EU airports (e.g. this procedure is in use at Heathrow Airport due to the diversity of traffic, and exceptionally good results have been achieved, with each company using CDA in 80% of landings) and the air traffic control guides the aircraft in such a way so as to avoid populated areas. In that case, it is very important for the air traffic control to provide the pilot with information about the total distance to landing at certain strategic approach points, so that the pilot can adjust the vertical profile. A negative side would be that the air traffic controller would have to give precise data on distance to the runway at each segment (greater time required for each aircraft).

Operative take-off procedures
Noise abatement procedures in take-off differ in relation to conventional take-off procedures in that the engine strength is reduced at 1,500 ft though the aircraft continues to climb at a minimum speed to 3,000 ft. Only at that altitude is the climbing angle reduced and the wing flaps retracted. With this procedure, the aircraft would be able to climb faster to twice the altitude, which ensures noise abatement under the flight course. The impact on fuel consumption is negligible though the gains in noise abatement are very large. The noise map on the ground is shown in Figure 4.2.2-2.

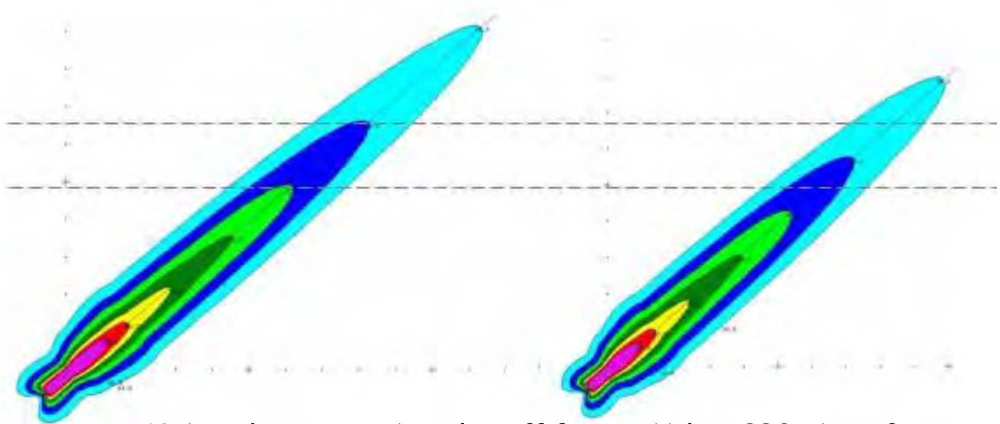


Photo 4.2.2-2 Noise abatement in take-off for an Airbus 320 aircraft - conventional take-off procedure (left) and noise abatement procedure take-off (right)

Introduction of time restrictions at the airport
Each airport has strictly defined time periods during which planes may fly and the noise limits permitted. Initially, these restrictions were directed at the condition and reputation of the airport and were only implemented if they were in the interest of the airport. In the present day, measuring aircraft noise levels and the implementation of restrictions are integral parts of airport functioning. In developed countries, night restrictions have been implemented that either reduce or eliminate noisy operations during the late night hours, when people are most sensitive to noise i.e. between 11 pm and 7 am while the L_{night} lasts.
The simplest solution for airlines in reducing noisy operations is to not fly into countries that have implemented restrictions on aircraft noise. In the current age, all the world airports have introduced restrictions in such a way so as to force air carriers to modernise their fleets or to pay taxes for exceeding noise levels. In the evening hours, these taxes are substantially higher than during daytime hours, and the highest during the night. Therefore, the same aircraft would pay much higher penalties for landing at night, and the consequence was the introduction of a higher number of daytime flights. This type of restriction model could also be applied at the Zagreb Airport if significantly higher noise levels during the night period were to occur due to an increase in transport.

Construction measures for noise protection
An assessment has been given for construction areas in settlements with regard to the Ordinance on the highest permitted noise levels in an environment in which people work and live (OG 145/04). The maximum permitted estimated level of noise immissions for mixed predominantly residential zones is 55 dB(A) by day and 45 dB(A) by night.

Pursuant to the same Ordinance, Article 8 stipulates the highest permitted estimated equivalent noise levels L_{RAeq} in *closed living areas for the same zone as 35 dB(A) by day and 25 dB(A) by night.
**Note: with closed windows and doors.*

According to the Guidelines 89/106/EEC of December 21 1988 and the Construction Act (OG 145/03), noise protection is listed as one of the important requirements for every structure. According to Article 11 of the said Act, "Structures must be designed and constructed in such a way that the sound perceived by a person residing in the structure or in its immediate vicinity is not at such a level that would endanger health and that ensures night time peace and satisfactory conditions for rest and work". For the above reason, and depending on the type of structure and intended use of the space, the minimum values of sound insulation are defined in line with:

- HRN U.J6.201 (1989) acoustics in construction—technical conditions for the design and construction of buildings, technical requirements for: air sound insulation, impact sound insulation, sound insulation of windows and doors;
- HRN U.J6.151 (1982) acoustics in construction—standard values for the assessment of sound insulation;
- HRN U.J5.153 (1989) acoustics in construction—methods of expressing sound insulation with a single number;
- HRN EN ISO 140-5:1999 Acoustics; measuring sound insulation of buildings and construction elements—Part 5: field measurements of air sound insulation of facade elements and facades (ISO 140-5:1998; EN ISO 140-5:1998)
- DIN 4109 (1989) sound protection in building construction.

Construction protection measures imply the improvement of construction membranes of residential structures. In order to propose passive protection measures, it is necessary to conduct an analysis based on project designs and physical plans of the assessed sound insulation of legally constructed residential buildings lying in zones exposed to excessive noise emissions from air transport.

The assessment of sound insulation is given with regard to the measurements and analysis of results according to the HRN EN ISO 140-5:1999 Acoustics - measuring sound insulation of buildings and construction elements - Part 5: field measurements of air sound insulation of facade elements and facades (ISO 140-5:1998; EN ISO 140-5:1998).

4.2.3 Impacts on the health of the population

4.2.3.1 Air pollution impacts

Research on the impact of the airports on human health perceive recorded and proven impacts of individual pollutants, and correlate risks to which residents in airports surroundings are exposed. Several studies conducted in the region of Amsterdam airport Schiphol (about 50 million passengers in 2011) have shown that air traffic pollutions can not be connected with respiratory problems, the use of drugs to treat allergies and asthma and cardiovascular disease. Also, there was no difference in the incidence of cancer among residents in the area to Schiphol Airport in relation to the inhabitants of one part of Amsterdam. Study conducted in the area of Heathrow Airport, London (approximately 58 million passengers in 1999) also showed no significant increase in chronic respiratory disease within 5 kilometres from the airport, compared with control population in West London.

The recent studies have shown that air quality in major airports can be compared with the air quality of typical urban environments, and in most cases it is better than the air quality near roads with heavy traffic. The results of these analyzes assume that the population is under load, resulting in health risks no greater than the risk inherent to the population of urban areas.

Statements of the inhabitants of Petina and small Kosnica regarding the effects of aircraft emissions on the local population could not be confirmed by comparing the level of permissible pollution limit values of pollutants in the air (the Regulation on limit values of pollutants in the air (OG 133 / 05). Limit value (LV), in accordance with the Regulation on limit values of pollutants in the air (OG 133/05), is the level below which - on the basis of scientific knowledge -the risk of adverse effects on human health and/or the environment in general does not exist or is at least possible. All defined air pollutions in areas closest to residential buildings today are and will be within allowable limits for the planned phases of increasing traffic.

