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Creation of an Airport Mapping Database for DABC
Airport and Generating an Aerodrome Chart - ICAO

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Exploitation

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Abstract

This thesis focuses on the development of an Airport Mapping Database (AMDB) for DABC Airport, using QGIS software. The objective of the study is to establish a comprehensive and accurate spatial database that encompasses critical airport infrastructure and operational information. The research methodology involves data collection from various sources, including aerial imagery, airport blueprints. Using QGIS, the collected data is processed, analyzed, and organized to create a detailed AMDB, which will be used to generate an Aerodrome Chart _ ICAO.

Keywords: AMDB, GIS, QGIS, Aerodrome Chart, DABC.

ملخص:

تركز هذه الرسالة على تطوير قاعدة بيانات خرائط المطار (AMDB) لمطار قسنطينة ، باستخدام برنامج QGIS. الهدف من الدراسة هو إنشاء قاعدة بيانات مكانية شاملة ودقيقة تشمل البنية التحتية الحيوية للمطار والمعلومات التشغيلية. تتضمن منهجية البحث جمع البيانات من مصادر مختلفة ، بما في ذلك الصور الجوية ومخططات المطارات. باستخدام QGIS ، تتم معالجة البيانات التي تم جمعها وتحليلها وتنظيمها لإنشاء AMDB مفصل ، والذي سيتم استخدامه لإنشاء مخطط المطارات ICAO _

الكلمات المفتاحية: قاعدة بيانات لمعلومات رسم خرائط المطارات، خريطة المطار، الإسناد الجغرافي.

Résumé:

Cette thèse porte sur le développement d'une base de données de cartographie aéroportuaire (AMDB) pour l'aéroport de Constantine, à l'aide du logiciel QGIS. L'objectif de l'étude est d'établir une base de données spatiales complète et précise qui englobe les infrastructures aéroportuaires essentielles et les informations opérationnelles. La méthodologie de recherche implique la collecte de données à partir de diverses sources, notamment des images aériennes et des plans d'aéroport. À l'aide de QGIS, les données collectées sont traitées, analysées et organisées pour créer une AMDB détaillée, qui sera utilisée pour générer une carte d'aérodrome _ OACI.

Mots clés : SIG, QGIS, AMDB, carte d'aérodrome, géoréférencement.

Dedication

All praise and thanks are due to Allah, the Lord of all the worlds, who has blessed us with the gift of knowledge and intellect. And gave me health and the will to be able to accomplish this modest work.

I dedicate this thesis to my family and my friends. A special feeling of gratitude to my loving parents, for their support, encouragement, and inspiration throughout this journey. I am deeply grateful for their patience, understanding, and sacrifices they have made to help me pursue my educational goals. My brother and my sisters who have supported me throughout the process. I will always appreciate all they have done.

I also dedicate this dissertation to my best friends. Their belief in my abilities and their constant encouragement have been a source of inspiration and motivation throughout this research.

Lastly, I dedicate this dissertation to my big family members, especially my uncles, who have been a constant source of inspiration and support throughout my academic journey.

Preface

I noticed during my previous studies that I avoided stepping outside my comfort zone. This year I wanted to approach the thesis differently, by choosing a subject which required skills I did not yet have. I have worked with unfamiliar computer software tools, such as Quantum GIS. I have also gained more experience with programs I was already familiar with. Also, I have learned that struggling is part of the process. Therefore, this thesis has taught me valuable lessons both professionally and personally.

I would like to thank my supervisor, Mr. Benaissa Rachid, for the excellent guidance and support during the process. I also want to thank Mr. Abdallah Benaissa chief of the aeronautical Information department at the National Air Navigation Establishment for his contribution to this project, from his wise advices to his invaluable assistance in spite of his professional duties.

My sincere thanks to Mr. A. DJTOUF, Director of Operations and Aeronautics, for welcoming us into the organization.

And all employees, for integration, welcome, support and cooperation in our mission.

Also, I would like to express my appreciation to my fellow classmates and colleagues who have enriched my academic experience through stimulating discussions and shared passion for the subject matter.

Finally, I want to thank my family and friends for being there for me. I would also like to thank you, my reader: I hope you enjoy your reading.

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Abbreviations

Abbreviation	Definition
AIP	Aeronautical Information Publication
AIRAC	Aeronautical Information Regulation and Control
AIS	Aeronautical Information Service
AIM	Aeronautical Information Managements
AIXM	Aeronautical Information Exchange Model
AMDB	Aerodrome Mapping Database
ARP	Aerodrome Reference Point
ATC	Air Traffic Control
GIS	Geographic Information System
GNSS	Global Navigation Satellite System
GPS	Global Positioning System
ICAO	International Civil Aviation Organization
LAHSO	Land and Hold Short Operations
NOTAM	Notice to Airmen
WGS-84	World Geodetic System - 1984

Definitions

Accuracy: A degree of conformance between the estimated or measured value and the true value.

Aerodrome: A defined area on land or water (including any buildings, installations and equipment) intended to be used either wholly or in part for the arrival, departure and surface movement of aircraft.

Aerodrome elevation: The elevation of the highest point of the landing area.

Aerodrome reference point (ARP): The designated geographical location of an aerodrome.

Aerodrome surface movement area: That part of an aerodrome that is to be used for the take-off, landing, and taxiing of aircraft. This includes runways, taxiways, and apron areas.

Aeronautical data: A representation of aeronautical facts, concepts or instructions in a formalized manner suitable for communication, interpretation or processing.

Aeronautical Information Publication (AIP): A publication issued by or with the authority of a State and containing aeronautical information of a lasting character essential to air navigation.

Aeronautical information regulation and control (AIRAC): A system aimed at advance notification based on common effective dates, of circumstances that necessitate significant changes in operating practices.

Aeronautical information service (AIS): A service established within the defined area of coverage responsible for the provision of aeronautical

Altitude: The vertical distance of a level, a point or an object considered as a point, measured from mean sea level (MSL).

ArcGIS - A comprehensive desktop GIS software package developed by ESRI.

Clearway: A defined rectangular area on the ground or water under the control of the appropriate authority, selected or prepared as a suitable area over which an Aeroplane may make a portion of its initial climb to a specified height.

Computer-based systems: Systems operating from pre-assembled aeronautical databases. Systems include, but are not limited to, area navigation systems, flight management systems, flight planning systems, flight simulators, computer modelling and design systems.

Database: One or more files of data so structured that appropriate applications may draw from the files and update them.

Data element: A term used to describe any component of an AMDB. For example: a feature, an attribute, an object, an entity, or a value.

Data quality: A degree or level of confidence that the data provided meet the requirements of the data user in terms of accuracy, resolution and integrity.

Data set: Identifiable collection of data.

DBMS: Database management system. It is a set of computer programs for organizing the information in database. A DBMS supports the structuring of the database in a standard format and provides tools for data input, verification, storage, retrieval, query, and manipulation.

Elevation: The vertical distance of a point or a level, on or affixed to the surface of the earth, measured from mean sea level.

Feature: Abstraction of real-world phenomena.

Feature attribute: Characteristic of a feature.

Imagery: The product of photography or advanced imaging sensors. Can be produced via either aerial or satellite fly-overs.

Integrity (aeronautical data): A degree of assurance that an aeronautical data and its value has not been lost or altered since the data origination or authorized amendment.

Land and hold short operations (LAHSO) location: Marking used for land and hold short operations

Marking: A symbol or group of symbols displayed on the surface of the movement area in order to convey aeronautical information.

NOTAM: A notice distributed by means of telecommunication containing information concerning the establishment, condition, or change in any aeronautical facility, service, procedure, or hazard, the timely knowledge of which is essential to personnel concerned with flight operations.

Open-Source Software (OSS): A computer software with its source code made available with a license in which the copyright holder provides the rights to study change and distribute the software for any purpose. Open-source software is developed in a collaborative public manner.

Precision: The smallest difference that can be reliably distinguished by a measurement process.

Python: A general purpose and high-level programming language.

Resolution: A number of units or digits to which a measured or calculated value is expressed and used.

Runway: A defined rectangular area on a land aerodrome prepared for the landing and take-off of aircraft.

Runway displaced area: That portion of a runway between the beginning of the runway and the displaced threshold.

Service road: Part of aerodrome surface that must be used only by service vehicles and is not considered as surface movement areas for aircraft.

Stopway: A defined rectangular area on the ground at the end of take-off run available prepared as a suitable area in which an aircraft can be stopped in the case of an abandoned take-off.

Shapefile: A geospatial vector data format for geographic information system (GIS) software. The shapefile format can spatially describe vector features: points, lines, and polygons,

Taxiway: A defined path on a land aerodrome established for the taxiing of aircraft and intended to provide a link between one part of the aerodrome and another.

WGS 84: An extensively used term in mapping. It stands for World Geodetic System 1984 and comprises of an ellipsoid, a horizontal datum, a vertical datum and a coordinate system.

Introduction:

The transition from aeronautical information services (AIS) to aeronautical information management (AIM) is a significant development in the aviation industry. The International Civil Aviation Organization (ICAO) has recommended this transition as a means of improving the efficiency and effectiveness of aeronautical information management, including data on airports, airspace, and flight procedures.

The AIS system traditionally focused on the collection, management, and dissemination of aeronautical information, including flight plans, notices to airmen (NOTAMs), weather reports, and other critical information related to air navigation. However, the increasing complexity of the aviation industry has created a need for more efficient and integrated management of this information, leading to the development of the AIM system.

The AIM system integrates a wide range of information sources, including the AMDB, to provide more comprehensive and reliable information to aviation stakeholders. By transitioning from AIS to AIM, aviation authorities can streamline the management of aeronautical information, reduce errors and inconsistencies, and improve the safety and efficiency of air transportation.

The transition from AIS to AIM involves a range of technical and operational changes, including the adoption of new technologies and data formats. The integration of the AMDB into AIM systems is a critical part of this transition, as it provides accurate and up-to-date information on airports and their surrounding areas, including runway and taxiway geometry, airport markings and signage, terminal buildings and parking areas, and other airport infrastructure and facilities.

The primary aim of this thesis is to develop an Aerodrome Mapping Data Base for Constantine/Mohammed Boudiaf utilizing the QGIS computer software.

The dissertation is structured into four chapters, each serving a distinct purpose.

In the first Chapter, titled "Concepts and Generalities," an effort is made to provide precise definitions of key notions and concepts relevant to our research project.

The second Chapter, an overview about Geographic Information System GIS and its software tools.

The third chapter is dedicated to the introduction and exploration of the Airport Mapping Data Base, its role, components, and applications.

Chapter 4, the final chapter, concentrates on the creation of the Constantine/Mohammed Boudiaf Aerodrome Cartographic Database, detailing the specific steps taken to achieve this objective.

The thesis concludes with a comprehensive summary and concluding remarks in the general conclusion section, encapsulating the outcomes and significance of the project as a whole.

Chapter 1

Generalities

1.1. Aeronautical Information Management AIM:

1.1.1. Definition:

Aeronautical Information Management (AIM) refers to the global and interoperable provision of high-quality aeronautical data, covering the needs of the current and future Air Traffic Management (ATM) system and all phases of flight. AIM takes a holistic, data-oriented approach to ensure the accuracy and reliability of shared information. [1]

The role of AIM is to oversee and maintain the quality of shared data and establish mechanisms that facilitate information sharing among the ATM community. It supports improved decision-making processes at the strategic, pre-tactical, and tactical levels. AIM serves as a central repository of aeronautical data, which is accessed by various user applications, such as pilots and air traffic controllers. The focus is on the information itself rather than the underlying technology.

1.1.2. Objective of the transition from AIS to AIM:

Recommendation 1/8 of AN-Conf/11 clearly stated the objective for global aeronautical information as follows:

That ICAO, when developing ATM requirements, define corresponding requirements for safe and efficient global aeronautical information management that would support a digital, real-time, accredited and secure aeronautical information environment.

The Global Air Traffic Management Operational Concept, which had been developed to be visionary in scope and not constrained by the level of technology available at the time, was also endorsed by AN-Conf/11.

Much has been done in the community, and the technology has become more mature and more widely deployed. However, some regions are more advanced than others and the need for the adoption of global Standards is becoming more evident now than it was in 2003. Present and future navigation systems and other air traffic management systems are data-dependent. All require access to global, broad-based aeronautical information of a considerably higher quality and in a timelier manner than is generally available today. The provision of aeronautical information is a core element of air navigation services.

To satisfy new requirements arising from the Global Air Traffic Management Operational Concept, aeronautical information services must transition to a broader concept of aeronautical information management, with a different method of information provision and management

given its data-centric nature as opposed to the product-centric nature of AIS. Roles and responsibilities may need to be adapted as the transition progresses.

1.1.3. Roadmap to AIM:

Published by ICAO on 2009, The purpose of this roadmap is to develop the AIM concept and associated performance requirements by providing a basis upon which to manage and facilitate, on a worldwide basis, the transition from AIS to AIM. The roadmap is based on what we know today but has been developed with sufficient flexibility for the new concepts that will emerge from future research.

Three phases of action are envisaged for States and ICAO to complete the transition to AIM:

Phase 1 Consolidation:

Existing Standards will need to be refined and strengthened and their implementation in all States ensured. This will concern mainly:

- quality requirements;
- AIRAC adherence;
- the implementation of the adopted standard reference system for coordinates (World Geodetic System-1984).
- the provision of terrain and obstacle data.

The projects in the first phase will be conducted to identify potential gaps in order to focus on near-term work program activities.

Phase 2 Going digital:

The introduction of database-driven processes will improve the value of current products by improving their quality and availability for current users. This will concern mainly the creation of a national database or regional databases to produce the existing products and services, but with better quality and availability. The projects in the second phase will be conducted to enhance the quality and availability of existing products in the medium-term work program activities.

Phase 3 Information management:

New products and services will be developed. Quality control and staff training and planning will be applied to current and new products and services. This will support a new AIM function for air navigation service providers enabling the provision of the new data that will be required

by the future ATM components. The projects in the third phase will be conducted to serve new users and to promote continuous improvement by the research community.

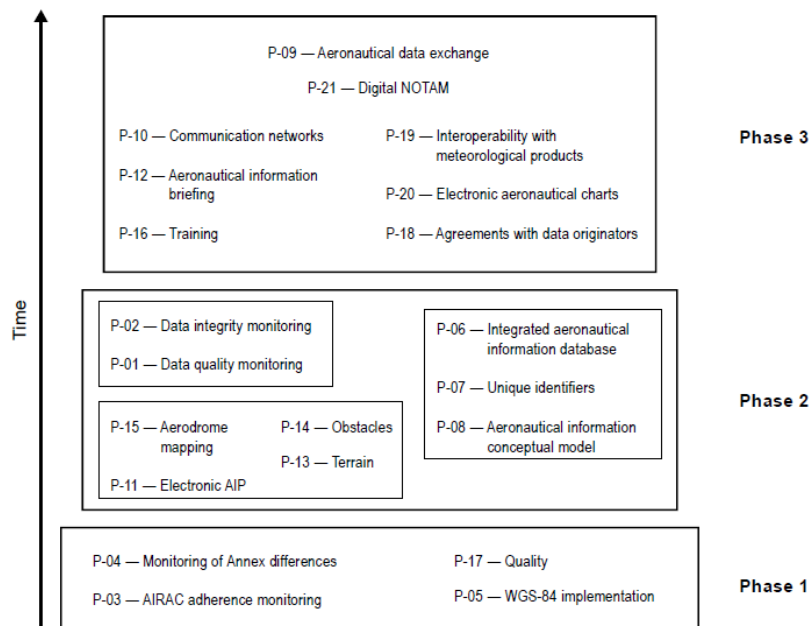


Figure 1-1 The three phases of the roadmap ¹

1.2. National Air Navigation Establishment ENNA:

The national institution responsible for air navigation services in Algeria. It is the organization that control and manage the airspace of Algeria, ensuring the safe and efficient movement of aircraft within the country's airspace.

1.2.1. History:

In 1962, the Aeronautical Management and Safety Organization (OGSA) was established as a joint Algerian-French organization with the aim of overseeing the management of all Civil Aviation Operation services in Algeria.

On January 1, 1968, the OGSA was replaced by the Office of Air Navigation and Meteorology (ONAM). Subsequently, on January 1, 1969, the merger of various airport managers, the Air Navigation and Meteorological Office (ONAM), and the EPAA led to the formation of the National Establishment for Exploitation and Meteorology (ENEMA).

¹ RoadMap Transition from AIM to AIS (Doc)

In 1975, meteorological activities were transferred from ENEMA to the newly established National Office of Meteorology (ONM) through Ordinance N°75-25 issued on April 29, 1975. The ONM later became a Public Establishment of an Industrial Character and Commercial (EPIC) for scientific and technical purposes following Decree N°98-258 on August 25, 1998.

In 1983, ENEMA underwent a division, resulting in the formation of two separate establishments: the National Airport Management and Operation Establishment (ENGEA) and the National Establishment for Aeronautical Operations and Safety (ENESA), which was established as a national economic enterprise.

Then, in 1987, the Algiers Airport Services Management Establishment (EGSA) was created as a national socialist company. The EGSA later obtained the status of EPIC, which remains in effect to this day.

On May 18, 1991, a reorganization of ENESA's statutes took place, leading to its transformation into the National Air Navigation Establishment (ENNA). This transition was facilitated by Executive Decree N°91-149 issued on May 18, 1991. [2]

1.2.2. Role and responsibilities:

1.2.2.1. Air Traffic Control:

ENNA operates air traffic control towers and centers at various locations in Algeria. These facilities monitor and direct the movement of aircraft, provide clearances for take-off and landing, and ensure safe separation between flights.

1.2.2.2. Communication and Navigation:

ENNA maintains communication systems, including radio frequencies and ground-to-air communication infrastructure, to facilitate communication between air traffic controllers and pilots. It also manages navigation aids, such as radars, beacons, and instrument landing systems, to assist aircraft in navigating through Algerian airspace.

1.2.2.3. Airspace Management:

ENNA is responsible for managing Algerian airspace, including the designation of routes, airspace classifications, and coordinating with neighboring countries regarding cross-border operations. It ensures efficient use of airspace while maintaining safety standards.

1.2.2.4. Safety and Security:

ENNA places a strong emphasis on safety and security in air navigation. It implements international standards and procedures to ensure the safe movement of aircraft and mitigate potential risks. It collaborates with relevant national and international organizations to enhance aviation safety.

