# A REPORT ON ENVIRONMENTAL IMPACT ASSESSMENT FOR FEASIBILITY STUDY ON CONSTRUCTION OF EMIRATES RESORT APARTMENT BUILDINGS

**JULY 2021**

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## Executive Summary

The development objective of the EIA for the feasibility study is to the sustainable delivery of a productive, effective and efficient development of EMIRATES RESORT APARTMENT BUILDINGS located at Mouza Phulgran Zone 4-B-2 Murree Expressway adjacent to GOLF CITY BAHRIA TOWN. It is an area measuring 50 Kanals in khasra No.2551/2 to be used for Land Uses and Schedule of commercial plots & apartments. Under the project, the expected plan of construction includes Building 1: 18 floors, Building 2: 21 floors, Building 3: 25 floors, Building 4: 20 floors, Building 5: 13 floors and Commercial has ground + 1 floor equipped with elevators (lifts) in order to accommodate communities at different floors. Initially the construction of the EMIRATES RESORT APARTMENT BUILDINGS was planned to evaluate by Initial Environmental Examination (IEE) but considering the quantum of construction work an Environmental Impact Assessment has been carried out.

This EIA concern the resurfacing and strengthening the project to be implemented. A preliminary survey was conducted in order to familiarize the physical and socio-economic environment. Field surveys were carried out in order to investigate physical, biological and socioeconomic resources falling within and outsides the premises of EMIRATES RESORT APARTMENT BUILDINGS. Following components of studies have been included adopting the pattern as proposed by Pak EPA.

1. Geological and hydrological investigations explaining the significance of groundwater aquifers and impact of the scheme due to long-term pumping.
2. Electrical Resistivity Sounding Survey (ERSS) for delination of aquifers
3. seismological studies and fault lines implications
4. Precipitation, runoff in the adjacent Nalluh and Korang Rivers
5. Flora and Fauna
6. Evaporation, transpiration (Evapotranspiration)
6. Groundwater pollution from recirculation of disposal water
7. Identification of groundwater recharge zone (if any)
8. Historic discharges of the nearby Nallah-flow (30 years)
9. Soil contamination from fuel & lubricant

10. Disposal waste both liquid and solid during construction phases (discarded asphalt)
11. Water pollution from runoff of discarded asphalt, junks, less of productive land due to dust.
12. Adverse effects on residents from noise & dust (if any)
13. Mitigation measures etc.
14. Question answer session with the local stockholders

EMIRATES RESORT APARTMENT BUILDINGS falls within the Potwar Plains near the Korang River Flow in the South and Northeast. Geological investigations include study of geology, regional setting, stratigraphy, and description of rock. The area onward up to Islamabad falls in the Potwar Region. It is a realm of thick fluvial deposits represented by the rocks of Rawalpindi and Siwalik groups.

The aerial distribution of construction work of each block is provided in the following Tables. Overall construction work is likely to be completed within 3 years period and it is to be approved by CDA along with its construction plan. Later, the woodwork, elevators, finishing, and fixing of tiles, and plumbing work will be installed and probably take about 12 to 18 months to be tentatively completed. EMIRATES RESORT APARTMENT BUILDINGS is currently looking forward to acquire NOC from CDA and of Pak EPA after the submission of this Environmental Impact Assessment (EIA) Report along with water study report based on electrical resistivity sounding survey (ERSS).

## SUMMARY

Reliable data collection is the backbone of producing accurate and valid hydrological information to be used for locating a source for water supply by means of surface water resources and or groundwater aquifers. Therefore, onsite field data acquisition is made and also procured from Pakistan Meteorological Department (PMD), and geological survey of Pakistan (GSP).

Precipitation is the major component of the hydrological cycle by which the hydrology of the region is governed. Infiltration, surface runoff, and evapotranspiration all are dependent upon precipitation. Hydrological study includes collection of rainfall data, analysis, computation of design rainfall, and estimation of river flows / stream discharges. Besides, estimation of flood record of the Korang River of different return periods, cross-section of streams and evaluation of hydrological parameters are the integral part of the hydrological studies. Discharges of the Soan River are dependent upon the base flow during dry spell. Land use and schedule of commericial plots and apartments are given in the following Tables:

TABLES

**LANDUSE MATRIX**

| Land Use | Area (Kanal) | %age | CDA STANDARD |
|---|---|---|---|
| Commercial | 2.50 | 5.01 | Not more than 5% |
| Residential Apartments | 18.44 | 36.90 | Not more than 40% |
| Public Building | 3.12 | 6.24 | Not more than 4% |
| Open Spaces | 8.00 | 16.01 | Not more than 15% |
| Roads | 17.91 | 35.85 | Not more than 40% |
| Tot | 49.97 | 100.00 | |

**PLOTS TYPOLOGY COMMERCIAL**

| Sr. No. | Plot Size | Total |
|---|---|---|
| 1 | 2.5 Kanal | 1 |

**PLOTS TYPOLOGY APARTMENTS**

| Sr. No. | Blocks | Apartments Area |
|---|---|---|
| 1 | Block 1 | 3.97 Kanal |
| 2 | Block 2 | 3.91 Kanal |
| 3 | Block 3 | 3.97 Kanal |
| 4 | Block 4 | 3.64 Kanal |
| 5 | Block 5 | 3.96 Kanal |

## SUMMARY OF AREA ALLOCATION FOR CONSTRUCTION

Seismicity and ground accelerations due to earthquakes are also studied within 50 kilometres around EMIRATES RESORT APARTMENT BUILDINGS. Faults lines have been delineated which might have some implications over the EMIRATES RESORT APARTMENT BUILDINGS. Structural maps along with fault lines have been demarcated and seismic hazard analysis carried out. Quantitative study contains peak ground acceleration (PGA) in relation to the earthquakes of different magnitude focused at fault lines in the vicinity of the area.

Electrical resistivity sounding surveys (ERSS) are consisted of Schlumberger electrodes configuration of 15 Probes with a maximum spread of about 250 meters. Groundwater aquifers of the Potwar and alluvial plains have been identified from resistivity surveys and appropriate water well locations are marked within the EMIRATES RESORT APARTMENT BUILDINGS, where water well will be drilled to meet the futuristic water demand of the inhabitants.

# EMIRATES RESORTS MOUZA PHULGRAN

Emirates Resorts comprises of 5 Apartment Buildings and Commercial G +1 spead over an area of 50 kanal. Tower heights (Floors) are as follows:

Apartment Buildings 1: 18 floors, Building, Building 2: 21 floors, Building 3: 25 floors, Building 4: 20 floors, Building 5: 13 floors and Commercial has ground + 1 floor

equipped with elevators (lifts). The following diagram provides the locations of Towers and layout plans of the Emirates Resorts Mouza Phulgarn.

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EMIRATES RESORTS
MOUZA PHULGRAN ,TEHSIL
AND DISTRICT ISLAMABAD
Landuse Matrix
Plots Typology Apartments
APT BUILDING -1
APT BUILDING -2
APT BUILDING -3
APT BUILDING -4
RESIDENTIAL 5
COMMERCIAL
PARK 1
PARK 2
PARK 3
SERVICE ROAD
MURREE EXPRESSWAY
TO ISLAMABAD
TO MURREE
DRAWING TITLE:
LAYOUT PLAN
DRAWING NUMBER:
HS-294/ERM/LP-001
REVISION:
00
SCALE: 1:1,000
DATE: JULY 15, 2020
A PROJECT OF:
TOWN PLANNER:
SYED RIZWAN MUNIR
P-000688
DESIGN CONSULTANT:
Project Code: 2020-US/HS-294

# 1.0 ***INTRODUCTION***

## 1.1 General

Site selected for developing apartments buildings Emirates Resorts range along the width (parrell to Murree Expressway from 33$^{o}$-46'-30" N latitude and 73$^{o}$-14'-05" E longitude to 33$^{o}$-46'-13" N latitude and 73$^{o}$-14'-16" E longitude, and along the length 33$^{o}$-46'-08" N latitude and 73$^{o}$-14'-1.63" E longitude to 33$^{o}$-46'-15.8" N latitude and 73$^{o}$-14'-7.6" E longitude The elevation difference between the lowest level (641 m) and the higest level (687 m) is 46 m (151 feet). The site has its spacious sprawl spread over a parcel of land measuring altogether 50 kanals. The Emirates Resorts Mouza Phulgran, is located along the Murree Expressway before the Toll Plaza and Golf City Bahria Town. The site is bounded on Eastern and Southern side by the local Nullah Flows.

Building 1 is comprised of 18 floors; building 2 of 21 floors; building 3 of 25 floors, building 4 of 20 floors; building 5 of 13 floors and commercial area with ground plus 1 floor. Emirates Resort Apartment Buildings, Islamabad being based upon the concept of modern techniques, would be the first of its kind in which the EIA aspects have been considered on priority basis. The purpose of launching the EMIRATES RESORT APARTMENT BUILDINGS , Zone-4-B-2 is to provide a modern living apartments for inhabitants, which would be environmental friendly.

This Volume also incorporates "Initial water study based on electrical resistivity soundings of the EMIRATES RESORT APARTMENT BUILDINGS Zone-4-B-2" that is prepared as a part of the consulting services assigned to the consultants. Consultants are well versed in the preparation of such kind of

reports in the past with the multinational oil and gas companies, WAPDA, CUST (formerly MAJU). Asian Development Bank sponsored projects etc that included Initial Envirnomental Examination (IEE), Environmental Impact Assessment (EIA), Independent Monitoring Consultancy (IMC), and Health Safety Environment (HSE) studies.

A location map is provided indicating the distribution of Blocks in Zone1, Zone2, Zone3, Zone4, and Zone5 includinh the premises of Emirates Resort Apartment Buildings Zone 4-B-2 (Figure 1). Other related Figures 2 to 7 show details about the locations of geotechnical studies and distribution of area of 50 kanals within the Emirates Resorts.

EIA report is prepared under the guidance of *Prof. Dr. Zulfiqar Ahmad*. A regional map is shown indicating the location of EMIRATES RESORT APARTMENT BUILDINGS Zone 4-B-2 along with other Zones in Fig. 1.

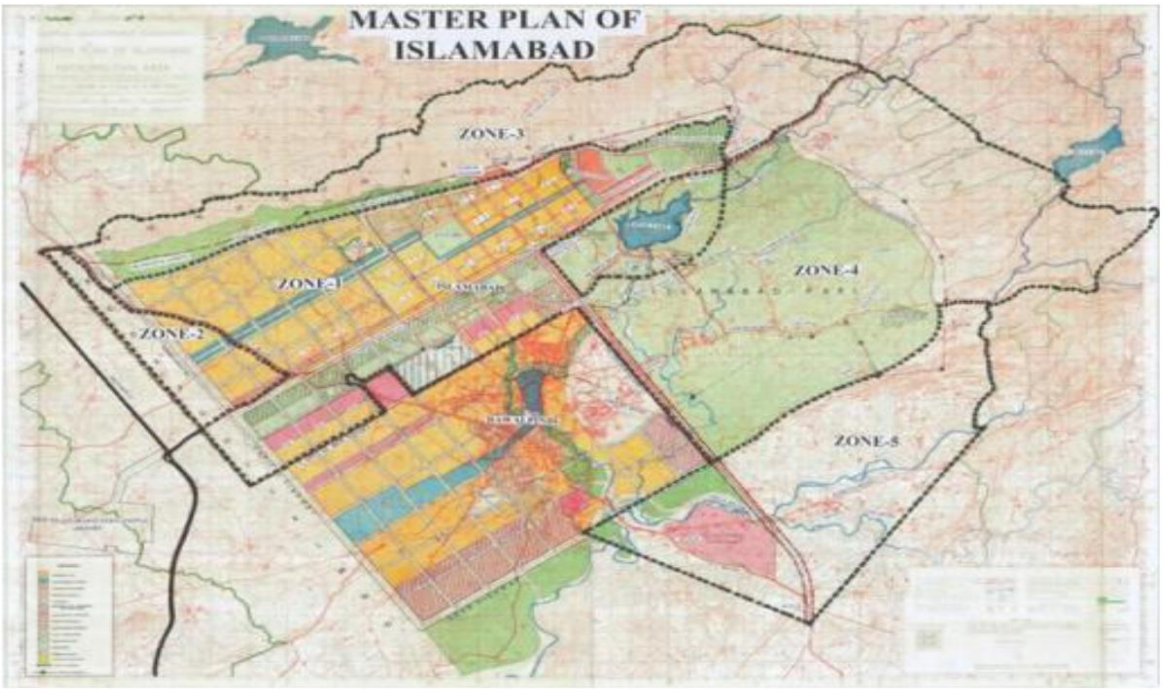



Figure 1. Layout Master Plan of Emirates Resort Apartment Buildings along other Zones


Figure 2. Location of Boreholes 1, 1-C, 1-D, 1-E used for geotechnical (soil) Testing, Emirates Resort Apartment Buildings


Figure 3. Location of Boreholes 1, 1-C, 1-D, 1-E from different orientation used for geotechnical (soil) Testing, Emirates Resort Apartment Buildings


Figure 4. Location of Boreholes 1, 1-C, 1-D, 1-E from broader prospective used for geotechnical (soil) Testing, Emirates Resort Apartment Buildings


Figure 5. Location of Electrical Resistivity Sounding Stations Emirates Resort Apartment Buildings Mouza Phulgarn

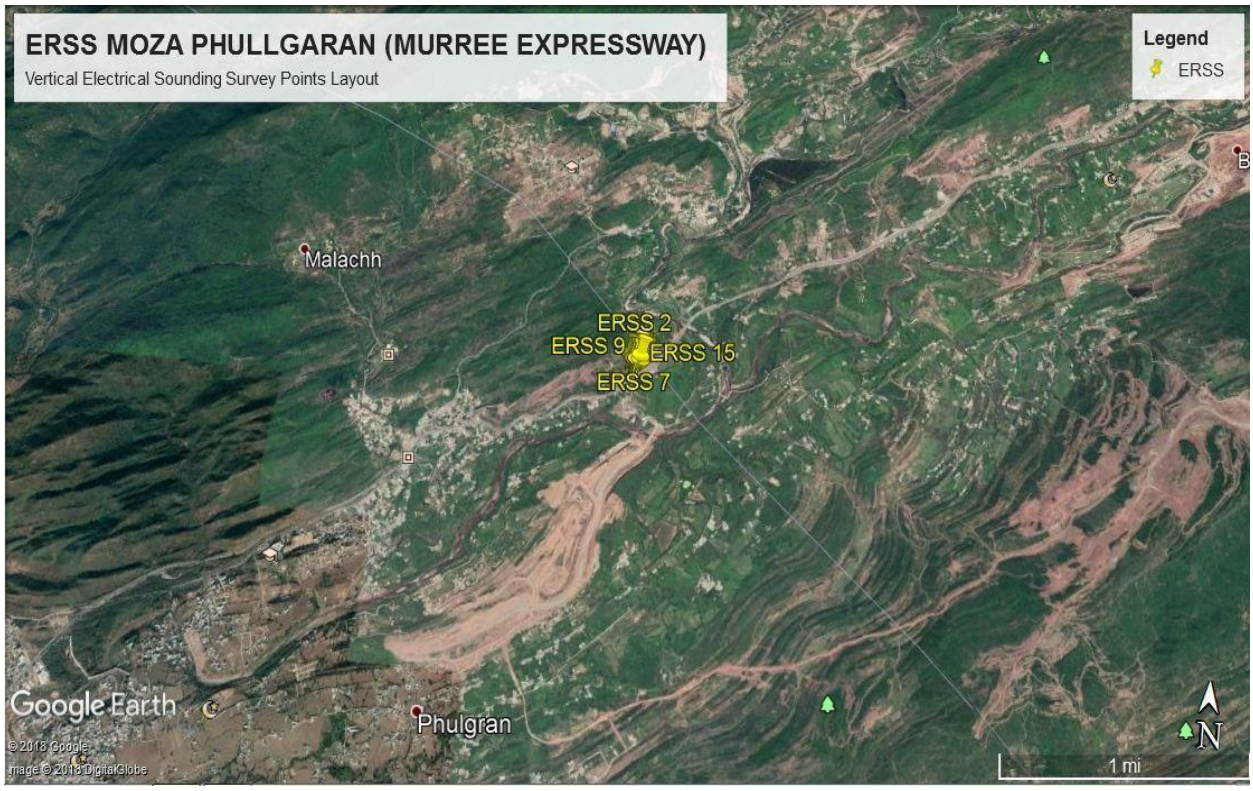



Figure 6. General view of the Area covering larger view of the Emirates Resort Apartment Buildings