4.2.3.2 Impact of noise

The increase of air traffic, particularly with the increase of night flights in recent years, represents a significant source of noise, whose impacts on human health may not be ignored. The aircraft is a source of noise that remains at ground level, and this noise is created during take-off, landing and taxiing. This problem is particularly pronounced for airports situated near city neighbourhoods, and the concern of the population living in the vicinity for their own health and safety is no surprise. These concerns are supported by proof of the harmful impacts on noise on health, including sleeping disorders, intolerable noise and cardiovascular diseases. Following from this and from public pressures and environmental protection organisations, maximum permitted levels of aircraft noise during take-off and landing have been prescribed, both at the national and international levels.

As a future Member State of the European Union, the Republic of Croatia has adjusted its laws and regulations to those of the European Union. The adjustment of the legislation relates to the prevention and/or reduction of harmful impacts on human health that are caused from environmental noise. The Noise Protection Act (OG 30/09) was drafted according to the European Union guidelines (Directive 2002/49/EC) that were not fully integrated during the adoption of the previous Noise Protection Act from 2003. Pursuant to the new Act, the development of noise maps is mandatory to give an overview of the existing and/or envisaged state of noise immissions, expressed in the aligned noise indicators L_{den} and L_{night} - acoustic magnitudes for the description of environmental noise associated with the harmful effects of noise on human health. Noise maps also determine the critical zones and prescribe the adoption of action plans to reduce noise in areas where the permitted values have been exceeded.

In making noise maps, detailed information about the airport (runway coordinates, altitude, temperature and humidity), landing and take-off vectors used and the percentages of their use are used. Furthermore, a database with all aircraft divided into groups (commercial, cargo, general aircrafts and military) is used, with the average operations in one day, divided into the periods day, evening and night, as prescribed by the regulations. With the development of noise maps, an overview is obtained into the existing state with regard to the level of environmental noise, and the maps then serve as a starting point in defining measures to prevent increases in emissions or to decrease noise emissions and immissions in the future. The noise map visually presents the noise expansion mechanisms from the site of emissions and the ratios of size, intent and the spatial position of buildings to the noise expansion, which is important in the spatial planning process in urban centres.

Due to the unstoppable spread of cities and the settlement of areas abound airports, the number of complaints about the intolerability of life in those areas is increasing. Scientific research has shown that aircraft noise raises stress levels, anxiety and generally has a negative effect on human health. These negative effects can depend on many factors: the magnitude of the sound and its duration, the direction of flight of the aircraft during take-off and landing, the number and type of operations, operations procedures, time of day and meteorological conditions.

The measurement of noise immissions in the area around the Frankfurt Airport have shown that about 200,000 inhabitants, some living up to 20 km from the airport along the air corridor, are exposed to a continual daily noise level of 55 dB(A) and higher.

Noise acts both directly and indirectly on human health, causing fatigue, a decrease in work capacities, and hindering comprehension, concentration, rest and sleep. Reactions to noise are individual, and depend on the level and frequency of the noise, and the duration of the exposure, and can range from mild and temporary, to permanent damage.

A healthy sense of hearing can hear and differentiate sounds in the frequency range from 16 to 20,000 Hz. The hearing threshold in a person with healthy hearing is from 0-25 dB(A) of intensity. The first phase of hearing damage is the initial acoustic trauma phase, which appears in the frequency area from 4000 Hz. The ear continues to behave normally, but the irritation threshold is objectively increased, as the loss of hearing has occurred in the frequency area higher than the range in which speech is conducted (1000-3000 Hz). The second phase of hearing damage is the hearing impairment phase. Hearing impaired persons have a hearing threshold between 29 and 93 decibels. Negligible hearing impairment appears when the person cannot hear sounds of up to 20 dB, slight impairment (20-40 dB), moderate impairment (40-60 dB), and profound impairment when the person cannot hear sounds between 60-80 dB. Everything about 93 dB (hearing threshold) is considered deafness. If a person is exposed to noise of an intensity of 85 dB(A) or more, there is a likelihood of hearing impairment. Professional hearing impairment and deafness are the most common occupational diseases, with irreversible consequences. Therefore, the permitted noise exposure for workers during an eight hour work day may not, under any circumstance, exceed the maximum permitted level of 85 dB(A) as stipulated by the Ordinance. However, numerous studies have shown that hearing loss is also a dictate of civilisation (electro acoustic devices, firecrackers, concerts).

The noise indirectly affects the organs and bodily systems such as the nervous, vascular, and digestive and hormone systems. It can lead to metabolic and endocrinological disorders. It also influences the functioning and execution of daily tasks, and disturbs rest and sleep. It is particularly detrimental to mental functioning and leads to difficulties in concentration, attention spans, mastering new knowledge and causes anxiety and insomnia. Non-auditory health disturbances are the physiological response of the body to stress.

In recent years, the number of night flights has been on the rise, and those surveyed most often note sleeping disturbances as the main problem. Research has been conducted on two groups of people, one living in the direct vicinity of a large airport, and the second living in an ordinary environment. The results indicated a significant difference between the groups in terms of sleep disorders, a lower quality of life that was seen in the inability to adequately perform daily activities such as listening to the radio or watching television, speaking on the telephone and interpersonal communication (Bronzaft et al., 1998). To sleep well, it is desirable that noise levels not exceed 30 dB(A), and individual sound irritations of 45 dB(A). It has been shown that noise extends the time needed to fall asleep. A minimal level of noise that will awaken a person is from 45 to 50 dB(A). Long-term partial loss of sleep from two to three hours per night has a detrimental impact on the human body, even when there is no subjective feeling of a lack of sleep.

In the psychosocial aspect, continual exposure to noise of 35 dB(A) hinders appropriate human communication and has long-term consequences that are seen in a reduced tolerance to frustration and an increased threshold of reactivity. Even minimal noise levels can cause an increase in anxiety, aggressive and hostile behaviour. These noise effects can be partially explained by the contemporary trend of dehumanisation in interpersonal relationships (Ohrstrom et al.[8]). These changes were particularly pronounced among elderly people. Social and behavioural impacts of noise include changes in daily behaviour patterns (closing windows, not using balconies, turning up the sound on the television or radio), negative changes in interpersonal relations (aggressiveness, hostility) and mood swings.

Noise exceeding 60 dB(A) indirectly affects the stimulation of the sympathetic part of the autonomic nervous system, i.e. the part of the central nervous system that is not dependent on human will and which manages the important vital functions. Increases in noise levels cause an increase in the tonus sympaticus, which causes accelerated heart beat, increase in blood pressure, rapid breathing, increased sweating, disturbances in the digestive organs, particularly the intestines, disturbances in the function of endocrine glands, and even sudden muscle contractions. Exposure to aircraft noise in excess of 50 dB(A) at night increases the risk of hypertension by 20% (Eriksson 2007[9]). The HYENA[10] study conducted among the population (aged 45 to 70 years) living in the vicinity of six European airports showed that levels of night noise from 40-44 dB(A) significantly increased the prevalence of hypertension. This prevalence ranged from 49 to 57%, based on age and gender. Furthermore, the study showed that each increase in the level of night noise by 10 dB(A) increased the prevalence of hypertension by 14%.