1.2.2.5. Training and Development:

ENNA provides training and development programs for air traffic controllers, technicians, and other aviation professionals. It aims to enhance the skills and expertise of its workforce to meet the evolving demands of the aviation industry.

1.2.2.6. International Cooperation:

ENNA collaborates with various international organizations, such as the International Civil Aviation Organization (ICAO) and the African Civil Aviation Commission (AFCAC). It participates in regional and global initiatives to harmonize air navigation services, improve coordination, and promote the development of aviation infrastructure.

1.2.3. Organization:

The National Air Navigation Establishment is structured as follow:

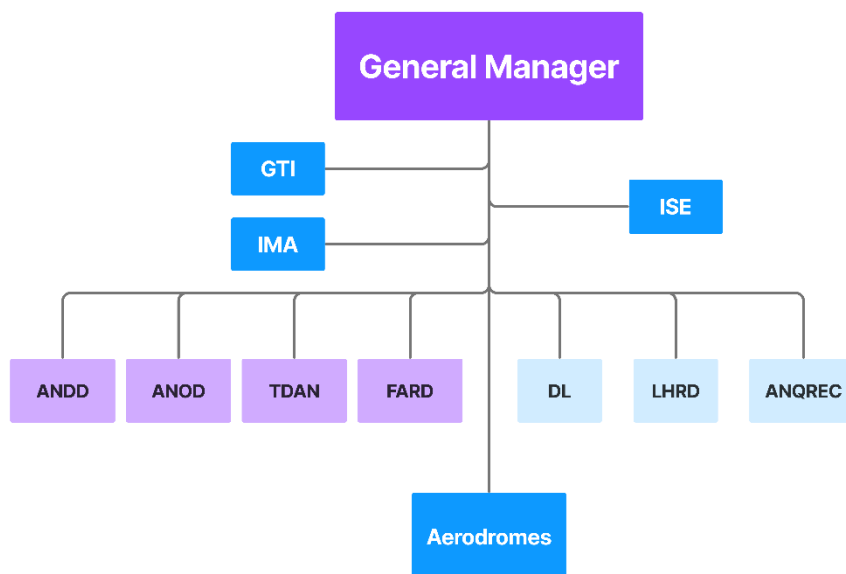


Figure 1-2. ENNA Organization

ANDD: Air Navigation Development Department.

ANOD: Air Navigation Operations Department.

TDAN: Technical Department of Air Navigation.

FARD: Finance and Accounting Resources Department.

LHRD: Legal and Human Resources Department.

ANQREC: Air Navigation Qualification, Retraining and Experimentation Center.

LD: Logistics Department.

GTI: General Technical Inspection

IMA: Internal Management Audit

ISE: Internal Security of the Establishment

AERODROMES: Aeronautical Safety Departments.

1.2.4. Air Navigation Operations Department (ANOD):

1.2.4.1. Overview:

The Air Navigation Operations Department is responsible for:

- Ensure the safety and regularity of air navigation;
- Manage and control the airspace (en-route and on the ground) entrusted by the area control center (ACC) and the various air traffic departments;
- Ensure good technical management at the aerodrome level
- Manage aeronautical telecommunication services;
- Ensure the rescue and firefighting service at aerodromes (SSLI).

The DENA is made up of six (06) departments and a regional control center (RCC).

1.2.4.2. Aeronautical Information Department AID:

The Aeronautical Information Department is responsible for:

- receiving and/or creating, compiling or assembling, editing, formatting, publishing/storing and disseminating aeronautical information and data concerning its area of competence. Aeronautical information is published as an integrated aeronautical information system.
- Informing users of legislative, regulatory and administrative texts relating to air traffic.

- Verification of the elements to be published in the integrated aeronautical information system and coordinated by the organizations concerned before being transmitted, in order to guarantee before the diffusion that nothing useful has been omitted and that all the details are exact.

The Aeronautical Information Department supervises two services that report directly to it:

1.2.4.2.1. The NOTAM Operation department:

Responsible for the work of centralization, drafting, distribution, and exploitation of NOTAM

1.2.4.2.2. The Documentation and Regulations department:

responsible for collecting, editing, centralizing, formatting and distributing aeronautical information (AIP, AMDT AIP, SUP AIP, AIC, AMDT AIRAC, LIST RECAP)

1.3. DABC Airport:

1.3.1. History:

The airport was built in 1943 as Constantine Airfield by the United States Army during the World War II North African Campaign. It was primarily a maintenance and supply depot for Air Technical Service Command and also served as headquarters for XII Bomber Command as a command-and-control base. It also was used as a command post for Allied Forces Command (AFHQ) for Free French, British and United States ground forces in Algeria in February 1943, under the command of General Sir Harold R. L. G. Alexander to coordinate the actions of the United States First Army advancing from the west and the British Eighth Army, advancing from the east against the German Afrika Korps. In 1944 it was turned over to the Algerian government and used occasionally by Air Transport Command aircraft on the North African route until the end of the war.

1.3.2. Presentation:

Mohamed Boudiaf International Airport, also known as Mohamed Boudiaf Airport, is an airport in Algeria, located approximately 9 km south of Constantine; about 320 km east-southeast of Algiers.

General Information:

- ICAO code: DABC
- IATA code: CZL
- Coordinates: 36° 16' 41" N, 6° 37' 7" E
- Altitude: 706 m
- Temperature: 33.6 °C
- Operator: EGSA-Constantine
- Elevation AMSL: 2316 ft / 706 m



Figure 1-3. DABC Airport location

1.3.3. Infrastructure:

1.3.3.1. Runways:

➤ Main Runway (13/31):

- Dimension: 2400m x 45m
- Strip dimension: 2600m x 200m
- Surface: Asphalt

- Magnetic Azimuth: 134°/ 314°
- TORA=TODA= LDA=2400m
- ASDA = 2460m
 - Secondary Runway (16/34):
- Dimension: 3000m x 45m
- Strip dimension: 3200m x 300m
- Surface: Asphaltic concrete
- Magnetic Azimuth: 159°/ 339°
- TORA=TODA= LDA= 3000m
- ASDA = 3100m

Table 1-1 - DABC Airport's Runways

RWY	Bearings		Dimension des RWY (m)	Resistance (PCN) & revetement of RWY and SWY	Coordination	Threshold elevation and altitude of the highest point of the precision runway TDZ	
	VRAI	MAG				THR	TDZ
1	2		3	4	5	6	
13	136°	134°	2400 x 45	54 F/C/W/T Asphalt	361704.08N 0063653.34E	702 M	
31	316°	314°			361607.98N 0063800.02E	687 M	
16	159°	157°	3000 x 45	93 F/D/W/T bituminous	361716.9N 0063638.4E	705 M	
34	339°	337°			361546N 0063721E	706 M	

1.3.3.2. Terminals:

The airport currently has 2 terminals. The main terminal has a capacity of 1.2 million passengers and was put into service in June 2013. It has an area of 16,200 m² and has 2 levels³.

The former international terminal with a capacity of 700,000 passengers will be renovated and modernized to accommodate domestic flights, charter flights and pilgrimage flights.

1.3.3.3. Taxiways:

The runways are linked to each other and to the parking areas by taxiways intended for aircraft and sometimes narrower service lanes reserved for service and emergency vehicles (firefighters):

- width: 23 m
- Surface type: Asphaltic concrete
- Resistance: PCN 93 F/D/W/T

Table 1-2 - DABC Airport's Taxiways

TWY	Width	surface type	Resistance
A1, A2, B, B1, B2, B3, AB1, AB2.	23 M	Asphaltic concrete	PCN 93 F/D/W/T

1.3.4. Air traffic services:

- Constantine TWR (118.3Mhz - 119.7Mhz).
- Constantine APP (120.1Mhz).
- Constantine SOL (120.9Mhz).

1.3.5. Radionavigation Aids:

Table 1-3 - DABC Airport' Radionavigation Aids

Aid Type	Identification	Frequencies	Hours of operation	Transmit antenna location coordinates	Transmit antenna altitude DME	Observations
1	2	3	4	5	6	7
DVOR/DME (2°E 2017)	CSO	115.5 MHz CH 102 X	H 24	361735.75N0063629.96E		
NDB	CNE	397 KHz	H 24	361125.09N 0064337.83E		50 NM
LLZ31/ILS CAT I (2°E 2017)	CT	109.3 MHz	H 24	361710.89N 0063645.23E		291M THR13
GP 31	-	332 MHz	H 24	361619.36N 0063753.14E		334°/ 390M THR31
DME	CT	CH 30X	H24	361619.36N 0063753.14E		
LLZ34/ILS CAT I (2°E 2017)	CS	108.3 MHz	H 24	361724.90N 0063634.50E		265M THR16
GP 34	-	334.1 MHz	H 24	361553.34N 0063712.77N		137°/305M THR34
DME	CS	CH 20X	H24	361553.34N 0063712.77N		

1.3.6. Obstacles:

1.3.6.1. Landing area:

Table 1-4. DABC Obstacles - Landing Area

RWY or Area concerned	Type of obstacle			Coordination
	Type of obstacle	Hight	Marking and light beaconing	
A	b			c
RWY 13	mountain peak	55 M	None	5300 M du THR 13
RWY 31	mountain peak	160 M	None	1620 M du THR 13
RWY 34	LLZ antenna	3 M	Beacon day and night	361724.90N 0063634.50E
RWY 31	LLZ antenna	3 M	Beacon day and night	361710.89N 0063645.23E

1.3.6.2. Aerodrome area:

Table 1-5.DABC Obstacles - Aerodrome area

Type of obstacle Hight Marking and light beaconing				Coordination
Type of obstacle	Hight (M)	Marking and light beaconing		
A				B
GP 31 Antenna	17	Not beacon		361619.36N 0063753.14E
TWR Antenna	29	Not beacon		361707.40N 0063708.67E
radar Antenna	25	Not beacon		361631.70N0063636.08E
GP 34 Antenna	18	beacon day and night		361553.34N 0063712.77N
Water tower	29	beacon day and night		361709.14N 0063716.74E
9 Pylons	22	beacon day and night		None
Antenna	18	beacon day and night		361716.65N 0063715.03
Wind Antenna (1)	10	beacon day and night		See aerodrome chart
Visibility meter antenna (1)	2.5	beacon day and night		
Luminance meter antenna (1)	1.5	beacon day and night		
Linge haute tension	pylon 1	beacon day and night	Beacon day	361753.25N 0063528.15E
	pylon 2	22.37 ALT: 716.15	Beacon day	361811.99N 0063623.63E
	pylon 3	22.16 ALT: 714.83	Beacon day	361812.72N 0063631.98E

1.3.7. Statistics:

The following chart represent the evolution of Air traffic on Mohammed Boudiaf Airport from 2011 to 2020. [3]

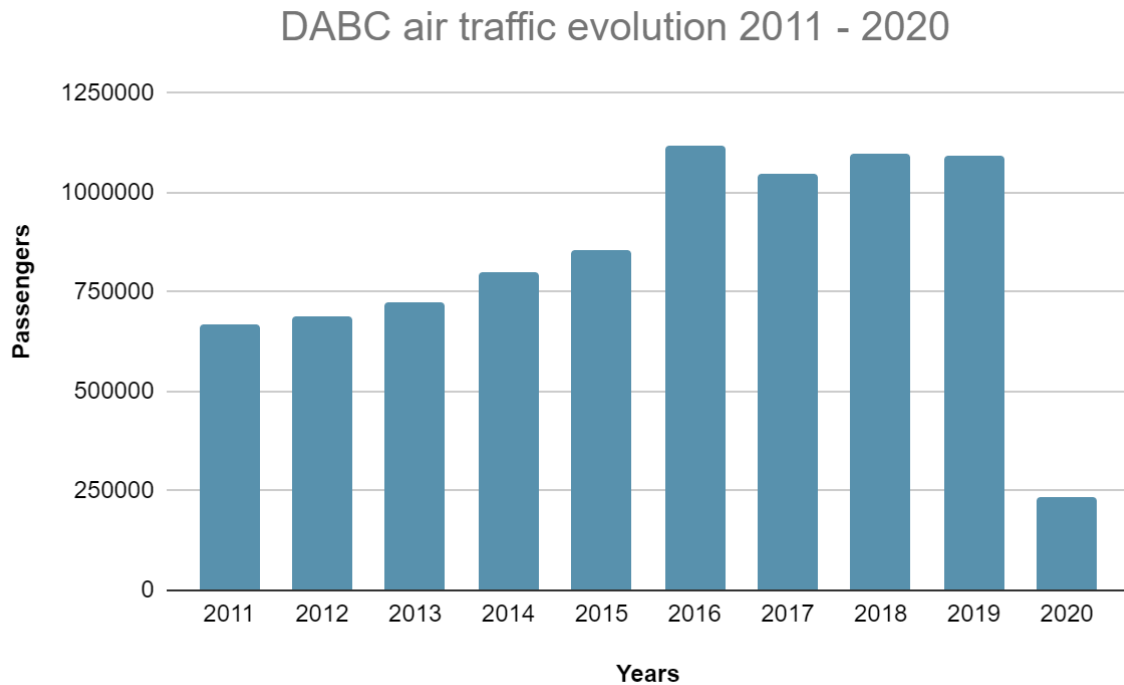


Figure 1-4 - DABC statistics 2011 – 2020

1.4. Conclusion :

The goal of this chapter was to provide an overview about the National Air Navigation Establishment its history, mission and organization, and outline the fundamental elements of Constantine aerodrome's infrastructure as well as the statistics on air traffic at the aerodrome.

Chapter 2

Introduction to Geographic Information

System GIS

2.1. Introduction:

Geographic Information Systems (GIS) refer to computer-based systems designed to capture, store, analyses, manipulate, and visualize spatial or geospatial data. The core concept of GIS revolves around the relationship between data and location, allowing users to explore and analyze patterns, trends, and relationships in a geographical context.

We can also define GIS as a type of software which consists of a computer system that allows us to handle information about the location of features or phenomena on the Earth's surface. It has all the functionality of a conventional DBMS plus much of the functionality of a computer mapping system.

This chapter provides an overview of GIS, tracing its historical development and exploring its components and wide-ranging applications specially on airport's mapping.

2.2. History of GIS:

Historically, the concept of GIS started a long back during 1854 when British physician John Snow began mapping of the probable sites for Cholera outbreak disease locations and found the real locations along the water lines of London city. During the period of 1854 -1960, there were some concepts developed related to this subject but none of them had been satisfactory.

[4]



Figure 2-1 - John Snow's 1855 map of the Soho cholera outbreak in London 1854²

² Fundamental of GIS (Book)

In the 1960s the field of geographic information systems (GIS) started as computers and early concepts of quantitative and computational geography emerged. Early GIS work included important research by the academic community. Later, the National Center for Geographic Information and Analysis, led by Michael Goodchild, formalized research on key geographic information science topics such as spatial analysis and visualization. These efforts fueled a quantitative revolution in the world of geographic science and laid the groundwork for GIS. [4]

On 1962: The Canadian Geographic Information System (CGIS) became one of the first computer-based GIS projects, focusing on land use mapping and natural resource management.

On 1963: Roger Tomlinson, known as the "father of GIS," created the first true GIS for the Canadian government to manage land resources.

On 1970s: Advancements in computer technology and the availability of satellite imagery led to the development of more sophisticated GIS systems.

On 1980s: The commercialization of GIS software by companies like Esri further popularized the use of GIS in various industries.

On 1990s to Present: The proliferation of spatial data, advancements in data collection technologies (e.g., GPS, remote sensing), and the open-source movement have further expanded the use and accessibility of GIS

2.3. Components of GIS:

A GIS system in working order integrates the following five key components:

2.3.1. Hardware:

Hardware is a computer on which GIS software runs. There are a different range of computers like Desktop or server based. Arc GIS, Arc Info and Arc view GIS software servers are server-based computers where GIS software runs on network computer. The good computer hardware components must have high capacity. Examples of hardware components are: server, digitizer, PC, Printer, plotter, Hard driver, processor, graphics card, etc. These all components function together to run GIS software smoothly.

2.3.2. Software:

GIS software provides the tools and functionalities necessary to manage and analyze spatial data. Popular GIS software includes ArcGIS by Esri, QGIS (Quantum GIS), and GRASS GIS.

These software packages offer a wide range of capabilities, from data visualization to advanced spatial analysis.

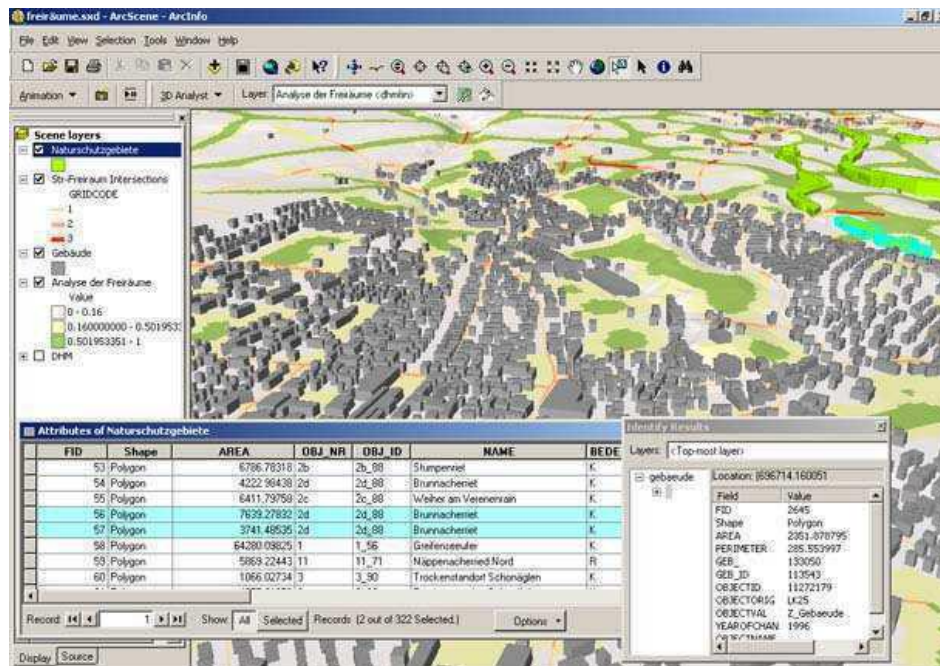


Figure 2-2 - GIS Software on the computer monitor

2.3.3. Data:

Geographic data refers to information about the earth's surface and the objects found on it. This information comes in three basic forms: spatial data, tabular data, and image data. Spatial data contains the locations and shapes of map features. Tabular data is collected and compiled for specific areas and is the descriptive data that GIS links to map features. Image data includes such diverse elements as satellite images, aerial photographs, and scanned data that's been converted from printed to digital format.