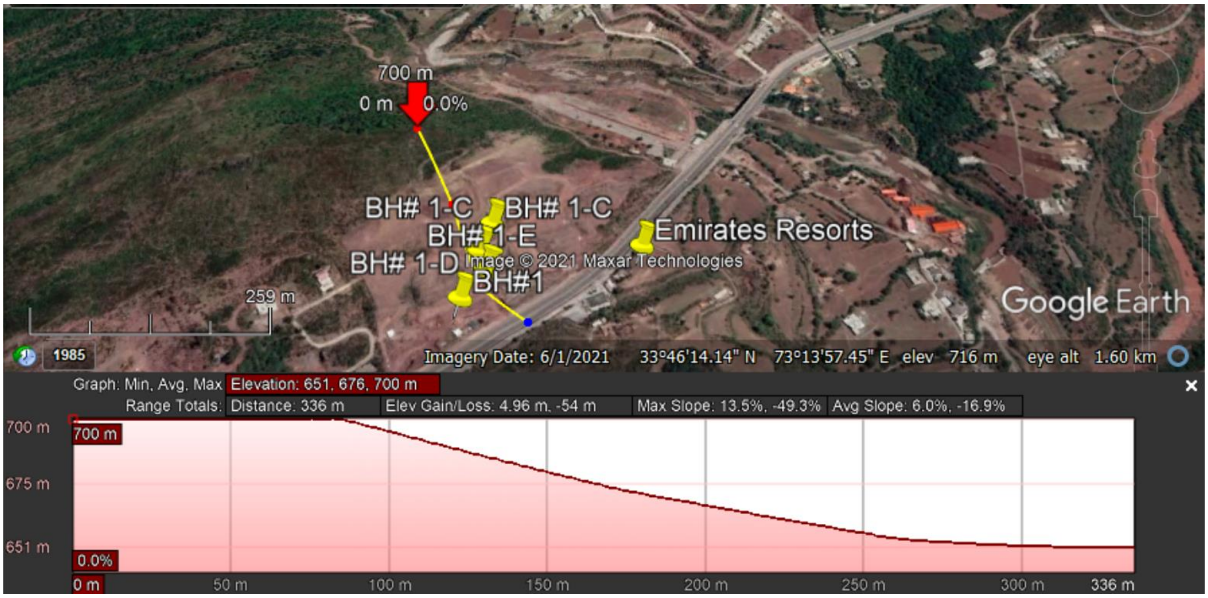



Figure 7. Elevation Profile of Emirates Resorts Mouza Phulgarn 700 m to 651 m over a stretch of 336 meters with a maximum slope of 13.5 percent

## 1.2 Objectives and Scope

### 1.2.1 Environmental Impact Assessment (EIA)

The objectives and scope of the Environmental Impact Assessment (EIA) study are:

- Documentation of the applicable policy, legislative and administrative framework
- Determination and description of the baseline physical, ecological and environmental conditions of Emirates Resort Apartment Buildings Zone-IV, Islamabad. The aim of the baseline conditions is to record pre-project state of the environments and social set up, so as to provide basis of comparison during the implementation and operation stages.
- Identification of the seismological and hydrological conditions
- Impact of high level runoff in the nearby Nullah on the building structure or flooding
- Geological significance
- Identification and assessment of the initial potential environmental evaluation of the project in qualitative and quantitative terms.
- Recommendations on the measures to mitigate the impacts of the project.
- Impact of construction of high rising Towers on flora and fauna

- Ecological Aspects
- Noise pollution and impact on Human Beings living in nearby surroundings
- Recommendations on environmental monitoring and evaluation mechanisms

### 1.2.2 LAND USE DISTRIBUTION

The land use plan involves the general functional arrangement in terms of types of activities, linkages and densities. The activities are grouped to perform functions in relation to each other. The blocks are designed keeping in view principles for self-contained neighborhood for all type of facilities and amenities. Proper linkages within blocks and other units of scheme are also ensured so that whole scheme acts as one body rather than segregated units. Planning principles of health, beauty and conveyance are given priority in every step of planning and designing of scheme.

The physical plan ensures equal distribution of land uses for various activities in every block required for balanced physical growth and embraces the land use standards set forth in the zoning regulations of CDA.

# 2.0 Policy, Statutory and Administrative Framework

## 2.1 General

This section describes the current legal responsibilities of the proponents of projects in the context of initial environmental evaluation. The following material is taken from already published material.

## 2.2 Policy Framework

The Ministry of Environment is responsible for the policy making and planning on the subject of environmental protection in Pakistan. The Pakistan Environmental Protection Council (PEPC) headed by the Chief Executive of Pakistan is the apex inter-ministerial and multi-stakeholders decision making body.

### 2.2.1 The Pakistan National Conservation Strategy (NCS)

The Pakistan National Conservation Strategy (NCS) is one of the principal policy documents for environmental issues in the country that was developed and approved by the Government of Pakistan on March 1, 1992. The NCS has three following explicit objectives:

- Conservation of natural resources
- Sustainable development
- Improved efficiency in the use and management of resources

The NCS, acting on a ten-year planning and implementation cycle, deals with fourteen (14) programme areas, which are stated hereunder:

- Maintaining soils in cropland
- Increasing irrigation efficiency
- Protecting watersheds
- Supporting forestry and plantations
- Restoring rangelands and improving livestock
- Protecting water bodies and sustaining fisheries
- Conserving biodiversity

- Increasing energy efficiency
- Developing and deploying material and energy renewables
- Preventing/abating pollution
- Managing urban wastes
- Supporting institutions for common resources
- Integrating population and environmental programmes
- Preserving the cultural heritage

## 2.3 Statutory Framework

Pakistan Environmental Protection Agency is the primary government institution dealing with environmental issues with delegated broad-based enforcement powers to the provincial environmental protection agencies.

The publication of the Pakistan Environmental Protection Agency Review of IEE and EIA Regulations 2000 provides the necessary details on the preparation, submission, and review of environmental impact assessments (EIA).

Pakistan's statute books contain a number of other laws that have clauses concerning the regulation and protection of the environment in addition to the Pakistan Environmental Protection Act, 1997.

### 2.3.1 Pakistan Environmental Protection Act (PEPA)-1997

Pakistan Environmental Protection Act, 1997 (PEPA 1997) was enacted by repealing PEPO 1983. The PEPA 1997 provides the framework for the implementation of National Conservation Strategy, protection and conservation of species, wildlife habitats and biodiversity, conservation of renewable resources, establishment of standards for the quality of the ambient air, water and land, establishment of Environmental Tribunals, appointment of Environmental Magistrates, Initial Environmental Examinations (IEE), Environmental Impact Assessments (EIA), promotion of public education and awareness of environmental issues through mass media. The PEPA, 1997 is the basic legislative tool empowering the Government to frame regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, soil, marine, and noise pollution, as well as to the handling of hazardous wastes.

### 2.3.2 Pakistan EPA Environmental Assessment Procedures

Federal EPA has published a set of environmental guidelines for conducting environmental assessments and the environmental management of different types of development projects. The guidelines that are applicable to Emirates Resort Apartment Buildings, Zone-IV (proposed University) are listed below, followed by comments on their relevance:

- Policy and Procedures for Filing, Review and Approval of Environmental Assessments, Pakistan Environmental Protection Agency, 2000: These guidelines define the policy context and the administrative procedures that govern the environmental assessment process, from the project pre-feasibility stage to the approval of the environmental report.

- Guidelines for the Preparation and Review of Environmental Reports, Pakistan Environmental Protection Agency, 1997: The guidelines on the preparation and review of environmental reports specify the following for the project proponents:

  - The nature of the information to be included in environmental reports

  - The need to incorporate suitable mitigation measures at every stage of project implementation

  - The need to specify monitoring procedures

## 2.4 International and National Non-Governmental Organizations

International environmental and conservation organizations, such as the International Union for the Conservation of Nature (IUCN) and the World Wide Fund for Nature (WWF), have been active in Pakistan for some time. Both these organizations have worked closely with the Government and have played an advisory role with regard to the formulation of environmental and conservation policies. Since the Rio Summit, a number of national environmental non-governmental organizations (NGOs) have also been formed, and have been engaged in advocacy and, in some cases, research. The most prominent national environmental NGOs, such as the Sustainable Development Policy Institute (SDPI) and Shirkatgah, are members of the Pakistan National Committee of IUCN. The role of these organizations would be very important in the project perspective.

# 3.0 ***DESCRIPTION OF PROJECT***

## 3.1 Project Overview

Emirates Resort Apartment Buildings, Zone-4-B-2, Islamabad project contributes towards achieving the following basic objectives:

- To provide modern living apartments in the area.
- Ensuring to conserve and ameliorate the environment
- The proposed Project would improve the standard of living with its most appropriate water treatment facilities with diversified benefits to the inhabitants.

## 3.2 Key Permanent Physical Components of EMIRATES RESORT APARTMENT BUILDINGS

The key permanent physical components of Emirates Resort Apartment Buildings, Zone-4-B-2 Project are described in the following paragraph.

Emirates Resort Apartment Buildings is located close to Golf City Bahria Town and Islamabad Theme Park at Lat 33$^{o}$ 46' 30" and Long 73$^{o}$ 14' 05".

Key Works during Planning and Development of the Emirates Resort

The major activities will commence with the development of Emirates Resort Apartment Buildings, Zone-4-B-2. Following are the major works:

- Levelling of land for plots and roads
- Contractor's Camp
- Contractor's Workshops
- Concrete Batching Plant
- Spoil Deposits
- Temporary Access Roads
- Construction of Metalled Roads
- Water well drilling and Construction
- Construction of Overhead Tanks

- Development of Mosque
- Construction of Buildings Apartments / Offices, Mosque, Commercial etc.
- Excavation and construction of sewer and storm water channels

**Figure 8** shows locations of Emirates Resort Apartment Buildings, Zone-4-B-2 Islamabad and surrounding areas of Mouza Phulgarn and Theme Park on a Topographic Map..

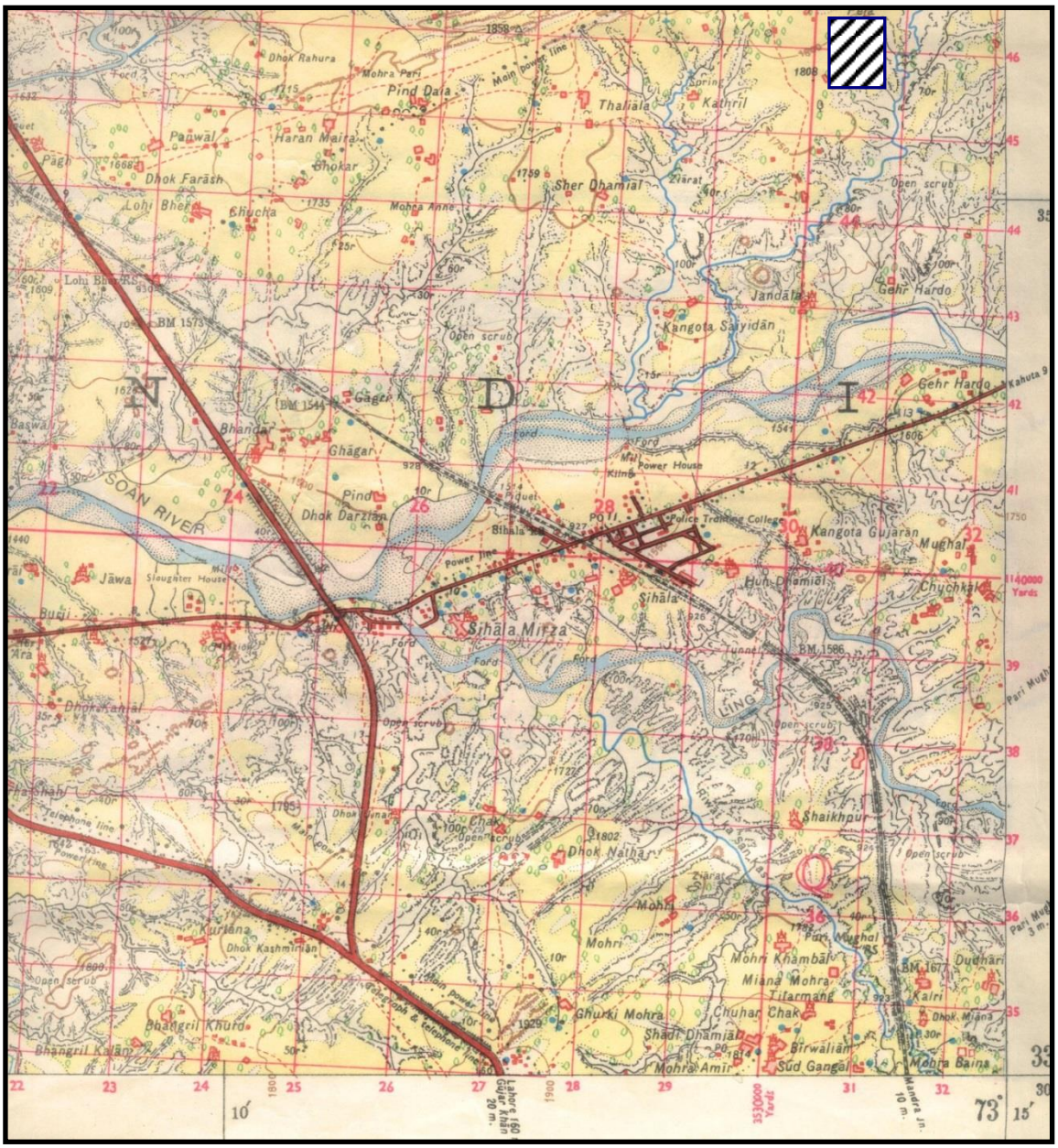



Figure 8 Emirates Resort marked by Black slanting lines Box, Topographic features

### 3.3 Key Project Data of EMIRATES RESORT APARTMENT BUILDINGS

The Key Project Data of EMIRATES RESORT APARTMENT BUILDINGS has been presented in Table 2.The land use plan involves the general functional arrangement in terms of types of activities, linkages and densities. The activities are grouped to perform functions in relation to each other. The Apartment Buildings are designed keeping in view principles for self-contained neighbourhood for all type of facilities and amenities. Proper linkages within blocks and other units of scheme are also ensured so that whole scheme acts as one body rather than segregated units. Planning principles of health, beauty and conveyance are given priority in every step of planning and designing of scheme. The physical plan ensures equal distribution of land uses for various activities in every Apartment Building required for balanced physical growth and embraces the land use standards set forth in the zoning regulations of CDA as detailed below:

**Table 2**

**Key Project Data EMIRATES RESORT APARTMENT BUILDINGS**

**LANDUSE MATRIX**

| Land Use | Area (Kanal) | %age | CDA STANDARD |
|---|---|---|---|
| Commercial | 2.50 | 5.01 | Not more than 5% |
| Residential Apartments | 18.44 | 36.90 | Not more than 40% |
| Public Building | 3.12 | 6.24 | Not more than 4% |
| Open Spaces | 8.00 | 16.01 | Not more than 15% |
| Roads | 17.91 | 35.85 | Not more than 40% |
| **Tot** | **49.97** | 100.00 | |

### 3.4 Project Design of EMIRATES RESORT APARTMENT BUILDINGS

Architectural design of the EMIRATES RESORT APARTMENT BUILDINGS is made by The URBAN SOLUTIONS (pvt) LTD. Their office is located at

H.no. 39-A, Block B, Street 1, PAK PWD Housing Society, Islamabad. +923110541507. E-mail: info@theurbansolutions.com

Website:- http://www.theurbansolutions.com

Key Works during Planning and Development of the EMIRATES RESORT APARTMENT BUILDINGS included the following major works:

- Excavation and Levelling of land along proposed and approved covered area
- Contractor's Rooms (temporary)
- Contractor's Workshops
- Concrete Batching Plant
- Spoil Deposits
- Temporary Access Roads
- Micro water well drilled at proposed location
- Construction of fence around work place
- Excavation and construction of pipelines for sewage and water supply
- Septic tanks

## 4.0 Data Collection Methodology

This section presents the approach and methodology, which has been adopted for the collection of the requisite data, for the initial environmental study of the Project.

### 4.1 Initial Studies and Field Reconnaissance

Initial studies and review of the available documents and maps, related to the project, were carried out to gain an overall understanding of Emirates Resort Apartment Buildings, Zone-4-B-2 Project.

#### 4.1.1 Emirates Resort Apartment Buildings, Zone-4-B-2 Project Area

Field reconnaissance visits of the EMIRATES RESORT APARTMENT BUILDINGS, Zone-4-B-2, were made in November, 2020. The objective of these visits was to have an overview of the area, in order to develop

comprehensive and effective field data collection. During these visits, data documents, available with the local agencies, were also obtained.

