SIERRA LEONE CIVIL AVIATION AUTHORITY

ADVISORY CIRCULAR

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Land Use and Environmental Management

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1 GENERAL

The Sierra Leone Civil Aviation Authority's Advisory Circulars contains information about standards, practices and procedures that the Authority has found to be an Acceptable Means of Compliance (AMC) with the associated Regulations.

An AMC is not intended to be the only means of compliance with a Regulation, and consideration will be given to other methods of compliance that may be presented to the Authority

Information considered directive in nature is described in this AC in terms such as "shall" and "must", indicating the actions are mandatory. Guidance information is described in terms such as "should" and "may" indicating the actions are desirable or permissive, but not mandatory.

1.1 Purpose

This Advisory Circular provides guidance on land-use planning in the vicinity of airports and on environmental management regarding airport development and operations, with a view to ensuring the safety of aircraft operations.

1.2 Description of change

This is the first AC to be issued on this subject.

1.3 References

(a) SLCAR's Part 14A – Aerodrome Design and Operations Standards

(b) ICAO Doc 9981 – PANS Aerodromes

(c) ICAO Doc 9184 Part II – Land Use and Environmental Management

1.4 Cancelled Document

N/A

2 INTRODUCTION

2.1 The Airport and Its Environment

(a) The compatibility of an airport with its environs is ideal, and can be achieved by proper planning of the airport, management of pollution-generating sources, and land-use planning of the area surrounding the airport (airport vicinity). The aim is to provide the best possible conditions for the needs of the airport, the community in the surrounding area and the ecology of the environment.

(b) Airport planning is an integral part of an area-wide comprehensive planning programme. The location, size and configuration of the airport needs to be coordinated with patterns of residential, industrial, commercial, agricultural and other land uses of the area, taking into account the effects of the airport on people, flora, fauna, the atmosphere, water courses, air quality, soil pollution, rural areas (such as deserts) and other facets of the environment.

(c) Within the comprehensive planning framework, airport development and operations should be coordinated with the planning, policies and programmes for the area where the airport is located and vice versa. In this way, the social and economic impact, along with the environmental effects of the airport, can be evaluated to ensure to the greatest extent possible that the airport environs are compatible with the airport and, conversely, that the physical development and use of the airport is compatible with the existing and proposed patterns of land use.

(d) To the extent that safety and operational considerations permit a choice, decisions on runway alignment and other airport development should take into account their potential effects on the environment in order to prevent or minimize environmental conflicts. “Land-use planning” or “planning for compatible land uses which takes into account the needs of airport development” more adequately describes the process of achieving an optimum relationship between an airport and its environs.

2.2 The Need for Environmental Management

(a) There is concern regarding the protection of the natural environment from the impact of transportation, and consequently, a growing emphasis on the need to employ effective measures to minimize such impacts. Since pollution may be generated within an airport as well as within the area surrounding it, environmental management practices should be applied at the airport and its environs.

(b) The natural environment has been defined as including:

(i) air, land and water;

(ii) all layers of the atmosphere;

(iii) all living organisms, including both plants and animals; and

(iv) the interacting natural systems referred to in (i) to (iii).

These components interact in an ecosystem, and disruption to one may have a profound effect on the entire system.

(c) Pollution occurring in and around the airport can have an effect on human health and the ecology of a broad area surrounding an airport. Efforts should be made towards pollution prevention in the first instance and impact management in the second instance. Environmental management thus provides a means of either decreasing pollution at the source or reducing the potential for negative environmental impacts. Environmental management controls may include items such as air and water quality guidelines, aircraft engine or ground-sourced noise limits, waste management plans, environmental emergency plans, and environmental management plans.

(d) Aerodrome operators should endeavour to reduce the environmental impact of their operations, by incorporating environmental management plans and procedures with land-use planning. There are several important components of environmental management at an airport, such as noise mitigation, emissions reduction and pollution prevention. A certain amount of emissions and noise are inevitable from aircraft operations, but can be minimized. Pollution prevention can be defined as "the use of materials, processes or practices that reduce or eliminate the creation of pollutants and wastes at the source." It includes practices that reduce the use of hazardous and non-hazardous materials, energy, water or other resources. Adequate pollution prevention pre-empts the need for remedial or clean-up actions later.

(e) Appropriate planning and infrastructure decisions at airports help to facilitate good environmental management. By planning for intended growth and development, estimations can be made about the type and extent of potential future environmental impacts to allow for a more integrated approach to environmental management (refer to Chapter 3 of this AC).

2.3 The Need for Land-Use Planning

(a) The need for land-use planning in the vicinity of an airport focuses on the use and control of land. This includes height control of possible hazards or obstacles to flight into or out of aerodromes. The objective of this measure is to ensure the safety of people in the air and on the ground, to maintain efficient airport operations, and to limit environmental impacts to local communities.

(b) Though land-use planning focuses on possible hazards or obstacles to flight, modern land-use planning includes several additional considerations;

(i) land-use zoning that encourages compatible land-uses in the vicinity of an airport;

(ii) reducing the environmental impact from aviation activities, including noise exposure to the local communities;

(iii) managing habitat and accumulated solid waste on which wildlife may feed and thus could cause a hazard to approaching or departing aircraft (refer to SLCAA-AC-AGA010A Rev01 – Wildlife Hazard Management);

(iv) eliminating light pollution or glint/glare effects that might affect a pilot's interpretation of navigational aids, or air traffic control tower personnel's ability to visually monitor aircraft; and

(v) monitoring activities that could compromise the safe flight of aircraft such as electrical interference with radio communications and navigation aids; and

(vi) minimizing the impact of wind turbulence from obstacles in the vicinity of the runway, etc.

(c) Aircraft noise can have a significant impact on local communities and is therefore a major factor influencing land-use planning in the vicinity of airports. The goal is to minimize the population affected by aircraft noise by introducing compatible land-use zoning around airports. Compatible land-use planning is also a vital instrument in ensuring that the gains achieved by the reduced noise of the latest generation of aircraft and improved operational measures are not offset by further residential development and encroachment around airports.

(d) Compatible land-uses in noise-affected areas near airports can include commercial, industrial and agricultural activities. Incompatible land-uses include noise-sensitive areas such as residential homes, schools, hospitals and libraries.

Note - For the purpose of this AC:

Obstacle – means all fixed (whether temporary or permanent) and mobile objects, or part of an object, that:

(i) are located on an area intended for the surface movement of aircraft; or

(ii) extend above a defined surface intended to protect aircraft in flight; or

(iii) stand outside defined obstacle limitation surfaces and that have been assessed by the appropriate authority as being a hazard to air navigation

Obstacle Limitation Surfaces (OLS) – means a series of surfaces that define the volume of airspace at and around an aerodrome to be kept free of obstacles in order to permit the intended aircraft operations to be conducted safely and to prevent the aerodrome from becoming unusable by the growth of the obstacles around the aerodrome.

Authority – means the Sierra Leone Civil Aviation Authority

3 ENVIRONMENTAL MANAGEMENT MEASURES AND CONSEQUENCES

3.1 General

(a) Implementation of environmental management measures at airports and surrounding areas is in the best interest of the airport operators, the community and the natural environment. These measures may include compliance with applicable National standards, other state regulations and approved SOPs. These provisions should be implemented by airports operators, often in collaboration with other airport stakeholders. When planning infrastructural development, an airport operator should consider how environmental management should be integrated to minimize the impact on operations.

(b) Some measures limit pollution at its source while others reduce its effect on communities and ecosystems. An environmental management system (EMS) is seen as the best method to incorporate environmental management into all levels of corporate operations and decision-making processes. A well-planned EMS at an airport can help manage environmental impacts. Chapter 4 provides more guidance on the infrastructure that can be planned and built to enable and enhance the environmental management of an airport.

3.2 Environmental Management

(a) The environmental management activities of an airport can be divided into four basic categories:

(i) planning;

(ii) operations and monitoring;

(iii) mitigation and remedial measures; and

(iv) environmental awareness

(b) Most of the environmental activities at airports involve planning and monitoring, including:

(i) environmental assessments;

(ii) monitoring and compliance;

(iii) environmental audits, where necessary; and

(iv) environmental emergency contingency plans

(c) The environmental assessment process has proven to be an important part of any airport development project. Potential environmental impacts can be identified before they occur and before irrevocable decisions on the design of a project are made. Mitigation of environmental impacts can and should be made an integral part of the planning process. In this regard, reference is made to Guidance on Environmental Assessment of Proposed Air Traffic Management Operational Changes (ICAO Doc 10031).

(d) Monitoring and compliance programmes assess air quality, water quality, soil and groundwater quality, noise levels, etc. These programmes are designed to detect developing problems in the early stage before environmental impacts become significant and to identify the source of the problem.

(e) Periodic inspections should be undertaken in order to provide a thorough assessment of the environmental implications of operations and management practices at a given point in time, and to determine the degree of compliance with applicable standards, guidelines and SOPs. The inspections are used to assess whether the monitoring and compliance programmes are functioning properly and to identify any problems not previously detected. They also provide a basis for action plans, and are valuable tools for identifying opportunities for enhancing environmental management practices as a whole.

(f) The ultimate goal of a proactive environmental strategy is to prevent the creation of environmental impacts, but there may be a need for mitigation and remedial measures to correct situations resulting from material handling and management practices of the past.

(g) An environmental awareness programme should be established at an aerodrome, with the objective to promote increased environmental consciousness and to make individuals aware of their own environmental protection responsibilities, both in decision-making and in the day-to-day operations of the airport. This is accomplished primarily through employee education, training and incentives.

3.3 Environmental Management Systems (EMS)

(a) Achieving and demonstrating sound environmental performance requires managing the impacts of activities, products and/or services on the environment, taking into account environmental policies and objectives. Legislations are more stringent, with economic policies aiming to foster environmental protection, and there is a growing awareness of environmental issues among society at large.

(b) Many organizations carry out environmental reviews or audits to assess their environmental performance. Organizations can use a series of standards for environmental management, which can be integrated with other management requirements, to assist them in achieving their environmental goals.

(c) The *Report on Environmental Management System Practices in the Aviation Sector* (ICAO Doc 9968), describes the function of an EMS and presents case studies from the global aviation industry where EMS principles were used to manage environmental impacts. Airports, for example, reported that they were using EMS to manage: hazardous and solid waste, water, national environmental regulations, air emissions and noise. Many of these airports had integrated their EMS with other airport management systems, including safety or quality management systems.

(d) There are a number of benefits of implementing an EMS, such as:

(i) enhance reputation and image among stakeholders, including local communities, customers, and regulators;

(ii) enhance compliance or mitigate risk of environmental impacts and regulatory violations resulting from airport activities, products, and services; and

(iii) environmental improvements, enabling organizations to better achieve organizational goals and vision

(iv) improved management efficiency by consolidating all environmental programmes into one system;

(v) reduced costs by adopting proven, well-developed approaches to environmental management; and

(vi) increased flexibility to meet changes in legislation and stakeholder concerns

(e) Airports in general have an obligation to protect the physical environment by evaluating the impacts of their policies and regulatory decisions on the environment, and by promoting and meeting environmental standards while serving the public to optimal satisfaction and safety. EMS provides airports with efficient and effective methods for achieving environmental standards and objectives while also establishing credibility and strengthening public perceptions.

3.4 Environmental Impact Assessment (EIA) Of Airport Development Projects

(a) An environmental impact assessment is part of the planning and approval process that identifies the environmental effects of a proposed project. This approach allows for the environmental impacts of the proposed projects to be identified in order to allow for, where necessary, the modification of plans and incorporation of measures to minimize or eliminate any potential adverse effects on the environment.

(b) Preparatory work should start with determining what environmental regulations apply in terms of both the environmental impact assessment itself, and also those related to the impacts that are to be assessed. It would also be prudent to identify relevant stakeholders at an early stage and continually engage with them throughout the process, regardless of the size of the project.

(c) The environmental impact assessment report should contain the details that are needed to make informed decisions with respect to the environment. Gathering information on the current situation and the development of project(s) should begin as early as possible.

This can be achieved by:

(i) identifying all project components for the purpose of refining the scope of the project and the scope of the environmental assessment;

(ii) evaluating alternatives to the project that may achieve the airport development objective with fewer adverse environmental impacts;

(iii) defining the “do nothing” scenario to provide the “base case” against which the impacts of the project(s) can be assessed; and

(iv) identify core context assumptions of the project:

(1) the proposed date the development will come into service;

(2) the expected life-time of the development;

(3) agreed "milestone" dates that need to be assessed as part of the EIA;

(4) key impact influencers for these milestone years, such as traffic forecasts, etc.;

(5) the legislation, regulations and agreements that apply

(d) A vital part of any assessment is the effective documentation, communication and reporting of the assessment process and the results, and this should be constantly reviewed during all phases of the EIA process.

(e) The environmental assessment process should include:

(i) a detailed project description;

(ii) details of alternatives that are being considered or not and the rationale;

(iii) an environmental description, including:

(1) a list of the applicable environmental regulations and agreements that are applicable;

(2) a project environment interaction analysis and all associated impact; and

(3) mitigation measures

A final report should be prepared which details all the phases and results of the environmental assessment. The environmental impact assessment report must be clear, concise and suitable for public scrutiny, if required.

(f) The next stage should be to carry out a detailed and organized environmental screening of the project based on specific terms of reference and any approved modifications/additions. A report should be drafted presenting the process and results in a screening report suitable for public scrutiny and decision-making.

(g) For the environmental assessment process, it is necessary to develop a description of both the physical and social environments, within which the project will be situated. This should include:

(i) context, study area, and site plan;

(ii) definition of the types of environmental and social impacts that are expected and their relative magnitude, including any cumulative effects that need to be considered in the assessment;

(iii) physical environment:

(1) physiography and local topography;

(2) soil;

(3) landscaping;

(4) surface water/drainage basins;

(5) groundwater/aquifer;

(6) air quality and emissions;

(7) atmosphere/weather/climate;

(8) vegetation/crops;

(9) terrestrial species/habitat;

(10) aquatic species/habitat;

(11) avifauna migration routes; and

(12) ecological systems

(iv) social environment:

(1) land use;

(2) light emissions;

(3) impact on the community;

(4) recreational uses;

(5) aesthetics;

(6) employment;

(7) economic;

(8) municipal services;

(9) noise;

(10) archaeological, cultural, heritage and historical factors; and

(11) planning framework

(h) Project-environment interaction analyses require identification of the environmental components listed which may be affected by both the project construction and/or operational activities. A matrix should be used to identify the interaction between activities and general categories of environmental components involved.

(i) The identification of possible impact points is followed by an impact analysis. This will require a general description of each potential impact, the determination of valued ecosystem components, and the prediction and evaluation of impacts.

(j) Specifically, the potential impacts of the proposed activities on the environmental components should be described. Any particular concerns of the public or extraordinary circumstances regarding environmental or social impacts should be noted. Through further detailed analysis and consideration of mitigation measures, impact prediction regarding specific project-environment interactions should be developed.