2.3.4. GIS users:

GIS technology may have many limitations without the involvement of people who manage the system and develop plans for applying it to real world problems. GIS users range from technical specialists who design and maintain the system to those who use it to help them perform their everyday work. GIS user/people/personnel specifically include the following categories of working environment:

- Project coordinators
- Data analysts
- Programmers

- Data and knowledge managers
- Librarians Types of GIS

2.4. GIS data models:

Data models are a set of rules used to describe or represent aspects of real-world surfaces and characteristics in GIS, and can be classified into the categories of vector and raster data models:

2.4.1. Vector Data:

The vector data model represents geographical object/feature/points as collections of points, lines, and polygons.

The vector data model represents geography as collections of points, lines, and polygons. The method using geometrical formulas for data model is known as vector or vectorized graphics.

Vector storage implies the use of vectors (directional lines with their x, y coordinates) to represent a geographic feature.

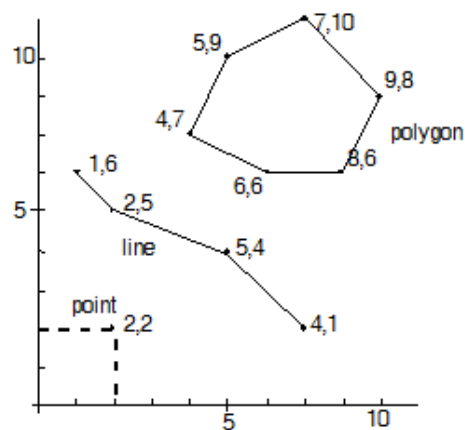


Figure 2-3 - Vector Model-Geometric objects (Points, Lines and Polygons)

2.4.2. Advantage of Vector model:

- Vector data provide good representation of features/objects/phenomenon
- It is a Compact data structure
- Topology can be completely described
- Highlight accurate graphics
- Retrieval, updating and generalization of graphics and attributes are possible.
- Vector data are also in the form of images.
- Vectorized images describe every aspect of their shape in terms of a mathematical formula.
- Vector data tend to be more compact in data structure, so file sizes are typically much smaller than their raster counterparts.

2.4.3. *Disadvantage of Vector model:*

- The vector data structure tends to be much more complex than the simple raster data model.
- As the location of each vertex must be stored explicitly in the model, there are no shortcuts for storing data like raster models.
- The implementation of spatial analysis can also be relatively complicated due to minor differences in accuracy and precision between the input datasets.

2.4.4. **Raster Data:**

The raster data model represents the geographical feature as cell matrices that store numeric values.

A raster consists of a matrix of cells (or pixels) organized into rows and columns (or a grid); each cell contains a value representing information.

The method using dots, in which each pixel (picture element) is bitmap imaging, and is known as raster graphics.

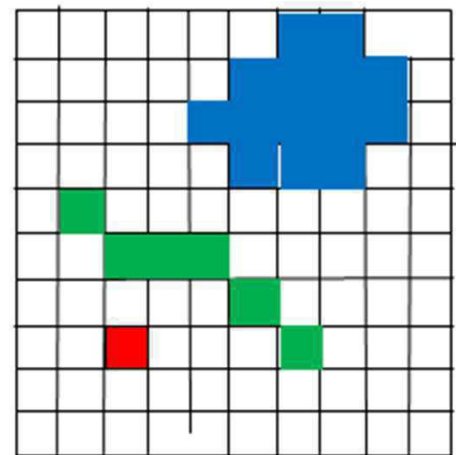


Figure 2-4 - Raster Model - Image files composed of grid cells (pixels)

2.4.5. *Advantage of Raster model:*

- Raster graphics technology is inexpensive and widely available, as most people own devices capable of generating raster images.
- Raster graphics have a simple underlying data structure, where each grid location represents a single value or series of values.
- The simplicity of the raster data structure makes it useful for a wide range of applications and allows for easy overlay analysis.
- Raster graphics are easily interpretable and maintainable compared to their vector counterparts.
- Raster format is powerful for advanced spatial and statistical analysis, representing continuous surfaces and performing surface analysis.
- Raster data can uniformly store points, lines, polygons, and surfaces.
- Raster data allows for fast overlays with complex datasets.

2.4.6. *Disadvantage of Raster model:*

- Raster files can be very large in size, especially for datasets covering large areas with fine resolution.

- Increasing quantities and qualities of raster datasets result in larger file sizes.
- Enlarging or zooming raster images may result in loss of details and coherence, leading to pixelation.
- Geometric transformations during map re-projection can cause issues with the size, shape, and pixel values of raster graphics.
- Overlaying and analyzing raster graphics produced at different scales and pixel resolutions can lead to nonsensical output and difficulties in interpretation.
- Some types of spatial analyses, network analysis, and geocoding can be problematic to perform on raster data.

2.5. How GIS work:

Geographic Information Systems work by integrating spatial data (data with a location component) with various analytical tools to understand and visualize geographic patterns, relationships, and trends. The process involves several key components and steps:

2.5.1. Data Collection:

GIS begins with the collection of geospatial data. This can include data from satellite imagery, aerial photography, GPS surveys, field surveys, and existing datasets. The data collected should be relevant to the specific application or analysis being conducted.

2.5.2. Data Input:

Once collected, the geospatial data is input into the GIS system. This involves converting data from different sources and formats into a common format that can be processed and analyzed by the GIS software. Common data formats include shapefiles, geodatabases, raster images, and GPS coordinates.

2.5.3. Data Storage:

The geospatial data is stored in a spatially-enabled database or file system within the GIS software. This allows for efficient storage, retrieval, and management of the data. The data can be organized into layers or themes, representing different geographic features such as roads, buildings, or vegetation.

2.5.4. Data Integration:

GIS allows for the integration of diverse data sources into a single framework. Spatial data can be combined with attribute data, which provides additional information about the features.

Integration involves linking the attribute data to the corresponding geographic features based on a unique identifier or spatial relationship.

2.5.5. Spatial Analysis:

One of the key strengths of GIS is its ability to perform spatial analysis. This involves applying various analytical tools and techniques to the geospatial data to uncover patterns, relationships, and insights. Spatial analysis can include overlaying multiple layers to identify spatial relationships, conducting proximity analysis, generating buffers, performing statistical analysis, and running geoprocessing operations.

2.5.6. Data Visualization:

GIS enables the visualization of geospatial data through maps, charts, graphs, and 3D representations. Visualization helps in understanding complex spatial patterns and communicating information effectively. GIS software provides tools for symbolizing and styling map features, creating thematic maps, and generating interactive visualizations.

2.5.7. Output and Decision-Making:

The results of spatial analysis and data visualization are used to inform decision-making processes. The insights gained from GIS help in making informed decisions related to resource allocation, urban planning, environmental management, emergency response, infrastructure development, and more.

2.6. Applications of GIS:

Urban Planning and Infrastructure Management: GIS aids in urban planning by analyzing land use patterns, transportation networks, and infrastructure management. It helps identify suitable locations for new facilities, assess environmental impacts, and optimize resource allocation.

Environmental Management: GIS plays a crucial role in environmental management by monitoring and analyzing natural resources, ecosystems, and environmental risks. It enables the identification of sensitive areas, tracking changes over time, and supporting decision-making for conservation efforts.

Emergency Management and Disaster Response: GIS assists in disaster preparedness, response, and recovery by providing real-time spatial information. It aids in evacuation planning, resource allocation, and damage assessment during natural disasters or emergencies.

Agriculture and Natural Resource Management: GIS helps optimize agricultural practices by analyzing soil characteristics, water availability, and crop suitability. It supports precision agriculture techniques, such as variable rate application of fertilizers, and aids in natural resource management, such as forestry and wildlife habitat mapping.

2.7. GIS Software tools:

There are a lot of GIS software tools, each theme has a significant role in GIS technology:

2.7.1. Arc GIS:

Developed by ESRI, a general-purpose GIS software system. It's a large and well-integrated software platform for creating operational GIS. A geographic information model for modelling aspects of the real world; components for storing and managing geographic information in files and databases; a set of out-of-the-box applications for creating, editing, manipulating, mapping, analyzing, and disseminating geographic information; and a collection of web services that provide content and capabilities (data and functions) to networked software clients are all included in ArcGIS. Mobile devices, laptop and desktop PCs, and servers may all run parts of the ArcGIS software system. ArcGIS offers a broad range of features bundled in a basic set of menus driven GIS apps that execute core geographic operations.

2.7.2. Googol Earth:

It is a computer application that creates a 3D picture of Earth based mostly on satellite images, previously known as Keyhole Earth Viewer. The application maps the Earth by superimposing satellite photos, aerial photography, and GIS data onto a three-dimensional globe, allowing users to view towns and landscapes from multiple perspectives. It simplifies the exploration of world by Entering addresses and coordinates, with the help of modern peripherals. it is also a Web Map Service client that can display many types of imagery layered on the earth's surface. In addition to Earth navigation, Google Earth's desktop program offers a number of other features, including a distance measurement tool. It includes photorealistic 3D images created using photogrammetry, as well as 3D architectural models in select cities. The imagery from Google Earth is shown on a digital globe that shows the planet's surface as a single composited image taken from a large distance.

2.7.3. GRASS GIS:

GRASS GIS is one of the most widely used freeware GIS software. It's been around for almost a quarter-century. It was designed by the United States Army Corps of Engineers as a land management and environmental planning tool. This open-source software is now used by academics, government entities (NASA, NOAA, USDA, and USGS), and GIS practitioners since the code can be scrutinized and modified to their needs. GRASS GIS stored the processed data from several projections to be stored in different folders. The tools of GRASS GIS are:

- Image classification and PCA.
- Edge detection.
- Radiometric correction.

2.7.4. QGIS:

QGIS (Quantum GIS) is a user-friendly Open-Source Geographic Information System (GIS) licensed under the GNU General Public License. QGIS is an official project of the Open Source Geospatial Foundation (OSGeo).

That provides a comprehensive set of tools for managing, analyzing, and visualizing geospatial data. [5]



Figure 2-5. QGIS Logo

2.7.4.1. Installation:

To install QGIS, follow these steps:

- Visit the official QGIS website (<https://www.qgis.org>) and navigate to the "Download" section.
- Select the appropriate version of QGIS for your operating system (Windows, macOS, Linux).
- Download the installer and run it.
- Follow the on-screen instructions to complete the installation process.

2.7.4.2. User Interface:

The QGIS user interface consists of various components:

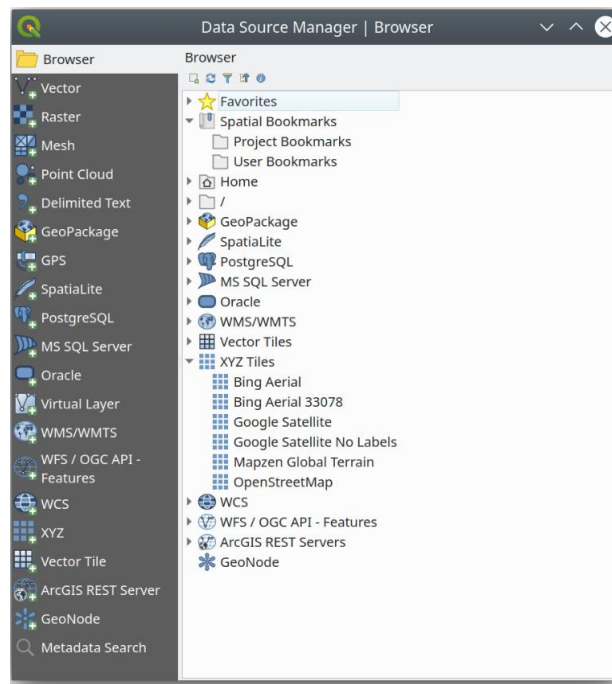


Figure 2-7: QGIS Data Source Manager dialog

- **Adding Data:** QGIS allows you to add data from different sources, such as local files, online services, and databases.
- **Data Editing:** Enables editing of vector data, including creating, modifying, and deleting features.
- **Data Querying:** Provides tools for querying attribute data and spatial relationships between features.
- **Data Joins and Relates:** Allows you to combine attribute data from different sources based on common fields.
- **Data Export:** Enables the export of data to different formats for further analysis or sharing.

2.7.4.3.2. Analysis and Processing:

QGIS offers a wide range of tools for spatial analysis and geoprocessing:

- **Buffering:** Creates buffers around features based on a specified distance.
- **Overlay Analysis:** Performs operations like intersection, union, difference, and spatial joins between layers.
- **Spatial Queries:** Allows for querying features based on their spatial relationship with other features.
- **Network Analysis:** Provides tools for routing, network analysis, and optimization.

- **Geoprocessing:** Offers an extensive set of tools for data manipulation, conversion, and analysis.

2.7.4.3.3. Cartographic Representation:

QGIS provides advanced cartographic tools for creating high-quality maps:

- **Styling:** Allows you to customize the appearance of map features, including symbolization, colors, and labels.

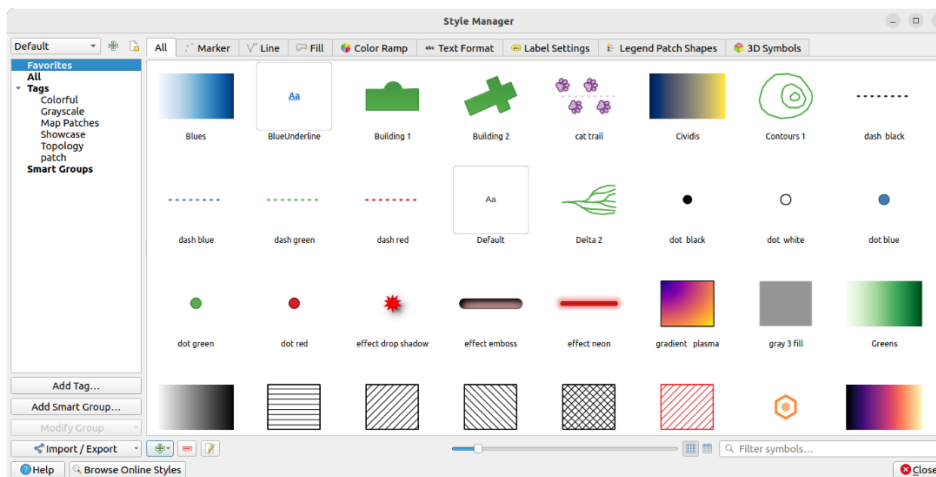


Figure 2-8 - QGIS style library⁴

- **Printing and Layouts:** Enables the creation of map layouts with multiple map views, legends, scale bars, and other elements, and printing or exporting them to various formats, including PDF, SVG, and image formats.

⁴ https://docs.qgis.org/3.28/en/docs/user_manual/style_library/style_manager.html

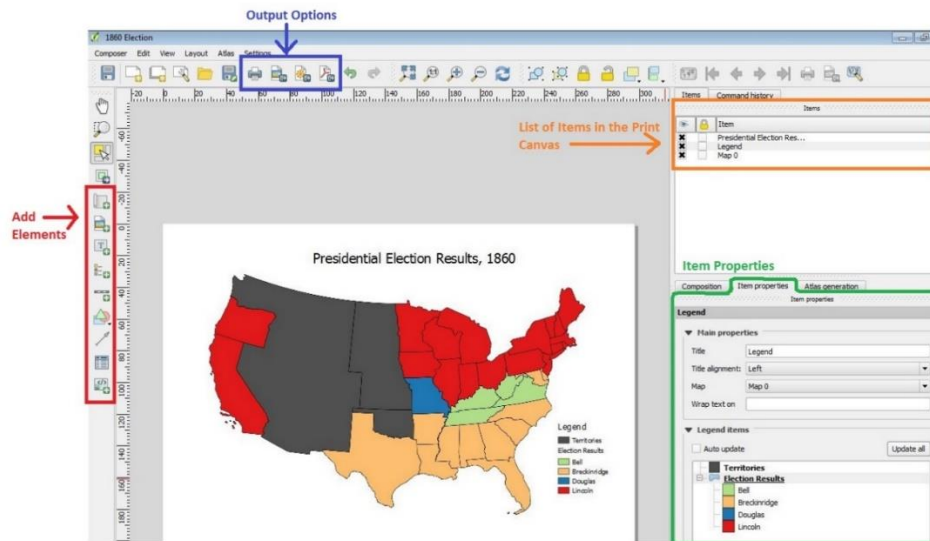


Figure 2-9 - Print layout ⁵

2.7.4.3.4. Plugin System:

QGIS supports a plugin system that extends its functionality. Users can access a wide range of community-developed plugins for specific tasks or integrate custom plugins.

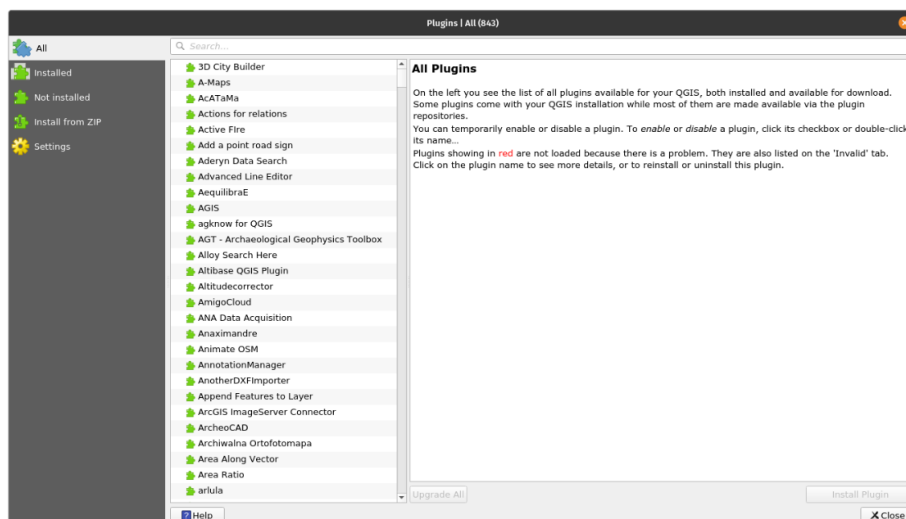


Figure 2-10 - QGIS plugins manager ⁶

⁵ https://docs.qgis.org/3.28/en/docs/training_manual/map_composer/map_composer.html

⁶ https://docs.qgis.org/3.28/en/docs/training_manual/qgis_plugins/index.html

Chapter 3

Airport Mapping Data Base AMDB

3.1. Definition:

ICAO further references the notion **aerodrome mapping database (AMDB)**, defined as "A collection of aerodrome mapping data organized and arranged as a structured data set", and points at the industry requirements of the related applications,

ICAO also defines AMDB as a digital database that contains accurate and up-to-date information about the physical and operational characteristics of an airport and its surroundings. [6]

3.2. Role of AMDB:

An aerodrome cartographic database contains all the information and data concerning the aerodrome and its infrastructure and its environment, it is also a directory of installations, Notam data and frequencies used, accessible to all aerodrome users in order to allow safe and efficient operations regardless of visibility and traffic density, and this by exposing to the users of the aerodrome, the infrastructures of the airport and their arrangements as well as their real positions on the surface of the aerodrome. [6]

The use of cartographic databases ensures the transition from the graphic display of the aerodrome to an electronic display allowing the various operators of the aerodrome to have a better visualization of their environment. [7]

This electronic chart information may also be used by other aerodrome operators such as aerodrome managers and aerodrome security personnel to ensure:

- Management of emergency and security services.
- Cartographic information.
- Flight simulation.
- Airfield management.
- Runway operations.
- Surveillance, detection and warning of runway incursions.
- Aerodrome surface guidance and navigation.