Exposure to increased noise levels also impacts the consumption of medicines. According to a Swedish study, exposure to night noise from 40-45 dB(A) increased the consumption of hypertension medication by 27% and 66% in women at noise levels of 46 dB(A) and 61 dB(A), respectively, while in men, an increase in consumption was noted at levels 46 to 61 dB(A) (Swedish study 2005[11]).

Exposure to aircraft noise increases both systolic and diastolic blood pressure by 6.2 mmHg and 7.4 mmHh, respectively, even when the person is asleep and seemingly calm. Hypertension increases the risk of heart disorders, stroke and dementia. The risk of heart attack is 50% greater in people exposed continuously for 15 or more years to noise levels of 60 dB. Therefore, scientists have called for a re-examination of the existing regulations on noise limits. Long-term exposure to traffic noise at an intensity of 60-70 dB(A) can also lead to the above health problems, or can aggravate existing illnesses, such as arthritis, bronchitis and depression (WHO LARES Report, 2004).

Numerous studies have indicated the exposure to low levels of traffic noise, including air traffic, stimulates increased secretion of the stress hormones cortisol, adrenalin and noradrenalin, especially in children living in the direct vicinity of airports. In women whose bedrooms were oriented towards busy streets with a relatively high noise level, a greater level of secretion of catecholamine was found in comparison to women who lived in relatively quiet homes.

With regard to the economic development of Croatia and Croatia's position as a tourism destination, the expansion of existing airports is both essential and fully justified. Meanwhile, care should be taken of the quality of life of the population living nearer and further from airports. Due to the unstoppable process of urban sprawl and the settlement of areas around airports, there are increasing complaints

[8] Bronzaft et al., 1998
[9] Eriksson 2007
[10] HYENA
[11] Öhrström E, Barregĺrd L, Andresson E, Skĺnberg A, Svensson H, Ăngerheim P. Annoyance due to single and combined sound exposure from railway and road traffic. J Acoust Soc Am 2007;122:2642-2652.

about the intolerability of life in those areas. These complaints most often relate to irritation, insomnia and impaired communication. The noise at the Zagreb Airport represents a limiting factor in its work and development, as along the outer edges of the airport grounds, settlements are expanding parallel, and often times unplanned, and the number of people exposed to disturbing noise is increasing. The reactions of the population to aircraft engine noise have been strong since the 1960s.

Zagreb Airport is about 20 km from the City of Zagreb, and just south of the airport is the City of Velika Gorica, which has a significant rate of population increase. There are many rural settlements in the direct vicinity of the airport. Based on the developed noise map with the state of air traffic in 2009, Table 4.2.3.-1 shows the settlements where noise immissions expressed by indicators have exceeded the permitted upper limits pursuant to the Ordinance on the highest permitted noise levels in an environment in which people work and live (OG 145/04), the assessed population exposed to noise by the classes of noise indicators L_{den} and L_{night}, and the percentage of the population exposed. According to the Ordinance, the permitted level of noise for primarily residential zones is 55 dB(A) during the day and 45 dB(A) at night.

With the current and future expansions of the Zagreb Airport, the noise levels measured during the day and night will represent a significant problem for the health and social aspects of the population of the settlements Donja Lomnica, Drenje Ščitarjevo, Mala Kosnica, Obrezine, Petina, Selnica Ščitarjevska, Šćitarjevo and Velika Kosnica. Noise levels from 65 to 69 dB(A) obtained in the simulation models for 2024 and 2040 will affect the population of the settlements Petina and Mala Kosnica, and a large portion of the population of the settlement Donja Lomnica to 2040. Noise levels exceeding 65 dB(A) are considered impermissible for extended exposure by the population (source: World Health Organisation). Noise exceeding 65 dB(A) can cause serious psychological and neurovegetative disorders. Therefore, much attention must be dedicated to technical measures that could reduce the exposure of the population to excessive noise immissions, and the possibility of relocating the most threatened population, particularly those in the settlement of Petina.

4.2.4 Impacts of the project on water

Drainage of part of the wastewaters at the Zagreb Airport location has been resolved with a separation system and connection to the sewerage system of the City of Velika Gorica. Sanitary wastewater from various structures at the Zagreb Airport, including wastewaters from aircrafts (from sanitary tanks) are collected in collection pits and pumped to the public sewerage system of Velika Gorica. The drainage of runoff waters from roofs and from parts of the aprons (operative and manoeuvring areas envisaged for the preparation of aircraft for the boarding and disembarking of passengers, loading and unloading of cargo and post, fuelling, maintenance and parking) has been resolved by connection to the surface runoff drainage system of the City of Velika Gorica. All runoff waters in the Zagreb Airport area can be considered moderately polluted runoff waters, considering that they may contain particles of oil and fuel as aircraft remain or are parked on the aprons, while runoff waters from manoeuvring areas contain pollutants originating from the exhaust fumes of aircraft engines and are dissolved in precipitation.

Runoff waters are drained from 30% of the operative and manoeuvring areas, i.e. from 155,00 m^2 via pipelines into two treatment plants with a capacity of 40 m^3/h and over one hundred settlers. Within the area of the Zagreb Airport, a system for the measurement of changes in groundwater levels and a system for discovering losses in the potable water pipelines have been installed and regular monitoring and analysis of wastewater has been organised.

The greatest shortcoming in the protection system for water and the water environment is the protection of surface and ground waters along the runway, since the runway does not have a drainage system in place, and instead runoff waters naturally run off into the environment. An aircraft accident in that area would result in a spillage of fuel and its seepage into the ground, while compounds used for de-icing aircraft and de-icing the runway during the winter period today freely seep into the ground.

These impacts are currently present and will not increase with the construction of the new passenger terminal and accompanying structures. However, with the resolution of the drainage and treatment of runoff waters from the transport areas of Zagreb Airport included as an integral part of the planned project, this issue is also resolved. The release of treated water under controlled conditions into the recipient canals (Kosnica, Bapča) or the Sava River have no negative impacts as the guaranteed water quality meets the criteria for release into recipients of the Danube Basin.

4.2.5 Impacts of the project on soil

The larger presence of immissions of solid particles in agricultural soil can be expected along the future road, and in the zone of aircraft take-off and landing, i.e. within the zone of dominant negative impacts for air pollution. Namely, in suspension with heavy metals, dust particles from the road are scattered to both sides of the road and accumulate in the soil, and the distance they are scattered depends primarily on the size of the particles. A lack of tall natural vegetation between agricultural surfaces and the road, which is dominantly the case on the proposed route, further enhances this. The emission of heavy metals in agricultural soil can lead to their leaching into ground water, and also into canals and rivers, or their inclusion into the animal and human food chains via farmed plants. For example, cadmium and lead are found in fuel (leaded gasoline), in exhaust fumes, tires, lubricant oils, etc. and these metals represent potential poisons that have an exceptionally negative impact on human and animal health, which leads to a number of serious health problems or even fatalities. It is necessary to know that in areas where traffic stops (intersections, etc.), significantly higher emissions of heavy metals and solid particles can be expected in comparison to those parts of roads with normal traffic flow. Agricultural lands at such places are exposed to a significantly higher risk of pollution with harmful compounds in comparison to lands in areas with normal traffic flow.

4.2.6 Impact of the project on protected areas and areas of the Ecological Network

Considering the distance of the project site from protected areas and areas of the Ecological Network and the objectives to preserve areas of the Ecological Network, it is believed that the project will not have any temporary or permanent impacts during its use on such areas.