(k) Ultimately, the environmental assessment should provide clear and realistic projections regarding the type and extent of the impact. The assessment should conclude by summarizing decisions regarding the environmental impacts of the project, the specific mitigating measures and monitoring requirements. A recommended environmental assessment decision should be provided, reflecting the options selected among those presented.

(l) The environmental assessment report should be organized in such a manner that information (procedures, findings, etc.) for each of the key stages of the assessment is presented. A table of contents with major headings similar to the following would be appropriate:

(i) Name of the proposal

(ii) Description of project activities

(iii) Description of the environment

(iv) Environmental impacts (including any cumulative environmental impacts)

(v) Proposed mitigation measures

(vi) Determination of significance

(vii) Expert government agencies consulted (expert help, if required)

(viii) Public consultation (including methods and results, if required)

(ix) Approximate date of implementation

(x) Decision and rationale

(xi) Consultant/expert contact (name, title, and address)

(m) An ongoing environmental management programme should detail individual monitoring processes required to evaluate the effectiveness of the mitigation measures, as well as determine the accuracy of the environmental assessment. This programme is not always required for every project. The decision-maker should identify and implement a follow-up programme if one of the following situations occurs:

(i) the project involves new or unproven technology;

(ii) the project involves new or unproven mitigation measures;

(iii) the assessment was based on a new assessment technique or model, or there is some uncertainty about the assessment's conclusion.

(n) Communication with stakeholders is an essential aspect to finalizing the assessment process, and the final report and supporting documentation may be used to inform them of the outcome and to highlight the process and gain their support for the process. Active engagement with stakeholders and public groups about the process reduces the chance of questions and concerns at a later date.

3.5 Noise Management

(a) Noise emissions generated on or in the vicinity of airports are unavoidable due to the nature of aircraft and ground operations. In 2001, the ICAO Assembly endorsed the concept of a "balanced approach" to aircraft noise management (Appendix C of Assembly Resolution A35-5) and subsequent ICAO Assembly Resolutions. This consists of identifying the noise problem at an airport and then analysing the various measures available to reduce noise through the exploration of four principal elements, namely reduction at source (quieter aircraft), land-use planning and management, noise abatement operational procedures and operating restrictions.

(b) To reduce noise at source (quieter aircraft), States, manufacturers and research institutions have undertaken research which has led to considerable aircraft engine and airframe performance improvements and reduction of aircraft engine source noise. As a result, modern aircraft are significantly quieter than earlier generations of aircraft. With this in mind, before an aircraft is permitted to operate, it must receive a noise certification to required standards granted by the State of Registry. Aircraft noise certification provisions are detailed in SLCAR Part 16A - Aircraft Noise, and the Environmental Technical Manual on the use of Procedures in the Noise Certification of Aircraft (ICAO Doc 9501, Volume I), which provides practical guidance to certificating authorities on the implementation of the technical procedures of the ICAO Annex 16.

(c) Land-use planning and management is an effective means to ensure that the activities nearby airports are compatible with aviation. Its main goal is to minimize the population affected by aircraft noise by introducing land-use zoning around airports. Compatible land-use planning and management is also a vital instrument in ensuring that the gains achieved by reduced noise of the latest generation of quiet aircraft are not offset by encroachment and further residential development closer to the airports. In addition, with a view to promoting a uniform method of assessing noise around airports, ICAO recommends the use of the methodology contained in *Recommended Method for Computing Noise Contours around Airports* (ICAO Circular 205).

(d) Noise abatement procedures, to further reduce the population adversely affected by aircraft noise, should be employed to reduce noise levels around airports. Noise abatement procedures enables reduction of perceived noise during aircraft operations and can be achieved at comparatively low cost. There are several methods, including preferential runways and routes, as well as noise abatement procedures for take-off, approach and landing. The appropriateness of any of these measures depends on the physical layout of the airport and its surroundings, but in all cases, the procedure must give priority to safety considerations. ICAO's noise abatement procedures are contained in the Procedures for Air Navigation Services - Aircraft Operations (PANS-OPS, ICAO Doc 8168), Volume I - Light Procedures, Part V. In addition to noise abatement procedures, operating restrictions are discussed in 3.5 (i) below.

(e) Acoustical barriers can also provide benefits in a fairly limited number of situations. A wall or berm between residences and an airport will be effective against ground-based noise sources such as aircraft taxiing and apron vehicles, but will generally not shield residences from the noise during aircraft take-off, landing and flyover. Furthermore, a wall may need to be placed very close to the residences (within about 20 m) and needs to be built sufficiently high to block the line-of-sight between the noise source and receiver.

(f) If the airport has a large buffer area between it and areas affected by ground-based noise, a forested area can provide better noise mitigation than bare land. The forest buffer would need to be at least 100 m deep and care would need to be taken not to create a wildlife hazard for aviation.

(g) The use of a noise barrier or enclosure to reduce the noise from aircraft engine run-ups is discussed in 4.6.2 of this AC.

(h) Sound insulation can be used to improve the aircraft noise intrusion levels within buildings affected by aircraft noise. Whether retrofitted to existing buildings or required a part of a building code for new constructions, sound insulation clearly can only improve the internal noise levels of a residence, hospital or school. Furthermore, as the benefits of sound insulation are negated if a building occupant opens external windows or doors, in many climates, sound insulation will need to be accompanied by the provision of alternative ventilation for habitable spaces. Further discussion on sound insulation can be found in the land-use planning sections of this AC in Chapter 7.

(i) Operational restrictions on certain aircraft types may be considered, also the introduction of night curfews due to noise considerations.

3.6 Air Quality Management

(a) Some degree of air pollution associated with an airport may be unavoidable, and this can be managed with proper pre-development planning, environmental impact assessment and mitigation measures.

(b) Detailed guidance on the management of air quality at airports is provided in the *Airport Air Quality Guidance Manual* (ICAO Doc 9889), which should be consulted if more specialized information is required. A brief overview is provided in this section and more detail on infrastructure for air quality management is provided in Chapter 4.

(c) Airport-related emissions sources that affect airport air quality (AAQ) can be divided into four groups - aircraft, aircraft handling and support vehicles, infrastructure and stationary sources, and landside access traffic. An overview of each of these is provided below covering the standards/regulation, technology and infrastructure, and operational measures.

3.6.1 Aircraft

(a) The aircraft's main engines and to a lesser degree the auxiliary power unit (APU) are the primary sources of gaseous emissions from aircraft, though particulate emission sources include brakes and tyres, as well as the engines and APU.

(b) Most aircraft emissions that affect AAQ are subject to the Standards contained in the SLCAR Part 16B, which provides standards on instruments and methods used for measuring aircraft engine emissions from a range of engine types.

(c) Operational procedures that reduce aircraft emissions are addressed in detail in the manual on *Operational Opportunities to Reduce Fuel Burn and Emissions* (ICAO Doc 10013). These procedures are generally under control of the aircraft operator and air navigation service providers (ANSP), but are subject to the aircraft performance and airport runway characteristics and the prevailing meteorological conditions.

(d) Airport facilities and operations can facilitate efficient aircraft operations, such as:

(i) providing an efficient runway and taxiway layout;

(ii) providing fixed electrical ground power (FEGP) and preconditioned air (PCA) installed at terminal gates, while remote stands can enable a parked aircraft's auxiliary power unit (APU) to be switched off; and

(iii)using towing operations to delay the start-up of the aircraft engines, provided this does not create delays which could contribute to congestion

(e) Air pollution originating from aircraft engine testing and maintenance facilities may be controlled through the use of test cells equipped with afterburners and catalytic converters.

3.6.2 Aircraft handling and support vehicles

(a) Aircraft handling can include towing vehicles while GSE covers all vehicles providing services to aircraft, such as fuelling, baggage, catering and stairs. A number of steps can be taken to decrease emissions from aircraft handling and GSE, and increase the fuel efficiency of these vehicles. These include:

(i) maintaining the vehicles and conducting regular emissions tests;

(ii) avoiding unnecessary idling by shutting off engines when operation is stopped for periods of more than one minute;

(iii) reducing driving distances by planning routes;

(iv) accelerating smoothly;

(v) driving at optimum speeds;

(vi) using alternative low-sulphur diesel fuels;

(vii) converting vehicles to natural gas, propane, hybrid-electric or electric power;

(viii) using oxidation catalysts and particulate traps which can reduce hydrocarbon and particulate mass emissions up to 95 per cent; and

(ix) encouraging purchase of fuel-efficient vehicles, the use of alternative energy sources, such as ethanol and propane, or electric vehicles, and providing the infrastructure to refuel or recharge them

(b) Environmental impacts should be considered when selecting vehicles. A common mitigation measure is conversion of airport vehicles with internal combustion engines to vehicles utilizing alternative fuels. Alternatives include hybrid-electric (vehicles that partially utilize electric motors) and electric vehicles. The environmental benefits of these options depend on the ultimate source of electricity.

3.6.3 Infrastructure and stationary sources

(a) These sources include incinerators, heating and air-conditioning plants, firefighting training, and certain construction or maintenance works (e.g. smoke from asphalt paving plant or refuse burning).

(b) The main ways to reduce AAQ emissions from these sources include the modernizing of equipment and optimizing the energy efficiency of operations and building use. The latter is addressed in more detail in 3.7 below.

3.6.4 Landside access traffic

(a) The transport of people (and cargo) to and from (and within) an airport area presents another source of emissions that impact AAQ. In certain situations, rail transport, "people movers" and careful design of an airport layout can all contribute significantly to the minimization of the environmental impacts and operating costs arising from such transport needs.

(b) The provision of an excellent public transport system may be outside the scope of the airport authority, but there is the possibility of encouraging airport employees to use public transport. Provision can be made for intermodal interchange facilities in the layout, planning and design of new airports and in the extensions of existing infrastructure, particularly terminals. Passengers may be provided linkage to light, conventional or high-speed rail systems as well as regional and local bus facilities, the latter being particularly appropriate for employee access. The provision of such facilities should go hand-in-hand with the development of an airport public transport strategy appropriate to local conditions and consistent with a policy of cooperation with transport providers. Airports should coordinate with municipalities to ensure convenient intermodal transport is considered in municipal plans.

3.6.5 Ambient air quality regulation

(a) There are State regulations which makes provisions for ambient air quality for the protection of human health and the environment which are usually based upon the guidelines of the World Health Organization. Ambient air quality regulations provide indications of levels of pollutant concentrations considered acceptable in occupied locations and usually include NO2, CO, O3, SO2, some organic compounds (e.g. benzene (C6H6), and PM).

(b) Note that, in contrast to the ambient air quality regulations, emissions certification applies to individual sources such as road vehicles or aircraft, etc. Furthermore, emissions and ambient air quality regulations do not always target exactly the same pollutants - for instance, ICAO engine certification provides limits to NOx emissions (including NO and NO2) whereas mostly State ambient air quality standards specify maximum concentrations of NO2. Similarly, the ICAO smoke number (SN) 4 Standard is not consistent with PM10 and PM2.5 concentrations regulated for ambient air.

(c) To achieve compliance with ambient air quality regulations, an airport operator should establish and have an "air quality management" plan in place. Air quality management involves measuring ground level pollutant levels and assessing compliance with the relevant regulations. If limits are exceeded, it is then necessary to identify and, where possible, quantify the emissions sources that are impacting air quality in the area where the exceedance is occurring. This involves developing an inventory of sources and then carrying out a modelling exercise of the likely dispersion to estimate the expected pollutant concentrations. In most cases, this modelling will be a complex and involved process, as the contributions from local roads and industry will also need to be considered as well as the variable nature of some emission sources. As a result, air quality modelling should be carried out by specialists.

(d) The results of the modelling should indicate those emissions sources that have the greatest impact on the air quality in the area of concern, allowing the airport operator to prioritize and target these areas for mitigation action.

3.7 Greenhouse Gas Emissions Management

3.7.1 Drivers

(a) Many airports address GHG emissions on an unregulated or voluntary basis. Drivers for such action might include company policy on environmental stewardship, corporate social responsibility or proactive steps to curtail government regulation Inventory

(b) An airport GHG inventory is a report of the sources and amounts of GHG emissions at an airport. An airport GHG inventory should be divided according to the ownership and control of emissions sources. The World Resources Institute GHG Protocol provides three categories for emissions management:

(i) Scope 1 emissions are from sources that are owned or controlled by the airport operator, such as airport power or heating plants, airport fleet vehicles, construction, and firefighting training.

(ii) Scope 2 emissions are those from the off-site generation of electrical power (and heating or cooling) purchased by the airport operator.

(iii)Scope 3 emissions are those from airport-related activities from sources not owned or controlled by the airport operator, including aircraft, most ground support equipment and most ground access vehicles.

3.7.2 Mitigation

The GHG emissions at airports are dominated by the CO2 emitted from burning fossil fuels, thus airports should be developed and operated to minimize these emissions. Most of the mitigation measures to address local air quality in 3.3 above and those to improve energy management, will also benefit the total GHG emissions associated with an airport.

3.8 Water Management

(a) The Airport operator should comply with the applicable State regulations on water quantity and quality discharge limits. Waste water, including sewage, should be treated on site before being discharged or directed to non-potable uses, such as landscape irrigation. Alternative methods should be agreed upon with the recognized State authority.

Storm water

(b) Airport storm water run-off will generally need to be collected and treated before being discharged so as not to pollute groundwater or nearby bodies of water. The primary products which can be found in untreated storm water include suspended solids, fuel, oil and greases, heavy metals etc. Settling ponds can be used to control discharge flow rates and for the removal of solids. Further treatment may be required depending on the types and levels of contaminants. The nature of airport operations will influence the type and extent of waste water treatment required.

(c) When planning water management facilities, the following issues need to be considered:

(i) oils and fuel should be contained and segregated at their source;

(ii) the use of desalinated water can cause piping system corrosion so the aggression index for the water should be monitored;

(iii) where and how to discharge into natural water systems;

(iv) water quality monitoring of airport surface run-off, as water could be stored for long periods in underground or elevated reservoirs not frequently cleaned or liable to contamination; and water conservation practices to reduce the use of potable water and harvest rain water

(d) In order to determine the type of practices to be incorporated in a water management programme, the airport developer and operator should conduct a review of the site conditions. This review should include the following:

(i) topography;

(ii) presence of bodies of water;

(iii) storm water discharge points, including infrastructure and natural bodies of water;

(iv) drains, culverts and catch basins;

(v) paved areas and buildings;

(vi) aircraft and vehicle service areas; and

(vii) operational areas and activities, e.g. fuelling, de-icing and maintenance areas

Petroleum and chemical management

(e) Large quantities of petroleum and chemical products, which are potential sources of water pollution are stored and handled at airports. The following paragraphs outline management practices that may be employed in maintenance areas, aprons, fuel farms, etc.