3.3. AMDB Requirements:

The general requirements for acquiring and processing aerodrome mapping data for the creation of an Airport Mapping Database:

- **Data Acquisition:** Various methods, such as aerial photogrammetry, satellite photogrammetry, field surveying, and digitization of existing analog charts, can be used to capture aerodrome mapping data. The process used for data acquisition should be described and consistent with the document's requirements.
- **Data Merging:** When merging multiple data sets to create a complete AMDB, each individual data set must be geo-referenced to the WGS-84 ellipsoid (horizontal) and orthometric height (vertical). Digital graphical editing procedures are recommended to align and match features from different sources accurately.
- **Data Conversion:** Data sets may need to be converted to WGS-84 latitude/longitude (horizontal) and orthometric height (vertical), but the original data must meet quality standards. Data conversion algorithms should not degrade the data quality below the specified levels.
- **Data Source Identification:** The originator of the aerodrome mapping data must identify the source of the data provided to the user.
- **Data Traceability:** Adequate information must be provided to maintain the traceability of the AMDB, following established quality procedures and processes. This can be achieved by providing metadata records or survey reports upon request.
- **Database Update Cycles and Timeliness:** The AMDB should be updated in accordance with the AIRAC cycle schedule to account for new data, changes, and errors. The database manager must issue the updated database no later than the next AIRAC date and provide a list of changes since the previous issuance.
- **Processing, Handling, and Distribution of Aeronautical Data:** The integrity of the aeronautical database products, including the AMDB, must be preserved during all phases of transfer, distribution, and handling.
- **Verification and Validation:** Sufficient verification and validation of the data must be performed to ensure its quality. Various techniques can be employed, such as independent measurement, comparison with other recorded data, user feedback, and demonstration through simulation or flight tests.
- **Supplier Qualifications:** Suppliers should provide quality information with the aerodrome mapping data, demonstrating compliance with relevant standards and guidance.

- **Data Element Extent and Boundary Definition:** The spatial extent of the AMDB varies depending on the data element being collected and handled. Different data types may have different collection methods and requirements.

3.4. Creation of an AMDB:

On general we need two types of data to create an AMDB, Geographical data which work as a geospatial references and Aerodrome data.

3.4.1. Geographic data:

According to doc 9181, Any method is acceptable for capturing aerodrome mapping data as long as it subject to the information requirements specified in the document, for example:

- **Satellite Imagery:** High-resolution satellite imagery provides a visual representation of the airport and its surroundings, including runways, taxiways, terminals, and other infrastructure.
- **Aerial Photography:** Aerial photographs offer detailed views of airport features, such as markings, signage, and ground markings, which are essential for precise mapping.

3.4.2. Aerodrome data:

Aerodrome databases are typically constructed by converting photogrammetric image to vectors (geometry elements) and assigning themes and attributes using GIS techniques.

3.4.2.1. Geometry elements:

Typical types of geometry are point, line and polygon:

- A point is the smallest unit of geometry and has no spatial extent. Points are described by two dimensional (2-D) or three-dimensional (3-D) coordinates.
- A line consists of a connected sequence of points. Start- and end-points of a line are referred to as start and end-node. Connecting points that are in between start- and end-nodes are referred to as vertices. A start-node and an end-node define a line's directionality. A connection between a node and a vertex or between vertices is a straight line.
- A polygon is a surface described by a closed line (i.e., a line whose start-node and end-node are coincident). The closed line forms the outer edge of the surface. The inside of the polygon is defined by the left side in the order of vertices.


Symbol	Type
✕	Point
—	Line
	Polygon

Figure 3-1 - Type of Geometry

It is recommended that vector-based data be used for the characterization of aerodrome features in AMDBs for its several advantages:

- Small data storage requirement
- Easy use of a relational database structure
- Easier updating
- No need of feature recognition software
- Easy attachment of attributes

An alternate approach is to use raster data or imagery.

Using this approach, features are portrayed via contiguous pixels of equal or similar density number. This less precise method may be acceptable for some applications.

3.4.2.2. Data elements:

Data elements are listed in six classes according to doc 9881: runways, helipads, taxiways, aprons, vertical structures, construction areas, and quality data. For each element (feature) the following information must be provided: name, description, survey method, geometry type, and attribute list (featype, idarpt, objectid, idp, vacc, hacc, vres, hres, source, integr, revdate, ...). These attributes are defined in Table 1. For each attribute, a name and description should be provided. [8]

Table 3-1 - Required attributes for supplemental aerodrome features

Attribute	Name	Description
Feature type	featype	Textual description of the feature type
Airport ID	idarpt	ICAO location indicator
Object ID	idobj	Unique identifier for the feature
Data Source Identifier	source	Name of entity or organization that supplied data. In case of initial data origination, name of data originator
Geometry	geopnt, geoline, geopoly	Point feature, line feature or polygonal feature, respectively
Horizontal Accuracy	hacc	Horizontal accuracy of the recorded position
Horizontal Confidence Level	hconf	The probability that the recorded position is within the stated horizontal accuracy of the true position
Vertical Accuracy	vacc	The vertical accuracy of the recorded elevation
Vertical Confidence Level	vconf	The probability that the recorded position is within the stated vertical accuracy of the true position
Horizontal resolution	hres	Horizontal resolution of the recorded position
Integrity	integr	Integrity of data is the degree of assurance that the data and its value have not been lost nor altered since the data origination or authorized amendment
Time Stamp	revdate, revtime	Time of origination or of last data revision

3.4.2.2.1. Runway:

The runway class has eleven elements:

- Runway Elements
- Runway Intersections
- Runway Thresholds
- Runway Markings
- Painted Centerline
- Land and Hold Short Operations (LAHSO) Locations
- Arresting Gear Locations
- Runway Shoulders
- Stopways
- Runway Displaced Areas

- Runway Exit Lines

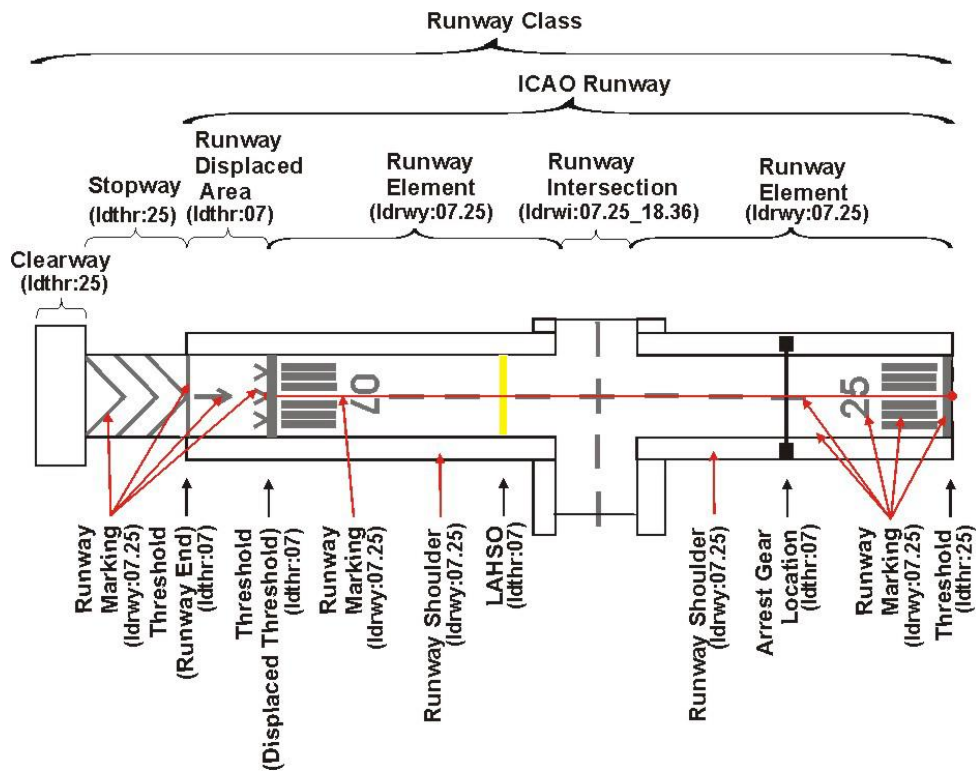


Figure 3-2 Runway elements class

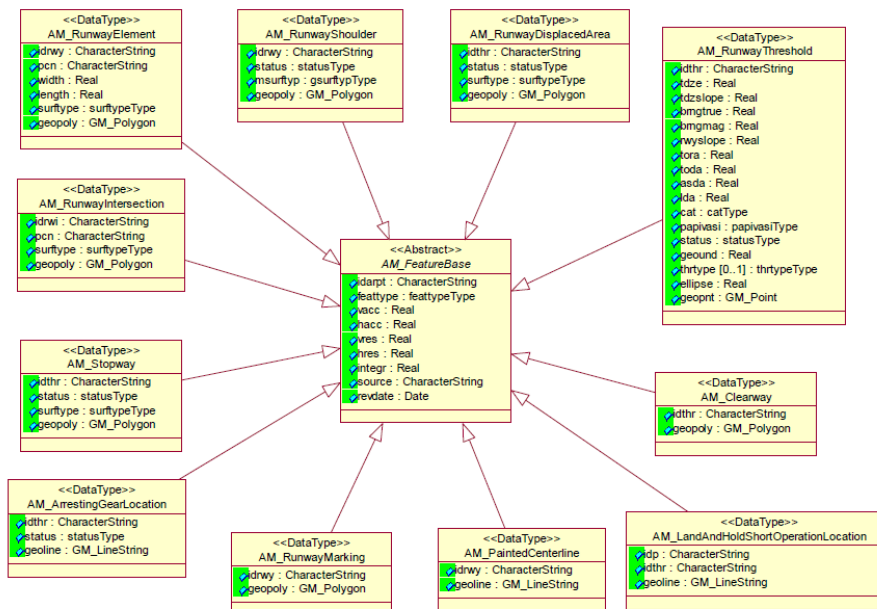


Figure 3-3 Runway feature types for aerodrome mapping data

3.4.2.2.2. Taxiway:

The taxiway class has 5 elements:

- Taxiway Element
- Taxiway Shoulders
- Taxiway Guidance Lines
- Taxiway Intersection Markings
- Taxiway Holding Positions

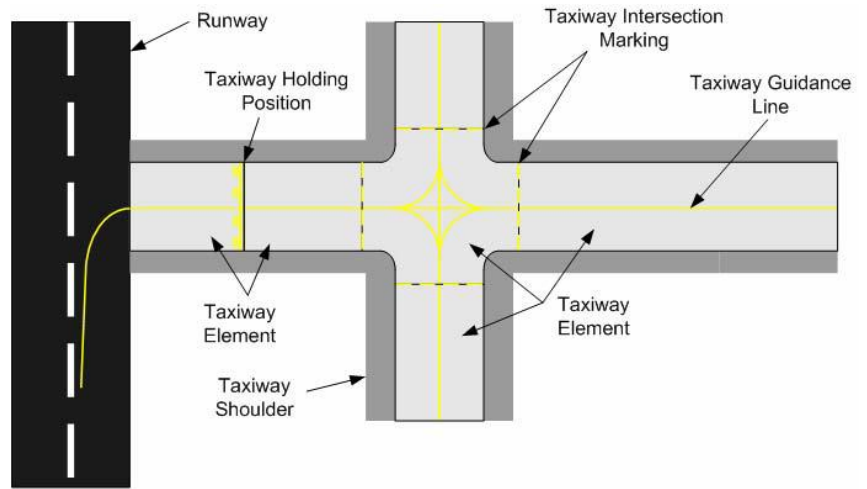


Figure 3-4. Taxiway elements class

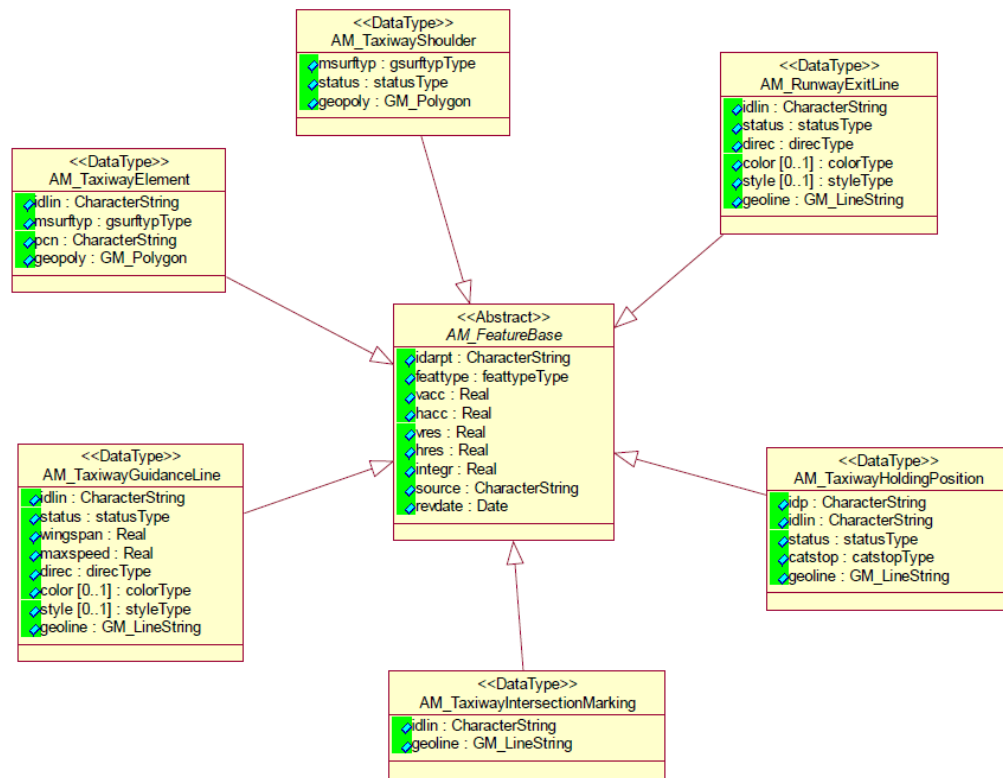


Figure 3-5 Taxiway feature types for aerodrome mapping data

3.4.2.2.3. *Apron:*

The Apron class contains 5 elements:

- Apron Elements
- Stand Guidance Lines
- Parking Stand Locations
- Parking Stand Areas
- De-icing Area

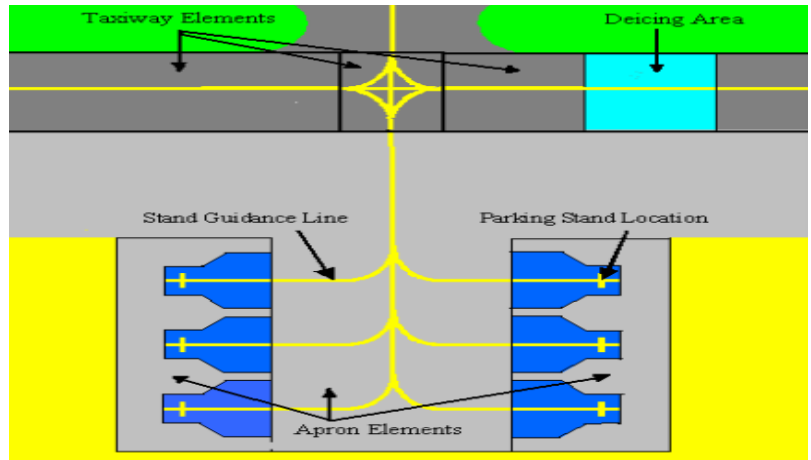


Figure 3-6. Aprons elements class

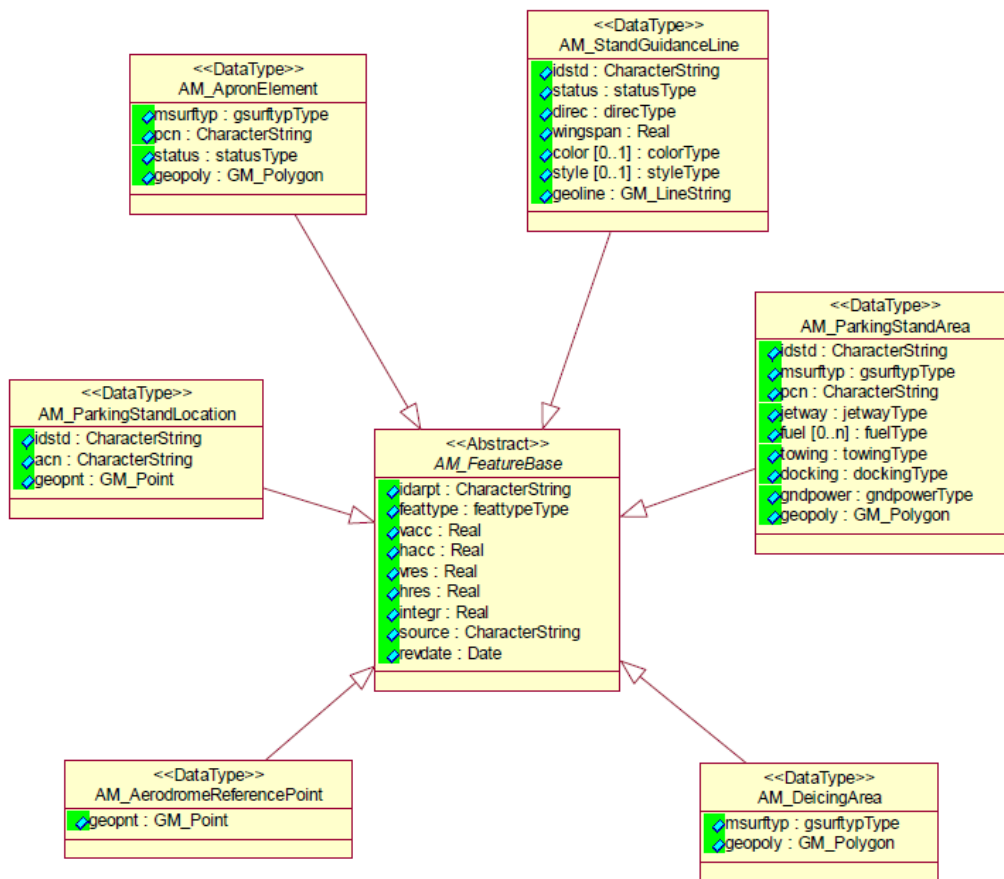


Figure 3-7 Apron feature types for aerodrome mapping data

3.4.2.2.4. *Vertical Structures:*

- Vertical Polygonal Structures
- Vertical Line Structures
- Vertical Point Structures