4.2.7 Impact of the project on biological diversity

Ornithofauna

There are no concrete data that would allow for an assessment of the negative impacts of noise on bird populations in the area surrounding the project area. In order to assess the impacts of this factor on bird populations of special interest for conservation, it is assumed that their abundance in the buffer zone will be reduced by a maximum of about 25% due to increased noise. The increased noise and disturbance for birds during the phases of construction and use of the planned project will not have a significant contribution in the total cumulative effect of disturbances to target species of birds in this area.

Bat Fauna

Considering though that there are no known bat colonies in the general area and that there are no data on migrations or migration routes passing through the study area, the increased flight frequency will not cause increased fatalities of bats due to deaths caused directly by aircraft. The planned expansion of Zagreb Airport will not contribute to a negative cumulative impact neither due to a loss of hunting habitat or due to a loss of shelters.

Mammals

A certain degree of disturbance and pollution already exist as the present airport has been in use for years. However, with the expansion of the airport, the zone of the disturbance will be expanded into new habitats, and an increased intensity of air transport will occur at the airport, which will also increase the degree of disturbance. The construction and functioning of the new airport will have a limited and local impact on small mammal fauna, in the actual area of the project and during its use.

Amphibians

The construction and use of the new airport will impact the local amphibian fauna to a lesser extent (ponds, channels, woods) due to filling, drying, clearing or extreme pollution.

Therefore, it is necessary to focus attention to preservation of the Kosnica Channel and consider it as the link between the habitats cut off by the new access road and the project itself.

Reptiles

Reptiles (snakes and lizards) are most often killed on roads, as these are exothermic organisms that use roads as sources of heat from the surface and from the sun's rays. The number of animals killed increases with road size, vehicle speed and traffic intensity.

4.2.8 Impact of the project on cultural and historical heritage

With regard to the distance of the planned project from structures of cultural and historical heritage, no significant impacts of the project are expected on such structures during the period of use.

4.2.9 Impact of the project on the landscape

The arrival of foreign travellers by aircraft at an airport is usually the first contact with that country, and therefore it is important that the airport have a representative appearance. Pursuant to the development plans of the Zagreb Airport, an international urban planning and architecture competition for the new passenger terminal and accompany facilities was held in 2008. The project selected as the best competing project was that by the IGH Institute d.d. (IGH d.d., Neidhardt Architects d.o.o. & Klincl d.o.o. Zagreb) which offered an attractive appearance of the new passenger terminal and urban planning solutions for the approaches to the terminal from the north and south sides. The construction of the new passenger terminal will be the first phase of the execution of the integral solution for the airport complex, as determined by the Zagreb Airport Development Plan. The project can therefore be characterized by having a positive impact on the landscape, as it will contribute to defining the visual identity of Zagreb and the Republic of Croatia.

With regard to the fact that the planned project was designed at the same location as the existing Zagreb Airport and Pleso military air force base, the planned project will not have a significant impact on changing the landscape of the natural and cultural characteristics of the general area, nor will it change the identity of the surrounding rural areas. This is ensured by maintaining a buffer zone of non-construction areas with the existing tall vegetation on the eastern side, which will physically and visually separate the new, planned airport from the existing settlement structures, and ensure spatial integrity and the integrity of the surrounding rural areas.

Photo 4.2.9.-1 Spatial depiction of the new passenger terminal of Zagreb Airport (1)

Photo 4.2.9.-2 Spatial depiction of the new passenger terminal of Zagreb Airport (2)

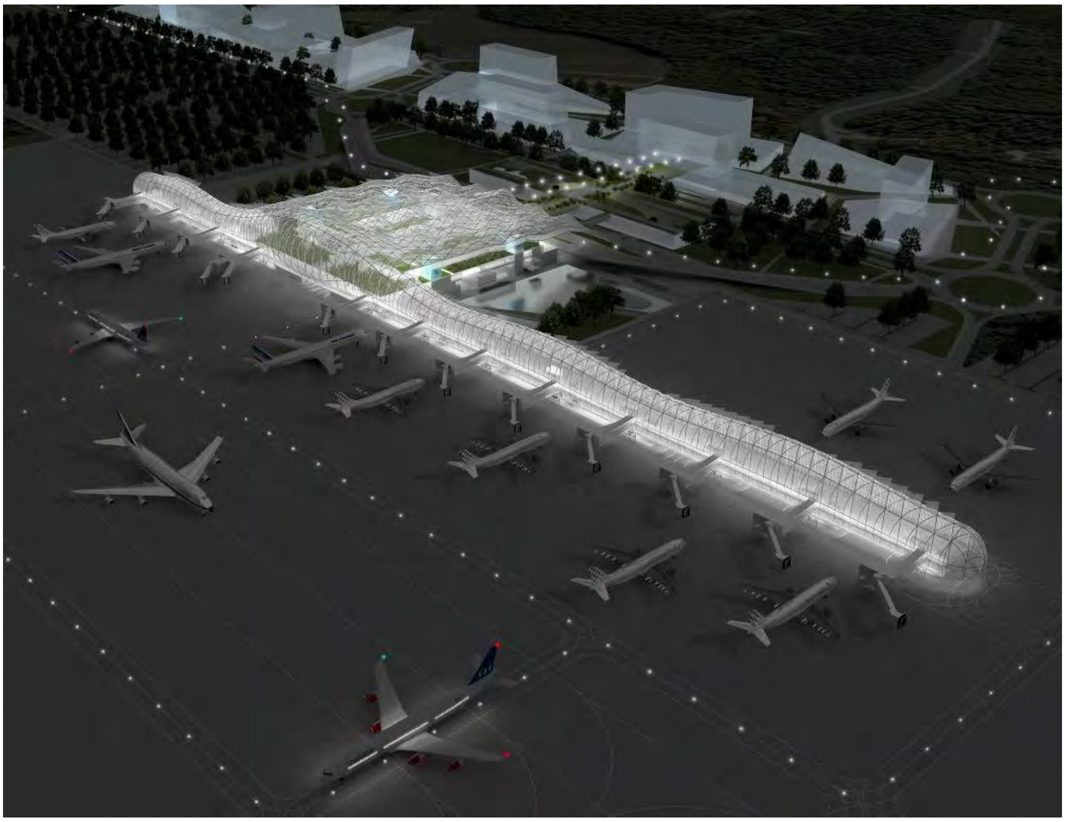
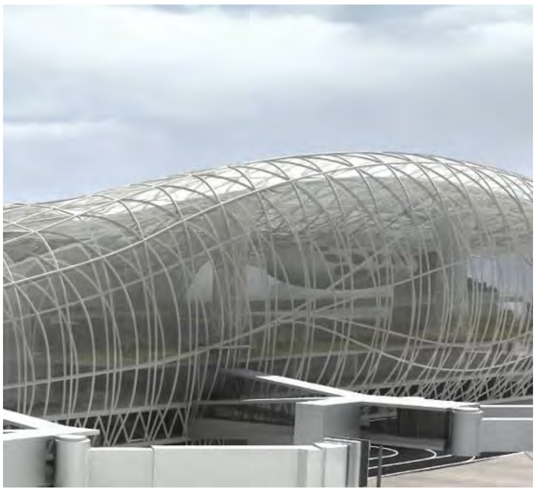


Photo 4.2.9.-3 Spatial depiction of the new passenger terminal of Zagreb Airport (3)

Photo 4.2.9.-4 Spatial depiction of the new passenger terminal of Zagreb Airport (4)