(f) Aircraft maintenance areas, as well as automotive and equipment service areas, should be provided with oil-water separators which are, in turn, connected to sanitary sewers leading to the municipal waste treatment plant serving the airport.

(g) It is important to manage water originating from aprons as it is likely to contain many contaminants including hydrocarbons from spills. Grease and suspended solids from various sources such as aircraft, service vehicles and minor aircraft maintenance may also be present. The airport pollution control programme should therefore focus on:

(i) strict enforcement of storage regulations to control pollution at its source and to minimize hazards that could result in spills;

(ii) removal of spilled oil and fuel through immediate containment and spill recovery;

(iii) maintenance activities in hangars, where possible, that are protected by oil-water separators and to reduce aircraft maintenance on the aprons;

(iv) washing of equipment in dedicated areas; and

(v) immediate cleaning of all spills of fuel, oil, or other dangerous goods by using environmentally sound absorbents, which are subsequently removed from the airport by handlers who are licensed and trained disposers.

(h) Airport personnel must regularly check all relevant access pits and sumps, monitor the removal of any fuel or oil found therein, and always respond to spill reports, analysing them for common causes in order to prevent future spills. Trucks used for fuelling operations should be inspected every six months and hydrant pits used for transferring fuel from the underground piping systems should be checked on a routine basis for any accumulation of fuel.

(i) Another water pollution problem can be the presence of underground oil-saturated soils at fuel farms. Several potential sources of oil contributing to the oil-saturated soil beneath a fuel farm:

(i) leakage from storage tanks;

(ii) leakage from distribution lines;

(iii) leakage from mechanical equipment which penetrates cracks and joints in the slabs beneath the equipment; and

(iv) leakage through the joints in the storm water drainage pipe used to transport condensate from the fuel storage tanks to the oil-water separator system

(j) Number of steps can be taken to solve the problem of underground oil-saturated soils. It may be necessary to consult a specialist in this area

3.9 Waste Management

(a) Waste management is concerned with the reduction of both hazardous and non-hazardous wastes. Waste management at airports should be done in accordance with the local regulations.

(b) In general, the 4Rs - reduce, reuse, recycle and recover; are good practices for waste management at any workplace. Airport waste can be divided into nine general categories of waste, including

(i) municipal solid waste (MSW);

(ii) construction and demolition waste (C&D);

(iii) green waste (e.g. from landscape management);

(iv) food waste (domestic);

(v) waste from aircraft flights (i.e. deplaned waste);

(vi) lavatory waste;

(vii) spill clean-up and remediation waste;

(viii) hazardous material; and

(ix) International Catering Waste (ICW).

A waste management programme should include three practices: planning, procedures and special provisions.

(c) Planning. Airports should establish a dedicated plan and programme for the management of waste. This plan should consist of the following:

(i) a description of design intent, as well as anticipated wastes, their volumes, and disposal or treatment methods;

(ii) construction details for new infrastructure such as incinerators or landfills, including an overall landfill development plan, and a site closure plan;

(iii) a clear description of the chain of authority, organizational structure, job descriptions and job responsibilities for all personnel;

(iv) an itemized list of mandatory regulatory reporting requirements;

(v) an itemized list of internal, written reporting requirements and record-keeping;

(vi) a waste minimization, reuse and recycling plan (i.e. reduce or eliminate operations/processes that generate solid waste, redesign processes to minimize waste, substitute products for waste reduction), as well as a plan to either maximize municipal recycling capacity for airport and deplaned waste, or develop that capacity at the airport;

(vii) a description of health and environmental monitoring programmes and related reporting requirements;

(viii) a description of routine landfill, composting, or incineration operational procedures;

(ix) a description of health and environmental monitoring programmes and related reporting requirements;

(x) a hazardous materials and emergency procedure plan; and training of all employees in waste management concepts, including day-to-day procedures, equipment operating instructions, safe practices and emergency procedures.

(d) Procedures. It is important that the waste management plan incorporate the following procedural elements:

(i) describe procedures for the reduction, reuse and recycling of airport and deplaned waste;

(ii) choose sustainable products and services;

(iii) compost organic wastes;

(iv) provide training for proper material handling to reduce waste and spills, and equip waste transport vehicles with anti-spill equipment;

(v) centralize responsibility for waste management and establish written procedures for loading/unloading and transfer operations;

(vi) track waste to allow for better management (this applies to all utilities); create a spreadsheet or tracking system that does the following, especially for wastes that leave airport property:

(1) identifies waste streams;

(2) evaluates the process generating the waste;

(3) prioritizes waste streams;

(4) prepares inventory reports; and

(5) maintains records on waste production and disposal costs;

(vii) isolate hazardous wastes by containment and prevent mixing of hazardous and non-hazardous wastes;

(1) isolate liquid waste from solid waste;

(2) separate biomedical wastes with infection potential for special treatment and disposal; and

(3) segregate incompatible materials/wastes to avoid dangerous reactions in the event of a spill

(e) Special provisions. It should be noted that in the management of hazardous wastes, special provisions may be required. These provisions can include the following:

(i) perimeter security fence;

(ii) security alarms on the gate and security fence;

(iii) designated vehicle wash-off area;

(iv) a dedicated building or storage sheds for materials storage;

(v) safety control devices such as fire and gas alarms;

(vi) installation of ventilation systems, non-spark electrical controls and fire extinguishers;

(vii) specialized training of personnel; and

(viii) implementation of a wildlife hazard management programme including location of airport waste storage and facilities

(f) An effective waste management programme can be enhanced by employee awareness of the three waste management practices. An awareness programme can include training, participation in special events, information sessions and informative newsletters. Employees should stay current on changes and new information to ensure adherence to policies and procedures. The concept of segregation of recyclable solid waste components should be communicated to all parties. It is possible to recycle and remanufacture both solid and hazardous wastes into other products. Segregation and recycling policies should be implemented (mandatory) by aerodrome operators.

3.10 Energy Management

(a) The majority of energy used at an airport is associated with the provision of heating, ventilation, air conditioning and lighting. The essential services such as airfield lighting and instrumentation actually use a relatively small amount of energy. It has been estimated that energy costs account for about five per cent of the operating costs of a modern airport. These costs can be reduced through energy efficient design of new airport facilities.

(b) To assess energy and environmental performance in existing facilities, suitable indicators are required. The actual choice of the indicators will depend on the size of the airport, but suitable indicators may include:

(i) energy consumption per:

(1) 1,000 passengers;

(2) air transport movement;

(3) tons of cargo movement;

(4) traffic unit (TU);

(ii) pollutants released:

(1) directly per 1,000 passengers/TU; and

(2) indirectly per 1,000 passengers/TU

(c) Actual energy consumption, or the best available estimate, separated by energy source should be recorded. This data should be reported annually so that performance improvements can be demonstrated and compared to other indicators, such as traffic, finance and employment. Indicators based on measures of consumption and pollutants are essential for reports on environmental effects. In addition, indicators based on cost are essential from a financial management viewpoint.

(d) An airport energy audit or assessment may be conducted by qualified airport personnel, outside consultants, or through coordination with an energy provider. Audits typically analyse energy use and building characteristics for multiple airport facilities, and result in a list of measures that can increase energy efficiency. Often, the cost of the audit and implementing measures can be offset by the cost savings from reduced energy usage, or through coordination with energy providers. Energy audits can also identify opportunities to increase an airport's use of renewable energy sources, or pursue more substantial programmes to increase energy efficiency and energy security (e.g. micro grids and smart grids). To be effective, energy audits should be carried out at regular intervals.

(e) In order to heighten awareness of energy efficiency within the airport and interested communities, airports should adopt an energy policy guidance statement. Turning these statements into effective action requires a clear definition of responsibility for energy efficiency. Ideally, each operational manager will have this responsibility, with expert knowledge being provided by engineering and energy specialists. Examples of policy statements are as follows:

(i) "This airport aims to use energy as effectively as possible in the pursuit of its corporate objectives."

(ii) "This airport will always consider the environmental impact of its direct and indirect energy consumption."

(iii)"This airport is committed to the efficient use of energy in all its activities."

(f) An effective energy strategy will include a statement of objectives to make all personnel aware of what the organization is committed to achieve. It should integrate environmental performance as well as financial considerations.

(g) An energy strategy should consider the following:

(i) ***Choice of energy source***: in the context of an effective energy management plan, the choice of energy source will result from a range of different factors (e.g. resilience, energy security, costs, mandates, available resources, environmental impact, and legislation). It is up to each organization to consider these factors when deciding which energy mix best meets its needs. When making decisions, it is important to consider both the direct and indirect environmental effects. For example, using electricity may have a negligible environmental effect locally, but its effect may be significant elsewhere if the power is generated by the combustion of fossil fuels.

(ii) ***Effective utilization and management of energy***: A key aim must be to conserve energy and still meet the operational objectives of the airport. The focus of an energy strategy should be to improve energy efficiency. To do this, it is necessary to understand where, how and why energy is used. This is one of the objectives of the energy audit.

(h) All control points related to heating and air conditioning systems should be checked, including the heating and cooling temperatures, control of humidity, and boiler adjustments. While such actions are simple, the combined effect of incorrect settings could mean the use of ten per cent more energy than is necessary. Other simple procedures include checking the insulation of pipework, duct work and buildings themselves (building envelope, ventilation, etc.). All these measures can optimize the performance of the system. Where a comprehensive building management system is installed, many checks and adjustments can be carried out from a central control room. Once the existing plant is operating efficiently and as much waste is eliminated as possible, further capital investment may be considered, including investments in additional sophisticated control systems, variable speed drives for fans and pumps, heat recovery systems, and new boiler plants.

(i) The lighting of buildings accounts for a major part of the energy consumption at an airport. Sometimes it is possible to reduce the requirement for artificial lighting by the introduction of more natural lighting - providing this does not add significantly to heat or cooling loads. Smart meters on individual buildings can have similar effects on a smaller scale.

(j) Where artificial lighting is installed, it should be appropriately controlled and should use the most efficient, suitable light source. Paying close attention to the location of lighting and operating on the basis of time, ambient light levels, occupancy, etc., can lead to very worthwhile savings and can be self-financing. Since most light fittings produce heat, recovering this heat ensures that it does not add to the air conditioning loads of the building.

3.11 Environmental Emergencies

(a) Emergencies include fuel and chemical spills, and incidents involving dangerous goods or hazardous materials that may affect the environment. In order to respond effectively to environmental emergencies, the airport emergency plan and environmental emergency plan should include specific procedures to deal with such emergencies. These plans and procedures should be coordinated, and must clearly identify a predetermined sequence of communication and actions to deal with the various types of environmental emergencies. The plans and procedures must incorporate the elements of command, communication and coordination.

(b) Environmental emergency planning should include the following:

(i) General:

(1) Table of contents;

(2) Record of agreements;

(3) Purpose of the plan;

(4) Geographic location of airport;

(5) Environmentally sensitive areas;

(6) Emergency telephone list; and

(7) Grid and reference maps.

(ii) Actions:

(1) Persons of authority — site roles;

(2) Major types of airport environmental emergencies;

(3) Site management/spill clean-up and restoration and remediation;

(4) Site hazardous materials inventory;

(5) Emergency equipment on site;

(6) Spill clean-up contractors, agencies and specialists;

(7) Monitoring, reporting and follow-up procedures;

(8) Media relation guidelines; and

(9) Training protocol.

(c) Environmental emergency planning should incorporate the following steps for emergency response:

(i) Secure: Establish a hazard zone that will keep non-emergency response personnel out of danger.

(ii) Approach: Approach from upwind to avoid coming in contact with vapours.

(iii) Identify: Utilize placards and labels on containers to provide information on the product involved. The United Nations Product Identification Number (PIN) will provide information for personnel protection and spill response information. The exact identity of the products involved can also be found by examining the shipping documents.

(iv) Assess: The following points should be considered:

(1) Is there a fire?

(2) Is there a spill or a leak?

(3) What are the weather conditions?

(4) What is the terrain like?

(5) What is at risk: people, property or the environment?

(v) Respond:

(1) Respond in an appropriate manner.

(2) Establish lines of communication.

(3) Establish line of command.

(4) Ensure coordination

(d) It is important that the airport emergency plan be tested on a regular basis and that corrective measures been taken immediately after an exercise or real incident where deficiencies in procedures are identified.

4 INFRASTRUCTURE FOR ENVIRONMENTAL MANAGEMENT

4.1 General

(a) This chapter provides high-level guidance material on the infrastructure that can be included in an airport design which can enable and facilitate environmental management by the airport operator. The focus of this chapter is on facilities and infrastructure usually included in an Airport Master Plan.

(b) It should be noted that aviation safety is of paramount importance when considering airport infrastructure changes. For further information on aerodrome safety requirements, please refer to the SLCAR Part 14A - Design and Operations of Aerodromes. Risk management approach can be used to assess infrastructure and environmental management options. Further information on using a risk management approach, see the SLCAR Part 19 – Safety Management and SLCAA-AC-AGA017 Rev01 – Safety Management System.

(c) Airport system planning can aid environmental management by accommodating future demand and distributing operations in a manner that reduces adverse environmental effects at individual airports. This also ensures that expected demand and capacity are addressed and overcapacity is avoided, which could result in unnecessary environmental impacts. The potential for impact reduction is particularly high at airports that are capacity-constrained or attempting to reduce a local environmental impact. The primary purpose of airport system planning is to study the performance and interaction of an entire aviation system to understand the interrelationship of the member airports. System planning involves examining the interaction of the airports with the aviation user requirements, economy, population, and surface transportation within a specific geographic area.

4.1.1 Overarching considerations

(a) Some issues need consideration regardless of the infrastructure being developed. Airport planners and infrastructure designers should consider the ecosystem services of the existing environment when considering projects. Ecosystem services are the provision of services by the ecosystem itself, such as treatment of storm- water through wetlands. These services can be economically valued and incorporated into infrastructure planning.

(b) Another overarching consideration is the life cycle cost and management of infrastructure being planned and designed. This will assist with better decision-making with regard to costs and best practices for long-term asset management.

4.1.2 Airport structures

This chapter is organized into five subsections: Airport-wide, Airside, Passenger Terminal Facilities, Airline/Airport Support Buildings, Landside, and Environmental Aspects. The first four subsections present guidance on the infrastructure that can be included in an airport design, which can enable and facilitate environmental management organized by airport component (e.g. runway layout, terminal building, and landside facilities). Within each component, infrastructure options are discussed and the environmental benefits of the options are highlighted. The fifth subsection

(Environmental Aspects) is environmental aspect-focused and re-emphasizes the prior information in terms of the environmental aspect that the infrastructure option benefits the most.