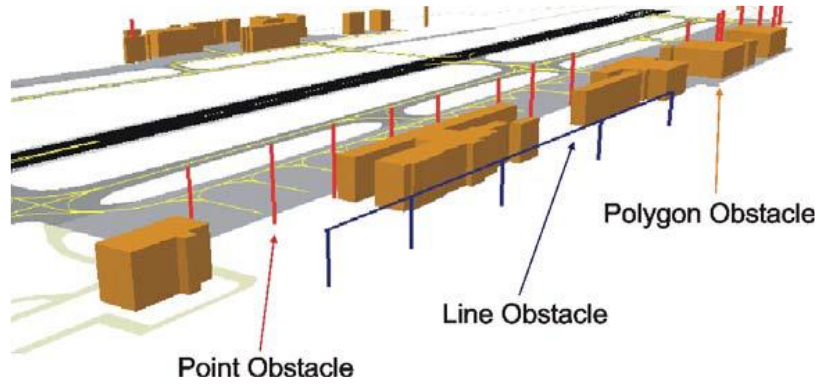


Figure 3-8. Vertical Structures

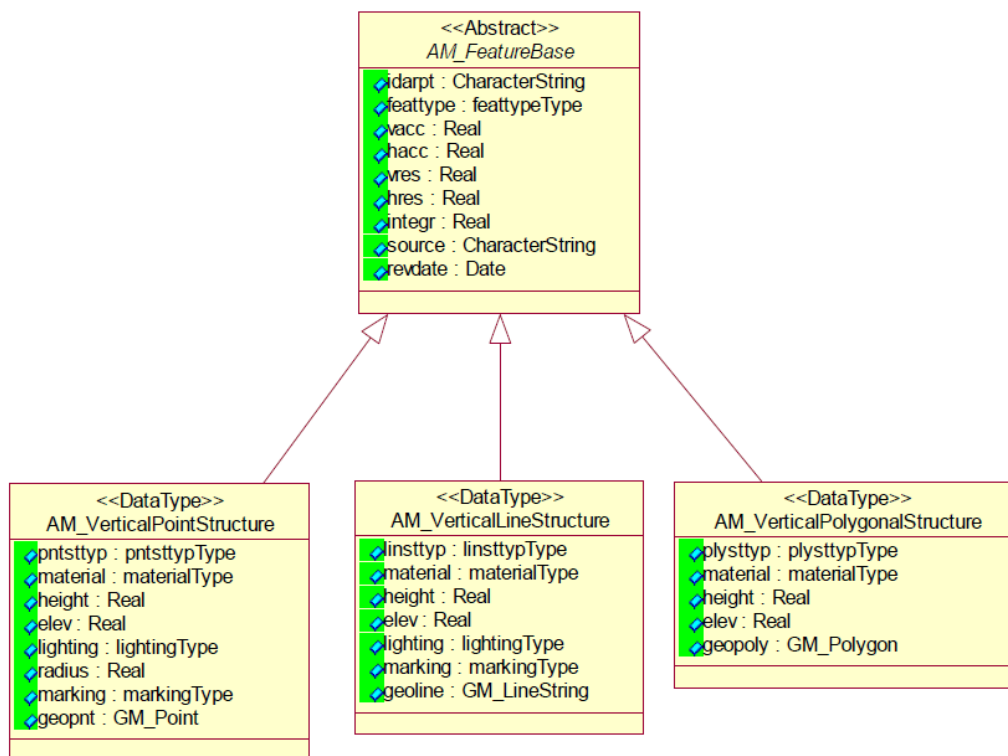


Figure 3-9 Vertical structure feature types for aerodrome mapping data

3.5. AMDB Quality:

3.5.1. Accuracy:

The accuracy of AMDB is categorized into three levels: Fine, Medium, and Coarse. Fine accuracy requires a confidence level of 95%, while Medium and Coarse accuracy require a confidence level of 90%. Critical elements may require additional validation to ensure accuracy within prescribed limits.

3.5.2. Resolution:

The resolution of the AMDB must be sufficient to meet the horizontal and vertical accuracy requirements specified in the tables. The tables provide minimum resolution requirements for different data elements.

3.5.3. Integrity:

The integrity of AMDB data is classified into three categories: Critical, Essential, and Routine. Critical data has a high probability of severely risking safe aircraft operation if corrupted and requires an integrity level of 10⁻⁸ or better. Essential and Routine data have lower probabilities and require integrity levels of 10⁻⁵ or better and 10⁻³ or better, respectively. Data integrity must be maintained throughout the data process.

3.5.4. Numerical Requirements:

The tables (Table 3-2 and Table 3-3) list data quality requirements for Coarse, Medium, and Fine categories of AMDB data. Coarse data has the minimum acceptable quality and supports limited applications. Medium data supports most aviation applications, and Fine data supports all aviation applications. The data derivation may be surveyed, calculated, or as charted, with preference given to surveyed values.

Table 3-2 Horizontal data quality requirements

Data Element	Data Derivation	Fine			Medium			Coarse			Max Error	
		A	R	I	A	R	I	A	R	I		
Runway element	S	1		0.1	C	5	0.1	-	30	1	-	-
Runway intersection	S	1		0.1	C	5	0.1	-	30	1	-	-
Runway threshold	S	1		0.1	C	5	0.1	-	NS	NS	-	3
Painted centerline	S	0.5		0.01	C	5	0.1	-	NS	NS	-	2
LAHSO	S	1		0.1	R	5	0.1	-	NS	NS	-	3
Arresting gear location	S	1		0.1	-	5	0.1	-	30	1	-	-
Runway shoulder	S	1		0.1	-	5	0.1	-	30	1	-	-
Stopway	S	1		0.1	-	5	0.1	-	30	1	-	-
Runway displaced area	S	1		0.1	C	5	0.1	-	30	1	-	-
Runway marking	as charted	NS		NS	-	NS	NS	-	NS	NS	-	-
FATO	S	1		0.1	C	5	0.1	-	5	0.1	-	-
TLOF	S	1		0.1	C	5	0.1	-	5	0.1	-	-

Helipad threshold	S	1		0.1	C	5	0.1	-	NS	NS	-	-
Taxiway element	S	1		0.1	-	5	0.1	-	5	0.1	-	-
Taxiway shoulder	S	1		0.1	-	5	0.1	-	5	0.1	-	-
Taxiway guidance line	S	0.5		0.01	C	5	0.1	-	NS	NS	-	2
Taxiway intersection marking	S	0.5		0.01	C	5	0.1	-	NS	NS	-	-
Taxiway holding position	S	1		0.1	-	5	0.1	-	NS	NS	-	3
Runway exit line	S	0.5		0.01	C	5	0.1	-	NS	NS	-	2
Frequency area	C	NS		NS	-	NS	NS	-	NS	NS	-	-
Apron	S	1		0.1	-	5	0.1	-	30	1	-	-
Stand guidance line	S	0.5		0.01	E	5	0.1	-	NS	NS	-	2
Parking stand location	S	0.5		0.01	E	5	0.1	-	30	1	-	2
Parking stand area	C	1		0.1	-	5	0.1	-	30	1	-	-
Deicing area	S	1		0.1	-	5	0.1	-	30	1	-	-
Vertical polygonal objects	S	0.5		0.1	E	5	0.1	-	30	1	-	-
Vertical point objects	S	0.5		0.1	E	5	0.1	-	30	1	-	-
Vertical line objects	S	0.5		0.1	E	5	0.1	-	30	1	-	-
Construction area	S	1		0.1	-	5	0.1	-	5	0.1	-	-
Aerodrome reference point	C	30		1	R	30	1	R	30	1	R	-
Survey control point	S	0.5		0.01	E	0.5	0.01	E	NS	NS	-	-
Service road	S	1		0.1	-	5	0.1	-	30	1	-	-
Aerodrome boundary	C	NS		NS	-	NS	NS	-	NS	NS	-	-

Table 3-3 - Vertical data quality requirements

Data Element	Data Derivation	Fine			Medium			Coarse			Max Error
		A	R	I	A	R	I	A	R	I	
Runway threshold (non-precision)	S	0.5	0.1	E	NS	NS	-	NS	NS	-	3
Runway threshold (precision)	S	0.25	0.01	C	NS	NS	-	NS	NS	-	-
Painted centerline	S	1	0.1	-	NS	NS	-	NS	NS	-	6
Helipad threshold	S	0.5	0.1	C	NS	NS	-	NS	NS	-	-
Survey control point	S	0.25	0.01	E	NS	NS	-	NS	NS	-	-
Threshold elevation (non-precision)	S	0.5	0.1	E	NS	NS	-	NS	NS	-	3
Threshold elevation (precision)	S	0.25	0.01	C	NS	NS	-	NS	NS	-	-
Max height of vertical object	C	1	0.1	E	1	0.1	-	NS	NS	-	-
Max elevation of vertical object	S	1	0.1	E	1	0.1	-	NS	NS	-	-
Touchdown zone elevation	S	1	0.1	-	1	0.1	-	NS	NS	-	-

3.6. AMDB Application:

AMDBs are used in wide variety application, such as:

3.6.1. Pilot Navigation:

Pilots require graphical representations of aerodrome sites, including movement and non-movement areas, for safe and efficient navigation. Currently, this is done through paper charts. An alternative or supplemental of graphically depicting aerodromes is by way of a flight deck electronic display. This would provide a tool for pilots to visualize their physical environment while on the aerodrome surface, or while planning an arrival to a specific aerodrome.

The display system can utilize a spatial database that includes various themes or layers, allowing pilots to integrate specific information types with the real-world scenes.

The themes can include physical features like runways, taxiways, aprons, pavement segments, hydrography, buildings/structures, lighting, signage, etc.

The database can support multiple spatial models or polygonal zones, which are 2D and/or 3D shapes used for spatial cueing or data visualization. The electronic display can also provide access to aerodrome-specific data, such as frequencies, operational constraints, and local procedures, which are typically included in paper charts.

this would reduce cockpit clutter and workload during surface operations and ease flight planning activities.

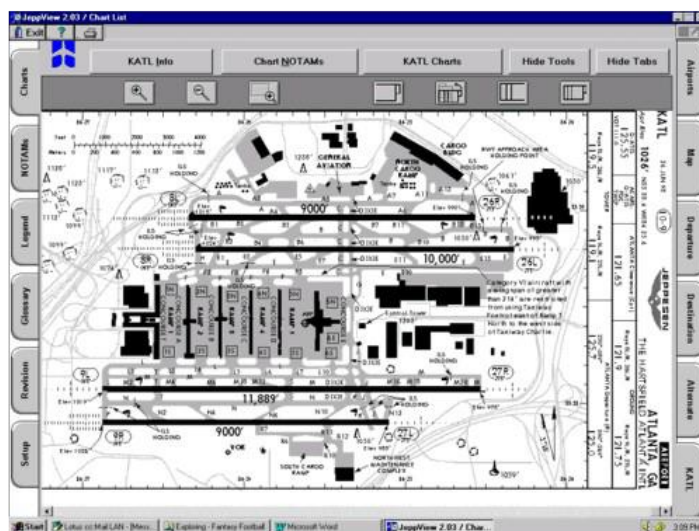


Figure 3-10 Example of aerodrome mapping information display

3.6.2. Surveillance and Conflict Detection:

In today's operations, flight crews maintain traffic awareness on the surface by way of frequent visual scans and, in some cases, radio communications with ATC to obtain traffic advisories. Except for a few rare runway/taxiway geometries (obtuse-angled intersections) and high-workload situations, this method of surveillance is adequate during VMC. However, as weather conditions deteriorate (i.e., IMC), at night, or under high workload conditions, maintaining awareness of traffic on the aerodrome surfaces can become increasingly difficult. In these types of situations, uncertainties can arise that, in the best case, reduce traffic flow rates, and in the worst case, increase the likelihood of a runway incursion and/or surface accident.

Air traffic controllers can utilize the Aerodrome Movement Area Safety System AMASS (A system based on aerodrome mapping database) to enhance situational awareness and make informed decisions. It provides a visual representation of the aerodrome layout, enabling controllers to monitor aircraft movements, plan taxi routes, and manage traffic flow more efficiently.



Figure 3-11. Aerodrome movement area safety system (AMASS) display

3.6.3. Route and Hold-Short Portrayal and Deviation Detection and Alerting:

In today's aerodrome environment, both departure and arrival taxi routes instructions are provided by ATC to the flight deck by way of VHF voice radio communication. Pilots are required to read back these instructions to confirm their understanding. Taxi routes are typically memorized or written down by the pilots, and they navigate using signage. Arrival taxi routes

are usually requested after clearing the arrival runway, while departure taxi routes are requested before entering the movement area. For this type of application, taxi routes would be depicted on a graphical display of the aerodrome layout.

One representation method is using a magenta line similar to navigation displays in flight (Figure 3-12). Hold-short instructions can also be graphically represented with red bars at designated hold points, which are removed when ATC clears the aircraft to continue taxiing. These methods have been flight tested and proven effective.



Figure 3-12. Perspective view

The taxi routes and hold-short locations can be transmitted to the aircraft, stored in an onboard database with a standardized naming convention, or entered manually by the flight crew. The goal is to enhance situational awareness and reduce errors by providing a clear and visual representation of taxi routes and hold-short locations on a graphical display.

3.6.4. Resources Management:

A spatial aerodrome surface database, along with an associated toolset, can provide numerous benefits to commercial airlines, cargo airlines, and services involved in aviation operations. The database can be accessed by aerodrome operations control centers, apron control operations facilities, and maintenance facilities, improving operational efficiency.

The database includes a graphical portrayal of aerodrome surface features, obstacles, and movement boundaries, as well as information on resource status and location. It can be layered with various types of information relevant to resource management, such as service facility information, maintenance areas for general aviation and business aviation, asset identification

and inventory, cargo maintenance areas, parking/stand assignments and status, airline maintenance, apron route planning, and crew scheduling and dispatch information.

One example of utilizing such a database is the Surface Movement System (SMS), which integrates various data sources like airline schedules, stand information, flight plans, radar feeds, and runway configuration. This integration enhances coordination and planning of ground aerodrome traffic operations. The integrated information is shared among relevant stakeholders, including Air Traffic Control Supervisors, Aerodrome Managers/Operators, Air Traffic Controllers, Airline Operators, and Apron Operators.

By utilizing accurate and standardized aerodrome mapping databases (AMDBs), the SMS can be easily configured, customized, and deployed in different aerodrome environments. This enables more efficient monitoring and movement of resources, including aircraft, service vehicles, equipment, crew, passengers, baggage, and cargo. The GIS system and its associated database also facilitate tracking and identification of physical resources, further enhancing operational management.

3.6.5. Training and High Fidelity Simulation:

Flight simulators play a crucial role in advanced flight training and education, including pilot type ratings and mission rehearsals. They are classified into four quality levels (A, B, C, and D), and each level requires a specific database. The database should include general aerodrome outlines, runways, glide slope transmitter and receiver positions, and approach lighting system details.

Level D certified visual systems, which provide the highest level of simulation fidelity, require additional scene content, such as aerodrome features, terrain with major features, and landmarks around the aerodrome. Modern flight simulator databases go beyond these requirements and also include taxiway outlines, markings, signs, apron markings, parking positions, aerodrome buildings, gates, and jetways.

To ensure realistic training and accurate simulation, the geo-referencing of aerodrome databases becomes crucial. As new procedures like GNSS approaches are introduced, simulation databases need to be geo-referenced with precise absolute three-dimensional positions, using the World Geodetic System – 1984 (WGS-84). This is particularly important for integrating Ground Proximity Warning Systems (GPWS) and next-generation navigation displays with moving map taxi-guidance functionality.

Aligning the geo-spatial information stored within aircraft systems (such as GPWS, flight management system, and navigation display) with the simulator's visual database is essential for realistic training. WGS-84 provides a common reference system for these distinct systems.

The use of geo-referenced aerodrome databases in simulators offers several benefits. Simulator database vendors can use these databases as a foundation for creating visual databases. The availability of aerodrome databases reduces costs, as existing databases can be made compliant with WGS-84-referenced GNSS approach procedures. Additionally, the consistency between simulator databases and onboard aircraft databases helps avoid issues with mismatched moving map guidance displays and algorithms like GPWS.

3.6.6. Aerodrome Facility Management:

Aerodrome Facility Management involves various activities such as planning, aerodrome design, facility design, construction, environmental management, and administration. Aerodrome mapping information can greatly benefit these activities by providing a GIS layered database structure with attribute data.

Currently, many aerodromes face the challenge of having isolated "data islands" within different organizations, resulting in duplicated databases and inconsistent standards. Storing data in a GIS database structure can bring significant efficiencies. The primary repository for this database would be an aerodrome operational control center, with secondary repositories located at maintenance control centers, aerodrome engineering centers, and aerodrome movement area control centers.

The planning process plays a crucial role in managing aerodrome facilities, addressing capacity, land use, noise, and environmental management. Planning databases can contain layered information that supports enterprise-level planning.

Aerodrome design requires accounting for larger aircraft, increased operations, and limited runway, taxiway, and apron availability. Design databases should consider present and future needs, allowing for three-dimensional simulations and assessment of alternative schemes.