## 4.2 Sources and Tools of Data Collection for Environmental Study

Both primary and secondary data was acquired to accomplish the said studies. In general, following sources and tools were employed for the collection of requisite data for Emirates Resort Apartment Buildings:

| | |
|---|---|
| Primary Data Collection | Field Reconnaissance<br>Field Measurements<br>Information from Officials / Locals |
| Primary Data Collection | Socio-economic data<br>Land Use data<br>Biological / Climatological Data<br>Environment Survey<br>Physical Assets Survey<br>Ecological Investigation |
| Sources of Secondary Data | Public Departments and Agencies<br>Regional and Local Maps<br>Literature |

All the data collected was reviewed, compared (where available from multiple sources), and verified to arrive at the final authentic figures.

## 4.3 Primary Data Collection

### 4.3.1 Land Use Survey

**a) Project Area**

The Physical Inventory has carried out Land use reconnaissance. The purpose of the reconnaissance is to identify land use for the construction of Emirates Resort Apartment Buildings, Zone-V at Islamabad.

The Land use data of the project area was primarily based upon the Land Maps, which were obtained during field study.

### 4.3.2 Trees Survey

The Physical Inventory has carried out trees survey. The purpose of the survey is to document numbers of fruit and other valuable trees, if any in the area. However, no trees were found in the area of study except large bushes and high cliff hillocks.

### 4.3.3 Ecological Investigation

Information and data on ecological and natural resources, of the project area, is mostly obtained from secondary sources, including government departments and published literature of the concerned agencies. The data have been collected the terrestrial fauna and flora and aquatic fauna, found in the project area, by interviewing the locals.

### 4.3.4 Institutional Survey

Regional plant data has been collected from the concerned Department.

Forest, wildlife, and fisheries are the important ecological aspects in many projects. The concerned departments were also visited to collect secondary data for these issues.

## 4.4 Sources of Secondary Information

Certain baseline information and data, for the project area, was either solely collected from the secondary sources or, where collected by primary means, was corroborated with the available secondary data.

Following secondary sources were resorted to, for the collection of secondary information:

| **Information Area** | **Secondary Source** |
|---|---|
| **Physical Environment** | |
| Climate | Meteorological Department |
| **Ecological Environment** | |
| Protected Areas like Reserve Forest | Forest Department, Wildlife Department, WWF |
| Terrestrial Fauna | Forest Department, Wildlife Department, WWF |
| Terrestrial Flora | Forest Department |
| Aquatic Fauna | Fisheries Department, WWF |

## 4.5 Photographs of Emirates Resort Apartment Buildings, Zone IV

Photographs are attached in Appendix giving details of the general location, access to roads, vegetation features etc.

# 5.0 ***DESCRIPTION OF ENVIRONMENT***

## 5.1 General

### 5.1.1 Delineation of the Study Area

Initial environmental examinations that were previously carried out encompass all project aspects and expected impacts during different stages of project in a delineated area, which is expected to be impacted by the project interventions. Experienced construction company URBAN SOLUTION (pvt) Limited is awarded the contract for the construction of the EMIRATES RESORT APARTMENT BUILDINGS under the supervision of the consultants.

### 5.1.2 Purpose of the Environmental Impact Assessment

Environmental Impact Assessment is intended to identify and establish all the physical, ecological and socio-economic environmental conditions, prevailing before the execution of the project, in order to use this information as a reference datum to compare future changes and judge them if the condition has changed for better or worse. As such, it must include all resources that can reasonably be expected to be affected by a project. EIA is intended to accomplish objectives:

- To provide sufficient knowledge about socio-economic set-up, ecological features, water resouces and disposal and infrastructure of the project area, and
- To allow the planners to evaluate the potential efficacy of actions to mitigate adverse impacts, if any, and enhance benefits.

## 5.2 ***Physical Resources***

### 5.2.1 Climate

Climate of the area is based on record of temperature and precipitation of Rawalpindi/Islamabad. Depending on the topography, there is an extreme variation in the temperature of Pakistan. The country is essentially arid except for the southern slopes of the Himalayas and the sub-mountainous tract where the annual rainfall varies between 760 and 1270 mm. This area has humid sub-Tropical climate. In the

extreme north - because of great heights-highland climate prevails. The controlling factors of the climate are: (Source: Pakistan Meteorological Department, 2020)

- The sub-tropical location of Pakistan tends to keep the temperature high, particularly in summer.
- The oceanic influence of the Arabian Sea keeps down the temperature contrast between summer and winter at the coast.
- Higher altitudes in the west and north keep the temperature down throughout the year.
- The Monsoon winds bring rainfall in summer.
- The Western Depression originating from the Mediterranean region and entering Pakistan from the west brings rainfall in winter.

Humid conditions prevail but over a small area in the north. True humid conditions appear after the rainfall increases to 750 mm in plains and 625 mm in highlands. There are two sources of rainfall in Pakistan: the Monsoon and the Western Depression. The former takes place from July to September and the latter, from December to March. **Figures 9 and 10** show minimum and maximum temperatures regimes of Pakistan. The area lies in the maximum temperature regime of 28-32 $^{0}$C and minimum temperature regime of 12-20 $^{0}$C (Source: UNEP Environment Assessment Programme for Asia and the Pacific (*http://www.rrcap.unep.org*).

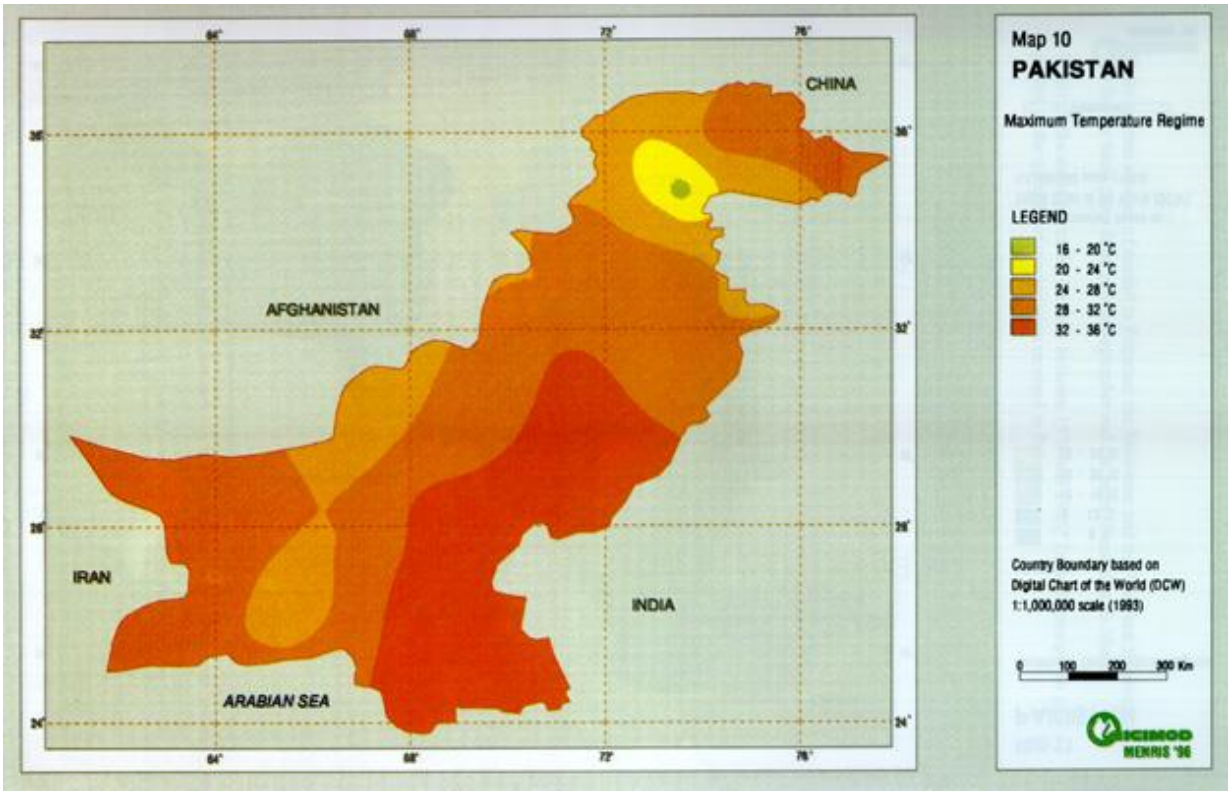



**Figure 9.** Maps showing maximum and minimum Temperature regimes

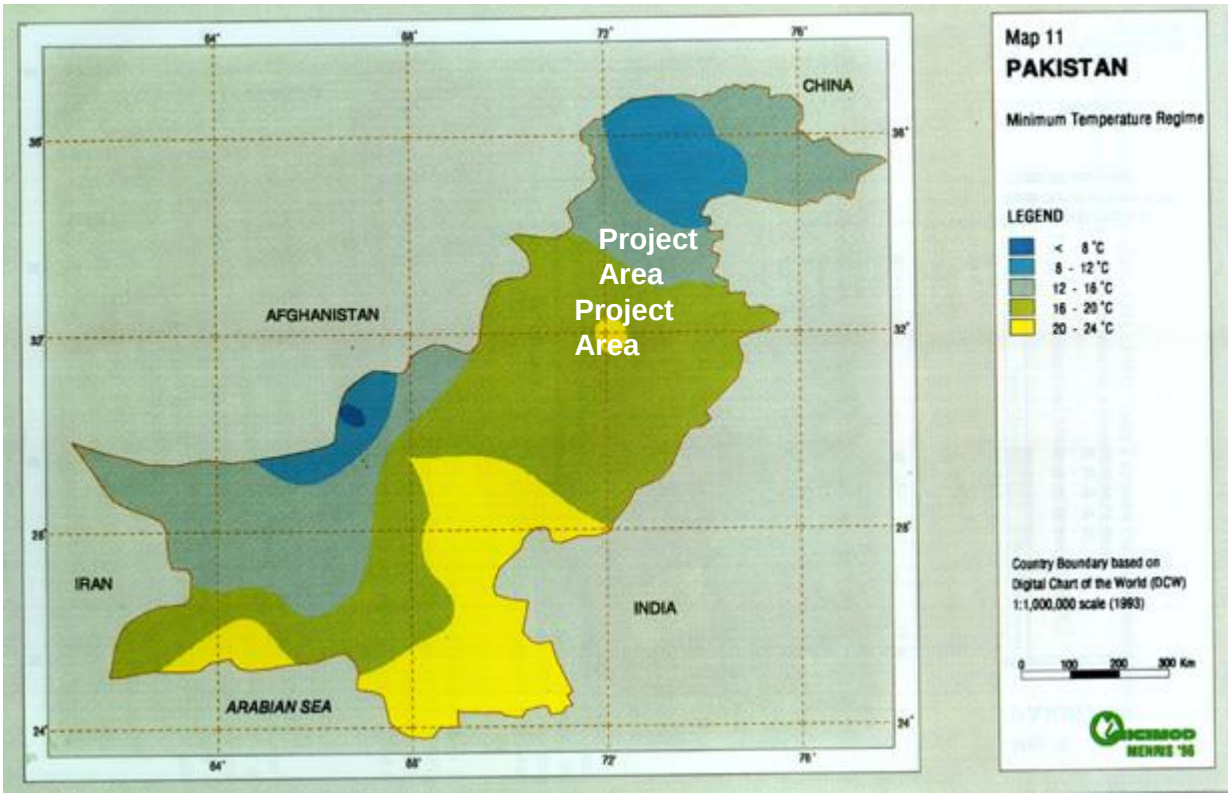



**Figure 10. Source:** UNEP Environment Assessment Programme for Asia and the Pacific (*http://www.rrcap.unep.org*)

**Islamabad- Rawalpindi Region**

Climate of the region is classified into following major four seasons. Hot season, April to June, monsoon season, July to August or mid-September. Post Monsoon season, mid September to November and cold season December to March. June is the hottest and January is the coldest month of the year. More than 50% of rainfall occurs in monsoon period. Mean monthly temperature is estimated at project area with the help of climate station located at Islamabad Airport. Mean monthly temperature varies from 10 $^{0}$C in January to 31 $^{0}$C in June at this station. The minimum temperature generally drops below freezing point, in the months of December and January. In June the temperature rises to as high as 46 $^{0}$C. In January the temperature falls to as high as -3.9 $^{0}$C. Mean Temperature, Minimum and maximum temperatures are plotted in **Figure 11** and **Figure 12**.

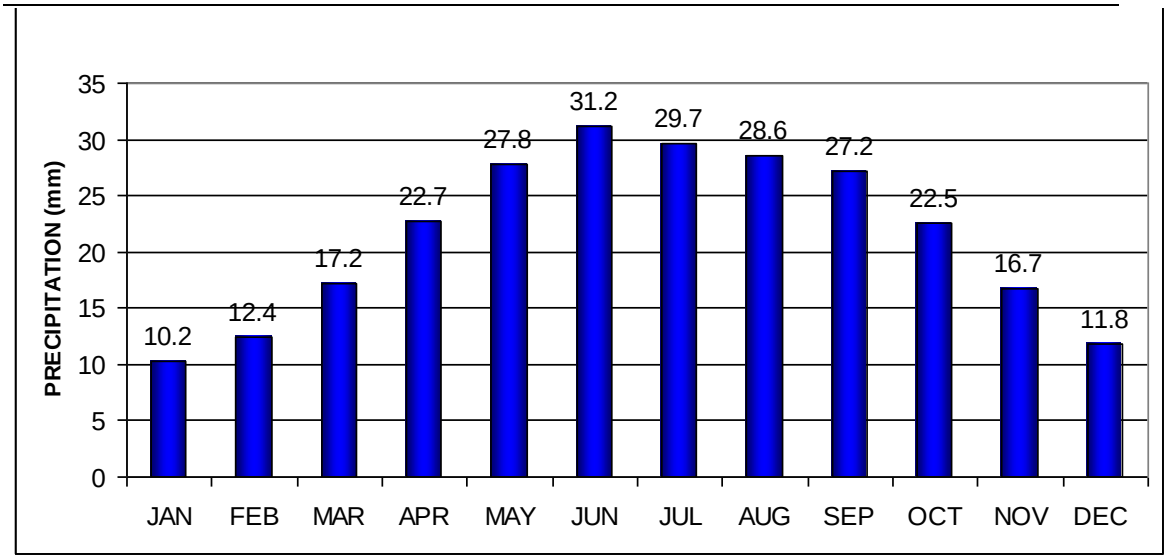



**FIGURE11**. MEAN MONTHLY TEMPERATURE AT ISLAMABAD=AIRPORT 1959-2020

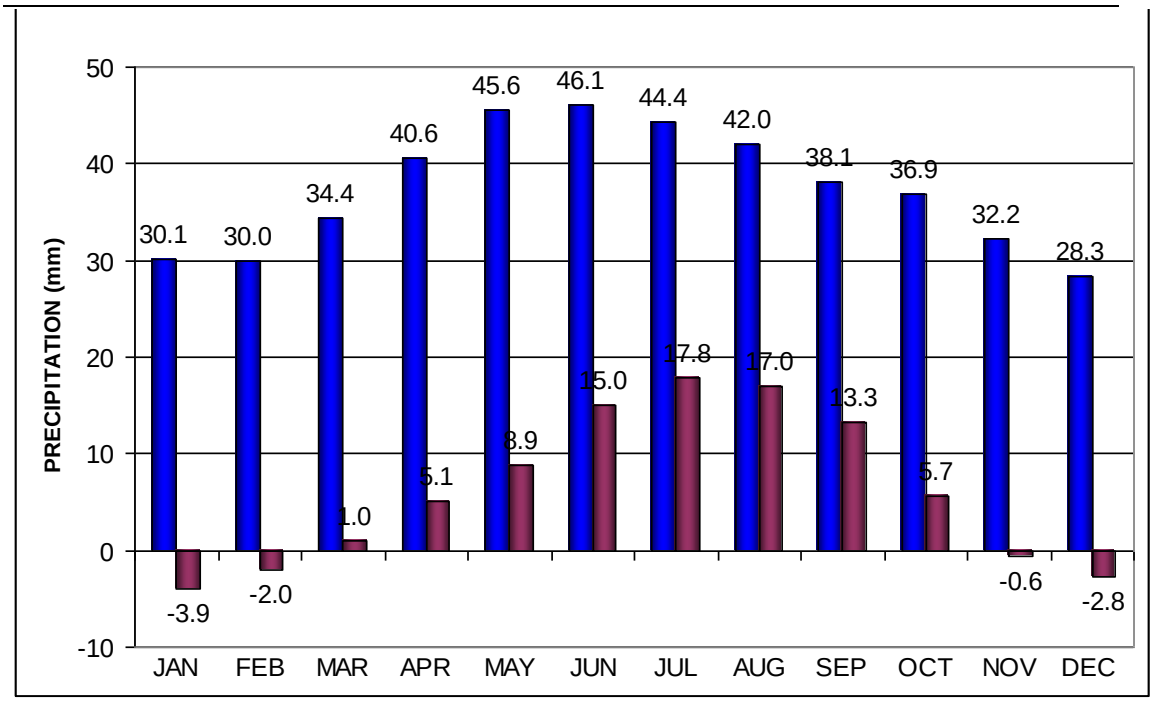



**FIGURE12**. MINIMUM AND MAXIMUM TEMPERATURE AT ISLAMABAD AIRPORT 1960-2020

### 5.2.2 Rainfall Data

Heaviest and normal rate of rainfall data have been used to compare and contrast the result, however, heaviest rainfall is important as compared to normal rainfall. Highest and lowest temperature and heaviest precipitation for these stations are

presented in **Table 5.1.** Monthly heaviest precipitation at Islamabad was recorded 743 mm in the month of July and annual heaviest rainfall comes to be 1735 mm at Islamabad.