4.1.3 Airport siting

(a) Appropriate siting of new airports is of vital importance to ensure that future environmental impacts can be avoided or mitigated. When considering a new airport site, many environmental and land-use planning-related considerations should be taken into account, including (but not limited to):

(i) meteorological conditions (e.g. prevailing wind direction);

(ii) required space for airfield operations;

(iii) required space for off-airfield impacts;

(iv) geological conditions;

(v) potential natural or artificial obstacles;

(vi) airfield layout;

(vii) runway / taxiway layout;

(viii) apron layout;

(ix) ground transport access to the airport;

(x) location and design of terminals;

(xi) locations of hangars and related installations;

(xii) access to and reliability of utilities and services — e.g. waste water treatment;

(xiii) value of existing ecosystem services at proposed site; and

(xiv) existing and planned land uses in the vicinity of the site

(b) For new and existing airports, many of the above considerations, including managing the expected future requirements of an airport, can also be performed through the master planning process, (see the SLCAA-AC-AGA030 Rev00 – Airport Master Plan and Layout Plan).

4.2 Airport-Wide

4.2.1 Landscaping

4.2.1.1 Plant species selection

(a) Grass and other plant species should be selected taking into account the following considerations:

(i) Plants and landscape should not create a wildlife hazard.

(ii) Type and extent of irrigation should be considered when determining the type of plants to include. Landscaping that requires little or no irrigation (xeriscaping) should be considered. Endemic or native plant species are usually best adapted to local climate and may require the least maintenance and watering. Temporary irrigation may be required to establish plants.

(iii) Some plantings, such as trees that provide shade, can reduce local temperatures or solar heat loading during hot weather; however, care must be taken with regard to tree height to avoid penetrating protected airspace surfaces.

4.2.1.2 Wildlife hazard management

(b) Wildlife at airports can be a hazard to safe aircraft operations. Though the airport operator is usually responsible for managing the hazard, wildlife management coordination with airport neighbours should be considered. An airport operator should develop a management plan to reduce the attraction of animals and prevent them from crossing the aerodrome perimeter. The SLCAA-AC-AGA010A – Wildlife Hazard Management should be taken into account during airport design in order to optimize future operational wildlife management actions. Some documents, such as the Airports Council International's "Wildlife Hazard Management Handbook (second edition, 2013) can also provide useful information.

(c) Items of particular importance regarding wildlife hazard management and the avoidance of providing water, food and shelter, include the following:

(i) water bodies, wetlands and drainage systems;

(ii) plant species selection;

(iii) structures or land forms;

(iv) landfills and waste management; and

(v) activities on and off the site of the airport

4.2.2 Surface water quantity and quality control

(a) To ensure a normal surface water discharge flow rate (hydrograph) is maintained, site drainage needs to be considered prior to all developments taking place. In some instances, settling ponds or vegetated swale drains can be installed to slow the rate of surface waters flowing off the site to a rate closer to the "natural" or predevelopment hydrograph.

(b) Water quantity management also has the added benefit of collecting natural and artificial litter thereby allowing time for suspended sediments and pollutants to drop out of the water improving water quality. Pollution management systems designed to address the pollutants anticipated from airport operations should be installed in such a way as to be easily accessed and maintained. These systems typically include: oil/water separators, sediment traps, and de-icing facility drainage and recovery systems. Pollution management systems that mimic natural processes can be most effective and easier to maintain.

(c) Systems should be designed for future conditions including potential for increased intensity of storms due to climate change.

(d) For occupied buildings, waste water or sanitary drainage systems should be kept separate from storm water and surface water systems.

(e) Settling ponds should be designed and located so as to not attract birds and wildlife, as discussed in 4.2.1 above.

4.2.2.1 Groundwater management

(f) Attention should be paid to subsurface, groundwater (aquifer) management. Management of groundwater should aim to ensure that normal subsurface flows are maintained and the risk of contamination to the subsurface water bodies is reduced. For more information, please see the Airport Services Manual (ICAO Doc 9137), Part 2 - Pavement Surface Conditions.

(g) Due to the large volumes of aviation fuel and other potentially hazardous products stored in and around airports, special attention should be given to ensure that the integrity of fuel storage and delivery systems are maintained. The use of oil/water separators and pavement sealer can be used to reduce the risks of contaminated surface waters from effecting groundwater. If the groundwater bodies are contaminated, then remediation works should be conducted to reduce pollutant levels to what is legally accepted.

(h) Subsurface flow disruptions could include utility tunnels, trenches, dewatering activities and borrow pits. Activities such as these can interrupt the natural movement of the subsurface waters resulting in the interruption of subsurface water bodies' downslope. The placement of aviation facilities that have the potential to contaminate the aquifer may render downslope water supplies unstable.

(i) Instances of groundwater rising to the surface as spring or as vernal or ephemeral ponds can be very important to the endemic biota and should be preserved where possible. This may also provide a water resource for the airport but should be monitored to ensure that it does not develop into a wildlife attractant.

(j) In conjunction with construction activities where the ability for surface water to naturally percolate through the ground's surface is removed, natural groundwater recharge can be established. Through careful planning and design of features such as swale drains, groundwater recharge can be re-established with the added benefit of natural surface water hydrographs, also maintained post-construction activities. New landscape features, such as swale drains, should be monitored to ensure they do not develop into a wildlife attractant.

4.2.3 Pavement materials

Consideration should be given to the types of materials used for pavements, including runways, taxiways and aprons. The use of recycled materials in pavements, and recently developed techniques using warm-mix asphalt, can reduce the cost and impact of building pavements. The Aerodrome Design Manual (ICAO Doc 9157), Part 3 - Pavements, provides guidance on airport pavements.

4.3 Airside

4.3.1 Airfield layout

The layout of an airfield has a strong correlation with environmental management of an airport and its environs. Specifically included in the airfield layout context is runway layout, taxiway layout, airport capacity, hold pads/parking positions, and airfield lighting, each addressed below.

4.3.1.1 Runway layout

(a) Runway characteristics such as orientation, length, placement, and threshold location can affect where the off-airport areas of high noise and emissions concentrations will be, as well as on-airport operational efficiency and the associated emissions. For more information, please see the ICAO Doc 9157 Part 1 - Runways. The following issues should be taken into account when designing the runway layout:

(i) prevailing wind direction;

(ii) minimizing the distance of the runway(s) to the terminal(s) and cargo areas to reduce taxi fuel

(iii) consumption;

(iv) off-airport geographical features such as water bodies and elevated areas;

(v) off-airport land use (both existing and planned) such as residential and other noise-sensitive areas;

(vi) allowing space for appropriately sized surface water drainage; and

(vii) sensitive ecosystems such as wetlands, where impacts should be avoided

4.3.1.2 Taxiway layout

An efficient taxiway layout can reduce aircraft fuel burn and emissions. Simulation modelling can be used to test possible taxiway layouts for efficiency and identify potential bottlenecks that can be mitigated during planning. Additionally, planning for possible future infrastructure needs while designing for current requirements should facilitate future development without the need for reconstruction or less than ideal geometry (e.g. plan for dual parallel taxiway separation if there is an expectation it may be needed in the future). Taxiway features to consider can include:

(i) dual taxiways that provide additional direct routes, which can help avoid holds or rerouting due to aircraft taxiing in an opposite direction;

(ii) additional taxiways at runway entrances can provide space for intersection departures and optimal queuing and sequencing of aircraft, minimizing ground delay and idling;

(iii) intersections and connections that allow efficient access from terminal and cargo areas to runway threshold;

(iv) high speed exits or rapid exit taxiways (RET) can reduce runway occupancy time and allow landing aircraft to exit at higher speeds over more traditional perpendicular exits. More information on siting RETs can be found in the ICAO Doc 9157 Part 2 — Taxiways, Aprons and Holding Bays;

(v) placing RET and traditional taxiway exits at locations which minimize runway occupancy time for a large component of the current and planned fleet;

(vi) end-around taxiways that can eliminate runway crossings, reduce taxi times and improve safety during peak periods; and

(vii) Siting taxiways to avoid noise exposure to nearby noise-sensitive areas.

4.3.1.3 Airport capacity

(a) An airport should be designed and built with sufficient capacity to meet demand, otherwise operational inefficiencies and delays can impact fuel burn and emissions. A general planning rule of thumb is that when an airport reaches 60 per cent of its capacity, planning for additional capacity should commence and when it reaches 80 per cent, design work for additional capacity should begin.

(b) While runway, apron, and terminal capacity are fundamental, some airports could be limited by other issues such as ground transport access. In addition to the above suggested practice, additional lead time should be considered for surrounding infrastructure to support the airport, e.g. roads, water mains, and clearance of sites.

4.3.1.4 Hold bays/parking positions and related infrastructure

(a) Aircraft holding bays and parking positions can be placed in the most appropriate position to increase efficiency and to reduce the need for long-distance aircraft relocation. See ICAO Doc 9157 Part 2 - Taxiways, Aprons and Holding Bays.

(b) New technologies for aircraft taxiing could have the potential to reduce fuel burn and emissions. Provisions may need to be made to include additional airside infrastructure for deployment of such vehicles.

4.3.1.5 Airfield lighting

(a) Airfield lighting is an area where recent technological improvements can reduce environmental impacts. Use of new lighting technology applications (e.g. light emitting diodes or LEDs) can reduce energy consumption and maintenance costs as these technologies generally provide a longer service life than traditional technologies. See ICAO Doc 9157, Part 4 - Visual Aids and Part 5 - Electrical Systems.

(b) Care must be taken to ensure that new lighting technologies produce the same result as traditional technologies. For example, LED taxiway light replacement can reduce energy consumption; Furthermore, lighting needs to produce the appropriate spectrum to accommodate enhanced flight vision systems (EFVS) or night vision imagery technology. Traditional LED lights do not emit infrared light, which is required for EFVS and heads up display systems. Therefore, LED lights could be used in all airfield lighting installations except obstruction lighting, approach lighting, and high-intensity runway lighting.

(c) Pilot-activated approach, runway, and taxiway lights at small airfields can reduce electricity use, as well as insect and wildlife attraction.

(d) Solar autonomous lights (each light is individually powered) are a secure system which can be an alternative source of lighting at an airfield where electricity is either non-existent or unreliable. Electricity consumption can be reduced by installing new technologies.

4.3.1.6 Apron

A properly planned apron should allow for efficient aircraft movement throughout the apron area and enable access to all gates and alleyways for the largest aeroplane design group operating on the apron.

4.3.1.7 Fixed electrical ground power and preconditioned air

Sufficient FEGP and PCA installed at terminal gates (and remote stands) can enable a parked aircraft's APU to be switched off. This will reduce fuel burn, lowering emissions as well as noise levels on the ground. The FEGP and PCA need to be appropriate for the aircraft type at a gate or hard stand.

4.3.1.8 Fuel supply, storage and delivery

(a) Fuel is generally regulated by the State, and there are established standards for fuel storage, handling, and dispensing designed to ensure safety. General principles for minimizing environmental impacts from fuelling systems include maximizing containment of the fuel, as well as minimizing use of vehicle fuel delivery. For more information, see the Manual on Civil Aviation Jet Fuel Supply (ICAO Doc 9977).

(b) There are numerous sources of information on aviation fuels and fuelling systems. The primary consideration for fuel supply, storage, and delivery should be safety. Fuelling system designs that prevent fumes, leaks, and spills are safer and prevent environmental contamination. ASTM International provides petroleum standards for aviation fuels, and ASTM Manual, Aviation Fuel Quality Control Procedures, provides a complete explanation of several common procedures used by fuel handlers. Fuelling system, pipelines, tanks, hoses, and other equipment should be constructed of the appropriate materials, and tested and maintained regularly.

(c) Fixed hydrant refuelling systems can reduce the need for fuel trucks to access the apron, lowering airport vehicle fuel consumption and emissions. While these systems usually require piping, the reduction of GSE movements in the terminal area can provide additional safety benefits.

(d) Fuelling is often a contracted service operation at airports. In this case, consultation with fuel service agents on the design of fuelling systems may result in a more efficient airport fuelling system. There should be a very specific training requirement for fuelling agents which can cover fire and explosions, safe handling and storage of fuels and lubricants, handling of hazardous materials, use of personal protective equipment (PPE), prohibition of smoking, and first aid for responding to accidents.

4.3.1.9 Infrastructure for deplaned sewage and waste water

Deplaned waste water needs to be pumped from the aeroplanes into either a self-powered truck or a cart pulled by a tug and transferred to a triturator facility, generally located airside, for pre-treatment prior to discharge to the sanitary sewage system. The deplaned waste water contains chemicals which present risks to the environment and human health and needs to be handled properly.

4.3.1.10 Aircraft maintenance facilities

(a) Aircraft maintenance is a vital aspect of the smooth running of the aviation system. Airline scheduling and a need to maximize the utilization of fleets can result in the need to carry out aircraft maintenance at night-time. There are a myriad of noise sources produced during aircraft maintenance such as engine testing, aircraft washing and noise from maintenance infrastructure. A well-planned aircraft maintenance facility will site these noisy activities away from noise-sensitive land uses. This will maximize the number of hours a day that the facility can be used.

(b) Aircraft run-up pads are usually used to do a post-maintenance engine test prior to operation and are often required in the night period. The main environmental considerations for designing the pad location are minimizing the taxiing required to reach the pad and the proximity to noise-sensitive neighbours. Planners should therefore consider the possible user(s) of the aircraft run-up pad(s) when choosing its location as well as any noise-sensitive receivers nearby.

(c) At an airport with particularly high demand for aircraft run-ups at night or with nearby noise-sensitive neighbours, an acoustic enclosure might be built. Such a structure should be designed to shield noise-sensitive areas from engine noise while providing sufficient ventilation to allow the engine test. A U-shaped semi-enclosure might be a cost-effective facility or a fully insulated and ventilated dedicated building or hangar might be required.

4.3.1.11 Rescue and Fire Services

(a) The main environmental considerations for airport fire and rescue activities are the training areas for simulated fire training and the recovery of related storm water run-off. The infrastructure for these activities should include a fire training area with road access as well as facilities for handling the fuels used, and for the collection and containment of run-off water. For more information, see SLCAA-AC-AGA005.Rev01 - Guidance on Rescue and Firefighting Services.

4.4 Passenger Terminal Facilities and Airline/Airport Support Buildings

(a) This section addresses the passenger terminal building and support buildings such as the control tower, hangars, provisioning, maintenance and cargo areas. For information and guidance on the development of airport master plans, see the SLCAA-AC-AGA030 Rev00 – Airport Master Plan and Layout Plan.

(b) The main environmental impact associated with existing buildings is the use of energy, for purposes including electricity, lighting, and heating, ventilation and air-conditioning (HVAC). Increasing energy efficiency and choosing lower emissions or renewable power sources reduces the impacts associated with power generation. The use and management of water and waste water is the another environmental impact associated with buildings.

4.4.1 Buildings

4.4.1.1 Overall design

(a) Key architectural decisions at the early planning or design stage can greatly influence subsequent opportunities to reduce building energy use. These include building form, orientation, shading, height-to-floor-area ratio and decisions affecting the opportunities for and effectiveness of passive ventilation and cooling.