Facility design on aerodromes involves special considerations such as safety, airspace restrictions, operational issues, noise abatement, and revenue generation. The database should encompass these requirements, including information about roadways, buildings, mechanical, electrical, and plumbing systems.

Construction activities at aerodromes require specific information for personnel, managers, and inspectors. Databases are needed to understand aerodrome operations, safety requirements, government regulations, and coordination of construction activities. Close cooperation between various stakeholders is essential for smooth project management.

Environmental issues are critical for aerodrome projects, and databases play a role in identifying and defining these issues, developing environmental evaluations, providing training, and administering environmental programs.

Administrative requirements involve familiarity with policies, procedures, internal structures, and funding sources. Databases assist in maintaining relationships with civil aviation authorities, understanding development plans, and preparing improvement strategies.

The benefits of aerodrome facility management with the help of GIS databases include reduced staff time, quick response to queries, better information for decision-makers, cost reduction in application development, and the creation of an efficient data warehouse. Consistent and standardized data enhance data management and analysis, provide a common language, and enable compatibility and cooperation between different systems and external data sources.

3.6.7. Emergency and security Services Management:

The operational concept for Emergency and Security Services Management at aerodromes emphasizes the need to integrate adverse weather navigation systems for both aircraft and ground vehicles. Central control and safe operation of the mixed vehicle fleet, including emergency and security vehicles, are crucial under normal and emergency conditions. Common guidance reference data with specific accuracy is essential to prevent coordination issues during adverse weather.

Ground vehicles equipped with special equipment can enhance response capabilities during poor visibility conditions. This improves the ability of rescue and firefighting operations, as well as security operations, to locate incidents and threats more quickly. The Primary Base Station (PBS) located in the aerodrome Operations Communications Center (OCC) serves as a coordination and management hub for emergency and security services. It facilitates tasks such as tracking vehicle location and identity, distributing checklists and procedures, monitoring vehicle status, acquiring incident and hazardous material information, enabling alarm functions, and dispatching resources.

The PBS display is supported by a GIS map database of the aerodrome and surrounding area, including the Aerodrome Emergency Plan (AEP) area. This database can have layered information and be customized for the control center or the vehicles' needs.

The benefits of implementing these systems and databases include faster response times and increased situational awareness for emergency and security vehicles, especially in poor visibility conditions. The OCC can work more efficiently to control and monitor movements, ensuring conflict avoidance and rapid response. The use of common guidance information prevents coordination issues during adverse weather. Developing aerodrome surface databases for simultaneous movement of mixed vehicle and aircraft fleets enhances safety and performance. Operators using these databases and associated displays can reduce workload, improve coordination and dispatch capabilities, facilitate clear communication, and enable drivers to reach destinations quickly and safely regardless of visibility conditions.



Figure 3-13. Emergency/security vehicle display

3.6.8. Aerodrome Operations:

The operational concept for Runway Operations focuses on providing real-time guidance to pilots during take-off, landing roll-out, and runway exit using robust position sensors, displays, and an aerodrome database. This guidance aims to help pilots effectively manage aircraft speed and location on the runway.

During take-off, the system can generate a guidance profile based on changing conditions and provide it on various displays in the flight deck. The guidance can include information on projected V speeds, take-off abort considerations, and alerts for insufficient runway remaining. Similarly, during landing and roll-out, the system can generate guidance profiles to assist the

pilot in making critical decisions. This includes warnings for landing fast or long, guidance to the optimal touchdown point, flare guidance, optimal guidance to the desired exit, remaining runway guidance, warnings of potential overrun, and deceleration guidance for passenger comfort and reduced brake wear.

In low visibility or night conditions, the application can help pilots maintain an appropriate track during take-off, landing roll-out, and taxiing. It can prevent runway excursions by providing a moving map of the aerodrome to ensure the aircraft stays on the runway or taxiway.

The potential benefits of implementing this application for take-offs include a reduced number of take-off aborts and accidents, optimized aircraft performance during departure, and improved fuel efficiency. For approach and landings, the benefits include a reduced number of overruns and go-arounds, predictable roll-out times in any visibility or weather condition, reduced brake wear, optimized aircraft performance, and fewer runway excursions.

Research centers, such as NASA, have developed systems with similar functionalities, such as the Take-off Performance Monitoring System (TOPMS) and the Roll-out Turn-off (ROTO) guidance system, which have been extensively studied in this context.

3.6.9. Notices to Airmen (NOTAM) and Aeronautical Data Overlays:

Aeronautical data overlays, including aerodrome NOTAM, are kind of advisory information that could be disseminated to flight crews using a Flight Information Services – Broadcast (FIS-B) data link system. FIS-B aims to provide advisory information such as weather and flight advisories to enhance pilot awareness and decision-making. The system is intended to supplement existing voice radio communication and is non-binding advice to assist safe flight operations.

The implementation of FIS-B does not replace existing voice radio services and is not considered flight critical. It is expected to supplement established sources of weather and operational information, providing continuous and readily available data to pilots. The Aerodrome Mapping Database (AMDB) can facilitate the graphical display of NOTAM information, overlaying graphical representations onto AMDB objects such as runways and taxiways.

The benefits of this concept include improved and more efficient communication of information, enhanced situational awareness for pilots, reduced reliance on traditional methods like dispatch release forms, and near-instantaneous dissemination of SUA (Special Use

Airspace) and aerodrome-related NOTAM. It also offers cost savings in communications and reduced data entry delays by eliminating intermediaries in the data entry and verification process.

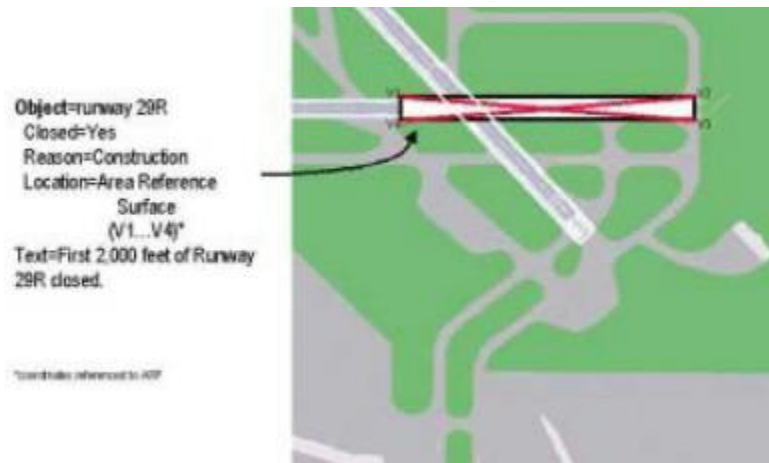


Figure 3-14. NOTAM graphical overlay denoting portion of runway closed

3.7. Conclusion:

While the implementation and maintenance of the AMDB involve significant effort and coordination, the benefits it offers are substantial. From providing accurate and up-to-date information on airport features, to optimizing airspace management and reducing operational costs, The Airport Mapping Database will continue to play a central role in shaping the future of safe and efficient air transportation.

Chapter 4

Application

4.1. Introduction:

In this chapter, we will explore the step-by-step process of creating an Airport Mapping Data Base for DABC Airport using the QGIS software, including data collection, creation of attribute databases and digital maps, and integration.

To ensure the integrity and accuracy of the AMDB, a robust verification and quality assurance process is implemented. This involves cross-referencing the newly created database with existing aeronautical charts, official documents, and other reliable sources of information.

4.2. Why QGIS:

As we saw in **GIS Software** tools: in chapter 2, there are many GIS software tools that help users to capture, store, manipulate, analyze, and present geographic information effectively.

For our project we are choosing the open-source QGIS and that for a various reason:

- **Free and Open-Source:** Being an open-source software, QGIS provides users with the freedom to access, modify, and distribute the software for free and without any licensing restrictions
- **Cross-Platform Compatibility:** QGIS is designed to run on multiple operating systems, including Windows, macOS, and Linux.
- **Extensive Data Support:** QGIS offers comprehensive support for a wide range of geospatial data formats, including vector data (such as Shapefiles, GeoJSON, and KML) and raster data (such as GeoTIFF, JPEG, and NetCDF).
- **User-Friendly Interface:** The software provides a visually appealing and customizable workspace, allowing users to personalize their GIS environment according to their preferences and workflows.
- **Documentation and Community:** QGIS also offers extensive documentation, tutorials, and a supportive community, ensuring users have the resources and assistance they need to maximize their productivity and proficiency.

4.3. Creating cartographic data base:

According to Doc 9881 data elements have been listed in seven classes, each element has different attributes or features that must be captured in the data base [Appendix B].

4.3.1. Create a new project:

From top menu click project > new project, add a name to your project,
You will have new blank map:

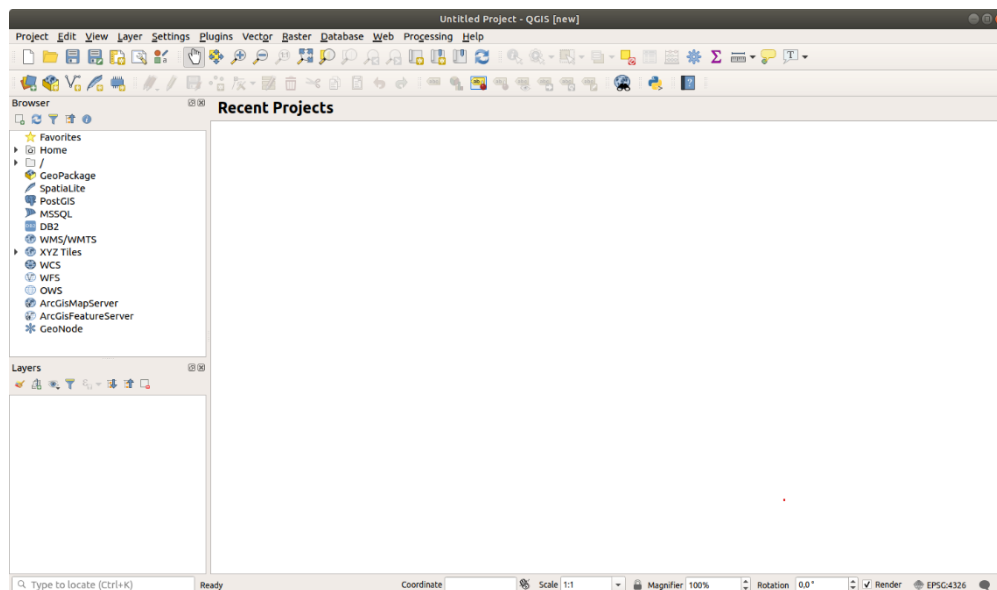



Figure 4-1. QGIS new project

After that we need to add some useful plugins that will help us on our work, from top menu go to Plugins and select  Manage and install plugins.

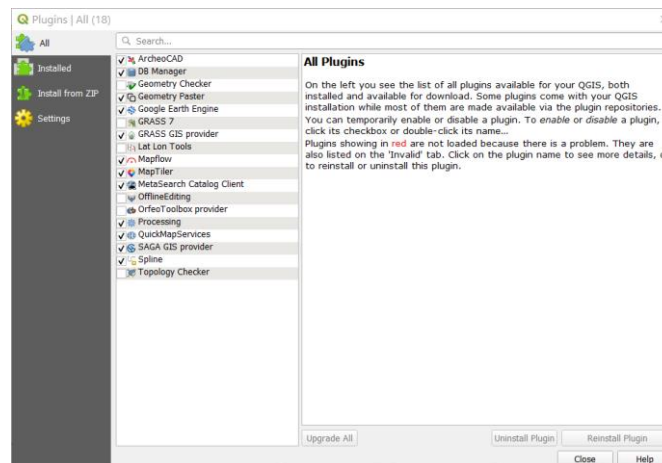


Figure 4-2. Searching a plugin from the showPluginManager All tab

Search for and install the plugins showing in [figure 4-2].

4.3.2. Add reference map:

We will use QuickMapServices plugin to add our reference map (google satellite map), from top menu click on QMS [icon] and chose search QMS, you'll be presented with the QMS dialog, which will allow you to add google satellite map to your project.

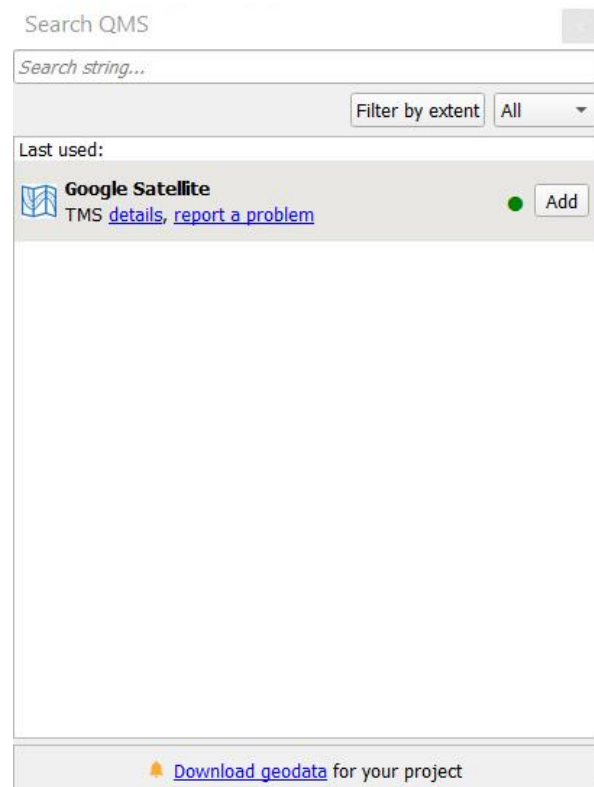


Figure 4-3. QMS dialog

Click the add button and you will see a new layer named **Google Satellite** added to the layers panel and a map added to map panel as follow:

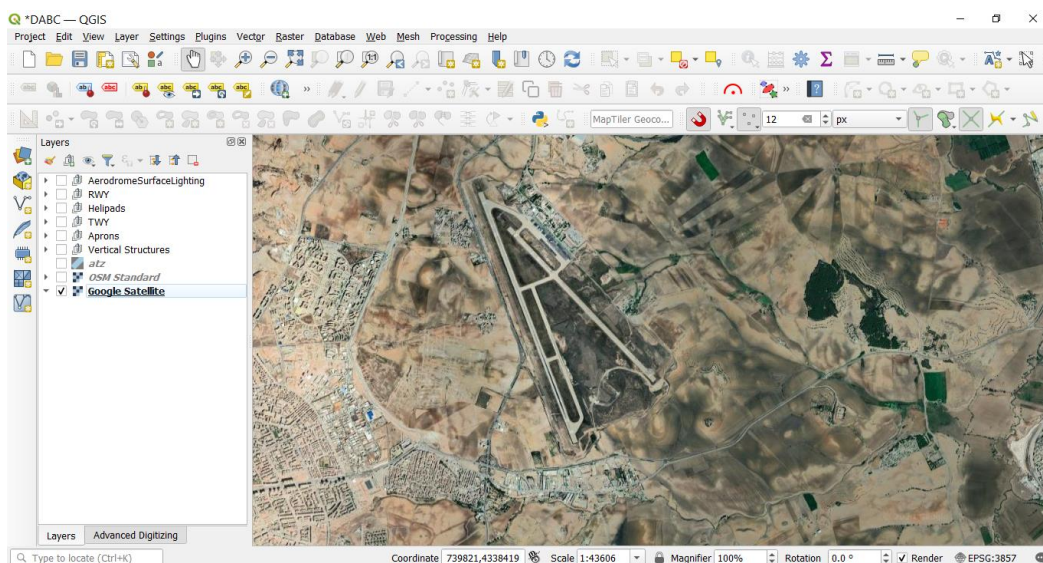























Figure 4-4. Google satellite map

Some basics tools that will use on our project:

Table 4-1. QGIS basics tools

Tool	Purpose	Tool	Purpose
	Access to save, rollback or cancel changes in all or selected layers simultaneously		Turn on or off edit status of selected layer(s) based on the active layer status
	Save edits to the active layer		
	Digitize using straight segments		Digitize using curve lines
	Enable freehand digitizing		Digitize polygon of regular shape
	Add new record		Add Feature: Capture Point
	Add Feature: Capture Line		Add Feature: Capture Polygon
	Vertex Tool (All Layers)		Vertex Tool (Current Layer)
	Set whether the vertex editor panel should auto-open		Modify the attributes of all selected features simultaneously
	Delete Selected features from the active layer		Cut Features from the active layer
	Copy selected Features from the active layer		Paste Features into the active layer
	Undo changes in the active layer		Redo changes in active layer

4.3.3. Add new vector datasets:

Before we can add new vector data, we need a vector dataset to add it to. In our case, we will begin by creating new dataset entirely for each feature in our database [Appendix B],

- Navigate to and click on the menu entry Layer ► Create Layer ► New Shapefile Layer. You'll be presented with the New Shapefile Layer dialog, which will allow you to define a new layer by adding a name, Geometry type and list of fields.

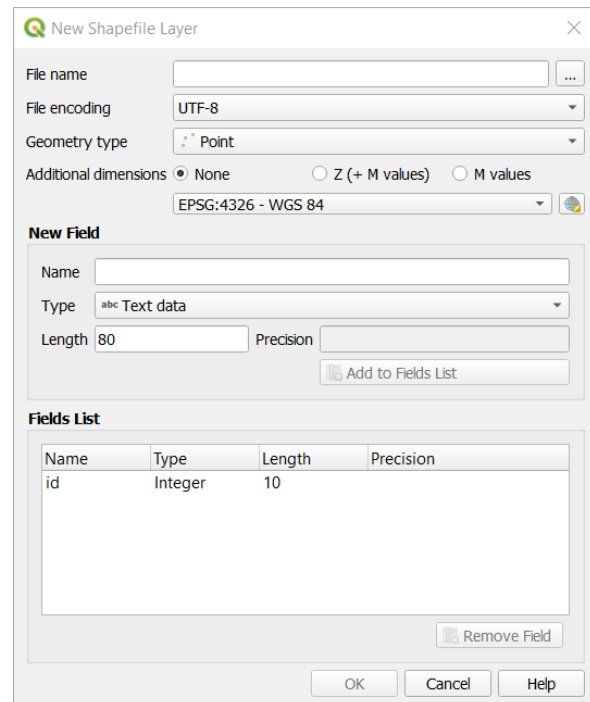








Figure 4-5. New shapefile dialog

For example, the **Runway Elements** feature:

- **Name:** RunwayElement.
- **Geometry Type:** Polygon.
- **Fields:** feattype, idarpt, idrwy, vacc, hacc, vres, hres, source, integr, revdate, pcn, width, length, surftype, geopoly,
- Click ok and the new layer should appear in your Layers panel.
- Click on the feature layer in the Layers panel to select it.
- Click on the  Toggle Editing button to enter **edit mode**. you'll see some digitizing tools become active depending on layer geometry:
 -  Capture polygon for polygons

-  Capture line for lines
-  Capture point for points
-  Vertex tool
- Click on the  Capture polygon button to begin digitizing the layer.
- Start by clicking on a point somewhere along the edge of the runway.
- Place more points by clicking further along the edge, until the shape you're drawing completely covers the runway.