#### 5.2.2.1 Temperature

Temperature data collected shows maximum and minimum extremes (**Table 5.1**). Highest maximum temperature at Islamabad was recorded 46.1 °C in the month of June and lowest minimum temperature was -3.9 °C in the month of December and January. Map in **Figure 13** collected from Pakistan Meteorological Department shows annual normal variation of temperature in Pakistan for 30 year period (1961-2020).

**Table 5.1**

| ISLAMABAD (During 1954-2020) | | | |
|---|---|---|---|
| **Month** | **Temperature (°C)** | | **Monthly Heaviest Rainfall (mm)** |
| | **Highest Maximum** | **Lowest Minimum** | |
| January | 30.1 | -3.9 | 166.9 |
| February | 30.0 | -2.0 | 248.8 |
| March | 34.4 | -0.3 | 224.0 |
| April | 40.6 | 5.1 | 264.9 |
| May | 45.6 | 10.5 | 115.3 |
| June | 46.1 | 15.0 | 239.0 |
| July | 44.4 | 17.8 | 743.3 |
| August | 42.0 | 17.0 | 641.4 |
| September | 38.1 | 13.3 | 279.1 |
| October | 36.9 | 5.7 | 95.8 |
| November | 32.2 | -0.6 | 91.2 |
| December | 28.3 | -2.8 | 177.9 |
| Annual | 46.1 | -3.9 | 1735.1 |

Source: Pakistan Meteorological Department

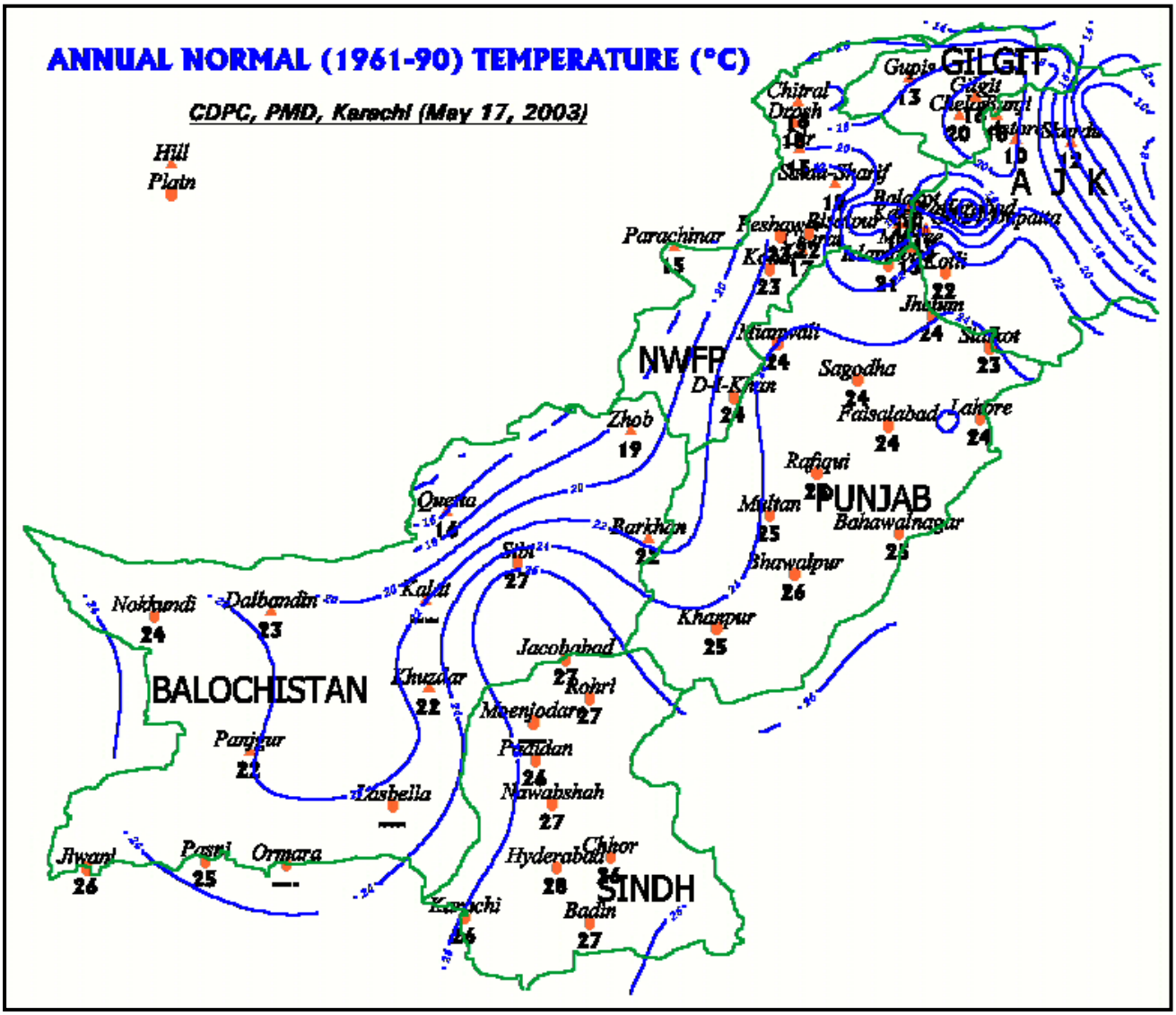



**Figure 13.** Annual Normal Temperature Map, Source: Pakistan Meteorological Department, 2020

### 5.2.3 Rainfall

#### 5.2.3.1 Rainfall Data

#### 5.2.3.2 Collection of Hydro-meteorological Data

There are several stations located in near and farthest of EMIRATES RESORT APARTMENT BUILDINGS area that include climate data some of these stations

have short record while others have long term record. Stations with long term records are important for estimating the peak discharges using the rainfall data. The important key stations with long term record are given in Table 5.2:

**Table 5.2 List of Key Stations**

| Sr. No. | Name of Climate Station | Latitude | Longitude | Period of Record (years) | Annual Precipitation (mm) | Agency |
|---|---|---|---|---|---|---|
| 1 | Islamabad Airport | 33.37' | 73.06' | 1959-2020 | 1164 | PMD |
| 2 | Jhelum | 32.56' | 73.44' | 1950-2020 | 872 | PMD |
| 3 | Lahore PBO. | 31.33' | 74.20' | 1954-2020 | 571 | PMD |
| 4 | Sialkot | 32.31' | 74.32' | 1952-2020 | 967 | PMD |
| 5 | Mangla | 33.04' | 73.38' | 1999-2020 | 1153 | PMD/WAPDA |

PMD = Pakistan Meteorological Department
WAPDA = Water and Power Development Authority
PBO = Pilot Balloon Observatory

### *5.2.4 Areal Distribution of Precipitation*

To understand the mechanism of flooding in the area, knowledge of areal distribution rainfall is important. Isohytal map showing annual normal rainfall (1961-2020) was collected from Pakistan Meteorological Department and shown in **Figure 14**. The map shows that annual normal rainfall varies between 700 mm to 1200 mm along the distribution range. In the lower part in the south, annual rainfall is lesser comparatively. Islamabad Airport being the upper most precipitation station receives higher precipitation.

### *5.2.5 Analysis of Data*

**Precipitation – Rawalpindi - Islamabad**

The maximum floods in the Soan and Ling rivers will be mainly from monsoon precipitation. For The EMIRATES RESORT APARTMENT BUILDINGS , nearest rainfall station with long term record is at Islamabad Airport. Mean annual precipitation at Islamabad Airport for the period 1960-2020 was estimated to be 1167 mm. Average annual rainfall in the catchment is around 1486 mm of which more than 50% is due to Monsoon from July to September, while 20 % of it falls during January to March and the rest is evenly distributed. The annual rainfall varies between 709 to 1735 mm at Islamabad Airport for the recorded period 1960-2020. **(Figures 15 and 16).** Average precipitation at Islamabad for the period 1959-2020 was estimated for different time periods of a year and it is given below:

| Station Islamabad A.P | |
|---|---|
| (1959-2020) | |
| Period | Rainfall |
| | mm |
| Jun-Oct | 803 |
| Nov-May | 360 |
| Annual | 1163 |

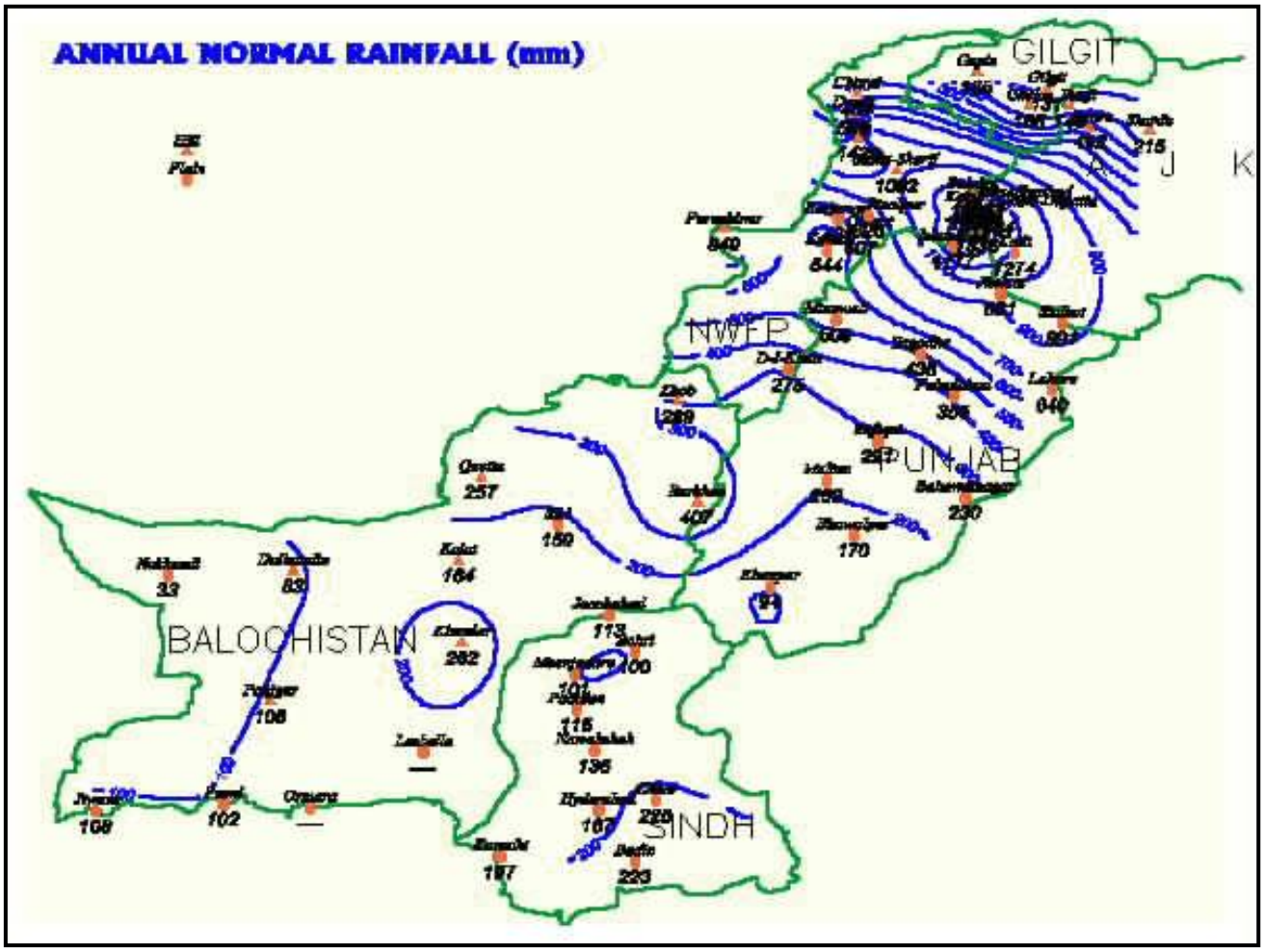



**Figure 14.** Annual Normal Rainfall Map, 1960-2020

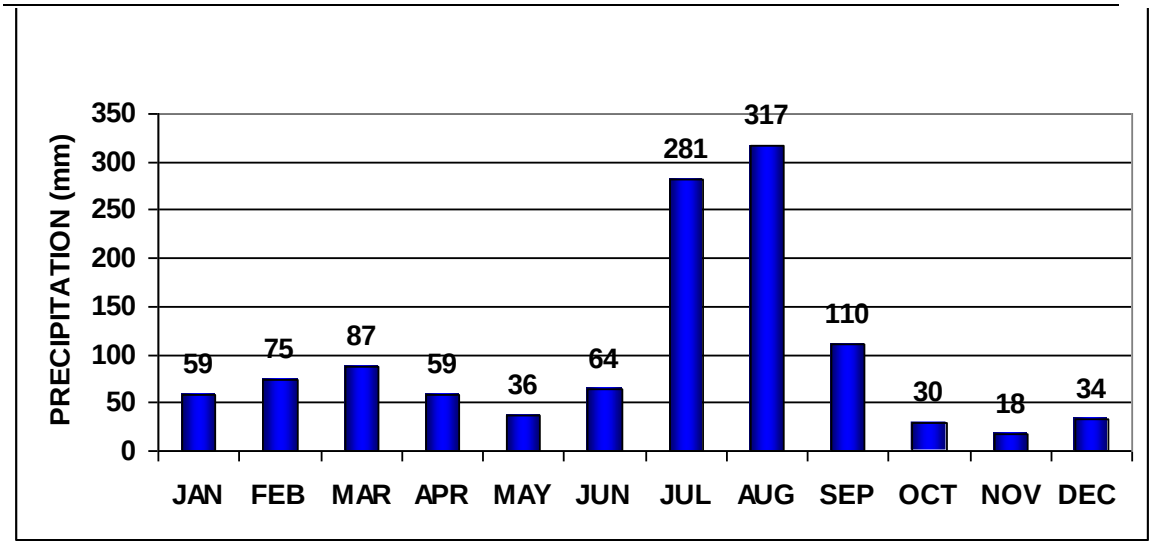



**FIGURE 15**. MEAN MONTHLY PRECIPITATION AT ISLAMABAD-AIRPORT (1959-2020)

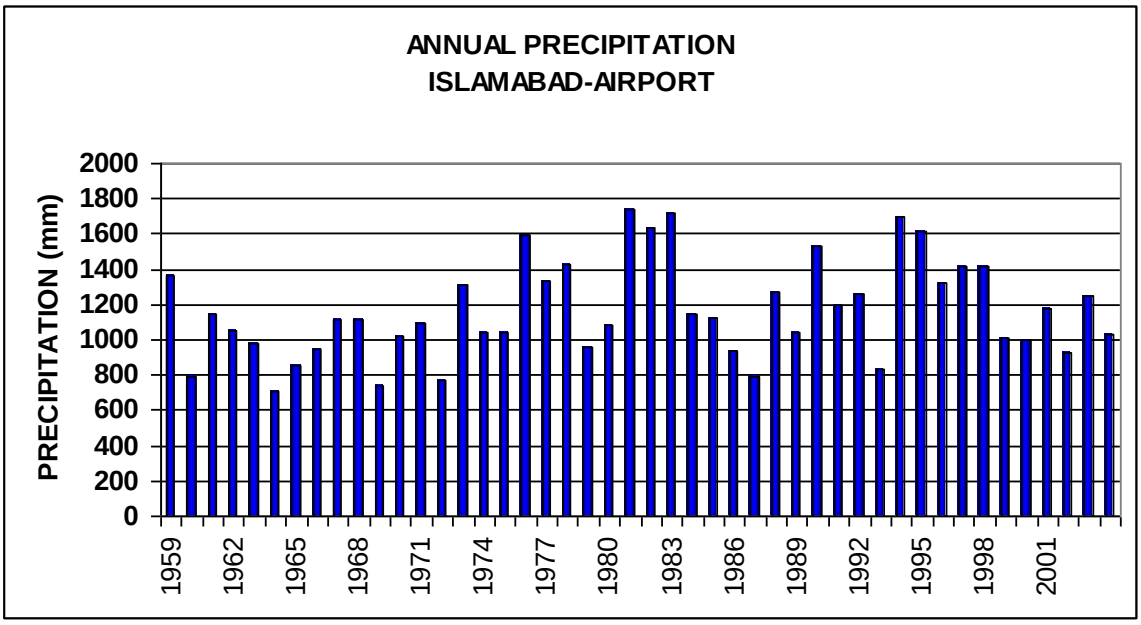



**FIGURE 16**. MEAN ANNUAL PRECIPITATION AT ISLAMABAD-AIRPORT (1959-2001)

### *5.2.6 Methodology*

With the help of present investigations rivers, canals/distributaries and nullahs were identified and their hydraulic parameters such as catchment area slope and length/width were estimated from the data collected. Maximum rainfall data of various stations in the project area and maximum recorded flood data of the rivers were collected and processed for determining the frequency curves.