(b) Attention should be given to the local environment, for example, local climate, types of surrounding buildings, types of vegetation, and modes of transportation that will be accessing the building, in order to assess how these may impact on the energy efficiency of the building. Where possible, the building orientation should take advantage of natural sunlight for heating and lighting. New buildings should consider the latest energy efficiency certification processes and green building codes and practices.

(c) Terminal and other buildings can be designed and built to energy efficiency standards and guidelines.

(d) "Smart" building technologies such as computer controls, sensors and whole-building automation (such as building automation systems (BAS)/building energy management (BEM) systems) enable an integrated design approach to energy management which considers the functioning of the building as a system, rather than focusing on individual energy-using devices. Building recommissioning provides a check that building systems are still functioning as originally planned, constructed, and delivered, and to identify where opportunities for improvement exist. These systems and approaches enable HVAC and lighting systems to react automatically to the operating environment to optimize energy efficiency. Features include moving external shades or louvres that track ambient sunlight and heat load to maximize light and control solar heat loads. Planting, such as green roofs, can be used to lower ambient temperatures.

(e) Furthermore, if the heating, cooling and electricity needs of a collection of buildings can be linked together in an integrated system without major distribution losses, then significant savings in primary energy use are possible beyond that which can be achieved by optimizing the design of a single building.

4.4.1.2 Heating

(a) The energy requirements to heat a building can be reduced through a number of building features and considerations. These can include the following:

(i) Careful consideration of the design and properties of the thermal envelope or shell of the building to prevent unwanted heat or air transfer between the interior and exterior. The effectiveness of the thermal envelope depends on factors such as the insulation level of the walls, the thermal properties of the windows and doors, the air-tightness of the building, driving forces such as wind, and inside and outside temperature differences.

(ii) The use of multiply-glazed windows; double or triple glazing for improved thermal performance.

(iii) Location of heating vents to maximize effectiveness and avoid heating unoccupied spaces where heat is not needed.

(iv) The use of natural solar heating through appropriate orientation of the building or windows to be sun-facing.

(v) The incorporation of a water vapour condensing system to improve the efficiency of boilers or furnaces.

(vi) The use of hydronic (piped water) heating systems can be more efficient than forced air systems.

(vii) The use of heat pumps drawing heat from the ground using a geological, geothermal or aquifer heat sink rather than outside air (can also use the ground for cooling).

4.4.1.3 Cooling

(a) The energy requirements to cool a building can be reduced through a number of building features and considerations. These can include the following:

(i) Reducing the solar cooling load on a building through orienting the building to reduce east and west facing walls, clustering buildings to provide shading, using high reflectivity building surfaces.

Note *- when adding reflective surfaces, consideration must be given to the potential adverse effects of glare and reflected light on the control tower and pilots operating aircraft*

(ii) Increasing thermal insulation, including using multiply-glazed windows.

(iii) Using landscaping such as planting trees to provide shade for buildings.

(iv) Location of cooling vents to maximize effectiveness for human activity and to avoid cooling unoccupied spaces where cooling is not needed.

(v) Using passive cooling techniques to meet some or all of the load, such as natural ventilation, evaporative cooling and channelling in-take air through underground pipes.

(vi) Selecting the most efficient modern cooling equipment and thermal distribution systems, such as hydronic cooling systems.

(vii) Designing so that cooling is not wasted on unoccupied areas. Thermal stratification can allow high spaces to remain uncooled.

4.4.1.4 Lighting

(a) Energy usage from lighting can be significantly reduced through the various designs and equipment including the following:

(i) Natural light as much as possible, for example, through the use of skylights, atriums and smart choices for the shape, size and position of windows.

(ii) Sensors and zone switches to dim or switch off electric lighting when not needed.

(iii) More efficient lighting devices, such as LEDs.

(iv) A relatively low background lighting level with local levels of greater illumination at individual workstations, referred to as task/ambient lighting.

4.4.1.5 Other electricity use

(a) Other than heating, cooling and lighting, the main uses of electricity in airport buildings include motors for conveyor belts, escalators and lifts, and energy used by concessionaires for food preparation and storage, as follows:

(i) Escalator and walkways that slow down or shut off when unoccupied or not in use.

(ii) Installation of metering systems for utility use including, water, sewer, gas, and electricity are important to allow for managing and creating appropriate business models to promote conservation.

(iii) Design that promotes human locomotion such as stairs over electric locomotion such as escalators.

(iv) This can be accomplished by providing convenient access to the alternative for human locomotion that equals or exceeds the powered locomotion.

(v) BEM systems are central energy control systems for individual buildings or groups of buildings that use computers for monitoring, data storage and communication. With energy meters and temperature, occupancy and lighting sensors connected to a BEMS, energy consumption can be better managed to reduce wastage, and equipment faults can be quickly detected either manually or using automated fault detection. BEMs enable ongoing monitoring and evaluation of operating efficiency for some hot water heating, BEMs may have hardware for using off-peak power which may not be available from suppliers at a lower price.

(vi) Electricity consumption can be reduced by switching to more efficient office equipment, consumer electronics, entertainment and communication systems, heating and cooling equipment and ventilation.

(b) Most other factors for reducing energy use will be operational in nature. These can include the following:

(i) implement building commissioning and improve operations and maintenance;

(ii) deploy continuous commissioning;

(iii) establish energy conservation teams;

(iv) use and reporting of metered data and information; and

(v) change of behaviour in occupants towards more conservative use of energy

4.4.1.6 Plumbing

(a) The use of potable water can be minimized, through the use, when practical, of low-flow and no-flow plumbing fixtures that are commonly available. Drainage piping should be compatible with and designed for low-flow and waterless fixtures.

(b) Recycled water or other non-potable water can be used for toilet flushing. The use of “grey water” for toilet use should be considered where necessary and or economically viable. In some areas, seawater can be used for toilet flushing. Grey water systems should be considered when designing new buildings. An option for waterless or dry urinals is also available.

4.4.1.7 Rainwater harvesting

Rainwater can be harvested from building rooftops and runway and airside rainwater run-off. The rainwater can be used for non-potable functions such as air conditioning cooling towers, landscape irrigation, washing of paved areas and aircraft, fire control, and toilet flushing.

4.4.1.8 Waste water management

Waste water including sewerage and grey water can be treated at an on-site waste water treatment plant or sent to a local waste water treatment plant. Benefits of on-site waste water treatment include the ability to recycle the waste water for a number of non-potable functions.

4.4.2 Passenger Terminal/Cargo/Hangar Area

4.4.2.1 Support vehicles refuelling facilities

Vehicle refuelling facilities can provide airport operations and tenants' efficient access to fuel needed to operate support vehicles. Additionally, alternative fuels, such as compressed natural gas (CNG), can be provided to encourage adoption of alternative fuel vehicles.

4.4.2.2 Recharging facilities

Consideration should be given to providing recharging facilities to ground support equipment, as well as passenger electric vehicles parked in terminal area parking. These facilities can encourage adoption of electric vehicles.

4.4.2.3 Spill containment

The aerodrome operator should have an environmental/safety and compliance unit, that regulate fuels and fuel storage, and also sets SOPs for spill prevention and clean-up. absorption materials should be used for spill clean-up that can better absorb fuels and oils, can be easily separated from fuels after clean-up (to reuse the fuel), and can be recycled instead of sent to a landfill. Primary environmental goals of spill containment include:

(i) have a good spill containment plan;

(ii) prevent discharge of fuels to waters; and

(iii) have properly engineered storm water containment and settling ponds to contain run-off

4.4.2.4 Hazardous materials management

(a) For any hazardous material, safe handling is the primary environmental consideration. Measures for handling, containment, and clean-up of hazardous materials should be described in a spill prevention plan, and the correct personal protective equipment should be maintained on site to adequately carry out the clean-up procedures. Some basic features of safe handling of hazardous materials include:

  (i) clear identification of hazardous chemicals;

  (ii) identification, training, and certification of those involved in handling hazardous goods;

  (iii) safe storage of hazardous material;

  (iv) plans for disposal of hazardous materials; and

  (v) ensuring airport tenants that handle or transport hazardous cargo have proper training, certifications, and safety procedures

(b) A hazardous materials plan should include recovery or neutralization of the hazardous materials, as well as disposal procedures. Most of these materials will need to be sent to a specific disposal facility, and some hazardous materials should be transported by a certified waste transporter. Large spills of some of these hazardous materials, such as mercury, can have air quality impacts, and plans should be made to monitor for fumes if such a spill occurs. Materials such as batteries should be kept in closed containers compatible with the contents. Specialized plastic containers can be purchased from commercial distributors such as Lab Safety Supply.

(c) Hazardous materials found at airports can include the following:

(i) potassium hydroxide (for hydrogen generators);

(ii) mercury (in barometers, thermostats, mercury switches, rotary joints);

(iii) lead acid, mercury-oxide, and other batteries;

(iv) ethylene glycol;

(v) dielectric oil;

(vi) solvents and degreasers;

(vii) fuel (diesel, jet, AVGAS, etc.) ;

(viii) paints; and

(ix) cleaners

4.5 Landside

4.5.1 Airport support elements

4.5.1.1 Power Generation

(a) Airports can be high electricity consumers with demand for power at multiple facilities. Power for airport support facilities can be drawn from a variety of energy sources. Airports can rely on local electrical grids, or combine power from a utility provider with on-site power generation.

(b) As a large airport can be the size of a small city, some include facilities to generate electricity. Maximizing use of on-airport renewable energy sources, such as solar, geothermal and wind power can provide a large portion of an airport's energy needs while reducing environmental impacts, and reliance on electricity grids. Power generation from wind turbines at, near or close to airports must consider obstacle limit surfaces (OLS) and the effects on aircraft and radar operations.

4.5.1.2 Renewable sources for power generation

(a) Airports surrounded by open landscapes may be particularly suited to large solar photovoltaic installations for electricity generation; these installations can be located on vacant airport land, or mounted on the rooftops of airport terminals, parking facilities, and other buildings.

Evaluation of an airport's geographic location, climate, and weather patterns can determine its solar energy potential.

(b) Consideration of a large solar array should be accompanied by an ocular analysis of glint (a brief flash of light) and glare (a continuous source of bright light). This would help identify solar panel orientations that maximize system performance while eliminating risk of glint and glare which could be hazardous to air traffic controllers and pilots.

(c) The use of wind power can be limited as large turbines may disrupt aircraft operations. An analysis of obstructions and potential wake effects can help airports determine the potential for wind power.

(d) Solar hot water systems can provide airports with a renewable energy source for heating water for bathrooms and other uses.

(e) Some types of waste can be incinerated to generate heat and electricity.

4.5.1.3 Heating and cooling plants

Modern electricity and heating plants tend to use cleaner burning and more efficient natural gas rather than coal. Further efficiencies can be gained using various technology options, such as:

(i) Cogeneration systems improve the efficiency of electricity production by harnessing the waste heat to heat buildings and generate hot water. Tri-generation uses the waste heat from the generation of electricity for both direct heating and the generation of cooling using absorption cycle refrigeration.

(ii) Fuel from renewable sources and forestry industry by-products, including wood pellets, can be used to generate heat.

(iii) Heat pumps use the same refrigeration equipment used for providing cooling (air-conditioning) and are substantially more efficient than heating with electricity.

(iv) Refrigeration and heat pumps can also use underground, geothermal or aquifer heat sinks to further improve efficiency.

4.5.1.4 Solid waste management

(a) Solid waste management infrastructure will depend on the waste management programmes adopted by the airport operator and tenants. A waste management programme can include a wide variety of options such as source separation, separation within a designated terminal area, separation off-site, and composting. Each of these and their related infrastructure is examined below.

(b) Waste reduction and reuse requires dedicated storage rooms complete with compactors, loading docks and parking facilities at the terminal in addition to a storage area for incoming supplies. A dedicated on-site or off-site cargo and supplies logistics centre can reduce the amount of packaging, pallets and wasteful material entering the terminal areas.

(c) Waste minimization might be an operator's overall goal: reduce, reuse and recycle are the methods to accomplish this. Installations could include filling stations for reusable water bottles to reduce the amount of disposable water bottle waste, combined with traditional drinking fountains. Integration with waste management programmes of the surrounding community should also be considered.

(d) Recycling may require source separation facilities in dedicated tenant spaces or, for whole building separation, large centralized collection and separation sites. Off-site processing may require an in-house transportation or piping system and off-site separation and storage.

(e) Composting facilities will need to address both wildlife and pest control. Organic material can be either degraded into a soil additive or used to generate energy through incineration or anaerobic digestion and methane capture in a specialized bio reactor. Organic waste disposal may be accomplished using a water-based slurry system requiring tanks or conventional container disposal.

(f) Agricultural security concerns should be considered. This can mean that waste from international flights is subject to special segregation and handling rules and may or may not be allowed to be recycled. Separate handling facilities may be necessary. Facilities for the consolidation of waste from international flights to a single terminal or pier should be considered.

(g) Incineration should be considered for waste disposal. Design considerations regarding an incinerator could include:

(i) airport obstacle limitation zoning;

(ii) options to combine municipal waste to make it practical;

(iii) the recovery of useful heat from the incinerator; and

(iv) the minimization of emissions

(h) Programmes to use demolition and excavated materials on-site may require a crushing and processing plant, as well as facilities for stockpiling, dust control and sediment management.

4.5.2 Ground transport, parking and internal airport circulation

4.5.2.1 Roadway layout

(a) Airport roads will normally link the airport to both the regional arterial road system and the local road network. Road traffic that must be considered includes air freight arriving or departing the airport by road and deliveries of goods to the airport terminal and nearby industries.

(b) A logical and efficient layout for traffic will be needed to maximize throughput for arrival and departure areas and other activities on and near the airport. Minimizing driving, congestion and idling time on the airport access roads will also benefit the local air quality in the vicinity of the airport.

4.5.2.2 Parking and car rental facilities

(a) Even with well-developed local transit infrastructure, an airport will need parking facilities for passengers, greeters, staff and deliveries. Ideally, such parking should be close to landside egress, if possible, within walking distance from landside to reduce requirements for airport transport.

(b) Technology such as green lights above vacant parking spaces can be used to assist parking and reduce traffic circulating in search of spaces.

(c) Car rental facilities are also ideally located within walking distance of the terminals. For larger airports with many cars rental companies consolidated rental car and general or long-term parking facilities can facilitate passenger access using consolidated shuttles buses or light rail.

4.5.2.3 Inter-terminal transport

For large, multi-terminal airports, inter-terminal transport design can reduce airport emissions and minimize energy use:

(i) use of aero trains or pods (driverless electric vehicles that follow a specific track) instead of airport shuttle buses either integrated into new buildings or as stand-alone projects at existing airports;

(ii) maximum utilization of low- or zero-emissions vehicles when shuttles are the key to inter-terminal transport; and

(iii)minimization of gate-to-aircraft vehicle shuttles

4.5.2.4 Intermodal transport facilities

Intermodal public transport links can bus stations, (light and heavy) rail stations and ferry terminals built to allow easy transfers for airport passengers. Such facilities are important for emissions reduction, and the long-term sustainability of an airport and the areas they serve. During the planning stages of an airport development, the airport developer needs to participate in regional planning to ensure that the airport is integrated into the regional (and national) transport plan.