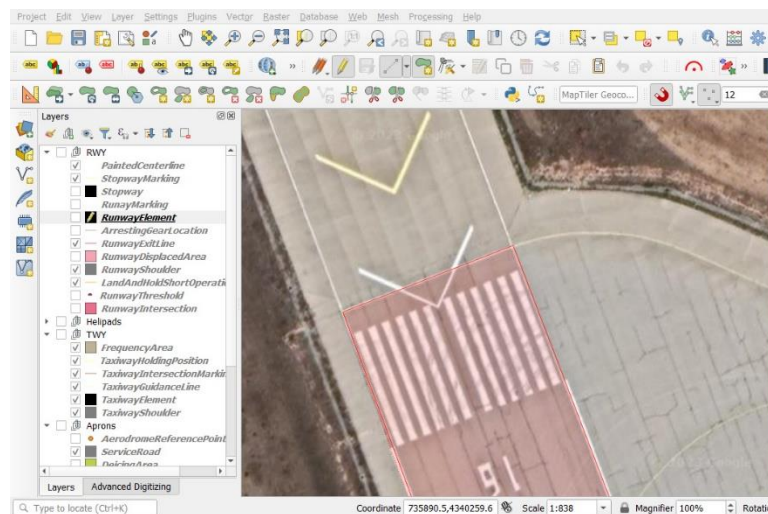


Figure 4-6. Digitizing RunwayElement layer

- After placing your last point, right click to finish drawing the polygon. This will finalize the feature and show you the Attributes dialog.
- Fill in the values as below:

Attribute	Value
pkuid	Autogenerate
featype	NULL
idarpt	NULL
idrwy	NULL
vacc	NULL
hacc	NULL
vres	NULL
hres	NULL
source	NULL
itegr	NULL


Figure 4-7. RunwayElement Feature

- Click OK, and you have created a new feature.

- In the Layers panel select the Runaway Element property layer.
- Right click and choose Open Attribute Table in the context menu.

	pkuid	featype	idarpt	idrwy	vacc	hacc
1	2	NULL	dabc	13/31	NULL	NULL
2	1 2		dabc	16/34	NULL	NULL

Figure 4-8. QGIS Attribute Table

- In the table you will see the feature you just added. While in edit mode you can update the attributes data by double click on the cell you want to update.
- Close the attribute table.
- To save the new feature we just created, click  on Save Edits button.

The same way we create a vector layer for all the elements in our data base.

4.3.4. Styling:

From the layers panel double-click on the layer, this will open a **Layers Properties** dialog which provides general settings to manage appearance of layer features in the map (symbology, labeling, diagrams).

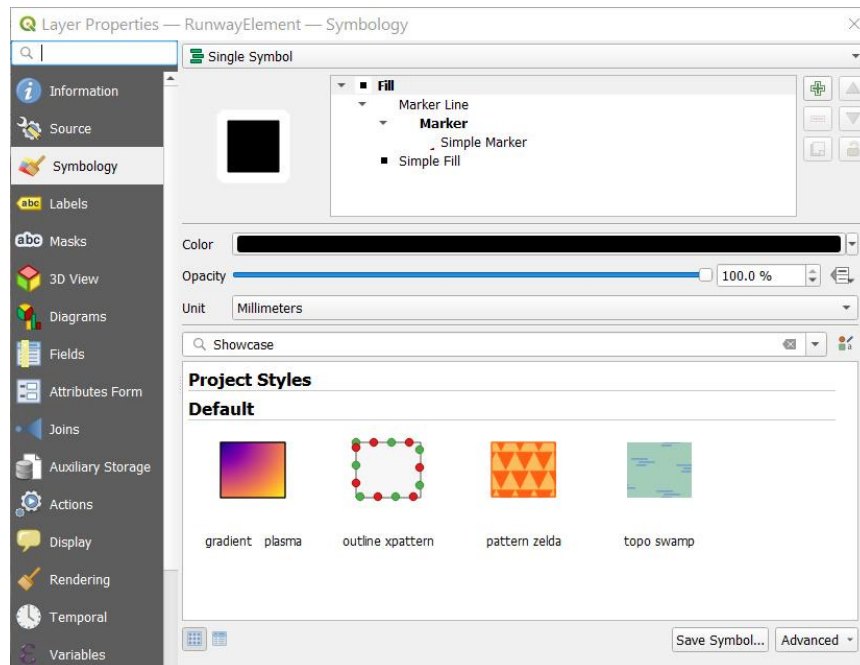



Figure 4-9. Layers Properties dialog

The Symbology tab  provides you with a comprehensive tool for rendering and symbolizing your vector data. You can use tools that are common to all vector data, as well as special symbolizing tools that were designed for the different kinds of vector data.

You can change the color, opacity, output unit, width and the angle of the selected symbol.

You can also add expression to apply theme for a specific layer, for example we are using the expression in [Figure 4-10] to create the runway heading (which is a part of the runway marking element) by adding a geometry generator to these layers only, then we add a font marker layer which take an input of type string and converted it to a layer on our map.

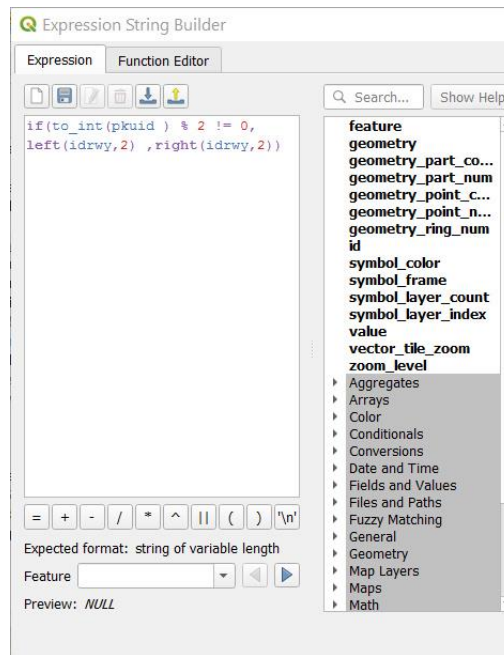



Figure 4-10. QGIS expression builder

4.3.5. Labeling:

Labels can be added to a map to show any information about an object. Any vector layer can have labels associated with it. These labels typically rely on the attribute data of a layer for their content.

2. You can access the labels panel by clicking the  toolbar button or from the Layer Styling panel.
3. You can specify the value that will be used for the labels from attribute table or by using an expression as shown in [Figure 4-11].
4. You can also change the style of the labels, the size, the color, the opacity and more....
5. Click Apply.

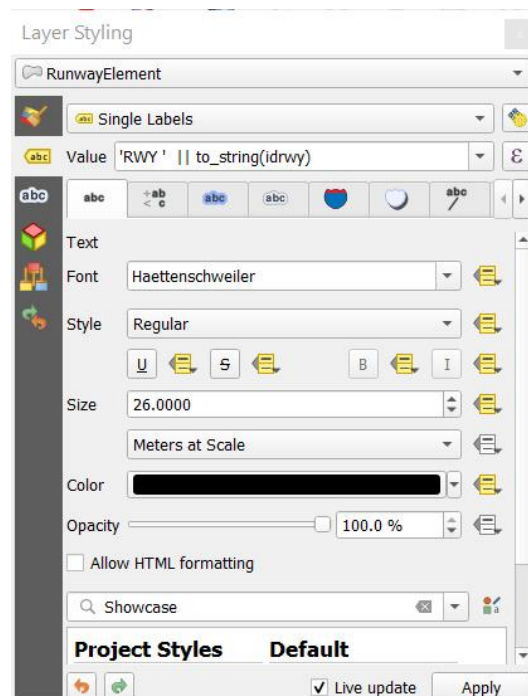


Figure 4-11. QGIS Labels panel

The result:

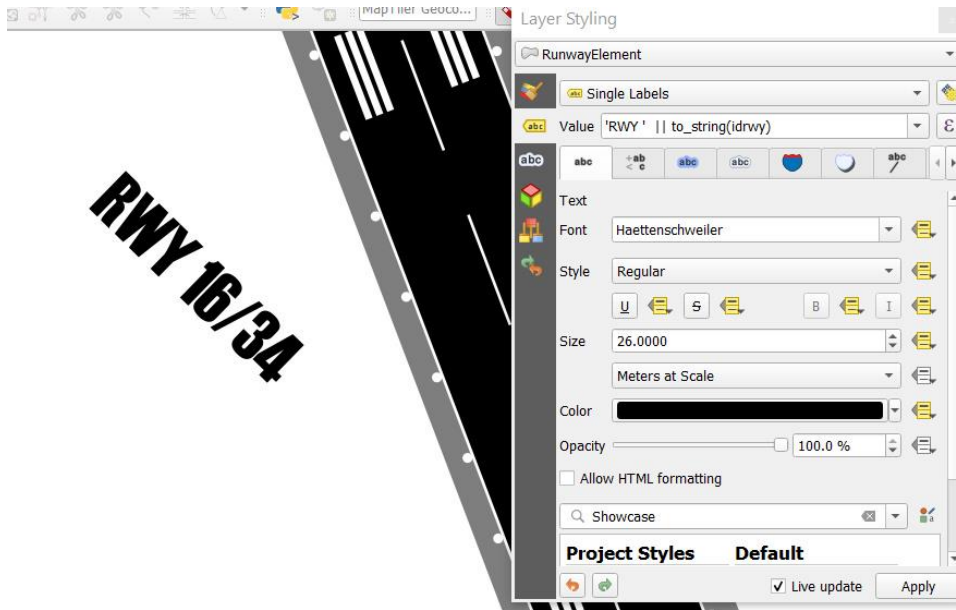



Figure 4-12. Add Runway Label

4.3.6. Printing and Layout:

The print layout allows you to add elements such as the QGIS map canvas, text labels, images, legends, scale bars, basic shapes, arrows, attribute tables and HTML frames. You can size, group, align, position and rotate each element and adjust their properties to create your layout. The layout can be printed or exported to image formats, PostScript, PDF or to SVG.

To create new print layout:

- From Project choose  new print layout, you will be presented with a new dialog.

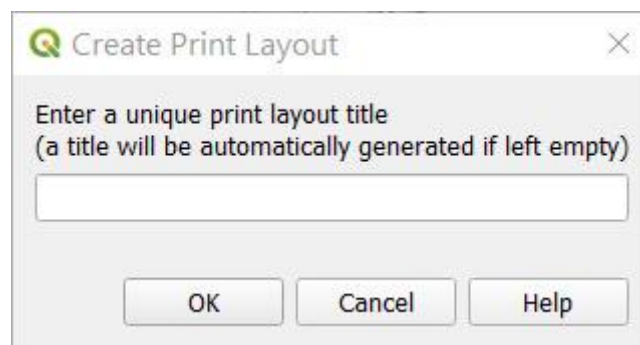


Figure 4-13. Create Print layout dialog

- Add a name to your new layout.
- Click OK.

Opening the print layout provides you with a blank canvas that represents the paper surface when using the print option. Initially you find buttons on the left beside the canvas to add print layout items, in this toolbar you also find buttons to navigate, zoom in on an area and pan the view on the layout as well as buttons to select any layout item and to move the contents of the map item.

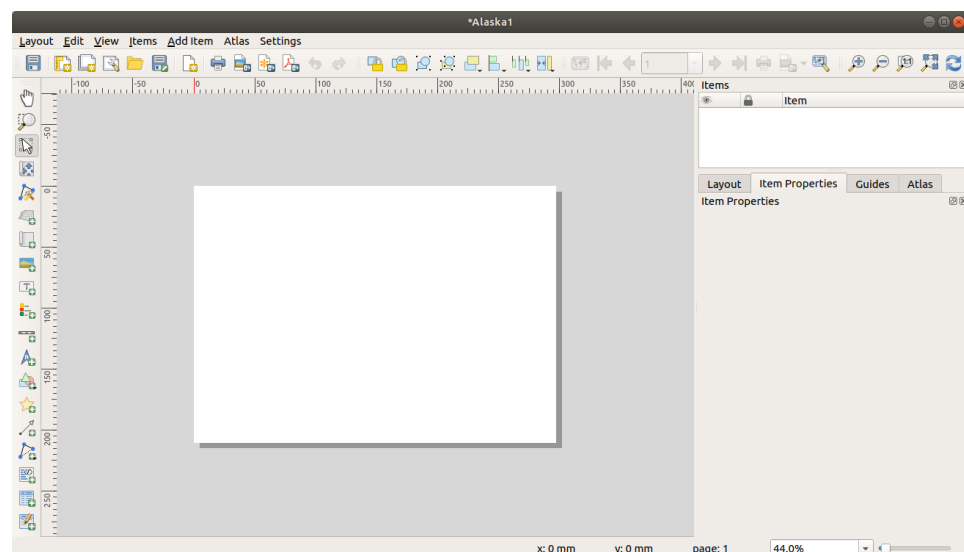







Figure 4-14. The Print Layout Window

For our project We will create the standard AERODROME CHART — ICAO for DABC Airport which provide the flight crew with essential information about aerodrome and ground movements. [9], and The Aircraft Parking/Docking Chart – ICAO.

On the left side, select the Add map toolbar button  and draw a rectangle on the canvas holding down the left mouse button. Inside the drawn rectangle the QGIS map view to the canvas.

The left toolbar has several tools that help you to add labels, scalebars, tables, polygons and more to your canvas.

- Use the  Add Label tool to add labels and texts to the canvas.
- Use the  Add Scale Bar tool to add a scalebar to the canvas.
- Use the  Add polyline tool to add Lines and arrows to the canvas.
- Use the  Add Fixed table tool to add tables to the canvas.

You can change the item’s properties (scale, position, rotation...) from the Item Properties panel.

You can also change the Theme of your map; this allows you to add different maps to the canvas.

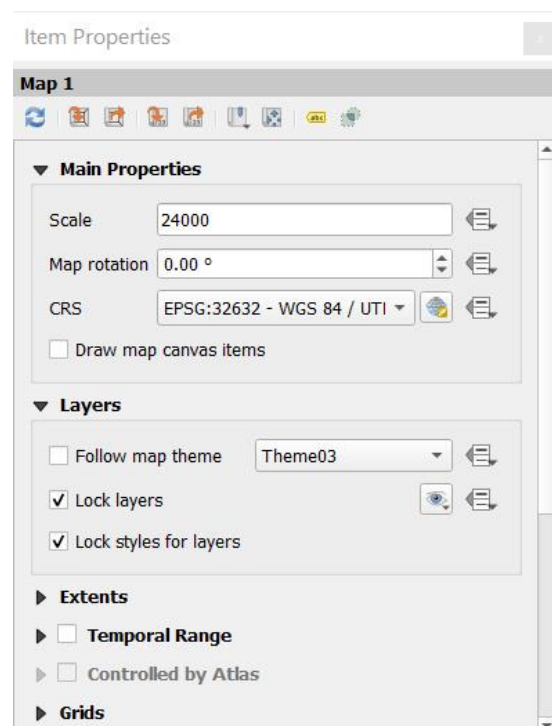


Figure 4-15. Item Properties Panel

4.3.7. Result:

The final result shown in [Figure 4-16 - Figure 4-17]:

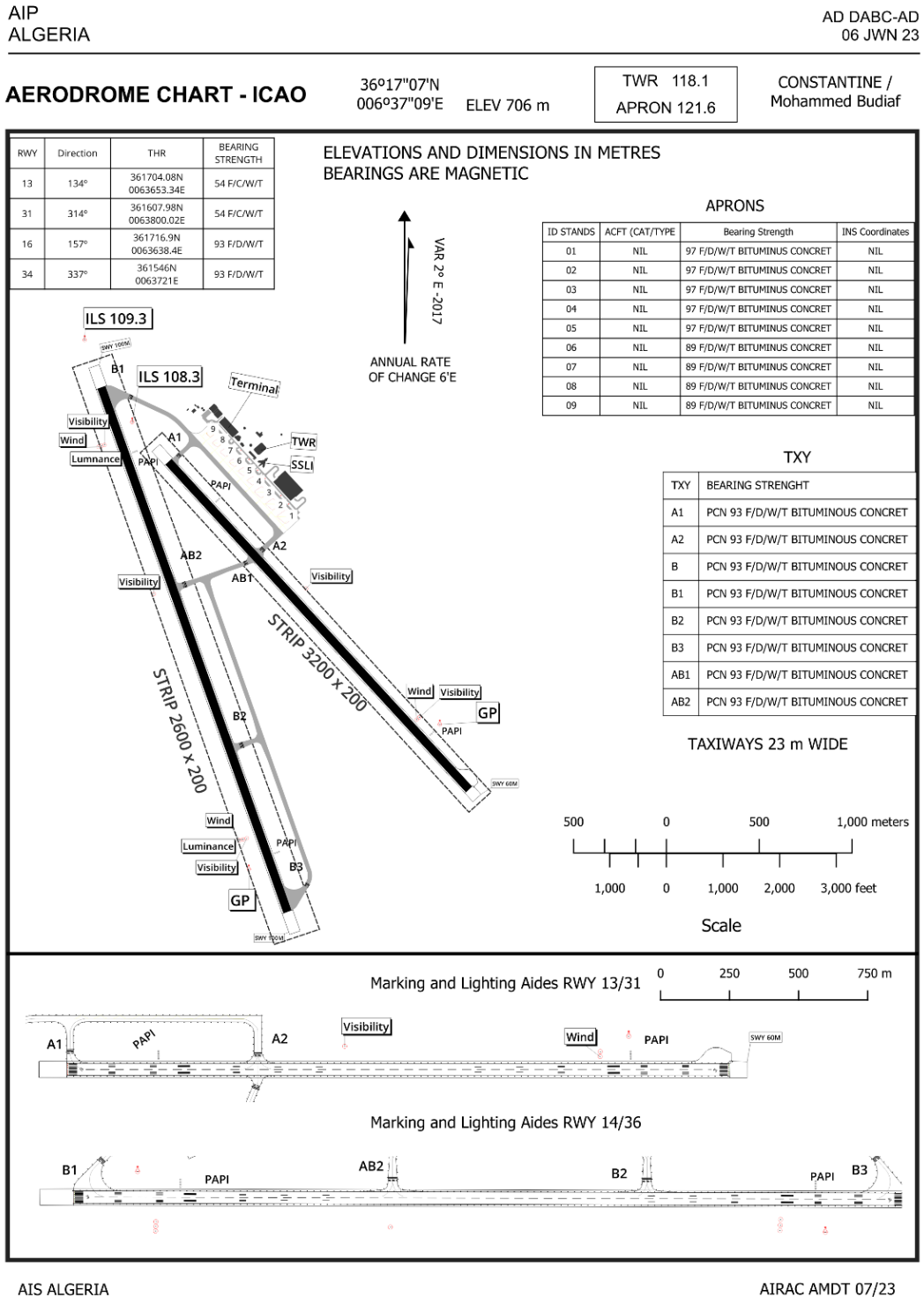


Figure 4-16. DABC Aerodrome Chart - ICAO

AIP
Algerie

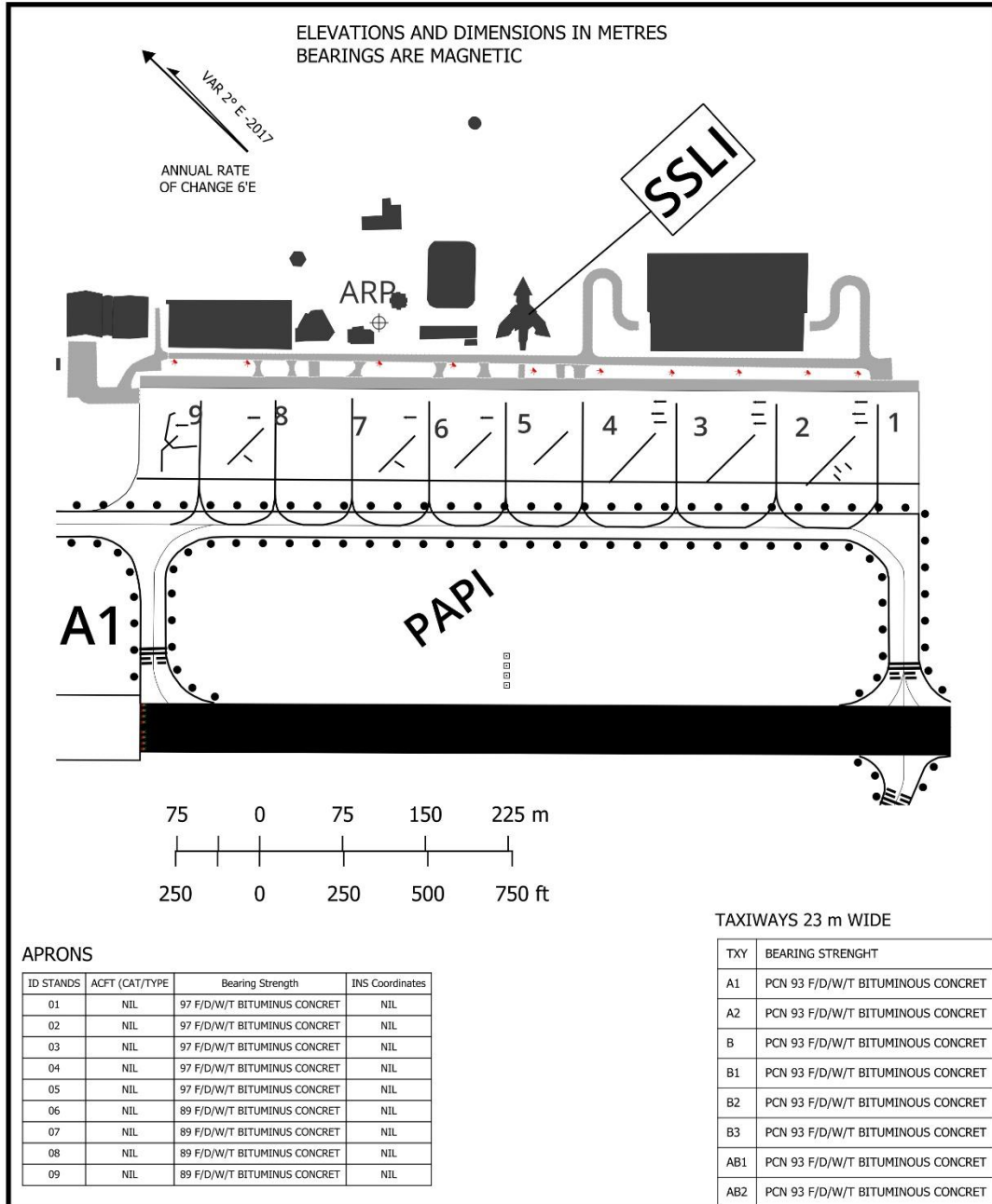
AD DABC-AD
06 JWN 23

**AIRCRAFT PARKING/
DOCKING CHART — ICAO**

36°17'07"N
006°37'09"E ELEV 706 m

TWR 118.1
APRON 121.6

CONSTANTINE /
Mohammed Budiaf



AIS ALGERIA

AIRAC AMDT 07/23

Figure 4-17. Aircraft Parking/Docking Chart - ICAO

Conclusion

In conclusion, this thesis has undertaken the task of creating an Airport Mapping Database (AMDB) for Constantine/Mohammed Boudiaf Airport and generating an Aerodrome Chart _ ICAO from it. Throughout this research, we have explored the essential components of airport mapping, data collection, and chart generation, with the objective of improving the efficiency and accuracy of aeronautical information management.

By utilizing the capabilities of QGIS, we have successfully developed a comprehensive AMDB for DABC airport. This database incorporates crucial spatial and attribute data, including runway layouts, taxiway configurations, terminal buildings, navigational aids, and other relevant airport features. The integration of this information within a centralized system enhances the accessibility and management of critical aeronautical data.

The generation of an Aeronautical Chart from the AMDB represents a significant milestone in this research. Through the utilization of cartographic techniques and symbology, we have transformed the raw data into a visually appealing and informative representation of the airport. This chart serves as a vital tool for pilots, air traffic controllers, and other aviation personnel in ensuring safe and efficient operations at DABC airport.

However, it is essential to acknowledge the limitations and challenges encountered during this study. The creation of an AMDB and generation of an AD Chart involve intricate processes that require continuous updates and maintenance. As the aviation industry evolves and regulations change, it is crucial to keep the AMDB up to date to reflect the latest information accurately.

Furthermore, while this research has focused on DABC airport, the methodology and techniques employed can be extended to other airports in Algeria. Each airport has its unique characteristics and requirements, necessitating customization and adaptation of the AMDB creation process. Future projects can build upon this study to develop standardized approaches for AMDB creation and chart generation, contributing to the advancement of aeronautical information management in our country.

References

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Appendix A

DABC Airport Chart

ARP : 36° 17' 07" N 006° 37' 09" E

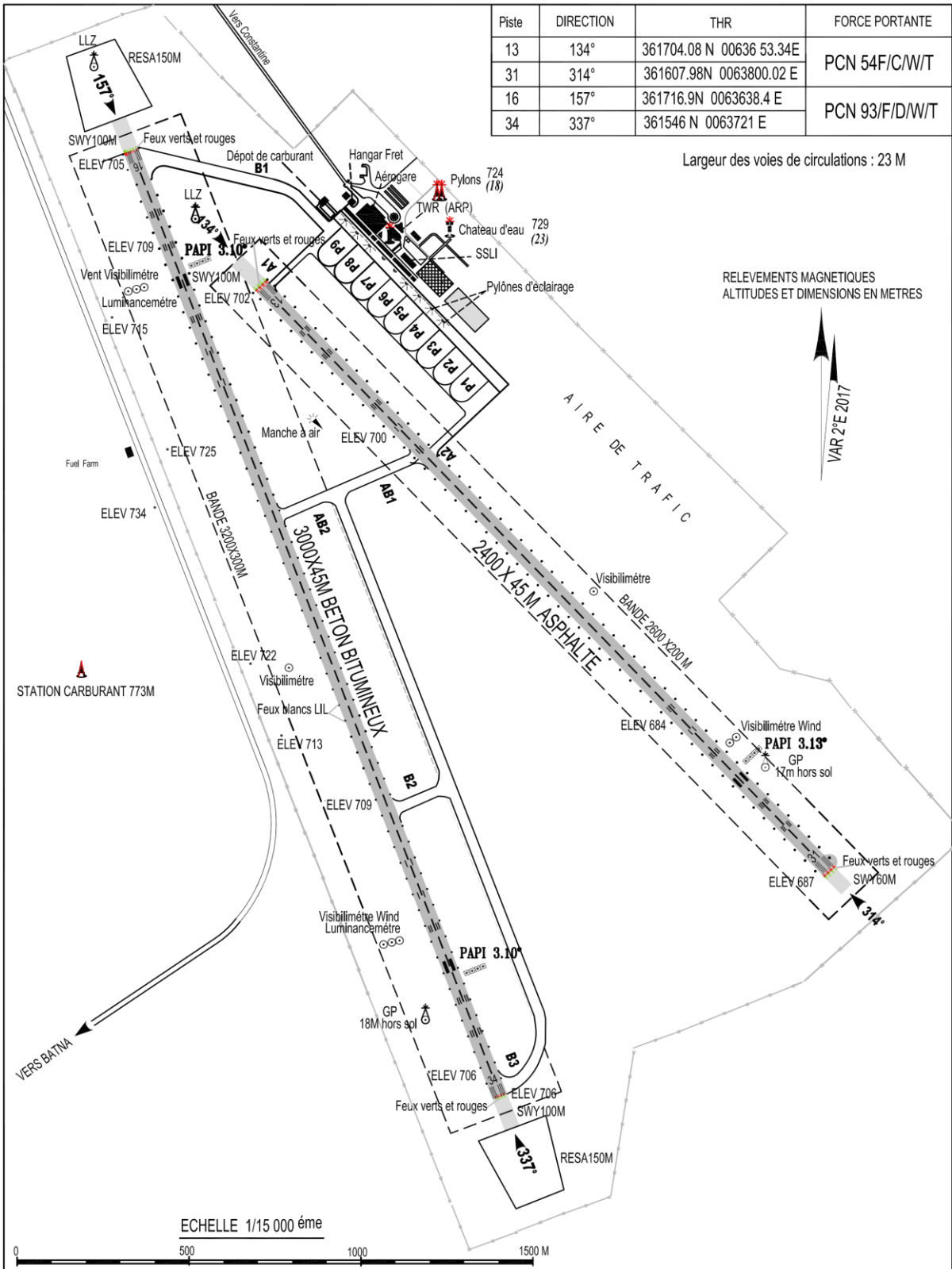
TWR : 118.3-119.7(s)
 SOL : 121.9
 APP : 120.1

CARTE D'AERODROME - OACI -

ALT. AD : 706 M

Piste	DIRECTION	THR	FORCE PORTANTE
13	134°	361704.08 N 00636 53.34E	PCN 54F/C/W/T
31	314°	361607.98N 0063800.02 E	
16	157°	361716.9N 0063638.4 E	PCN 93F/D/W/T
34	337°	361546 N 0063721 E	

Largeur des voies de circulations : 23 M



Appendix B

Aerodrome Mapping Feature Catalogue

Feature Type	Definition	Attribute List
'RunwayElement'	Part of a runway.	featype, idarpt, idrwy, vacc, hacc, vres, hres, source, integr, revdate, pcn, width, length, surftype, geopoly,
'RunwayIntersection'	Intersecting area of two or more runways.	featype, idarpt, idrwi, vacc, hacc, vres, hres, source, integr, revdate, pcn, surftype, geopoly,
'RunwayThreshold'	The beginning of that portion of the runway that is available for landing.	featype, idarpt, idrwy, vacc, hacc, vres, hres, source, integr, revdate, geopoly,
'RunwayMarking'	A symbol or group of symbols displayed on the surface of the runway in order to convey aeronautical information.	eatype, idarpt, idrwy, vacc, hacc, vres, hres, source, integr, revdate, geopoly,
'PaintedCenterline'	Continuous painted line in the center of a runway connecting the two thresholds.	featype, idarpt, idrwy, vacc, hacc, vres, hres, source, integr, revdate, geoline,
'LandAndHoldShortOperationLocation'	Location of marking used for Land and Hold Short Operations (LAHSO).	featype, idarpt, idthr, vacc, hacc, vres, hres, source, integr, revdate, idp, geoline,
'ArrestingGearLocation'	Location of the arresting gear cable across the runway.	featype, idarpt, idthr, vacc, hacc, vres, hres, source, integr, revdate, status, geoline,
'RunwayShoulder'	An area adjacent to the edge of a runway pavement so prepared as to provide a transition between the pavement and the adjacent surface.	featype, idarpt, idrwy, vacc, hacc, vres, hres, source, integr, revdate, status, gsurftyp, geopoly,
'Stopway'	A defined rectangular area on the ground at the end of take-off run available prepared as a suitable area in which an aircraft can be stopped in the case of an abandoned take-off.	featype, idarpt, idthr, vacc, hacc, vres, hres, source, integr, revdate, status, surftype, geopoly,
'RunwayDisplacedArea'	That portion of a runway between the beginning of the runway and the displaced threshold.	featype, idarpt, idthr, vacc, hacc, vres, hres, source, integr, revdate, status, surftype, geopoly,

'Clearway'	A defined rectangular area on the ground or water under the control of the appropriate authority, selected or prepared as a suitable area over which an aeroplane may make a portion of its initial climb to a specified height.	featype, idarpt, idthr, vacc, hacc, vres, hres, source, integr, revdate, geopoly,
'FinalApproachAndTake-offArea'	A defined area over which the final phase of the approach manoeuvre to hover or landing is completed or from which the take-off manoeuvre is commenced.	featype, idarpt, idrwy, vacc, hacc, vres, hres, source, integr, revdate, surftype, geopoly,
'TouchDownLiftOffArea'	A load bearing area on which a helicopter may touchdown or lift-off.	featype, idarpt, idrwy, vacc, hacc, vres, hres, source, integr, revdate, surftype, geopoly,
'HelipadThreshold'	The beginning of that portion of the helipad that is available for landing.	featype, idarpt, idthr, vacc, hacc, vres, hres, source, integr, revdate, status, geound, geopnt,
'TaxiwayElement'	Part of a taxiway.	featype, idarpt, idlin, vacc, hacc, vres, hres, source, integr, revdate, gsurfryp, pcn, geopoly,
'TaxiwayShoulder'	An area adjacent to the edge of a taxiway pavement so prepared as to provide a transition between the pavement and the adjacent surface	featype, idarpt, vacc, hacc, vres, hres, source, integr, revdate, gsurfryp, status, geopoly,
'TaxiwayGuidanceLine'	Guidance center line painted on a taxiway.	featype, idarpt, idlin, vacc, hacc, vres, hres, source, integr, revdate, status, wingspan, maxspeed, color, style, direc, geoline,
'TaxiwayIntersectionMarking'	Taxiway intersection marking painted across a taxiway.	featype, idarpt, idlin, vacc, hacc, vres, hres, source, integr, revdate, geoline,
'TaxiwayHoldingPosition'	Taxiway holding position painted across a taxiway.	featype, idarpt, idlin, vacc, hacc, vres, hres, source, integr, revdate, status, catstop, idp, geoline,
'RunwayExitLine'	Guidance line painted on the runway exit.	featype, idarpt, idlin, vacc, hacc, vres, hres, source, integr, revdate, status, color, style, direc, geoline,
'FrequencyArea'	Designated part of a surface movement area where a specific frequency is required by air traffic control or ground control.	featype, idarpt, hacc, hres, source, integr, revdate, frq, station, geopoly,
'ApronElement'	Part of a defined area, on a land aerodrome, intended to accommodate aircraft for purposes of loading or unloading passengers, mail or cargo, fuelling, parking, or maintenance.	featype, idarpt, vacc, hacc, vres, hres, source, integr, revdate, gsurfryp, pcn, status, geopoly,

'StandGuidanceLine'	Guidance line on a designated area on an apron intended to be used for parking an aircraft.	featype, idarpt, idstd, vacc, hacc, vres, hres, source, integr, revdate, status, color, style, direc, wingspan, geoline,
'ParkingStandLocation'	Location of an aircraft stand.	featype, idarpt, idstd, vacc, hacc, vres, hres, source, integr, revdate, acn, geopnt,
'ParkingStandArea'	A designated area on an apron intended to be used for parking an aircraft.	featype, idarpt, idstd, vacc, hacc, vres, hres, source, integr, revdate, gsurftyp, pcn, jetway, fuel, towing, docking, gndpower, geopoly,
'DeicingArea'	An area comprising an inner area for the parking of an aeroplane to receive de-icing treatment and an outer area for the manoeuvring of two or more mobile de-icing equipment.	featype, idarpt, vacc, hacc, vres, hres, source, integr, revdate, gsurftyp, geopoly,
'AerodromeReferencePoint'	The designated geographical location of an aerodrome.	featype, idarpt, vacc, hacc, vres, hres, source, integr, revdate, geopnt,
'VerticalPolygonalStructure'	Polygonal structure of a defined vertical extent that is located within a movement zone.	featype, idarpt, plysttyp, vacc, hacc, vres, hres, source, integr, revdate, material, height, elev, geopoly,
'VerticalPointStructure'	Point structure of a defined vertical extent that is located within a movement zone.	featype, idarpt, pntsttyp, vacc, hacc, vres, hres, source, integr, revdate, material, height, elev, lighting, radius, marking, geopnt,
'VerticalLineStructure'	Line structure of a defined vertical extent that is located within a movement zone.	featype, idarpt, linsttyp, vacc, hacc, vres, hres, source, integr, revdate, material, height, elev, lighting, marking, geoline,
'ConstructionArea'	Part of aerodrome movement area under construction.	featype, idarpt, hacc, hres, source, integr, revdate, pstartdate, pendate, piocdate, geopoly,
'SurveyControlPoint'	A monumented survey control point.	featype, idarpt, vacc, hacc, vres, hres, source, integr, revdate, coord, hdatum, spheroid, vdatum, project, geopnt,
'AerodromeSurfaceLighting'	Lighting within a movement area.	featype, idarpt, vacc, hacc, vres, hres, source, integr, revdate, status, geopnt,