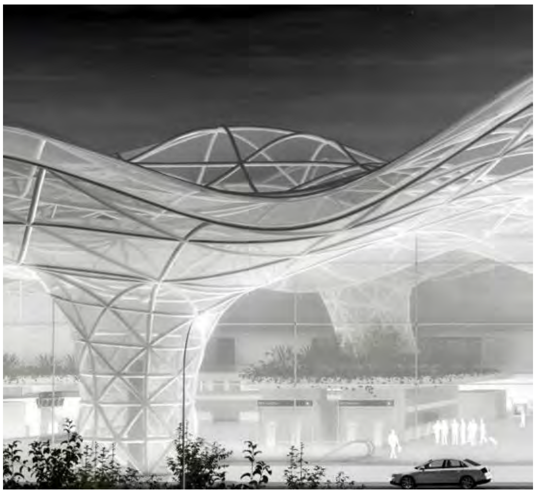


Photo 4.2.9.-5 Spatial depiction of the new passenger terminal of Zagreb Airport (5)

Photo 4.2.9.-6 Spatial depiction of the new passenger terminal of Zagreb Airport (5)

Photo 4.2.9.-7. Spatial depiction of the new passenger terminal of Zagreb Airport (7)

4.2.10 Creation of waste

During the use phase of the project, the same types of waste occurring to date will continue to be generated, as this is only an expansion project and the present activities of the Zagreb Airport will not change. During the use phase, the positive practice applied to date with regard to waste management will continue. Hazardous and non-hazardous production waste (as listed in Table 1) will be collected separately, stored pursuant to the valid legislation and handed over to the authorised collector for disposal or handling. With the application of the current practices and planned protection measures, there is not expected to be an impact of waste on the environment.

4.2.11 Impacts of light pollution

Considering that this project concerns the expansion of the existing Zagreb Airport, which has been in operation at this site for many years, with the application of the prescribed protection measures, no significantly increased impact of light pollution in the direct vicinity of the project is expected in comparison to the present state.

4.2.12 Impact of the project on economic activities

Air traffic is a very profitable activity that employs a large number of people. Therefore, one of the positive effects of the development of the airport is that with increasing numbers of passengers, the number of jobs for the local population in direct or indirect connection with the Zagreb Airport also increases. In addition to jobs concerning the receipt of passengers and cargo, jobs would also be opened in tourism and hospitality activities, public transport and municipal services and other activities. Another positive impact is the increase of revenues for all activities connected with the airport, and the increase of the overall revenues of the airport itself through airport taxes for aircraft take-off and landings, which will certainly mean better economic contributions for the local community, county and the state.

4.2.13 Assessment of the risk of an ecological accident

The dangers of an ecological accident currently in place at the current Zagreb Airport are the same as those for the planned product of the new passenger terminal. With the expansion, there will be an increase in the frequency of works and quantity of hazardous materials stored. The dangers and risks associated with fires/explosions of combustible materials such as liquid and gaseous fuels, hazardous cargo and other combustible chemicals used in airports were considered. Serious consequences from fire/explosions arise due to the use of large quantities of fuel for aircrafts, road vehicles and energy plants. This use implies the supply of fuel by cistern tanks to the locations at the Zagreb Airport, warehousing, manipulation, transport to the aircraft, fuelling the aircraft, aircraft fuel reservoirs, and aircraft take-off and landing. The likelihood of an accident of a fuel leak from an aircraft, the scope of the impact and consequences for passengers (based on peak hour), the environment and property were also assessed. All types of fuel are a real danger for the pollution of soil and groundwater in the case of an uncontrolled spill. The significance of considering this danger is particularly important due to the fact that the project is situated within a drinking water pumping area, and the soil is very permeable.
The risk analysis associated with the said dangers confirmed that it is necessary to conduct technical and organisation measures in line with the best available techniques and legal regulation. With these measures, the risk of accident situations can be reduced to an acceptable level.

4.2.14 Assessment of the risk of an aircraft accident

It has been assessed that the security risk of negative impacts on the direct and wider area of the Zagreb Airport caused by an aircraft accident outside the airport area. With consideration that the operative area of the Zagreb Airport is largely aligned with the provisions of Annex 14 of the ICAO and the Ordinance on airports, and is has been defined that based on statistically determined locations of approximately 70% of all civil aircraft accidents, it can be concluded that there would be no serious consequences for the narrow area around the airport in the event of an aircraft incident or accident at the airport or on its operative areas. With regard to the general area surrounding the airport, and considering the statistic that approximately 30% of all accidents of civil aircraft occur in the general area outside the operative area of the airport, the severity of the consequences of a possible accident depend both on the total mass of the aircraft and on the location of the actual accident. In line with that fact, it is proposed that a public security zone be established for the runway of Zagreb Airport in the directions 05 and 23, and this area should be protected with controlled construction so as to reduce the possible consequences of an aircraft accident to the minimum possible level.

4.3. POSSIBLE SIGNIFICANT CROSS-BORDER IMPACTS

The project will not cause any significant cross-border impacts.

4.4 DESCRIPTION OF POSSIBLE DEGRADED NATURAL ENVIRONMENTAL VALUES IN RELATION TO POSSIBLE BENEFITS FOR SOCIETY AND THE ENVIRONMENT

The expanded and modernised airport, with its increased traffic and overall offer, will bring with it increased traffic for arrivals and departures, a larger number of vehicles, and larger parking areas. In that sense, foreign airports can serve as very informative examples. In such situations, the overall landscape is urbanised, the natural areas reduced, and the transport corridors for the entry and exit to the airport as a new entity will be from two directions. A new, eastern interchange will be built and will direct traffic towards the city via a new bridge over the Sava River at Mićevec. The surrounding settlements on the eastern side of the airport will suffer certain changes and additional pressures in the form of increased traffic and environmental pollution by traffic in the direct vicinity. The spatial compression of the local population in those areas will increase, as will traffic and traffic noise.

This urbanisation of the airport landscape will be partially “softened” by the landscape development of the new passenger terminal of the Zagreb Airport, as recognised from the proposed project. The current situation contains small green areas, and the development of the new parts will continue in that direction. It is worthwhile mentioning that a motorway, the city bypass segment, runs through part of the settlements to the east and north of the airport and this also delivers noise and a certain level of air pollution into the environment. In these settlements, the negative impacts of the motorway and the runway corridor are compounded and the people in these settlements experience these segments extremely negatively, which is somewhat understandable. There are two sources of pressure on health and the quality of life for these local people, which simply increases the negative impression for each of these elements, and this is inevitable. Legal persons, and natural persons living in the area where the equivalent level of aircraft noise exceeds 67 dB(A) or 75 dB(A) have the right to compensation pursuant to the Air Transport Act (OG 69/09, 84/11). Pursuant to the Act, the said compensation is defined by a special ordinance that is yet to be adopted. With the adoption of this Ordinance, the mechanism will be in place by which the local population can receive some remuneration for their difficult living conditions due to their proximity to daily air traffic.

It is necessary to mention the social and cultural aspects of the possible impacts of the new Zagreb Airport on the local and general environment. The Zagreb Airport will be the point where, in terms of design, function and the style of behaviour, the “world will enter” into nearby Velika Gorica, one of Croatia's ten largest cities, into Zagreb and into Croatia. The airport aims to be a point that will represent both the capital city of Zagreb and the Republic of Croatia. The airport is striving towards the novel, excellent, attractive and cosmopolitan. The surrounding settlements that are part rural and part blue-collar character, with many structures built without permits and many households that live humbly in today's circumstances, are another, different world. The local population, for the most part, does not travel by air and does not use the services of the Zagreb Airport.