4.6 Environmental Aspects

4.6.1 General

This section analyses the use of airport infrastructure for environmental management. Adverse environmental effects from noise, emissions, and water hazards may be mitigated with optimal uses of airport infrastructure. Those environmental aspects, along with the most appropriate type and use of airport infrastructure to combat those negative effects are discussed below.

4.6.2 Noise

4.6.2.1 Aircraft noise

(a) At the airport, runway placement and layout is the main infrastructure that will assist with managing aircraft noise. In particular, approach and departure tracks can be placed over non-noise-sensitive areas (e.g. water bodies) or the least populated regions in order to mitigate noise (see 4.3.1.1 — Runway layout and 4.3.1.2 — Taxiway layout).

(b) Similarly, off the airport site, land-use planning to avoid incompatible land use in noise-affected areas near the airport is also crucial. This is discussed in Chapter 6.

(c) The noise from aircraft auxiliary power units (APU) occurs mainly at terminal gates and normally will not be very close to residential areas. Noise screening could also be partly provided by terminal buildings. Moreover, the installation of fixed electrical ground power (FEGP) and preconditioned air (PCA) at aircraft gates can allow APU switch-off. Most of the benefit from the reduction of noise (and emissions) will be derived by the ground support staff on the apron (see 4.3.1.7 - Fixed electrical ground power and preconditioned air).

(d) Aircraft run-up noise can be controlled by locating the run-up pad as far as possible from all neighbouring residential sites or the construction of an acoustic enclosure - either a semi-open U-shape or a fully ventilated run-up hangar (see 4.3.1.10 - Aircraft maintenance facilities).

(e) Noise screening for ground activity, such as from aircraft taxiing, can include barriers and earthen berms. To be effective acoustically, such screens should be placed either near the noise source or near the receiver, and should be sufficiently high to remove the direct line-of-sight between the source and receiver. To screen neighbours immediately adjacent to the airport, a boundary fence could be used.

4.6.2.2 Other noise sources

(a) Other airport noise sources include stationary mechanical plant and mobile equipment used for ground maintenance or cargo handling. If near a residential boundary, mechanical plant equipment can be acoustically treated by traditional means, such as ventilation attenuators, screens, and acoustic enclosures. Mobile equipment could be screened, or their operational area located indoors (e.g. within a cargo handling building) to reduce noise.

(b) The noise from ground access vehicles (GAV), including road and rail transport, on the landside of the airport property can also impact neighbouring residential areas. Acoustic screening and the use of low noise generating, porous road surfaces are ways of reducing these effects.

4.6.3 Emissions

(a) Infrastructure that reduces emissions can benefit either local air quality (LAQ) or greenhouse gas (GHG) emissions that affect climate change or both. The discussion below is divided according to the emissions sources. For more information, please see the *Airport Air Quality Manual* (ICAO Doc 9889). The use of airport air quality studies and modelling can help define priority areas for action.

4.6.3.1 Aircraft emissions

(b) Aircraft in the vicinity of airports are a large source of emissions and are dominated by landing and take-off (LTO) cycles. The capacity of the infrastructure (runway, taxiway, airspace, terminal, etc.) needs to be sufficient to avoid congestion and to reduce holding before landing and queuing before departure (see 4.3.1.3 - Airport capacity)

(c) Taxiing emissions can be minimized with an efficient overall airport layout of the runways and terminals. When the aircraft is not taxiing and parked at the gate, emissions can be reduced by installing sufficient FEGP and PCA to allow the aircraft to switch off their APUs. (See 4.3.1.7 - Fixed electrical ground power and preconditioned air and 4.3.1.2 - Taxiway Layout).

Additional emissions reductions from taxiing emissions can be achieved by incorporating new technologies.

4.6.3.2 Airside vehicles and ground support equipment (GSE)

(d) Minimizing the distance travelled by airside vehicles is the main way to minimize their emissions. This can be achieved with an efficient apron and terminal layout (see 4.3.1.1 - Runway layout and 4.3.1.2 - Taxiway layout)

(e) Additionally, airport infrastructure (airside and landside) can help reduce various emissions by promoting the use of non-diesel and non-petrol vehicles (see 4.4.2.2 - Recharging facilities) This can include:

(i) recharging facilities for electric vehicles; and

(ii) refuelling facilities for compressed natural gas (CNG), liquid petroleum gas (LPG), hydrogen, and even compressed air.

4.6.3.3 Ground access vehicles (GAV)

(f) GAV can be an important contributor to an airport's LAQ and GHG overall emissions inventories. These can be reduced with the following:

(i) an efficient roadway layout with well-planned city to airport access;

(ii) intermodal facilities including train, light rail, regional and local bus, and ferry; and

(iii)inter-terminal transport such as an automated people mover (APM)

4.6.3.4 Energy management

(g) In most cases, the generation of electricity (and heat) is dominated by the use of fossil fuels. Therefore, managing energy use and promoting efficiency can indirectly reduce emissions. If a power or heating plant is built at the airport, effective energy management can benefit LAQ as well. Energy management includes reducing the use of electricity, heating and cooling, and generating electricity from renewable sources.

(h) Planning infrastructure for promoting energy management involves designing terminals and other buildings (including the control tower, offices, and cargo and maintenance areas) (see 4.4.1 - Buildings). Terminal and other building energy efficiency can be improved using:

(i) lighting (natural lights, use of sensors, LED lights);

(ii) use of solar energy (e.g. solar heating, solar hot water);

(iii) electric motors that slow down or shut off when unoccupied or not in use (escalators, baggage belts);

(iv) LEED/BREEAM certification;

(v) smart building technology (such as BAS/BEM systems) for lights, HVAC;

(vi) heating and cooling using geological heat sink;

(vii) green roofs

4.6.3.5 Lighting - runway, aprons, car parks

(i) Energy usage which will lower emissions from lighting in runways, aprons and car parks can be significantly reduced through the use of:

(i) energy from renewable sources such as photovoltaic and wind turbines (see 4.5.1.2 - Considerations for on-airport power generation).

(ii) more efficient lighting devices such as LED (see 4.3.1.5 - Airfield Lighting and 4.4.1.4 - Lighting).

(iii) sensors and zone switches to dim or switch off electric lighting when not needed (where appropriate) (see 4.4.1.4 - Lighting).

4.6.4 Water management

Infrastructure to enable the management of water resources at an airport involves the consideration of multiple facets, including the following:

(i) minimizing the use of potable water;

(ii) treating waste water;

(iii) processing contaminated storm water; and

(iv) handling de-icing run-off

All of these efforts contribute to conserving precious water resources, including the quality of surface and underground aquifer water bodies downstream of the airport.

4.6.4.1 Water use

The use of potable water, whether from municipal supply, on-site purification or groundwater sources, can be minimized with the following techniques:

(i) plumbing fittings for low flow taps and showers;

(ii) toilet flushing and cooling tower supply with recycled or other non-potable water, such as seawater;

(iii) waterless urinals; and

(iv) landscaping with plants that require little or no watering

4.6.4.2 Waste water

Waste water, such as sewerage and grey water, can be transferred to municipal processing plants. Alternatively, an on-site treatment plant can be used to produce non-potable water for uses such as cleaning or irrigation.

4.6.5 Solid waste management

Airport infrastructure to assist with solid waste management can include the following:

(i) facilities for collecting, sorting and recycling of solid waste from terminals, offices, cargo, and aircraft;

(ii) energy recovery for incinerated materials;

(iii)composting facility for organic materials; and

(iv)on-site processing and reuse of topsoil, excavated material, and used concrete

4.6.6 Land, soil, and habitat management

(a) A design to prevent the contamination of soil should include spill containment infrastructure for critical areas, such as a fuel farm, hazard material handling areas, and maintenance facilities

(b) A hydrant system of the delivery of fuel to aircraft will reduce the handling of fuel along with the risk of fuel spills and the emissions of fuel trucks.

(c) Airport operators must manage conflicting requirements among the protection of certain plant and animal species, the need to manage the wildlife hazard, and the safe operation of aircraft. Habitat management (including storm water management) can include.avoiding plant species and water bodies that might provide food and shelter for animal species that pose a risk to aircraft. This may include establishing alternative areas for target species away from aircraft movement areas and flight tracks (see 4.2.1.2 - Wildlife hazard management).

5 COORDINATION WITH LAND USE AUTHORITIES ON OBSTACLE CONTROL

5.1 Requirement

(a) Chapter 4 of the SLCAR Part 14A (Aerodrome Design and Operations) requires "the aerodrome operator shall ensure the establishment of obstacle limitation surfaces for the aerodrome". These obstacle limitation surfaces are necessary to enable aircraft to maintain a satisfactory level of safety while manoeuvring at low altitude in the vicinity of the aerodrome. These surfaces should be free of obstacles and subject to control such as the establishment of zones, where the erection of buildings, masts and so on, are prohibited.

(b) It is important that any proposed building or structure does not infringe the required OLS areas. Consultation with the aerodrome operator and the relevant local authority at an early stage is essential.

(c) Further guidance on this can be found in SLCAA-AC-AGA011 Rev01 – Control of Obstacles.

5.2 Objects and Activities Affecting Navigable Airspace

(a) SLCAR Part 14A (Aerodrome Design and Operations) prescribes regulations for a person proposing to construct or erect an obstacle that could constitute a hazard to air navigation. Within the Republic of Sierra Leone, the most common obstacles are telecommunication towers and, it is common occurrence that these towers are erected near the aerodromes. Applicants or operators of such towers or any other structures are required to furnish the Authority with the following information prior to erection for evaluation:

(i) Written application containing relevant data.

(ii) Map of the area in the scale of 1:50,000.

(iii)The physical location of the proposed tower or building

(iv) Coordinates of the tower site (in WGS-84 coordinates)

(b) On account of the above supplied information, the Authority shall evaluate the structure based on obstacle evaluation principles.

5.3 Responsibility

Responsibility for restriction and control of obstacles, rest with the aerodrome operator. This includes the responsibility for controlling obstacles on aerodrome property and for arranging the removal or lowering of existing obstacles outside the aerodrome boundaries and any development or proposed construction near aerodrome that is likely to create an obstacle; the aerodrome operator should coordinate this with the Authority and land use authority. The aerodrome operator's area of responsibility should at least include the following:

(i) Surveillance of the OLS to carry out flight operations
(ii) To control obstructions
(iii) To inspect the height of the physical structures
(iv) To inspect the development of the physical structures
(v) To give information to the Authority
(vi) Name and role of the persons responsible for carrying out OLS surveillance activities

5.4 Land Use Planning for Obstacle Limitation

Land use planning is an important means in ensuring that land adjacent to or in the immediate vicinity of the airport is consistent with activities and purposes compatible with normal airport operations, including aircraft landing and takeoff.

5.4.1 Incompatible Land Use

Incompatible land use at or near airports may result in the creation of hazards to air navigation and reductions in airport utility resulting from obstructions to flight paths. Height restrictions are necessary in the vicinity of airports and airways for the protection of aircraft in flight. Height of the infrastructures should be limited below aerodrome obstacle limitation surfaces. Residential housing and other land uses near airports must remain compatible with airports and the airport approach/departure corridors.

5.4.2 Compatible Land Use

Compatibility of land use is attained when the use of adjacent property neither adversely affects flight operations from the airport nor is itself adversely affected by such flight operations. In most cases, the adverse effect of flight operations on adjacent land results from exposure of noise sensitive development, such as residential areas, to aircraft noise and vibration. Land use that adversely affects flight operations is that which creates or contributes to a flight hazard. For example, any land use that might allow tall structures, block the line of sight from the control tower to all parts of the airfield, inhibit pilot visibility (such as glaring lights, smoke, etc.), produce electronic aberrations in navigational guidance systems, or that would tend to attract birds would be considered an incompatible land use. For instance, under certain circumstances, an exposed landfill may attract birds. If open incineration is regularly permitted, it can also create a smoke hazard.

5.5 Mechanism for Coordination

(a) The Authority has the primary responsibility to establish criteria for the limitation of obstacles and to provide guidance and assistance to those directly concerned with control of obstacles. These criteria should take the form of the obstacle limitation surfaces and should be compatible with those in SLCAR Part 14A.

(b) In addition to setting criteria, the Aerodrome Operator should coordinate with other state Land use authorities when there is a plan to develop land in the vicinity of aerodrome so that no infringements takes place above the obstacle limitation surfaces in the interest of safety of aircraft operations (Aerodrome Operator should have a Memorandum of Understanding with Land Use Authorities). In the vicinity of aerodrome, Land Use authorities should coordinate with the Authority/Aerodrome Operator for development of land around an aerodromes vicinity.

5.6 Land Use Control

5.6.1 Enactment of Height Zoning Protection

The primary advantage of zoning is that it can promote compatible land use. Used within its limitations, zoning is the preferred method for controlling land use to achieve aerodrome-environs compatibility both for height and land use control. Zoning controls need careful tailoring in order to satisfy both the characteristics of the aerodrome and the special conditions affecting the land use. It is important for on-airport property and off airport property to be appropriately zoned so that required airport development can occur.

5.6.2 Acquisition

Acquisition strategies for land use control and compatibility are most effective if they are used in the preventative mode. As a preventative strategy, acquisition techniques are generally less controversial and costly to implement. It is important to note, however, that acquisition strategies can also be employed as "corrective' actions when incompatibilities already exist. Airport operators should consider acquisition strategies in this section as both preventative and corrective actions.

5.6.3 Land Purchase

Land purchase for an airport is the most positive of all forms of land use control, but is it usually the most expensive. It is preferable that land use authorities try to protect other land in the airport environs through comprehensive planning and zoning first, before outright purchasing, since the positive control method is less costly.

5.6.4 Easement

(a) Easements may be used as an effective and permanent form of land use control. Easements are permanent; with title held by the purchaser until sold or released, and work equally well in zoned municipalities or un-zoned municipalities. Short of purchasing fee of simple easements, property can be acquired by negotiation or condemnation. Easements permit by the purchaser the use of another's property and property rights for the special purposes stated in the easement agreement. Hazard easements are those which grant:

(i) The right of flight over the land in question
(ii) The right to remove existing obstructions
(iii) A restriction against the establishment of future obstruction
(iv) Compensation to the owner for the side effects of aircraft operations over the owner's property.

(b) One major advantage of easements is that they can be permanent, whereas zoning can be changed. Additionally, easements often may be acquired for a fraction of the total value associated with the simple purchase of the land and are, thus, less expensive. Easements can be an effective strategy for assuring compatible development around airports.