For the analysis computer software was employed. “Design Flood” is one of the widely used Packages in Pakistan, designed in compatibility and comprehension of the hierarchy of local flash floods. Rainfall and / or flows data are used as input in this model to determine the flash floods of different desired return periods. It uses standard hydrologic methods including US Soil Conservation Services (SCS) procedure for the determination of flows from rainfall data. Floods have been estimated using flood frequency analysis that includes Gumbel Extreme Value Type-I, Pearson Type-III, Log Pearson Type –III and Lognormal distributions. The floods of different return periods are calculated using the best-fit statistical distributions evaluated by the package using various statistical tests. The quality of the data is also evaluated with the package before to finalize the flash floods. If the data is inconsistent or some outliers are present the model reports the quality of data. The flood hydrograph of the flash floods were generated in this procedure by the package.

#### 5.2.6.1 Field Work/ Data Collection

Collection of field data of the train track includes number of channels/streams, length of main stream, Rainfall data or streamflow data, slope of the main river, topographic map etc. Using the standard hydrologic procedure, the package computes the flash floods for different return periods. For example fitted distribution and flood hydrograph, its volume and peak estimated by the package is computed.

### *5.2.7 Computations of Design Rainfall*

Computations were carried out to determine design rainfall for different return periods. Maximum rainfall data at Islamabad airport was processed for the frequency analysis and presented in **Figure 17.** Frequency analysis was carried of widely acceptable computer software “Design Flood” and frequency curves for design rainfall are shown in **Figure 18** and **Figure 19**. Computed design rainfall for various return periods are summarized in **Table 5.3**. These results indicated that maximum rainfall for 100 year return period at Islamabad was 250 mm. Rainfall for other return periods is given in the same table. These rainfall frequencies have been used to compute level of floods in the Soan and Ling Rivers that exist in the nearest vicinity of EMIRATES RESORT APARTMENT BUILDINGS .

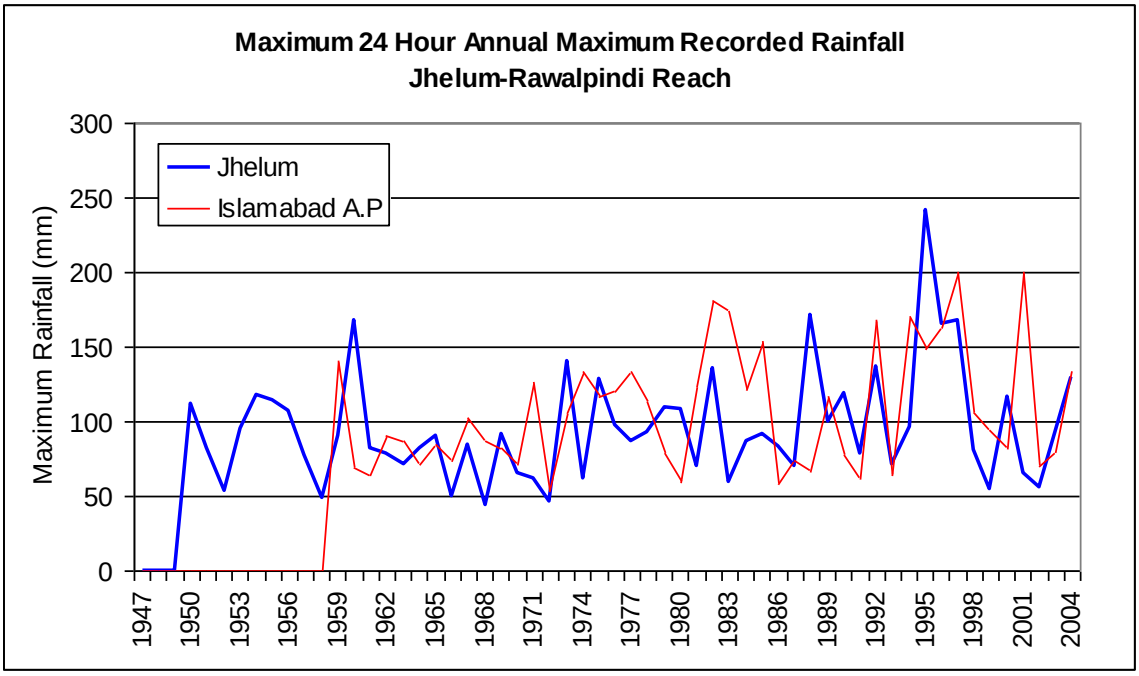



**Figure 17.** Maximum 24 Hour Annual Maximum Recorded Rainfall, Jhelum-Rawalpindi Reach

**Maximum Rainfall Frequency Curve**
Station: Islamabad Airport

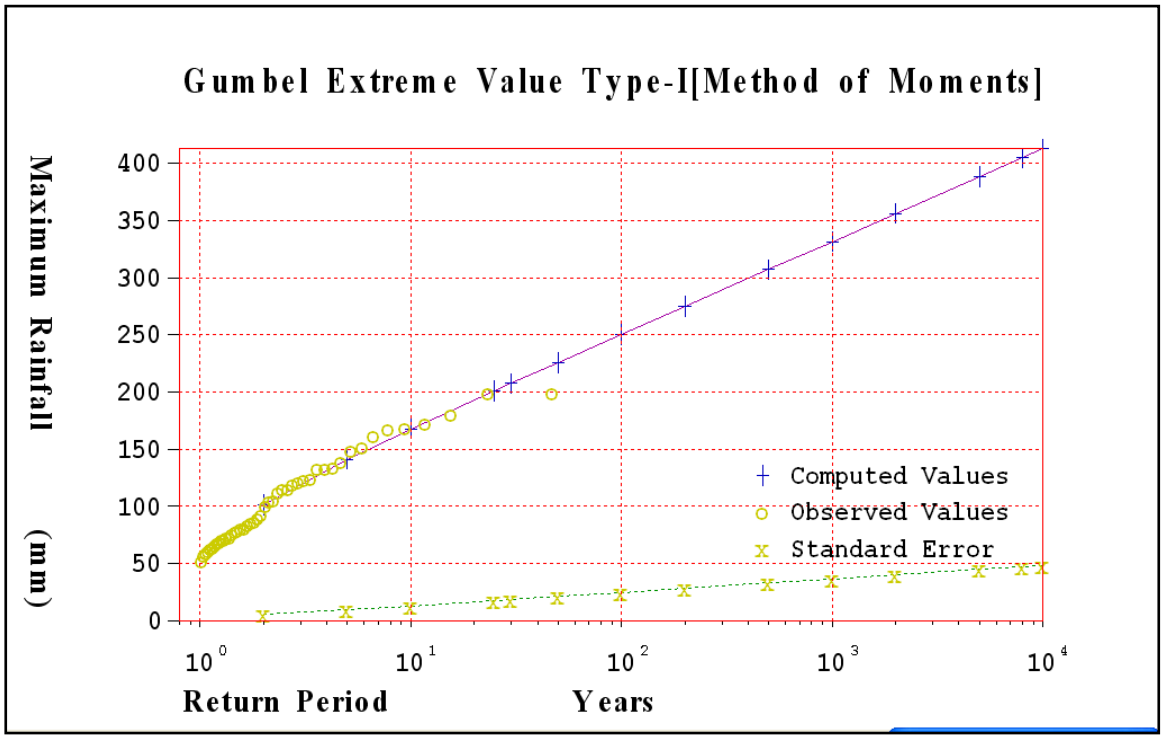



**Figure 18.** Maximum Rainfall Frequency Curve

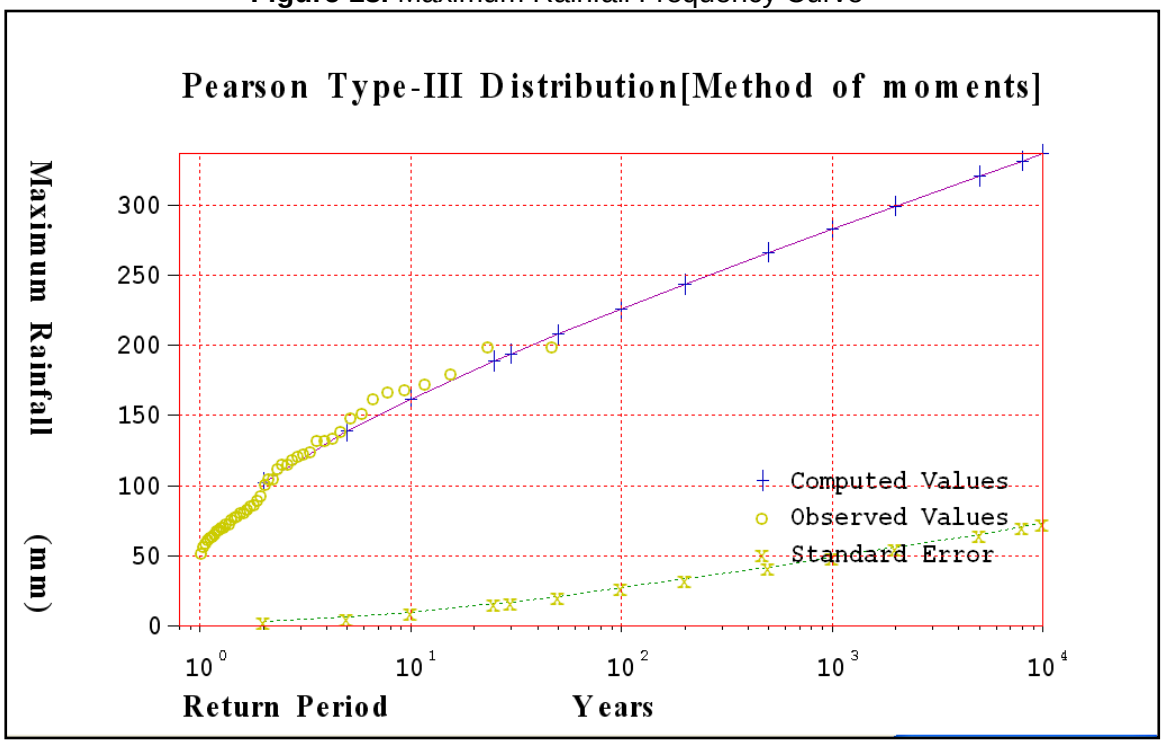



**Figure 19.** Maximum Rainfall Frequency Curve

**Table 5.3 Summary Results of Frequency Analysis for Design Rainfall Gumbel Extreme Value Type-I Distribution**

| Return Period (Years) | Maximum Rainfall (mm) | | | |
|---|---|---|---|---|
| | | Islamabad | | |
| 2 | | 101 | | |
| 5 | | 141 | | |
| 10 | | 168 | | |
| 25 | | 201 | | |
| 30 | | 208 | | |
| 50 | | 226 | | |
| 100 | | 250 | | |
| 200 | | 275 | | |
| 500 | | 307 | | |
| 1000 | | 332 | | |
| 2000 | | 356 | | |
| 5000 | | 388 | | |
| 8000 | | 405 | | |
| 10000 | | 413 | | |

#### 5.2.7.1 Wind

Hourly and intermittent wind records at Chaklala station are available since 1954. The Chaklala record shows a maximum observed wind velocity of 143 km/h. The records also show that the maximum wind velocity at Chaklala occurred in August.

#### 5.2.7.2 Evaporation

Evaporation is the most important climatic factor bearing on agriculture and water resources development. It influences the loss of water in the upper layers of the soil, received from rain or irrigation. It determines the major part of the losses from reservoirs and from river flows.

No pan evaporation data are available at Islamabad. Pan evaporation records are available at Tarbela since 1961. Although the area is away from the locality of the EMIRATES RESORT APARTMENT BUILDINGS , but it can be used to some extent. The average annual pan evaporation at Tarbela is about 2,358 mm. Highest evaporation is experienced during the early summer months of May and June before the monsoon season starts. About 70% of evaporation takes places during the summer season, i.e. from April to September. There is not much year-to-year variation in the annual pan evaporation.

### 5.2.8 Topography and Drainage

EMIRATES RESORT APARTMENT BUILDINGS lies close to the Korang River at slightly higher elevation. In the west flood plains of the Soan River and the Ling River could be seen. The project area of the EMIRATES RESORT APARTMENT BUILDINGS lies adjacent to the Korang, which flows approximately in East to West direction. The area has highest elevation 577 meters AMSL (Above Mean sea Level) as.shown in the following Figure. Most of the area is undulating features with rising hillocks. The area is adequately drained ultimately to the Korang River.

The area has compatible climatic condition for residential use. The maximum summer temperature varies from 40 to 43 C while minimum at 24 C. The normal wind direction is west to south West except for short spells during Monsoons when wind from North and southeast are experienced.

### 5.2.9 Top Soil and Physiography

The topsoil of the EMIRATES RESORT APARTMENT BUILDINGS carries all the typical characteristics of the Pothowar Plateau and Indus flood Plain Area in broader term. Most of the soils are extensively eroded, deeply dissected and badly gullied. Small cliffs are formed in the area. In general, it contains deposits of loess and ranges from silty-clays to clayey-silts, mixed with gravel. The topsoils are grayish brown to light brown in color. The alluvial soils cover the Nullah banks and terraces. These soils vary from sandy loams, in Nullah banks to clayey-loams in terraces. These are fertile soils and are suitable for farming.

The agricultural potential of the soils varies a lot, depending upon the extent of presence of gravels, soil fertility and its surface topography.

### 5.2.10 Geological Studies

EMIRATES RESORT APARTMENT BUILDINGS area falls in the Potwar region and alluvial plain in the vicinity of the Korang River having Quaternary alluvial deposits. It is a realm of thick fluvial deposits represented by the rocks of Rawalpindi and Siwalik Groups. Different geological aspects were studied by a number of geoscientists in this region. The region is also famous for oil and gas exploration, which are being extracted at various places in the licensed areas granted by the Directorate General of Petroleum Commission (DGPC) to different multinational Oil & Gas operator companies.

### 5.2.11 Landscape

The landscape of the Potwar is controlled largely by the rock packages, exposed in the area. The Pleistocene and residual gravels caps the Nimadric formations in several places and are seen in the marginal areas, where they form small rounded prominence.

The Loess forms sufficient flat interfluves in the central Potwar. Agricultural land is at its best at such places. The closely dissected Loess Clays exhibit Badland Topography in these parts. The dendritic growth of stream and uneven surface in the loessic areas becomes a hazard for the development of the agricultural land. However, with the introduction of the mechanical farming, the area is being rehabilitated. The Loessic Clays of the Badlands spreads over a large superficial area of the northwest Punjab over depressions, slopes and high ground, as a semi-consolidated, unstratified, structure less, wind borne drift. It is soft and easily denuded and yet it has a remarkable capacity of standing in high vertical walls, a surface feature commonly observed south and east of Rawalpindi.

The Loess signifies a desiccation of the Punjab plains, following the diversion of the numerous channels to the south and southeast flowing rivers, which previously flowed to the northwest direction. During this interval the finer detritus from the dried up stream basins was swept by winds and deposited over by any accidental features. It is the peculiar weathering of this un-compacted, calcareous, and partly saliferous dust from the desiccated swamps and mud flats into deep complex fretwork, which has produced the characteristic Badland topography of the Potwar, locally designated by name Khuddera. Perpendicular sided ravines of 100 meters depth are common in such a land.

Fossil teeth and bones of living forms such as Camelus, Equus, Bos, Canis etc, are found in the older alluvium. It is probable that Paleolithic man settled in the Potwar, indicated by the large number of flints and other tools of this handwork. A few delicately worked flints of Neolithic type are also met with in the area. Besides these, hundreds of detached chips of flint, fine quartzite and trap (with the cores of pebbles bearing signs of internal fracturing) are found in the gravels covering the surface of the valley (Wadia, 1928).