In its expanded form, the Zagreb Airport will be a structure of significance for the whole of Croatia. Landing from the world and Europe in Zagreb will no longer mean landing at an old-fashioned and somewhat neglected building. In a ranking of all the world's airports in terms of their functionality, aesthetics and traffic levels, we believe that the Zagreb Airport today would be somewhere in the middle. In its expanded and modernised form, it will certainly move up a few notches on this imagined ranking list.

Meanwhile, the Zagreb Airport has the opportunity to be different from the massive and somewhat inhuman airports around the world, in countries with tens of millions of citizens. It has the opportunity to be more beautiful, better, and more comfortable for travellers. The new ecological solutions of the local environment are in an appreciative ambient. The human dimension, high functionality and morphological values are achievable.

In that sense, the expansion of the Zagreb Airport, the increasing of its capacities, its modernisation and the construction of new content for a more pleasant stay for travellers and visitors will have a positive impact on the state budget of the Republic of Croatia (through the payment of concessions, increased transport, increased tax revenues) and on the self-awareness and pride of its citizens.

5 PROPOSAL ON ENVIRONMENTAL PROTECTION MEASURES AND ENVIRONMENTAL MONITORING PROGRAMME

5.1 PROPOSAL ON ENVIRONMENTAL PROTECTION MEASURES AND IMPLEMENTATION PLAN

ENVIRONMENTAL COMPONENTS

Air

1 For extremely dry weather, handling areas and roads should be sprayed with water in order to minimize raising dust particles in the atmosphere and their spreading to the surrounding area.

2 Silos for cement are set during project construction as part of the temporary concrete production plant must have appropriate filters which should to be regularly maintained.

3 Regularly maintain construction machinery.

4 Design a system of aircraft electricity supply for the new passenger terminal. Allow the usage of aircraft APU units only in exceptional situations.

5 Cleanse the air from parts of waste water treatment device in order to prevent the spread of odours.

6 Set up a station for continuous monitoring of air quality in the new passenger terminal.

7 Replace vehicles and equipment under the Ground Support Equipment category at the airport with new ones which are electrically or gas powered, no later than the 1st of May 2020.

Water

8 During the operation of the temporary concrete production plant, for the construction of the project, ensure maximum recycling of concrete waste and industrial waste water from washing concrete mixers.

9 Organize the preparation of asphalt outside the site and deliver it to the site in appropriate vehicles.

10 During building construction, park the machinery on an impervious surface with drainage system as well as with a built-in separator for grease and oil.

11 If the fuel tanks are installed at the construction site, set them in prehensile vessels or they should have two layers.

12 Store petroleum products and lubricants in impervious containers and on impervious surfaces.

13 Topping up oil and fuel as well as doing minor repairs on the working machinery must be done on foreseen, waterproof surfaces which are marked by curbs.

14 Topping up oil and fuel out of the waterproof surface is possible, only with the mandatory use of protective equipment (impervious containers, PVC, PE foil, etc. in order to prevent possible contamination of oil leaking into the environment.

15 Ensure proper disposal of sanitary waste water during construction by using adequate sanitation.

16 As part of project documentation elaboration, analyze the possibility of the usage of the container for water which is collected from the roofs in order to be used for different purposes (watering plants, washing roads and so on).

17 Design the drainage and wastewater treatment system and construct it to be watertight.

18 The snow which is collected from the airport traffic areas must be disposed on foreseen, waterproof surfaces which are connected to the drainage system and to the system of wastewater treatment of Zagreb airport.

19 The drainage of water from the aircraft de-icing/icing protection surface must be designed and constructed in such a way, that the aircraft de-icing agents should be separately gathered and further recycled.

20 Rain water collected from airport traffic areas, which were contaminated by de-icing agents (propylene glycol, formate) must be stored in a retention-equalization tank and treated using the appropriate procedure and discharge it into the recipient.

21 Out of season, the rain water collected from airport traffic areas must be treated in hydrocarbon/sand separators before discharging it into recipients.

22 The drainage of water from the road traffic areas must be designed and constructed with a closed drainage system and with a treatment system.

23 Contaminated rain water collected from road traffic areas which doesn't contain specific de-icing agents (parking zones, roads, etc.) must necessarily be treated in hydrocarbon/sand separators before discharging it into the rainfall drainage system in Velika Gorica town, or into recipients, respectively.

24 All key equipment of the drainage and treatment system must include the installation of the spare capacity in order to avoid uncontrolled overflows into the environment.

25 In the control and measure window of the treatment device, an automated sampler with an key parameter analyzer (TOC, KPK, total nitrogen, total phosphorus) must be installed which, in case of process disturbance, will alarm and announce the manager of the device, as well as will automatically stop the flow into the recipient of the water which was not sufficiently enough treated.

26 In case that it will be needed to remove some of the existing piezometers because of construction works for the new passenger terminal, the new one which will be replaced must be as close as possible to the current location of the existing one.

27 Stop with the use of urea as a de-icing agent at the latest by 01 January 2016. During the transitional period (01 January 2013 - 01 January 2016) the annual rate of consumption reduction is fixed to be 33%. As base consumption, the consumption of the urea in 2011 is fixed to be (100 t of urea). For surfaces and aircraft de-icing, further, it should be continued to use bio-degradable agents which are environmentally acceptable and which do not contain nitrogen concentrations higher than 1%.

Soil

28 In the planning phase for excavation, a location for temporary storage of materials from excavation must be foreseen.

29 Separately collect the humus layer and later use it for landscaping purposes.

30 The excess material from excavation must be delivered to Velika Gorica for their use.

Biological diversity

31 During the 2nd phase of construction, the function of the Kosnica canal must be preserved and it must be regularly maintained.

Landscape

32 As part of the main project, the project for the landscaping design should be done and it should include:

a) rehabilitation of areas which are intensively affected by construction works for all construction sites and handling areas;

b) landscaping arrangement of green surfaces of the New passenger terminal at Zagreb airport.

33 The project must include the arrangement of border parts of the terrain in terms of restoration of the indigenous and natural landscapes (wetlands- canals, ponds and groves and hedges).

CULTURAL & HISTORICAL HERITAGE

34 In case of finding any archaeological finds or deposits, all works must be stopped and the competent department for conservation must be announced.

35 Prior to the start of the construction of the 2nd phase, it is obligatory to make a sounding of potential points of archaeological sites in PAL 1-3 settlement, in the zone of direct influence. All findings must be documented and upon finishing researches, they must be submitted to the competent department of conservation.

ENVIRONMENTAL BURDENS

Light pollution

36 Implement environmentally friendly lamps, appliances and equipment that reduce direct emissions of light from the lamps above the horizon.

Protection of population and space regarding the traffic flows

37 During the construction, commercial vehicles must access the site from Zagreb Bypass (A3), the eastern bypass of Velika Gorica and its site and the main access road NPT ZLZ or its site.

38 Within the temporary traffic regulations project during implementation of the project, all points of access to the existing road system must be clearly defined and all collision points secured.

39 Provide circular movement of vehicles within the entire construction zone.

40 Limit the vehicle speed to 30 km/h at the construction site.

41 Repair the damaged sections of roads during construction if damage occurs caused by transport of materials, construction operations or other activities during construction.