5.7 Steps To Follow By the Aerodrome Operator

The aerodrome operator should coordinate with land use authorities for appropriate land use/zoning controls prior to the development of land near their airport. Adequate safeguards should be incorporated to prevent incompatible land uses or height obstructions from occurring in proximity to the boundaries of the airport. Adequate control can provide space for future airport expansion. Specific efforts that aerodrome operator can undertake to control and monitor land use compatibility around their airport are described below:

(a) Assist surrounding municipalities in understanding how the airport operates, the airport's flight patterns, and the type of aircraft operating at the airport. Also assist surrounding municipalities in understanding how the airport benefits the local economy and community's health, welfare, and safety.

(b) Stay involved because land use is fluid and subject to a public process that is constantly changing. By staying involved, the airport can influence the compatibility of land and related development surrounding the airport.

(c) Be aware of land use actions proposed by the land use authority and all individual municipalities in the airport environs.

(d) Assist local municipalities in understanding the SLCAR Part 14A Requirements and the special needs for protecting the safety and efficiency of airports operations.

(e) Make sure the Airport layout Plan (ALP) is up to date so that it reflects current aircraft usage relating to the critical aircraft, all current on-airport facilities and desired development within the planning period, and current information on land use and land use controls.

(f) Provide copies of the current Airport Layout Plan (ALP) to the land use authority.

(g) Attend planning meetings on land use and development issues in the vicinity of the airport.

(h) Invite land use authority officials and planners to be part of the airport advisory committee to keep them informed of the airport's plans and needs. By staying involved in local land use issues and local comprehensive plans, aerodrome operator can ensure that their airport's needs are brought to the attention of the land use authority that have the authority to control surrounding land use through zoning or other controls.

6 LAND-USE PLANNING

6.1 General

(a) The *Guidance on the Balanced Approach to Aircraft Noise Management* (ICAO Doc 9829) provides guidance on alleviating the problem of noise in the vicinity of airports. This "Balanced Approach" recommends consideration of four noise management pillars, one of which is land-use planning.

(b) Land-use planning can be an effective means to ensure that the activities nearby airports are compatible with both current and future aviation activities. Its main goal is to minimize the population affected by aircraft noise by introducing land-use planning measures, such as land-use zoning around airports. In addition, land-use planning also can have safety benefits for those people living in the vicinity of an airport.

(c) There are substantial benefits to be gained from the correct application of land-use planning techniques in the development of airports. Land-use planning benefits may take time to be fully realized and should be implemented as soon as noise problems are fore-seen. Efforts to correct situations detrimental to proper land-use around airports should however not be ignored simply because of the lead time for such measures to be effective. This is particularly true in the application of land-use planning to existing airports where it is recognized that the ability to make immediate land-use changes is limited, but where it is also important to prevent further expansion of incompatible land uses.

(d) Compatible land-use planning and management based on appropriate "planning" noise contours, rather than "current" noise contours, can prevent encroachment of residential development at airports where future aircraft noise levels are projected to increase. Using "current" noise contours for land-use planning can allow residential encroachment, thereby nullifying the benefits the reduced noise of the latest generation of quiet aircraft.

6.2 Assessing Noise for Land-Use Planning

(a) The intrusiveness of aircraft noise in airport communities is dependent upon many factors including the following:

(i) sound pressure level;

(ii) broadband frequency distribution;

(iii) tonal content;

(iv) noise duration;

(v) flight path, including take-off and landing profiles;

(vi) number, frequency and time of day of operations;

(vii) operating procedures (such as engine power settings, cutback altitude);

(viii) aircraft configurations;

(ix) mix of aircraft;

(x) runway utilization;

(xi) time of day and year including meteorological conditions; and

(xii) daily and seasonal meteorological variations

All these factors contribute to the total aircraft noise exposure to nearby communities.

(b) The response of communities to aircraft noise exposure is dependent upon such factors as:

(i) land use;

(ii) building use;

(iii) type of building construction;

(iv) distance from airport;

(v) ambient noise in the absence of aircraft;

(vi) diffraction, refraction, and reflection of sound due to buildings and topographical and meteorological conditions; and

(vii) factors of a sociological nature including community attitudes

All these factors contribute to the sensitivity of communities to the airport environment.

(c) Methods for forecasting community exposure to aircraft noise have been developed:

(i) to determine the relative merits of different aircraft operating procedures and runway utilization in reducing aircraft noise exposure; and

(ii) to serve as a guide for airport and community planners in planning land use and building construction in the vicinity of airports

(d) Noise exposure forecasts are necessary in the development of programmes to limit the total exposure of communities to aircraft noise and to make airport operations and community life mutually compatible. These programmes must coordinate various measures such as the monitoring of noise caused by aircraft movements, forecasting future aircraft fleets and operations, and the planning and control of land use. Effective programmes can be established only if the basic principle is applied, namely that aircraft noise around an airport should be described, measured, forecast and, if necessary, monitored by methods that make due allowance for the effect such noise has upon people. As most land developments such as dwellings will be in place for many decades, it is important that aircraft noise forecasts for land-use planning be projected as far into the future as possible.

(e) In general, land-use planning should be based on a "planning" noise contour for a projected future operational scenario or based on traffic forecasts and airport capacity, taking into account future runway and infrastructure development. Three time horizons are usually studied: short-term (around five years), medium-term (around ten years) and long-term (around fifteen years).

6.3 Noise Zones and Associated Maximum Noise Indices

(a) In general, the planning noise contours can be used to define noise zones around the airport. The structure of noise zones should be inherently related to the particular situation where they are applied. In many jurisdictions, two zones (e.g. medium and high noise zones) are used, but in some cases more zones, either with a finer gradation or a greater noise range (e.g. medium to very high) may be used.

(b) Land-use rules are then adopted and enforced based on the noise level in each zone.

(i) In a high-noise zone, new noise-sensitive developments, such as residences, hospitals and schools might be prohibited. Those which already exist might be subject to sound insulation and ventilation retrofits.

(ii) In a medium-noise zone, new developments might be allowed but subject to maximum density limits or specific sound insulation and ventilation requirements.

These zones or land-use rules may be subdivided into various noise exposure levels for appropriate land-use planning and other measures by the national or local authorities. Such measures should be strictly enforced to prevent any noise- sensitive development. Outside these noise zones, the level of aircraft noise is deemed to be compatible with residential activity and land-use restrictions are generally not required.

(c) The values of the noise exposure indices, corresponding to the noise zones adopted for land-use planning, should form a logical progression. Different noise descriptors and noise-exposure calculation methods are used to determine the noise levels for different land uses. An approximate comparison can be made between the values of the different methods used. For a description of these methods, see the Recommended Method for Computing Noise Contours around Airports (ICAO Doc 9911).

(d) Land-use restrictions for new constructions vary with noise zones. For example, only housing and facilities necessary for aeronautical activities, as well as public facilities which are vital to the existing population are allowed within Zone A, whereas no land-use restrictions for new constructions but obligation to insulate new housing and to inform inhabitants within Zone D.

Table 6-1 Overview of the limit values for the definition of noise zones

	Zone A	Zone B	Zone C	Zone D
Usual situations (including major civil airports)	$L_{den} \geq 70$	$70 > L_{den} \geq$ (62 to 65)	(62 a 65) > $L_{den} \geq$ 55 to 57)	(55 a 57) > $L_{den} \geq 50$
Aerodromes defined in planning code article R. 147-1-1	$L_{den} \geq 70$	$70 > L_{den} \geq$ (62 to 65)	(62 a 65) > $L_{den} \geq$ 52 to 57)	(52 a 57) > $L_{den} \geq 50$
Specific military aerodromes	$L_{den} \geq 70$	$70 > L_{den} \geq$ (62 to 68)	(62 a 68) > $L_{den} \geq$ 55 to 64)	(55 a 64) > $L_{den} \geq 50$

(e) In the whole noise protection area, the construction of noise-sensitive buildings (e.g. hospitals, schools) is generally prohibited. In the daytime protection Zone 1 as well as in the night-time zone, the construction of new dwellings is also not allowed. For existing residential buildings located in these zones, the Act for the Protection against Aircraft Noise contains provisions that oblige the airport operator to cover the costs for constructional soundproofing measures at these buildings. Moreover, the expenses for the installation of ventilation systems in rooms that are predominantly used for sleeping are to be reimbursed by the airport operator for buildings in the night-time protection zone.

6.4 Community Engagement

(a) Airport operators need to consult and engage their neighbouring communities on an ongoing basis to keep them informed and foster their support for the operation of the airport and expansions of infrastructure. When planning a new airport, it will be the airport developer who should conduct this engagement. In many jurisdictions, such consultation is mandatory.

(b) In the long-term, an airport needs to establish and maintain a relationship with local communities based on trust and transparency and keep groups well informed. It may be difficult to judge how much community engagement is needed and when enough has been done. Public consultation for a specific development project would generally be required until building and operational permits have been granted. However, most other engagements will usually need to be ongoing. Once a community is against the airport operation or a particular project, and the airport has lost the trust and support of the community, it is challenging to regain. One way of establishing such community engagement would be to set up a working arrangement similar to the collaborative environmental management (CEM) process developed by EUROCONTROL.

(c) Noise and land-use planning will invariably be two of the most important concerns for communities. In addition to the issues discussed in this chapter, community engagement should also keep in mind the following considerations.

(i) Most noise exposure forecasts are based on noise metrics which use decibel units on a logarithmic scale and which are averaged over a long period such as three months or a year. While such metrics are usually appropriate for design and land-use planning, they may be inappropriate for community engagement. This is because time-averaged decibel-scale noise metrics can be difficult to understand to a lay audience and can arouse suspicions that the effects of impacts are being concealed.

(ii) Noise contour lines can give an impression that outside the contours there is no audible (or visible) impact of aircraft.

(iii) Supplementary noise indices such as those based on the noise level of individual events and the number of events should be included in public consultation information.

(iv) Caution should also be used if charts of flight tracks are presented to the public that do not take into account actual track distribution that might occur either side of a designated track centre line.

6.5 Risk of Aircraft Accidents around Airports

(a) Airports are centers for air traffic in the air transportation system. Consequently, their presence causes a convergence of air traffic over the area surrounding the airport. For those people living in the vicinity of an airport, this implies involuntary exposure to the risk of aircraft accidents.

(b) Actual local risk levels around airports are perhaps higher than might be expected. Although the probability of an accident per flight is very low (typically in the order of 1 in 1,000,000), accidents tend to happen mostly during the take-off and landing phases of a flight and hence, close to an airport. The low probability of an accident per movement combined with the large number of movements (typically several hundreds of thousands) may suggest the probability of one accident per year near a large airport. This probability is of course much higher than the better known and smaller probability of being involved in an aircraft accident as a passenger.

(c) Local risk levels around large airports are, in effect, of the same order of magnitude as those associated with participation in road traffic. Because an increase in airport capacity usually involves changes to runway layouts, route structures and traffic distributions which in turn affect the risk levels around the airport, third-party risk is an important issue in decision-making on airport development.

(d) In order to assess such risks, specific methodologies should be developed by the operator, used to define a dedicated zoning policy, in a similar approach as the zoning policy related to noise exposure.

6.6 Land Uses within Noise Zones and High Risk Zones

Planning considerations, such as the need to provide community services (e.g. schools or hospitals) to communities already established in noise-exposed areas, may allow developments with adequate soundproofing, etc., in order to maintain the viability of the community.

Wherever possible, and particularly when planning the construction of new airports, the location of the airport should be considered as a part of the total planning environment, so that long-term community needs and the consequences of the airport’s operation in terms of noise exposure are not in conflict (see Table 6-4).

Table 6-4: typical examples of compatible land uses around airports

	Zones		
	A	B	C
Examples of compatible land uses or development	Most land uses and development are not permitted	Some restriction on land uses and developments	Unrestricted land uses and developments
Agricultural: Crop farming	unrestricted	unrestricted	unrestricted
Industrial: Machine shop	unrestricted	unrestricted	unrestricted
Commercial: Warehouse and shipping	unrestricted	unrestricted	unrestricted
Offices and banking	restricted	restricted	unrestricted
Residential: Low-density housing	restricted	restricted	unrestricted
High-density housing	prohibited	restricted	unrestricted
Public facilities: Schools and hospitals	restricted	restricted	unrestricted

Note 1 - with respect to certain uses (e.g. housing and commercial), a development might be allowed in a zone of a higher restriction when other planning considerations indicate a need, and where suitable building techniques, sound insulation, etc., can reduce the aircraft noise exposure to an acceptable level.

Note 2 - In special cases where activities depend on speech communication (e.g. schools) or require more stringent standards (e.g. certain hospital activities), additional restrictions may be required to take into account absolute noise levels as well as total noise exposure, unless noise reduction can be ensured in the building construction.

Note 3 - The zones will have to be defined against a noise exposure scale (e.g. noise contour mapping) and will have to take into account local and national needs when the zones are drawn up.

7 LAND-USE ADMINISTRATION

7.1 General

(a) Noise exposure is not the only factor to be taken into account for the purpose of land-use management in the vicinity of airports. It is recognized that economic factors are involved in land-use choices. Ideally, land-use decisions around airports would try to find a compatible balance between the interests in the land and the aeronautical use of the airport. For this reason, the authorities, local or central, have an important part to play in ensuring that aircraft noise exposure is taken into account when planning land use in the vicinity of airports and that the ensuing plans are implemented.

(b) There are many techniques for regulating development or bringing about conversion or modification of existing land uses to achieve greater compatibility between the airport and its environs. Some of these may be controls, such as zoning or building and housing codes; other methods influence development through acquisition or taxation. Experience has shown that any attempt to control land use through easements and purchases is extremely expensive and cannot be considered as a solution to the entire aircraft noise problem. A more practical approach is the adoption of proper land-use planning and zoning. Zoning, however, is limited in its ability to effect changes around existing airports located in developed areas. Land use can be managed more effectively when zoning is applied to new airports and existing airports in still undeveloped areas.

(c) The most common issues are; the return that the owners or developers want from their commercial properties, the local government's interest in increasing the tax base, and the interest of the owners and residents in maintaining or improving the value of their homes. For the airport environs, the cumulative total of such local decisions can seriously degrade a balanced, comprehensive planning approach and development policy. The desired goal is for effective land-use planning based on objective criteria, to minimize the amount of noise-sensitive development close to airports, while allowing for other productive uses of the land.

7.2 Land-Use Management

7.2.1 Introduction

Various measures are available for managing the use of land around airports. The effectiveness of these measures for both existing and new airports should be considered on a case-by-case basis. Land-use management measures can be categorized as:

(i) planning instruments, including comprehensive planning, noise zoning, subdivision regulations, transfer of development rights, and easement acquisition;

(ii) mitigating instruments, including building codes, noise insulation programmes, land acquisition and relocation, transaction assistance, real estate disclosure, and noise barriers; and

(iii) financial instruments, including capital improvements, tax incentives and noise-related airport charges

7.2.2 Planning instruments

7.2.2.1 Comprehensive planning

(a) Comprehensive planning takes into account existing development and ensures that future development is compatible with various community goals. In most countries, the land-use planning and control authority rests with local governmental bodies, which may be obliged or advised to take into account aviation noise measures.