In the Soan Synclinal area, the formations exposed are soft sandstones and clay stones of the Dhock Pathan and Nagri Formations. They are generally flat lying, or have a low dip only and heavily dissected. They give rise to

agricultural land. Away from the centre of the Soan depression, the general landscape is controlled by the attitude of the closely folded Middle and Lower Siwaliks and Murree Groups.

Across the Soan River there is a steep rise of 80 meters up the dip slope of the top Nagri sandstone. Northwards to the Nagri/Chinji boundary, the country presents a typical Nagri trellis with an appearance of clearly defined dip and strike streams. The later cuts back in the thin clay stones between the massive and thicker sandstones. The Nagri/Chinji boundary is marked at the bottom by a small scarp feature, or cuesta, formed by the bottom Nagri sandstone. This is a fairly regular feature on the northern flank of Soan Syncline.

The Chinji stage generally gives rise to depressed topography, which is flatter than the Nagri, because the sandstones are softer, thinner and less frequent than in the Nagri.

The Rawalpindi group has dark reddish colour which creates a somewhat ominous atmosphere. Apart from the occasional claystone belts the Kamlials do not give rise to much agricultural land.

As a whole, the scenery of the Potwar is dominated by the general level of the plateau dissected by steep sided nullahs, the occasional small cuestas and the main ridges, which must have been remnant hills, since the formation presumably a Pleistocene peneplain. The landscape shows all the phenomenon of essentially seasonal water erosion in a semi arid terrain.

### 5.2.12 Climatic Aspects

The Potwar area seems pleasant in winter with sunshine during the day, although it is cold in the morning with $27^0$F to $32^0$F. Snow rarely occurs in this area. Temperature rises during May to June months and may range from $112^0$F to $118^0$F. Dust storms also occur during May and in summer season and deposit fine dust silt on surface of various geological deposits.

### 5.2.13 Regional Geological Settings

EMIRATES RESORT APARTMENT BUILDINGS is placed at the rising cliff of mainly clayey deposits and underlain by sandstone and clay. Aquifers are formed in the sandstone and gravel formations that are recharged by the rainfall and surroundings Nallah flows and Korang River. In regional sense, geology of the area includes the Salt range rises from the Punjab Plains

forming an impressive escarpment that mainly trends eastwest in the east. It swings to NNW in the west and form a garland like feature. Towards north, it is separated from Kala Chitta Range with the intervening Potwar Plateau. The average height of the range is about 671 meters and highest peak being at Sakesar (1600 meters). It is an extremely arid area that sharply marks the boundary between the submountainous to the north and Indus plains (also known as Jhelum plains) to the South. It forms a series of irregular ridges, which are convex towards the south, overlooking the Mianwali Plains. The Salt Range in its western limits terminates at Mari on the Indus and ends at the River Jhelum towards east. However, on the western side the Salt Range continues beyond the Indus where it is called Trans-Indus Range.

Structurally, the Salt range shows many interesting folds and faults. Its southern forelimb of a large fault bend fold is steeply dipping towards the Punjab Plains and terminates at Salt Range Thrust. While relatively gentler back limb is dipping towards Potwar Plateau in the north. Eastward the Salt Range loses its stature and bifurcates into two narrow northeast trending ridges, the Diljabba and the Chambal-Jogi Tilla. The latter comprises steeply dipping monoclines, complicated by complex thrusts and tear faults, whereas the Diljabba Hill is a steeply dipping anticline traversed by Diljabba-Domeli Thrust. This E-W trending Salt Range terminates at N-S trending and left lateral strikeslip fault in the east which is called Jhelum fault.

The northern side of Salt Range consists of gently dipping strata merging into the Potwar Plateau, which are for the most part expose Neogene rocks. The northern face of the Salt Range represents a series of escarpments rising abruptly from the plains and exposing Cambrian strata and fairly continuous succession from the Permian to Tertiary. There are many cross faults along which block faulting has taken place. Several rifts cut the range in a radial direction and some of these undoubtedly follow zones of faulting. The acute form of the range is to be attributed to the great Himalayan movements, which compressed the strata and made them flow over some distance towards the south, the eastern and western ends have been held by wedges of ancient rocks, which lie underneath and may be called the Kashmir and Mianwali wedges. Exposures of Precambrian rocks belonging to the Delhi system are found near Sargodha, Chiniot and Sangla Hills, not far from the eastern end of the Salt Range.

The Potwar Plateau lies at a height of 300-600 meters in the south of Rawalpindi with some exposures of the Eocene rocks of the Khairi Murat

range. The plateau exhibits an intricately damaged topography with a well defined basin of sediments belonging to Early Miocene to Late Pleistocene. The Kohat-Potwar basin contains more than 500 meters of marine deposition (Precambrian to Eocene, with a major break during Ordovician to Carboniferous). More than 10,000 meters of Miocene to Pleistocene alluvial sediments, overlie the marine sequence. The main components of the plateau are Soan Geosyncline, Rawalipindi-Kohala area, Nara-Kahuta area and Jhelum valley area. The proposed track passes through Soan Geosynclinal area having axis more or less concordant with the main direction of the flow of the Soan River. The Soan Basin is a syncline of normal trough fold type. Its shape is that of an elongate oval with asymmetrical sides. The basin is one of the major geosynclines, which came into existence as the receptacles of the rapidly accumulating silt and detritus over restricted localized areas.

### 5.2.14 Stratigraphy

The area is underlain by the sedimentary rocks of marine and non-marine origin ranging in age from Precambrian to Recent. The oldest rocks exposed in the Salt range are of Precambrian Salt Range Formation followed by thick Cambrian sequence of the rocks of Jhelum Group which is disconformably overlain by rocks of Nilawahan Group belonging to Permian age. This succession is unconformably overlain by the rocks of Makerwal group. The unconformity is marked by laterite beds at places. The sequence is conformably overlain by the rocks of Chhart Group of Eocene age. The prominent cliff forming ledges or escarpments are of Palaeogene rocks.

The rocks of Salt range depict a variety of depositional environments ranging from open shallow marine to restricted marine glacial intertidal, lacustrine and fluvial etc. both transgressive and regressive cycles can be recognized in the Cambrian, Permian and Tertiary rocks.

Further north the succeeding succession belongs to Miocene-Pleistocene rocks of Potwar region. The Miocene rocks of Rawalpindi Group are bodies of fresh water clastics of rhythmically alternating deep and shallow water environments, consisting of sandstone and clay. The Pliocene-Pleistocene sequence constitutes the rocks of Siwalik Group (Chinji, Nagri, Dhok Pathan and Soan Formations). The group as a whole is a body of the sediments of

clastic origin of the molasses type, consisting of varying ratios of sandstone and clay with interbeds of conglomerates.

During upper Pleistocene, arresting of denudation forces took place and thick pile of loess silt was laid down in the area. Recent deposits include alluvial plains of the Ravi, Chenab and Jhelum rivers.

### 5.2.15 Description of Major Exposed Rock Units

The proposed track is nearly parallel to Lahore-Islamabad GT road. The rock packages exposed along the track are described as under:

1. Rawalpindi Group of Miocene age
2. Siwaliks Group of Pliocene-Pleistocene age
3. Loess Deposits of Sub-recent age
4. Recent-Early Recent sediments

#### 5.2.15.1 Rawalpindi Group of Miocene Age

**Murree Formation**

The Murree Formation is comprised of clay and sandstone. The clay is dark red and purple grey. The sandstone is greenish grey with intraformational conglomerate. The basal part is conglomeratic and contains derived foraminifera. It is named as Fatehjang member. The formation is poorly fossiliferous, yields plant fossils, silicified wood and mammalian remains, which include *Anthracotherium bugtiensis, Hemimeryx sp. Brachyodus gigantus, B, cf. africanus, Palaeochoerus pascoei* and *Teleceras fatehjangensis.*

**Kamlial Formation**

The Kamlial Formation contains sandstone and clay. The sandstone is pink, red, brown and violet yellow, fine to medium grained, medium to thick bedded, spheroidally weathered and ridge forming, with intraformational conglomerates. The clay is red and purple. The fauna includes *Trilophodon cf. angustilent, Dinotherium indicum, Dinotherium sp., Amphicyon cf, shahbazi, Hyaeneluros lahiri, Anthracotherium sp., Hemimeryx (?) blanfordi, Listriodon cf. guptai, L. pentapotamiae, Conohyus cf. sindiensis* and others.

#### 5.2.15.2 Siwaliks Group of Pliocene-Pleistocene Age

**Chinji Formation**

The Chinji Formaion comprises of clay with subordinate sandstone. The clay is bright red. The sandstone is fine to medium grained, occasionally pebbly, cross-bedded, pebbles of quartzite and thin lenses of intraformational conglomerate are found at different horizons. Plibeam and others (1977) identified the different fauna from the Chinji Formation including Mammalia, Creodonta, Hyaenid, indet and Perissodatyla etc. from the Potwar region.

**Nagri Formation**

The Nagri Formation consists of sandstone with subordinate clay. The sandstone is greenish grey, medium to coarse grained, cross-bedded and massive, at places salt and pepper textured, calcareous and moderately to poorly cemented. The clay is chocolate brown, reddish grey and purple orange, sandy and silty. The fauna includes Mammalia, Gomphotheriidae indet, Perissodactyla, Artiodactyla and Rodentia etc. from the Potwar plateau.

**Dhok Pathan Formation**

The Dhok Pathan Formation contains clay and sandstone. The clay is orange red in color. The sandstone is light grey, weathers gleaming white, thick beded, hard and calcareous. The conglomerate lenses are present in upper part. The vertebrate remains include *Indarctos salmontanus, Enhydriodon cf. silvalense, Lutra bathygnathus, Lepthyaena sivalensis, Hyaena cf. maxima, Hipparion punjabense etc.*

**Soan Formation**

The Soan Formation contains mainly conglomerate, sandstone, siltstone and claystone. The conglomerate is dark grey, compact and massive. The sandstone is grey, soft and massive. The claystone and siltstone are varicoloured and compact. The fossils include *Mastodon sivalensis, Stegodon clifti, Elephas cf. planifrons, Sivatherium giganteum, Proamphibos lachrymans, Dicoryphochoerus durandi and Sivafelis potens.*

### 5.2.15.3 Loess Deposits of Subrecent age

The loess deposits are characteristic units in the northern parts of the Potwar Plain, especially around Chakri area. The loess is spread over depressions, slopes and high ground alike as semi-consolidated, unstratified, structureless wind borne drift.

### 5.2.15.4 Recent –Early Recent sediments

**Older Flood Plain deposits**

The older flood plain deposits of rivers occur in the flood plain belt beyond the limits of Younger Flood Plain Deposits. On the surface these deposits consists of fine to medium sand, silt and clay. Presently covered by vegetation and near Lahore these deposits are part of population.

**Younger Flood Plain Deposits**

These deposits of the rivers border the areas adjacent to these rivers. The deposits constitute very fine sand, silt and silty clay. Presently these are occupied by cultivated fields and thick vegetation cover.

**Hill Wash deposits**

The Hill Wash Deposits comprise sand, silt and clay deposits brought by the hill torrents and floods and deposited beyond the foothill zone.

**Piedmont Deposits**

These deposits occur in the foothills of the Salt Rage around Lilla and constitute boulders and pebbles of the older rocks.

**Meander Belt Deposits**

The Meander belt deposits form a relative narrow zone, 3-6 km wide along the banks of the rivers, characterized by bars, cut off meanders and oxbows. The deposits consist largely, fine to medium sand (older channel deposits), silt and silty sand and smaller bodies of silty clay (channel filling and clay plugs).

**Surficial Deposits**

The surficial deposits constitute sand, silt and clay occurring within the mountain valleys. These deposits are semi-compact to compact, generally 5-10m thick.

**Stream bed Deposits**

The stream bed deposits consist of unconsolidated gravels, sand and clay, occurring in rivers and streambeds.

### 5.2.16 Aggregates for construction from indigenous material

The rock material is a blessing of God to human beings as this indigenous material is being extensively used in construction of minor and major projects like dams, roads and buildings etc. over the years and so. Any huge project whenever starts at whatever location, the main consideration is given on that the aggregate material availability and if it is not available nearby the project area, then the cost of transportation will increase to manifolds.

The main lithologies encountered and that are exposed include Sandstone, Siltstones, Conglomerates and clays along with some gravely material which is recent deposits of the Indus river system. All the rock units exposed are very loose and friable and unfortunately of very small use. But even then we might be able to use this material in different ways like sandstone is basic component of building stones but a friable sandstone is directly used as sand produced during excavation. Clays are one of the components of cement during manufacturing. Conglomerates and gravels are extensively used as aggregate material.

### 5.2.17 Photographs of Geological features

Photographs were snapped of the geological formation and other features. Some of them are presented to highlight the geological features encountered in the vicinity and surroundings of the EMIRATES RESORT APARTMENT BUILDINGS Zone-4-B-2 as given in the Appendix below.

## APPENDIX: Geological Photographs

Horizontally laminated clayey deposits near EMIRATES RESORT APARTMENT BUILDINGS

Interbedded creamish sandstone bed within shales of Siwalik near the Soan and Ling Rivers. Gravely material is lying at the bottom of the exposure.

Massive bed of Sandstone interbedded within shale of Rawalpindi group. Folding is also observable.

Sharp contact of bright red clays and greenish sandstone of Chinji formation.

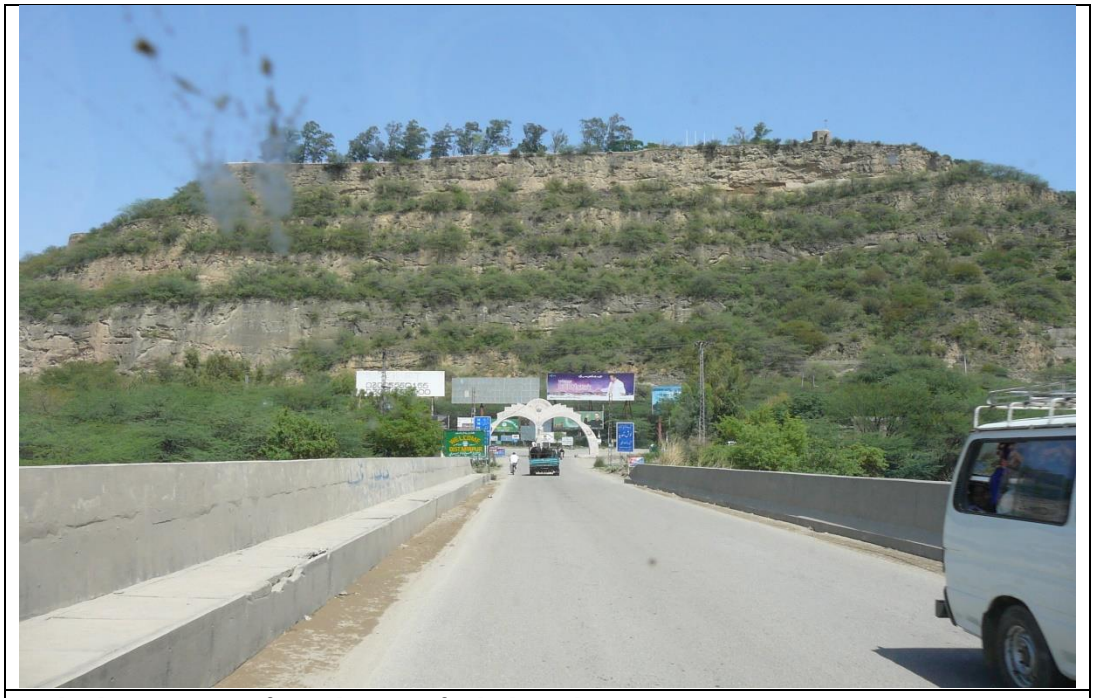
Another view of exposure of Chinji formation Muree Express Way

Nagri Formation exposed in the area. Chocolate brown and red clays on the right side and greenish grey cross bedded sandstone on the left side of the photograph

Exposure of Siwaliks (Chinji and Nagri Formations) along Murree Express road

Gravels (recent deposits)

Exposure of Siwaliks (Soan  Formation) which is almost horizontally bedded.



A thick exposure of Sandstone of Dhok Pathan Formation.

### 5.2.18 Seismology

Project area is located in a region of active seismic zone due to close proximity of the collision of boundary of the Indo–Pakistan and Eurasian plates. The Attock-Cherat-Kala Chitta-Margala Fold and Thrust Belt of the Lesser Himalayas have been subjected to earthquake in the past.