42 Start using the new passenger terminal only after obtaining permits for main access road that connects to the eastern bypass of Velika Gorica.

43 Traffic signs should clearly point to the targets in the internal and external network traffic network.

44 Dynamic traffic signs in the location area must indicate free access points and parking capacities.

45 Service and delivery vehicles must adhere to the defined itinerary.

46 Limit the vehicle speed up to 50 km/h on the internal connecting roads.

47 Limit the vehicle speed up to 20 - 30 km/h within parking areas.

Noise

48 Develop strategic noise maps and action plans in order to reduce noise.

49 Adopt measures for noise reduction through Action plan for operating noise reduction - Aircraft Landing and Take-off Protocol, in cooperation with the Croatian air control navigation, in order to reduce the impact of airport traffic noise on the surrounding settlements.

50 Coordinate operational for noise reduction with other operators in the air traffic - providers of transportation and aviation services and the local community covered by the influence of air traffic noise.

51 If the application of operational measures will not show satisfactory results, it is necessary to implement measures to protect passive objects in construction areas that are located in zones exposed to excessive immisions of the air traffic noise.

Waste

52 Regularly conduct and control disposal of waste, i.e. prohibit any temporary or permanent disposal of waste into the surrounding soil during construction.

53 Ensure watertight containers for waste for the purposes of the site.

54 Collect waste separately by type and place of origin and deliver it to authorized collector.

55 Keep proper records of the waste flows.

56 Treat excess biological sludge from the treatment process with the device for waste water treatment to the level that allows disposal.

57 Exceptionally, the excess biological sludge can be processed only to the extent necessary for anaerobic digestion (biogas) if there is an interest in one of surrounding municipal devices for wastewater treatment.

58 Temporarily store treated sludge in a covered and watertight plateau.

59 Give waste matter from the wastewater treatment process (oils and fats, sand, waste screens, etc.) to authorised collectors.

ECOLOGICAL ACCIDENT (DISASTER)

60 At the corporate level, implement safety management systems and quality environmental standards regulated by ICAO documents (Airport Services Manual) and European regulations, particularly in relation to the implementation of EMAS and the ETS system.

61 Establish a public safety zone for the runway of the Zagreb Airport, lines 05 and 23.

62 Underground cisterns of the energy plant for extra light fuel oil, with a total volume of 100 m^3, must have an impervious oil pit.

63 In the case of oil leakage from the transformer power unit in an air-tight pit, remove the leakage cause and give oil to the authorized waste collector.

64 At the construction site, ensure accessories (absorbing materials: sawdust, etc.) for prompt intervention in the event of fuel or oil leakage from the machinery.

65 In the case of soil contamination by fuel, motor oil, antifreeze or other dangerous chemicals, immediately neutralise contaminated area with excavation and give the contaminated soil to the authorized waste collector.

5.2 ENVIRONMENTAL MONITORING PROGRAMME AND IMPLEMENTATION PLAN

Air

1 At the station for monitoring air quality at Zagreb airport (Appendix 5.2 -1), before putting the project into operation, determine the air quality, in order to obtain information about the current state of air quality. During the project, conduct continuous measurements of air quality at the same station, with simultaneous monitoring of meteorological parameters (temperature, pressure, relative humidity, wind direction and speed). Air quality parameters are to be monitored are as follows: carbon monoxide (CO), ground-level ozone, nitrogen oxides (NO_x), expressed as nitrogen dioxide ($NO2$), particulate matter PM_{10} and benzo(a)pyrene (BaP) in particulate matter PM_{10}.

2 If monitoring determines exceeding allowable limits, create a plan of measures to prevent further contamination and to monitor the impact of the measures on pollution reduction.

3 Laboratory that will conduct quality measurements must deliver original and validated data on monitoring air quality and report on pollution levels and assessment of air quality to the competent administrative body of the County, City of Zagreb and the town of Velika Gorica, not later than 31st March of the current year for the previous calendar year. These documents are also submitted to the Agency for Environmental Protection.

4 During the trial operation and the use of energy facility, measure NO_2 and CO emissions:

- The first measurement: during the trial and before obtaining a use permit
- Periodic measurements (in the first year of use): 6 individual measurements under operating conditions that can cause the greatest emissions
- Periodic measurements (during usage - after the first year): once a year
- Prepare a report on monitoring according to the *Ordinance on monitoring air pollutants emissions from stationary sources*

Water

5 Analyze samples of groundwater from piezometers and wells for water; fire (Annex 5.2-1). Parameters and frequency will be determined by water permit.

6 Analyze the treated waste water at the outlet of the device for wastewater treatment.

7 Check the impermeability (tightness) of sewage and waste water treatment systems every five years:

- Gravity pipelines and canals - visual (camera),
- Pressure - pressure test,
- Retention basins, etc. – monitoring level changes without inflow.

Soil

8 Soil monitoring should be done during a period of 10 years from the date of release of the new terminal. The soil must be sampled and analyzed each year, once, at the beginning of September, in the arable and sub-arable layers, on locations of agricultural land (Appendix 2). In soil samples the following concentrations should be determined: the concentrations of heavy metals (Cd, Cr, Cu, Hg, Ni, Pb and Zn), total organic carbon (TOC) and the content of polycyclic aromatic hydrocarbons.

Noise

9 Conduct continuous monitoring of noise emissions at the immision checkpoints:

- Measurement point 1: distance from threshold 05 USS-e 306 metres,
- Measurement point: distance from threshold 23 USS-e 307 meters,
- Measurement point 3: settlement Donja Lomnica and
- Measurement point 4: settlement Obrezina.

10 Noise monitoring must be performed each year, from 1. June to 1. October. It is necessary, within this period, to conduct tests for at least fifteen days at each immision checkpoint:

- Measurement point 5: settlement Črnkovec,
- Measurement point 6: settlement Velika Kosnica,
- Measurement point 7: settlement Pleso and
- Measurement point 8: settlement Velika Gorica.

Use the results of noise measurements in the preparation of strategic noise maps and action plans for noise reduction.

Photo 5.2.-1 Locations for monitoring environmental status

STUDY OF ENVIRONMENTAL IMPACT

NEW ZAGREB AIRPORT PASSENGER TERMINAL - GRAPHIC APPENDICES

INSTITUT IGH, Plc. Janka Rakuše 1, 10000 Zagreb, CROATIA Tel:+3851 6125 413 Fax:+3851 6125 405 igh@igh.hr www.igh.hr

INSTITUT IGH, d.d.
IGH Hydrotechnics, Geotechnics and Ecology
10 000 ZAGREB, J.Rakuše 1