(b) As a land-use control system in relation to airports, comprehensive planning is applied in varying degrees in all the countries surveyed. This strategy appears to be a valuable instrument that is transferable to other countries.

7.2.2.2 Noise zoning

(a) Noise zoning for land use serves a two-fold purpose: the protection of the airport and the protection of the residents. It can be applied to existing airports as well as to future airport development. Zoning should take into account anticipated future airport development so that when airport development takes place, it has minimal impact.

(b) Noise zoning will enable local government and other relevant authorities to define the uses for each parcel of land, depending on the level of noise exposure. It generally consists of a zoning ordinance which specifies land development and use constraints, based on certain noise exposure levels. The noise contours extending outward from the airport delineate areas affected by different ranges of noise exposure. No uses other than those specified for a particular area should be permitted.

(c) The noise contours produced by the airport operator should be based upon maximum airport capacity and the worst possible noise case scenarios, and provided to a single high-level government authority to administer and oversee. The government authority would then ensure that any application of noise-sensitive developments are appropriately considered to ensure that developments only occur within acceptable noise zones, as prescribed by the relevant noise zoning regulations.

(d) In many instances where there are multiple local government authorities responsible for development approvals, these local jurisdictions with zoning power (cities, towns or larger administrative units) may often have differing or conflicting policies that have little continuity between authorities. They may also not be aligned to the noise zoning regulations and the maximum theoretical noise contours that have been produced. Having a single authority to enforce the continuity of noise zoning regulations across several local government areas within the airport noise contours can alleviate the problem of multi-jurisdictional interests.

(e) Another issue is that the interests of the noise-affected communities near airports are not always consistent with the needs and interests of the airport operator nor with those of each other. Within local government authorities and various communities there is usually a desire for greater population growth, and rising land values. It is these drivers that are often in conflict with the need to preserve surrounding airport areas so as not to compromise the noise reduction benefits achieved from new generation aircraft, with the ultimate goal being to further reduce the total number of people affected by airport related noise.

(f) Noise zoning can and should be used constructively to increase the value and productivity of the affected land. One of the primary advantages of zoning is that it may be used to promote land-use compatibility, while still leaving land in private ownership, on the tax rolls, and as economically productive as possible.

(g) Zoning is not necessarily permanent and may be changed. Zoning is usually not retroactive. Changing zoning primarily for the purpose of prohibiting a use which is already in effect is generally not possible. Where such zoning is allowed, an existing use may be allowed to remain as "nonconforming" until a later date when it is changed voluntarily to a conforming use. For this reason, zoning is most effective at airports that have not yet felt the impact of buildings. Furthermore, the proposed use of vacant land must be related to the market demand for the proposed activities, such as commerce or industry.

(h) Noise zoning around airports is applied in nearly all surveyed countries as a planning measure to prevent new noise-sensitive developments near the airport. However, it is sometimes only applied to the larger or national airport(s). Ideally, noise zoning should be established for all airports.

Subdivision regulation

(i) Noise zoning ordinances may include subdivision regulations. These regulations may serve as a guide to development in noise-impacted areas by reducing building exposure through orientation and density transfer and by providing open-space requirements.

(j) Subdivision regulations on their own can be useful in minimizing noise impacts on new development. They would not affect existing development. By means of restrictive covenants, the owner is legally notified that the property is subject to noise from aircraft operations. Additionally, a covenant could require buildings to be designed and constructed in such a way as to minimize interior sound derived from exterior noise sources to the acceptable level.

7.2.3 Transfer of development rights

(a) Under this concept, some of the development rights of a property are transferred to another property that is far from the airport where the rights may be used to intensify the level of allowable development. Land-owners could be compensated for the transferred rights by the sale of these rights at new locations or the purchase of the rights by the airport. Depending upon the market conditions and/or legal requirements, the airport could either hold or resell the rights.

(b) The transfer of development rights must be fully coordinated with a community's planning and zoning. It may be necessary for zoning ordinances to be amended in order to permit the transfer of development rights. Such transfers are usually effected within a single jurisdiction.

7.2.4 Easement acquisition

(a) An easement confers the right to use a land-owner's property for a limited purpose, normally in exchange for some value. In the context of airport noise-compatibility planning, two general types of easements are available:

(i) those which permit airport noise over land (including right of flight); and

(ii) those which prevent the establishment or continuation of noise-sensitive uses on the subject property

(b) For maximum effectiveness, easements should restrict the use of land to that which is compatible with aircraft noise levels. Easements should also ensure the right of flight over the property, the right to create noise and the right to prohibit future height obstructions into airspace. Restrictions that may be addressed by such easements include types of buildings, types of agricultural activity that may attract birds, electromagnetic interference, and light emissions.

(c) The first type of easement described in 7.2.4(a)(i), which simply buys the right to make noise over the land, has fewer advantages. It does nothing to change the noise-sensitive character of the land or to reduce noise for people on the property. However, it does legally protect the airport operator from noise litigation, financially compensates property owners for noise, and warns potential buyers that a property is subject to aircraft noise.

(d) The second type of easement described in 7.2.4(a)(ii) can be a highly effective strategy for ensuring compatible development around airports in situations where land is being developed for the first time or is being redeveloped in connection with a land acquisition and relocation strategy or general urban redevelopment programme. The easement has the advantage of being permanent. It is less costly than outright purchase of land (if the land has not otherwise been purchased) and it allows the land to remain in private ownership, in productive use, and on local tax rolls. This latter type of easement is used most frequently in combination with noise insulation. Such easements are often required by airport owners in exchange for noise insulation. Again, the use of certain easements is dependent on the legal system.

7.2.5 Mitigating instruments

7.2.5.1 Building codes

(a) Construction techniques and material standards often determine the interior noise levels of residential or commercial structures in noise-impacted areas. Building codes are essentially a legal means of requiring the incorporation of adequate sound insulation in new construction. Any noise-insulation strategy depends upon a closed-in structure for maximum effectiveness, and this in turn usually raises the issues of adequate ventilation and air conditioning in warm weather.

7.2.5.2 Noise insulation programmes

(a) Noise insulation can lower interior noise levels for structures that cannot reasonably be removed from noise-exposed areas (e.g. residential buildings). Noise insulation is particularly effective for commercial buildings, including offices and hotels. However, it is much more desirable to control insulation requirements for such buildings from the outset, if they must indeed be constructed in noise-exposed areas. While there may be difficulties in getting sound insulation requirements incorporated in building codes for new construction, these are slight compared with the problems of effective soundproofing for existing buildings, particularly housing. Even if houses in high-noise areas were made of stonework, insulation and air conditioning may cost more than the value of the additional rent or sales' prices.

(b) A noise-insulation programme should be preceded by a structural and acoustical survey of all homes and other buildings earmarked for noise insulation. The cost of noise insulation depends upon several variables, such as the degree of insulation required (from insulating the attic only to insulating all exterior walls and ceilings and upgrading doors and windows), size and condition of the building, and location within the noise exposure area.

(c) For effective noise insulation, it is necessary to have a closed-window condition, which may not be desirable to homeowners in all seasons and which imposes additional ongoing costs to home-owners for climate-control systems. The major drawback to noise insulation is that it does nothing to mitigate noise outdoors. This drawback however does not apply as much to schools, hotels, commercial structures, or even large apartment buildings, because they are frequently constructed with a closed-window condition and their activities usually take place indoors.

(d) Other insulation programmes could include sound conditioning or air conditioning. This can contribute much towards making all types of dwellings acceptable during the hours when the interior of the building is in use; this is particularly important during the night-time hours. Hence, the amount of sound reduction must be balanced against the external sound level in order to achieve an acceptable noise level for the occupants of the dwelling. Installation of sound conditioning can be relatively simple if incorporated initially in new construction but becomes more complex if incorporated as a modification of old construction.

7.2.6 Land acquisition and relocation

(a) This strategy involves the acquisition of land through purchase by the airport operator (or planning authority in case of new developments) and the relocation from the acquired land of residences and businesses that are not compatible with airport-generated noise levels. This strategy is within the direct control of the airport operator (or planning authority) and does not require additional action by another political entity.

(b) Land acquisition and relocation assure an airport of long-term land-use compatibility. Acquired land can be cleared, sold with easements (to control future development), and redeveloped for compatible land uses.

7.2.6.1 Transaction assistance

(c) Transaction assistance involves some level of financial and technical assistance to a homeowner who is trying to sell a noise-impacted property. It may involve paying realtors' fees. An airport operator may even buy the property which has been on the market for an extended period of time and then resell it. In order to become compatible with noise levels, the properties are noise-insulated prior to resale and usually resold with an easement. This strategy can be useful in areas where it has been decided that existing residential neighbourhoods will be maintained. It can also be less expensive than other acquisition strategies. Homeowners are sometimes given a choice of noise insulation/easement or transaction assistance. These choices enable those people most annoyed by noise to leave the area and prevent the airport authorities or developers from having to buy out everyone.

7.2.6.2 Noise barriers

(d) Noise barriers consist of earthen berms or man-made barriers on the ground which are located between sources of loud ground-level noise at the airport and very close-in, noise-sensitive receptors. Noise barriers must be both structured and positioned accurately to provide any meaningful relief. They are of limited use at airports except for ground-running operations, etc., and do not mitigate in-flight noise. However, they do appear to have a perceived benefit people tend to hear less noise if they don't see the aircraft on the ground or the maintenance facility that is the source of the noise. It is also particularly beneficial to install earthen berms for visual appeal. A proper positioning of airport buildings can also function as a noise screen for adjacent communities. Any obstacle near a runway such as a noise barrier may cause wind disturbances for landing and departing aircraft and should be assessed for its impact on the flight handling and aircraft performance.

7.2.7 Financial instruments

7.2.7.1 Capital improvements planning

(a) Development can be stimulated or discouraged by the presence or absence of an infrastructure network, which typically includes roads and utilities (power, gas, water and sewer). Other community facilities and services, such as schools, police, and fire service, also tend to promote development. Capital improvements can be planned in order to locate infrastructure in areas where industrial and commercial growth would be compatible. This strategy can also discourage certain types of growth, such as residential development, from areas that are deemed incompatible for such use. Similarly, the capital improvements programme can be developed to encourage noise-tolerant land uses with appropriate types, size, and locations of infrastructure in the noise-impacted areas.

(b) This strategy may be appropriate for directing new development or extensive urban redevelopment. It is however not useful when the impacted areas are fairly well developed and already have adequate infrastructure.

7.2.7.2 Tax incentives

(c) Tax incentive programmes are often used to promote noise-insulation improvements. The strategy is to provide tax incentives to existing incompatible uses in order to encourage structural improvements which would reduce interior noise levels.

(d) Additional tax incentive programmes may be instituted by governmental bodies as a means of redeveloping specific areas. For instance, a designated blighted zone or foreign trade zone can be a catalyst for redevelopment.

(e) Various tax incentives, such as reduction or elimination of property taxes, may also be introduced (usually to private industry) to encourage relocation or expansion of industry as a means to increase the local tax base or to diversify the local economy.

(f) Tax reduction or differential tax assessment can be offered as incentives for development in specific areas. For example, development of noise-tolerant uses in areas subject to higher noise levels can be encouraged, which may consequently discourage other noise-sensitive uses. Industrial development is particularly sensitive to taxation systems and is more affected by taxation than residential or commercial development. This type of strategy typically requires input and support from the local economic development agency in terms of designation of areas, and planning and zoning coordination with regard to compatibility and appropriate zoning issues.

7.2.7.3 Noise-related airport charges

(g) While some view noise-related airport charges as an incentive to encourage the use of the quietest aircraft technology, these charges can be related to land-use planning if the funds are used for a sound insulation programme. Charges may be levied by airports with noise problems in order to recover the costs incurred for the alleviation or prevention of noise. The costs recovered should not exceed the costs incurred. The application of noise-related charges should follow the principles for such charges and require approval by the Authority for its application.

(h) There are various systems of noise-related airport charges. One system divides all aircraft into several categories according to the noise production and determines the airport charge. Another system returns part of the landing fee if the aircraft meets certain noise criteria. A third system levies extra noise charges on top of the normal landing fee based on the noise production of the aircraft. In some countries, extra charges are levied on night operations because of the additional disruption during night hours.

7.3 Local Authority Zoning

Local authorities shall protect aerodromes in their areas to ensure the long term sustainability of the aerodrome, the safety of the aircraft operations, and the safety of persons and property. In addition to the required obstacle limitation surfaces, other areas can be specifically zoned to ensure that future land use plans are compatible with existing and planned aerodrome operations and protect both the aerodrome and the residents around the aerodrome. Zoning solely to protect the obstacle limitation surfaces is insufficient to prevent the construction of incompatible uses such as housing or uses that attract accumulation of people in the approach and climb out paths of aircraft. Zoning shall take into account anticipated future aerodrome development so that when aerodrome developments take place, interference to the vicinity will be minimal.

8 LAND USE ON AND AROUND AERODROMES THAT ATTRACTS WILDLIFE

The following is a non-exhaustive list of the types of land uses which have proven to attract hazardous wildlife and which should, in particular, be prevented, eliminated or mitigated on and in the vicinity of aerodromes:

(a) fish processing;

(b) agriculture;

(c) cattle feed lots;

(d) garbage dumps and landfill sites;

(e) factory roofs and parking lots, or other infrastructure;

(f) theatres and food outlets;

(g) wildlife refuges;

(h) artificial and natural lakes;

(i) golf or polo courses, etc.;

(j) animal farms; and

(k) slaughter houses

8.1 Refuse Dump or Landfills

(a) Refuse dump sites and landfill shall be located no closer than 13 km from the aerodrome facility. An aeronautical study shall be conducted prior to the siting of the dump or landfill.

(b) If a refuse dump is proposed in the vicinity of the aerodrome there may be a requirement to provide bird control at the site to reduce its attractiveness to birds. The potential threat to aircraft depends on location of the site relative to the aerodrome and flight paths, type of refuse, and the bird species expected in the vicinity.

8.2 Water

Surface water is a potential wildlife attractant and developments that consist of drainage ditches, artificial waterways and large areas of water close to an aerodrome may attract birds and other wildlife. It is noted that in the vicinity of an aerodrome artificial and natural lakes may increase the wildlife hazard depending on the size and the shape of the lake, its ecological state and the surroundings. It is recommended that an ornithologist/biologist evaluates the ecological conditions of the whole vicinity as well as migration in the area.

Note - Further guidance on land use on and around aerodromes that attracts wildlife can be found in SLCAA-AC-AGA010A Rev01 – Wildlife Hazard Management.