### 5.2.19. Earth Quakes, Fault line and Tectonics along the Study Area (within 50 km of the site of EMIRATES RESORT APARTMENT BUILDINGS, Zone-4-B-2 )

The site of EMIRATES RESORT APARTMENT BUILDINGS lies in the Northen Potwar Deformed Zone (NPDZ), which is the part of Potwar Plateau. Regionally it lies in the NW Himalayan fold and thrust belt (Kazmi and Jan, 1997). The geological setting and major faults within the 50 km of the site of the EMIRATES RESORT APARTMENT BUILDINGS, along with the regional tectonic setting of the NW Himalayan Fold and Thrust Belt are described below.

### 5.2.20 The NW Himalayan Fold and Thrust belt

This belt is one of the active fold–and–thrust belt along the north-western margin of the Indo–Pakistan plate, in which the Main Mantle Thrust (MMT) also known as the Indus Suture Zone; Main Boundary Thrust (MBT) and the Salt Range Thrust (SRT) delineate its major subdivisions. The area between the MMT is its northern boundary whereas SRT with its westward extensions i.e. Surghar, Marwat, Bhittani and Manzai ranges are referred to as its southern boundaries (**Figure 20**). The tectonic domains of Hazara- Kashmir Syntaxis and the Nanga Parbat Haramosh Massif comprise its eastern boundary. The western limit is not clearly defined. Besides the Kurram Fault in the southwestern portion, series of thrusts beyond the borders of Pakistan (like the Sarobi Fault in Afghanistan) are considered to be delineating this boundary.

A major thrust fault i.e. the Panjal-Khairabad fault, passes parallel in the north of the MBT divides it into a northern hinterland zone and the southern foreland zone. The hinterland zone is also referred to as the Hazara Crystalline Zone and Himalayan Crystalline Zone, whereas the foreland zone lies between the Panjal-Khairabad Fault and the Salt Range Thrust along with its westward extension. The site of EMIRATES RESORT APARTMENT BUILDINGS lies in the foreland zone (Figure 20). In the foreland zone, a thick

sequence (up to about 8 km thick) of sedimentary rocks ranging in age from Upper Proterozoic to Cenozoic overlies the older crystalline basement rocks. This foreland zone comprises of many thrust sheets (decollement zones) with a southward translation of up to 100 Km. Many workers have classified this part of the study area into different units based on various geological factors. Following the classification of Kazmi and Jan, 1997, the foreland zone on the basis of deformation style is divisible into the Salt Range and Kohat-Potwar fold belt, Kurram-Cherat-Margalla fold and thrust belt and the Hazara-Kashmir Syntaxis. The site of EMIRATES RESORT APARTMENT BUILDINGS lies in the Northern Potwar Deformed Zone (NPDZ), which is the part of Potwar area, and is described below.

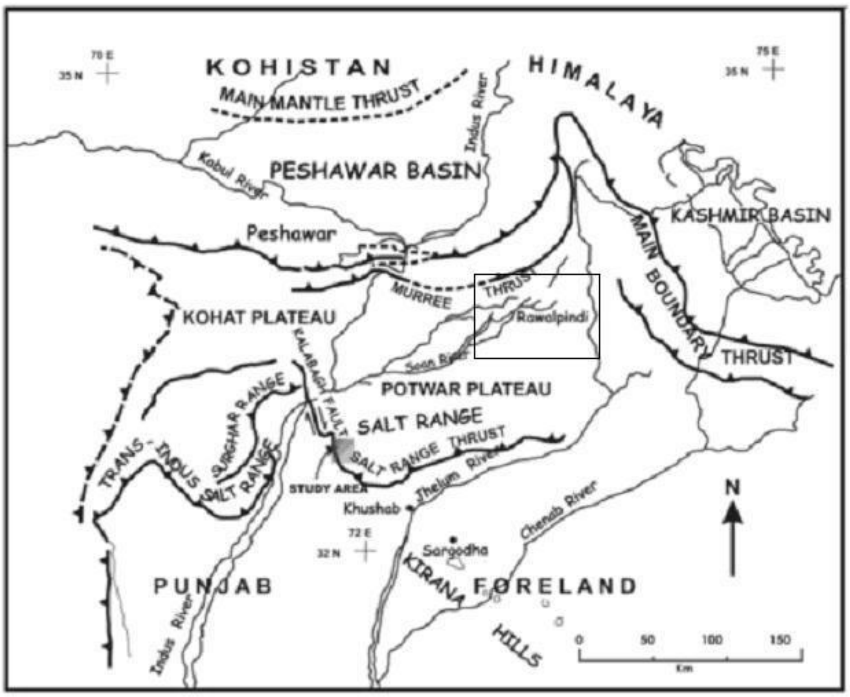



Figure 20. Tectonic map of North Pakistan (Ahmad et al., 2005).Square represents the area within 50 km of the site of EMIRATES RESORT APARTMENT BUILDINGS.

#### *5.2.20.1. The Potwar Area*

This area covers a wide area between the MBT in the north, and the Salt Range Thrust, Kalabagh Fault and the Surghar/Khisor and Marwat Thrusts in

the south. Along the eastern margin, the Jhelum Fault separates it from the Hazara-Kashmir Syntaxis, while the Kurram Fault delineates its western boundary (**Figure 21**). Sedimentary rocks of Eocambrian to Recent occur. Dominant structures present are east-west trending folds and thrust faults. However, within this large area, complex deformation styles have been observed. The intensity of deformation, as observed by these and other workers is more pronounced along the northern (near MBT) and southern margins (SRT and other related thrusts). Folds are more tight and complex, and commonly faulted. Balanced structural cross sections across the Potwar and Salt Range parts of the foreland recognize the presence of a decollement in the Eocambrian evaporates thereby implying thin-skinned tectonics. Recently, Moghal et al., (2003) have proposed the presence of at least two decollement levels. One as proposed by the above workers and another one at the interface between Eocene and younger rocks. On the other hand, work of Jan et al., 2004 and Sercombe et al., 1998 in the Potwar area suggests the presence of flower structures (thick-skinned tectonics) and involvement of basement in the deformation process.

The northern part of Potwar Plateau, also referred to as the Northern Potwar Deformed Zone (NPDZ) lies between the Main Boundary Thrust and the Soan Syncline. It is more intensely deformed than the southern Potwar and the Salt Range. Mostly E-W trending tight and complex folds with their southern limbs overturned with steep angle faults occur in NPDZ. The area contains a series of thrusts. Lillie et al., (1987) describe the northern Potwar as an imbricate stack of thrust faults on the surface and in the subsurface as blind thrusts. General trend of these thrusts changes from E-W to N-E direction in the eastern part of the NPDZ A number of workers have already given the description of these faults (e.g. Lillie et al., 1987; Jadoon et al., 1995, Jadoon and Frisch, 1997 and Jaswal et al., 1997). Soan Syncline is the major structural feature of Potwar. Its southern limb is less steep than the northern limb. In the study area, it is believed to have evolved between 3.4 to 1.9 Ma with the southern limb forming prior to the northern limb. According to Johnson et al., (1986) the development of the southern limb took place due to thrusting along the Rawat thrust (**Figure 21**). This thrust trends in the NE-SW direction lies about 20 km south of Rawalpindi. Jadoon et al., (1995) believe that cessation of movement along the Riwat thrust stopped at about 2.7 Ma. Soan (Dhurnal) backthrust is a distinctive feature of the Northern Potwar Deformed Zone, occurs in the northeastern portion of the NPDZ (**Figure 21**).

The dips along the backthrust are nearly vertical in contrast to near horizontal along axis of the Soan Syncline. The top of Kamlial Formation marks its location. North of the backthrust, highly deformed rocks of Murree Formation with steep to vertical dips occur; where as further north till the Khair-i-Murat Fault steeply dipping Siwalik Group rocks is exposed.

### 5.2.21 SEISMICITY

Pakistan and adjoining countries experience high frequency of earthquakes, which in some cases have resulted in great loss of life and destruction. In Pakistan, besides the two active fold and thrust belts (Sulaiman Fold and Thrust Belt and NW Himalayan Fold and Thrust Belt), high zones of seismicity exist in other parts of the country also.

Available information indicates that the Makran coastal earthquake of 1945 having a magnitude of mb 8.3 was the severest earthquake to affect Pakistan. This event created a number of offshore islands along the Makran coastline. In the vicinity of the study area, the 1905 Kangra earthquake (in India) of mb 8.4 activated the MBT. More recently, Pattan (1974), Rawalpindi (1977), Bunji (2002) and Batagram (2004) earthquakes badly affected the study area.

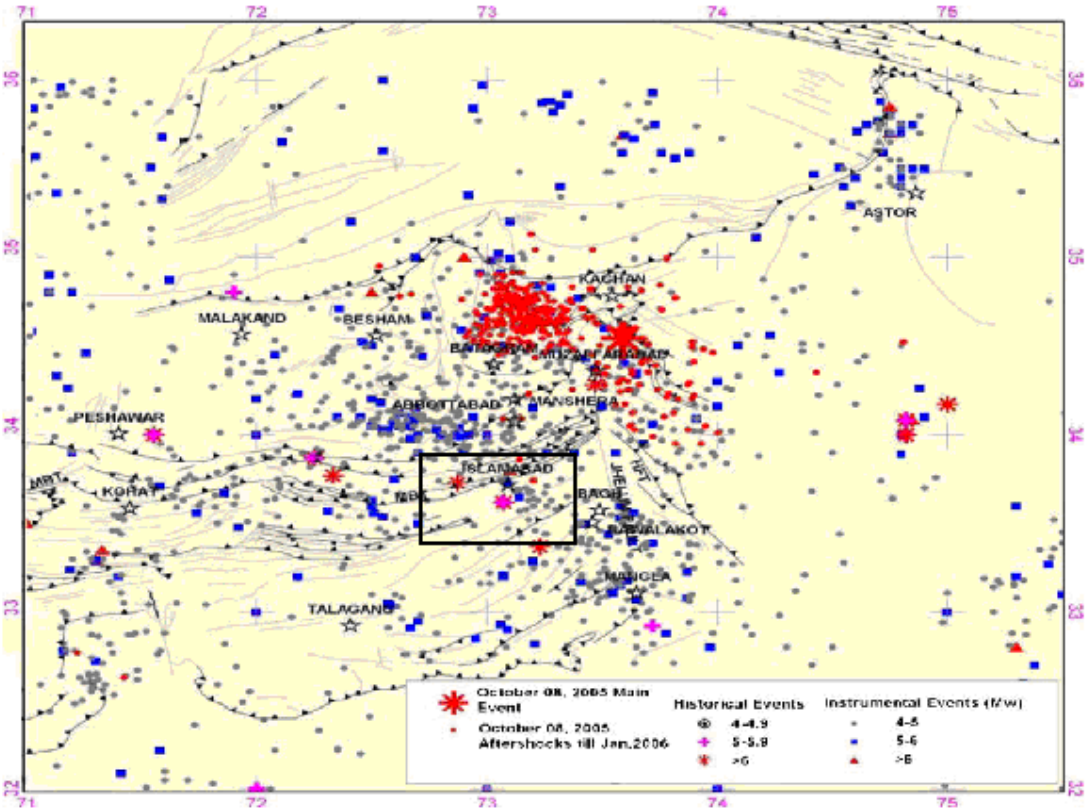



**Figure 21.** Seismicity map of the North Pakistan. The square shows the area within the 50 km of the EMIRATES RESORT APARTMENT BUILDINGS.

Another reason may be the presence of a thick sequence of EoCambrian salt in the Salt Range and Potwar area that may be having a damping effect. Further, the lithologies occurring in the Salt Range/Potwar are believed to be extending into the Bannu Basin also thereby implying the presence of salt in this part also.

### 5.2.22 Seismicity near the site of EMIRATES RESORT APARTMENT BUILDINGS

From the **Figure 22**, it is quite clear that the seismicity level near the site is scattered and no prominent pattern has been observed. The earthquakes with magnitude range of 4-5 are more as compared to the major earthquakes. Except one major earthquake (M 5.7), known as the Rawalpindi Earthquake occurred near Rawalpindi in 1977, there is no evidence of major earthquake. Thus overall the seismicity level is quite moderate in this particular area. Details about seismicity and seismic zones are discussed below.

### 5.2.23 Seismic Zones

The site of EMIRATES RESORT APARTMENT BUILDINGS lies in the Potwar Seismic Zones (**Figure 22**). A brief description regarding active faults within this zone is given below.

#### *5.2.23.1 Potwar Seismic Zone*

This zone lies between the Main Boundary Thrust (MBT) in the north, Salt Range Thrust (SRT) in the south, left-lateral strike slip fault in the east and right-lateral Kalabagh Fault in the west. It is largely covered by the Siwalik sequence. The northern part known as the Northern Potwar Deformed Zone (NPDZ) is more intensely deformed and consists of several east-west trending folds and steep angle faults. A broad asymmetrical syncline i.e. Soan Syncline (SS), which is gently northward dipping southern flank along Salt Range and a steeply dipping northern limb along NPDZ (Kazmi and Jan, 1997), separates the NPDZ from the southern Potwar Platform (PP) zone. PP is less deformed and consists of less prominent and structure.

#### *5.2.23.2 Active Faults*

From N to S, the active faults are briefly discussed below.

### *5.2.24.3 Main Boundary Thrust (MBT)*

Wadia (1957) recognized a series of nearly parallel faults in his division of the Outer Himalayas (also known as Sub-Himalayas). All these were referred to as the Main Boundary Thrust (MBT). Nowadays the outermost of the fault named Murree Thrust by him (Hazara Fault of Seeber and Armbruster, 1979) is called the MBT (**Figure 22**).

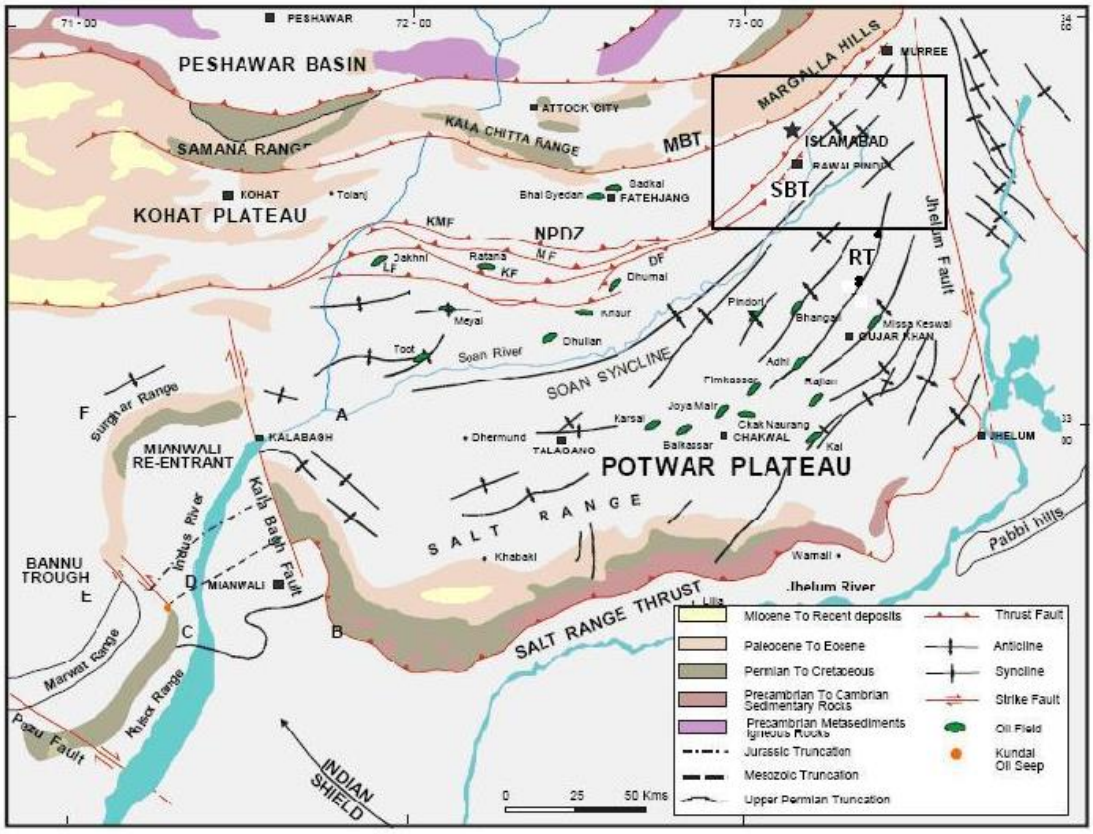



**Figure 22.** Oil and Gas Development Corporation (OGDC) Report, Prospective exploration licence, Pakistan (2006). Square represents the faults critical within the 50 km of site.

This distinct tectonic feature, in Pakistan, has thrust the Eocene and older rocks over the Mid-Tertiary Murree Formation. Some parts of the capital city (Islamabad) contain splays of the fault that runs immediately north of it.