Ordering Party:	**ZRAČNA LUKA ZAGREB d.o.o.**
Study Title:	**ENVIRONMENTAL IMPACT STUDY FOR THE NEW ZAGREB AIRPORT PASSENGER TERMINAL**
Study Level:	**KONAČNA VERZIJA**
Project Number:	81010-467/11
Book:	III Appendices
Responsible Development Manager:	Domagoj Vranješ, MSc Land Arch, Univ Spec Oecoing
Director:	Ivan Krstanović, MSc Civil Eng
Conceptual Design Team for the New Zagreb Airport Passenger Terminal:	Academician Branko Kincl, KINCL d.o.o. Academician Velimir Neidhardt, NEIDHARDT ARHITEKTI PhD Jure Radić, INSTITUT IGH d.d.
Collaborators:	PhD Aleksandra Anić Vučinić - *waste management* MSc Indira Aurer Jezerčić (*Institute of Safety Research and Development) -accident situations* Davor Barać, MSc Civil Eng -*site's geotechnical features* MSc Ivan Barbić, MSc Civil Eng - *NPT Airport Zagreb project coordination* Ena Bićanić, MSc Land Arch - *coordination and layout preparation* Erol Čičić, MSc Mech Eng - *light pollution* Hrvoje Damić, MSpec Civil Eng - *noise inventory* prof.dr.sc. Jagoda Doko Jelinić (*School of Medicine University of Zagreb, School of Public Health „Andrija Štampar“) - health impact assessment* PhD Miodrag Drakulić, MSc Mech Eng (*CTP Projekt d.o.o.) - project description/energetics* MSc Biserka Dumbović Bilušić, MSc Arch Eng - *cultural heritage*

Zlatko Franolić, MSc Eng - *noise inventory*

Zoran Golob, MSc Biotech Eng *(TEH Projekt Kemo d.o.o.) - alternative solutions for polluted rainwater treatment*

Draško Holcer MSc Eng *(Croatian Natural History Museum) -fauna: mammals*

Ines Horvat, MSc Arch Eng - *spatial planning analysis*

PhD Stjepan Husnjak - *soil*

MSc Slobodan Kljaić, MSc - *traffic analysis* MSc Stjepan Kralj, MSc Civil Eng - *project description/ traffic solution*

PhD Vladimir Lay - *sociological analysis*

Mato Lujić, MSc Civil Eng - *project description*/water supply and *sewage system*

Darija Maletić Mirko, MSc Arch Eng - *spatial planning analysis*

PhD Darko Mayer - *hydrogeology*

Natalija Mavar, MSc Arch Eng - *spatial planning analysis*

Vanja Medić, MSc Biol Ecol Eng - *flora, habitats and protected areas*

MSc Mirta Patarčić (*Meteorological and Hydrological Service*) *-meteorological data*

Marija Pašalić, MSc Spat. Plan. - *settlements and population*

PhD Igor Pavlinić, *(Croatian Natural History Museum) - fauna: mammals, fauna: bats*

PhD Natalija Pavlus, MSc Biol Ecol Eng, PhD – *ecological network*

MSc Zlatko Perović - *air quality, air pollution model*

PhD Ivan Pilaš - *forests and forestry*

PhD Martina Podnar *(Croatian Natural History Museum) - fauna: amphibians, fauna: reptiles*

PhD Božo Prtoljan - *geology*

Vanda Sabolović, MSc Eng Land Arch - *landscape* PhD Sanja Steiner - *project description/operative area of Zagreb Airport, aircraft accident risk assessment*

MSc Željko Štromar, MSc Civil Eng - *noise protection*

Dinko Tvrtković, MSc Mech Eng - *project description/ refined products pipeline*

PhD Vesna Tutiš - *ornithofauna*

Amelio Vekić, MSc Arch - *cultural heritage*

Place and date: Zagreb, October 2012

COPY NO

REVISION E

Study content - comprehensive list of books

I Environmental Impact Study

II Study Summary

III Appendices

BOOK III CONTENTS - GRAPHIC APPENDICES:

1 Decision on the acceptability of the new passenger terminal at Zagreb airport to the environment, Ministry of Environment and Nature, Class: UP/I-351-03/12-02/32, Ur.No: 517-06-2-1-2-12-19, Zagreb, 12. October 2012

2 Opinion on project planning with the spatial planning documents, Ministry of Environmental Protection, Spatial Planning and Construction, Class:350-02/11-02/79, Ur.No: 531-06-11-2, Zagreb, 21. December 2011

3 Certificate stating that the planned project *The new passenger terminal at Zagreb airport* will not have a significant impact on the conservation objectives and integrity of the ecological network, the Ministry of Environment and Nature, Class: 612-07/12-01/0064, Ur. No: 517-12-4, Zagreb, 28. February 2012

4 Certified excerpts from the spatial planning documents;

- Spatial plan of Zagrebačka County
  (˝Official Gazette of Zagrebačka County" No 3/02, 8/05, 8/07, 4/10 and 10/11)
- *Spatial plan of Velika Gorica*
  („Official Gazette of Velika Gorica" No 10/06 and 6/08)

Appendix 1.2.3-1 Project location M 1 : 25 000.
Appendix 1.2.3-2 Plan on the cadastral map M 1: 10000
Appendix 1.2.3-3 Plan M 1: 10 000
Appendix 1.3.6-1 Water supply and sewage plan NPT ZLZ
Appendix 3.3-1a Experiment P0-NOx_A - Immission NOx - zero status
Appendix 3.3-1b Experiment P0-NOx_B - Immission NOx - zero status
Appendix 3.3-1c Experiment P0-NOx_C - Immission NOx - zero status
Appendix 3.3-2a Experiment P0-PM10_A - Immission PM10 - zero status
Appendix 3.3-2b Experiment P0-PM10_B - Immission PM10 - zero status
Appendix 3.3-2c Experiment P0-PM10_C - Immission PM10 - zero status
Appendix 3.3-3a Experiment P0-BaP_A - Immission BaP - zero status
Appendix 3.4-1 Air traffic noise map for day and evening for the year 2009
Appendix 3.4-2 Air traffic noise map for night for the year 2009
Appendix 3.4-3 Air traffic noise map for L_{den} for the year 2009
Appendix 4.2.1-1a Experiment P1-NOx_A - Immission NOx - Phase I (2024)
Appendix 4.2.1-1b Experiment P1-NOx_B - Immission NOx - Phase I (2024)
Appendix 4.2.1-1c Experiment P1-NOx_C - Immission NOx - Phase I (2024)
Appendix 4.2.1-2a Experiment P2-NOx_A - Immission NOx - Phase II (2040)
Appendix 4.2.1-2b Experiment P2-NOx_B - Immission NOx - Phase II (2040)
Appendix 4.2.1-2c Experiment P2-NOx_C - Immission NOx - Phase II (2040)
Appendix 4.2.1-3a Experiment P1-PM10_A - Immission PM10 - Phase I (2024)
Appendix 4.2.1-3b Experiment P1-PM10_B - Immission PM10 - Phase I (2024)
Appendix 4.2.1-3c Experiment P1-PM10_C - Immission PM10 - Phase I (2024)
Appendix 4.2.1-4a Experiment P2-PM10_A - Immission PM10 - Phase II (2040)
Appendix 4.2.1-4b Experiment P2-PM10_B - Immission PM10 - Phase II (2040)
Appendix 4.2.1-4c Experiment P2-PM10_C - Immission PM10 - Phase II (2040)
Appendix 4.2.1-5a Experiment P1-BaP_A - Immission BaP - Phase I (2024)
Appendix 4.2.1-6a Experiment P2-BaP_A - Immission BaP - Phase II (2040)
Appendix 4.2.2-1 Air traffic noise map for day and evening for the year 2024
Appendix 4.2.2-2 Air traffic noise map for night for the year 2024
Appendix 4.2.2-3 Air traffic noise map for L_{den} for the year 2024
Appendix 4.2.2-4 Air traffic noise map for day and evening for the year 2040
Appendix 4.2.2-5 Air traffic noise map for night for the year 2040
Appendix 4.2.2-6 Air traffic noise map for L_{den} for the year 2040