The fault dips are not constant varying from $50^0$ to nearly vertical (Kazmi and Jan, 1997). In the east along the Hazara Kashmir Syntaxis, the fault loops around it. However, on the western side of the syntaxis, like the Panjal Fault, it is displaced by the left lateral Jhelum Fault. Seeber and Armbruster (1979) consider it to be a northward dipping reverse fault that in the lower crust is connected with the deeply buried faults referred to as the Hazara Lower

Seismic Zone. On both sides of the MBT i.e. Hazara region in the North and Northern Potwar/ Kohat plateaux in the south, a number of mostly left lateral strike slip faults occur (e.g. Jadoon et al., 1995). Seismicity map (Figure 2) indicates that a number of events mostly on the western side of the HKS occur in this part of the study area.

#### *5.2.24.4 Khair-i-Murat Fault (KMF)*

The KMF is a north dipping major emergent thrust in the NPDZ, along which high velocity Eocene Carbonates are thrusted southward over low velocity molasses (Moghal et al., 2003). It soles out in the basal decollement at a depth of about 9 km (Jadoon et al., 1999). The Khair-i-Murat thrust named after the range of this name lies to the southwest of Rawalpindi. It is about 22 km long and 2 km wide. Eocene rocks are exposed along this thrust and have moderate to vertical dips. Overturning also exists. In the Khair-i-Murat range, the moderately to steeply dipping Murree formation with small bedding parallel slip and related splay is imbricated.

#### *5.2.24.5 Dhurnal Backthrust (DBT) or Soan Backthrust (SBT):*

The DBT is a passive roof back thrust, had been considered previously as the eastward extension of the Kanet Fault (KF), but recent work has shown as a different fault with different sense of motion it runs parallel to Soan Syncline (SS), therefore it is also named as Soan Back thrust (SBT). According to Jadoon et al., 1999, the steep Dhurnal back thrust (or SBT) becomes shallower to the south and dies out at a depth of 2- 4 km.

#### *5.2.24.6 Kanet Fault (KF)*

KF is north dipping emergent thrust in the western part of the NPDZ, developed in the direction of tectonic transport, and in the eastern part of the NPDZ it is underthrusted beneath Dhurnal backthrust (**Figure. 23**).

#### *5.2.24.7 Mianwala Fault (MF)*

The MF is high angle intraformational thrusts at the surface that can be traced only in streams where good rock exposures are present, on the basis of shear zones, fault breccia and secondary calcite The rocks having steep dips are

exposed in the area between Mianwala and KMF and represent the northern most exposure of Siwaliks (Jadoon et al., 1999).

#### *5.2.24.8 Soan Syncline (SS)*

It is a broad, wide and asymmetrical syncline that divides the PP into NPDZ and SPPZ (**Figure. 23**). The Soan River marks its axis. Dhok Pathan Formation overlying the Nagri Formation crops out south of Dhurnal area on the northern limb of SS. The area north of SS is characterized by horizontal shortening and imbricate thrust faulting (Jadoon et al., 1999).

#### *5.2.24.9 Dil Jabba Fault*

The Dil Jabba Fault (Figure 23), a northeast trending thrust dipping towards the northwest is located in the eastern part of Salt Range/Potwar Plateau. Pennock et al., 1989 referred to the northeastern portion of this thrust as the Domeli Thrust and the southwestern portion as the Dil Jabba backthrust. Sercombe et al., (1998) referred to the Dil Jabba Fault as the left lateral strike slip Domeli Fault. Some unpublished reports of NESPAK based on observed seismicity pattern suggest that the Dil Jabba Thrust is an extension of the left lateral Jhelum Fault.

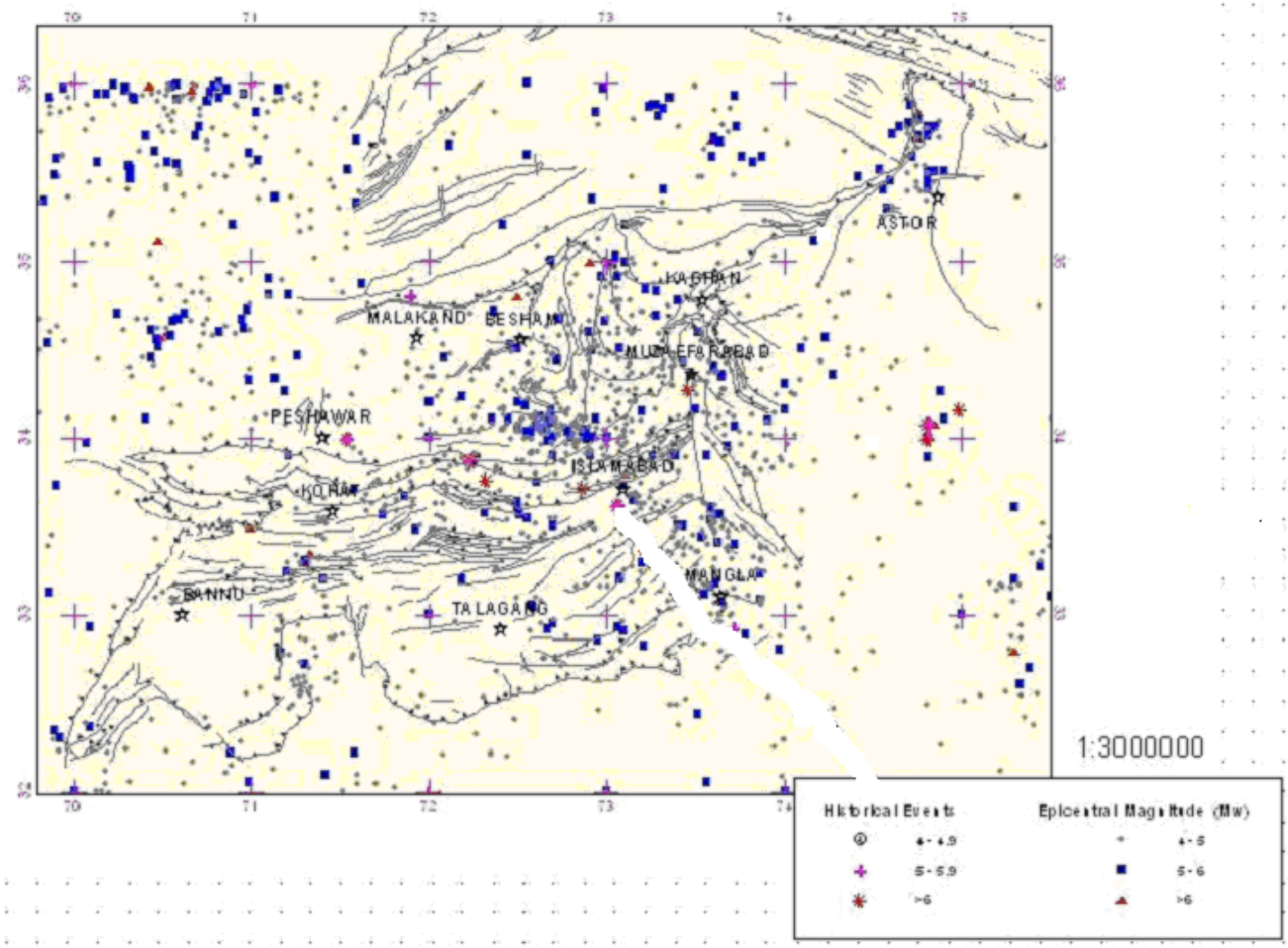



**Figure.23.** Seismicity and structural map of the area

The older rock lies on the less deformed Tertiary sequence. At other places, the abrupt contact of the alluvium of the Punjab Plain with the foothills of the Salt Range delineates the fault. Most workers consider it to be the surface expression of the leading edge of decollement that occurs within the Eocambrian evaporites (e.g. Kazmi and Jan, 1997). Comparatively low magnitude seismic activity (most likely due to the damping effect of salt) occurs although disturbance of Quaternary deposits from many parts is known.

### 5.2.25 Seismic Hazard Assessment (SHA)

The design of any man made structure is largely based upon the knowledge of seismicity and engineering practices, usually done by a technique known as the Seismic Hazard Assessment (SHA). The seismic parameters adopted for the design of structure are based upon the maximum earthquake calculated by SHA along the most critical tectonic feature for the site of investigation. For the site of EMIRATES RESORT APARTMENT BUILDINGS

, the modified studies by Dr. Zulfiqar Ahmad for Islamabad are given in Table 5.4.

Table.5.4.Peak horizontal accelerations calculated for the site of EMIRATES RESORT APARTMENT BUILDINGS within 50 km using seven attenuation equations.

| Tectonic Features | Maximum Magnitude (Mw) | Closest Distance to Faults (Km) | Computed Accelerations (g) | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | 1 | | 2 | 3 | | 4 | 5 | | 6 | | 7 | |
| | | | 54% | 84% | | 54% | 84% | | 54% | 84% | 54% | 84% | 54% | 84% |
| MBT | 7.8 | 4 | 0.56 | 1.02 | 0.64 | 0.54 | 1.02 | 0.39 | 0.44 | 0.78 | **0.44** | 0.75 | 0.47 | 0.88 |
| Thakot Fault | 7.1 | 46 | 0.09 | 0.17 | 0.09 | 0.08 | 0.15 | 0.06 | 0.07 | 0.13 | **0.08** | 0.13 | 0.07 | 0.13 |
| Kund Fault | 7 | 44 | 0.09 | 0.17 | 0.13 | 0.08 | 0.15 | 0.10 | 0.07 | 0.13 | **0.08** | 0.13 | 0.07 | 0.13 |
| Kanet Fault | 7.1 | 60 | 0.07 | 0.12 | 0.09 | 0.06 | 0.12 | 0.04 | 0.06 | 0.10 | **0.08** | 0.13 | 0.05 | 0.10 |
| Jhelum Fault | 7.1 | 39 | 0.11 | 0.21 | 0.16 | 0.09 | 0.18 | 0.08 | 0.08 | 0.15 | **0.09** | 0.15 | 0.08 | 0.16 |
| Sangargali Thrust | 6.9 | 18 | 0.22 | 0.40 | 0.3 | 0.17 | 0.32 | 0.22 | 0.14 | 0.25 | **0.17** | 0.28 | 0.15 | 0.29 |
| Thandiani Thrust | 6.8 | 15 | 0.24 | 0.45 | 0.3 | 0.18 | 0.35 | 0.19 | 0.15 | 0.26 | **0.18** | 0.30 | 0.17 | 0.31 |
| Nathiagali Thrust | 7 | 10 | 0.35 | 0.64 | 0.53 | 0.26 | 0.50 | 0.27 | 0.21 | 0.37 | **0.23** | 0.40 | 0.23 | 0.45 |
| Darband Fault | 6.8 | 40 | 0.09 | 0.17 | 0.12 | 0.08 | 0.15 | 0.06 | 0.07 | 0.12 | **0.09** | 0.16 | 0.07 | 0.13 |
| Khairabad Fault | 7.5 | 31 | 0.18 | 0.34 | 0.21 | 0.15 | 0.28 | 0.16 | 0.13 | 0.23 | **0.16** | 0.27 | 0.13 | 0.24 |
| Hissartang Thrust | 7.4 | 39 | 0.14 | 0.25 | 0.19 | 0.11 | 0.21 | 0.08 | 0.1 | 0.18 | **0.13** | 0.22 | 0.09 | 0.18 |
| Khair-I-Murat Fault | 7.4 | 27 | 0.2 | 0.37 | 0.27 | 0.16 | 0.30 | 0.13 | 0.14 | 0.25 | **0.17** | 0.28 | 0.14 | 0.26 |
| Riwat Thrust | 6.8 | 26 | 0.15 | 0.27 | 0.2 | 0.12 | 0.22 | 0.1 | 0.1 | 0.18 | **0.13** | 0.21 | 0.1 | 0.20 |
| Soan Backthrust | 7.6 | 15 | 0.17 | 0.32 | 0.24 | 0.14 | 0.26 | 0.11 | 0.12 | 0.21 | **0.18** | 0.28 | 0.12 | 0.23 |

**NOTE**: Here I, 2,3 up to 7 are representing the attenuation equations used in the study i.e.1. Joyner and Boore, 1982: 2. Sadigh et al., 1987: 3. Ambraseys and Bommer, 1991: 4. Campbell and Bozorgnia, 1993: 5. Ambraseys et al., 1996: 6. Boore et al., 1997:7. Tromans and Bommer, 2002

Based upon the observations from these tables, it is clear that for the EMIRATES RESORT APARTMENT BUILDINGS site, 14 faults are critical / hazardous. Further, MBT with the maximum magnitude of 7.8 and PGA of 0.44 g and Soan Back thrust (SBT) with maximum potential magnitude of 7.6 but comparatively low PGA value i.e. 0.18 g are the most critical faults for the site. Using the above mentioned analysis the site should be constructed using

the overall range of PGA for the area surrounding 50 km within the site can be deduced as 0.08g to 0.44g. It should be noted that the PGA values calculated by using the Boore et al., 1997 equation has been used only, due to the fact that this is the most reliable one for the region.

### 6.2.26 Conclusions and Recommendations

The NW Himalayas fold and thrust belt, Pakistan is seismically active with a number of faults. Among them a total of 45 faults are active. The site of EMIRATES RESORT APARTMENT BUILDINGS, which lies in Potwar Seismic Zone of this belt, is in the influence of 14 active faults (Table 5.4). However, the construction of any structure at the site would be safe by considering the design parameters with PGA values ranging from 0.08g-0.44g. URBAN SOLUTION (PVT) LTD. shall consider these parameters during the construction of the buildings.

# 6.0 SURFACE WATER HYDROLOGY

## 6.1 Estimation of River Peak Discharges

Estimation of peak discharges of the Soan and Ling Rivers is important for the design of the structure or to ascertain the rate of flooding during rainy seasons. Using GT Sheets and satellite images these rivers reaches were identified and their peak discharges were computed in the subsequent section.

### 6.1.1 River Discharge Data

There are one unnamed Nalluh and the Korang River passing in the nearby locality of the EMIRATES RESORT APARTMENT BUILDINGS site. Stream gauging station was installed by WAPDA and Irrigation Department since 1961. The data was recorded on daily basis. Therefore more than 45 years of data is available in these rivers. Inventory of hydrological stations are shown in the following Tables 6.1 and 6.2.

Table 6.1. Characteristics of the Ling River and the Soan River

| | **Name of River** | | | |
|---|---|---|---|---|
| **Characteristics** | **Ling at confluence with Soan** | | **Soan at Indus** | |
| | | | | |
| | **($km^2$)** | **($mile^2$)** | **($km^2$)** | **($mile^2$)** |
| Catchment Area | 427 | 165 | 11228 | 4332 |
| | **(km)** | **(mile)** | **(km)** | **(mile)** |
| Length of River | 58 | 36 | 273.5 | 170 |
| Average width of Basin | 7.4 | 4.6 | 41.1 | 25.5 |
| | **(masl)** | **(ft asl)** | **(masl)** | **(ft asl)** |
| Maximum Elevation | 1850 | 6070 | 2440 | 8006 |
| Minimum Elevation | 470 | 1542 | 240 | 787 |
| Maximum Ele. Difference | 1380 | 4528 | 2200 | 7218 |
| | (-) | (-) | (-) | (-) |
| Coefficient of Shape | 0.127 | 0.127 | 0.15 | 0.15 |
| Average Slope | 1:40 | 1:40 | 0.125 | 0.125 |

Table 6.2. Inventory of River Gauging Stations

| Sr. No. | Name of Station | Latitude | Longitude | Period of Record (years) | Basis | Catchment Area (km2) | Agency |
|---|---|---|---|---|---|---|---|
| 1 | Ling at Kahuta | $33^0$ 35" 28' | $73^0$ 21" 57' | 1961-71 | Daily | 145 | Wapda |
| 2 | Soan at Chirah | $33^0$ 39" 25' | $73^0$ 18" 15' | 1960-2004 | Daily | 326 | Wapda |
| 3 | Soan at Rawalpindi | $33^0$ 33" 05' | $73^0$ 06" 05' | 1961-2004 | Daily | 1684 | Wapda |
| 4 | Soan at Dhok Pathan | $33^0$ 07" 32' | $72^0$ 20" 05' | 1993-2004 | Daily | 6475 | Wapda |

### 6.1.2 Flood Records

Soan River is one of the major perennial stream of the Islamabad watershed. Gauging station at Rawalpindi exists on the Soan River by SWHP and WAPDA. Catchment area at gauging station was 1684 $km^2$. Mean monthly flows of the Soan River at Rawalpindi is given in the following Figures 24 & 25. The mean annual streamflow (1960-96) in the Soan River has been estimated about 25 $m^3$/sec. August and September are the months of maximum flow.

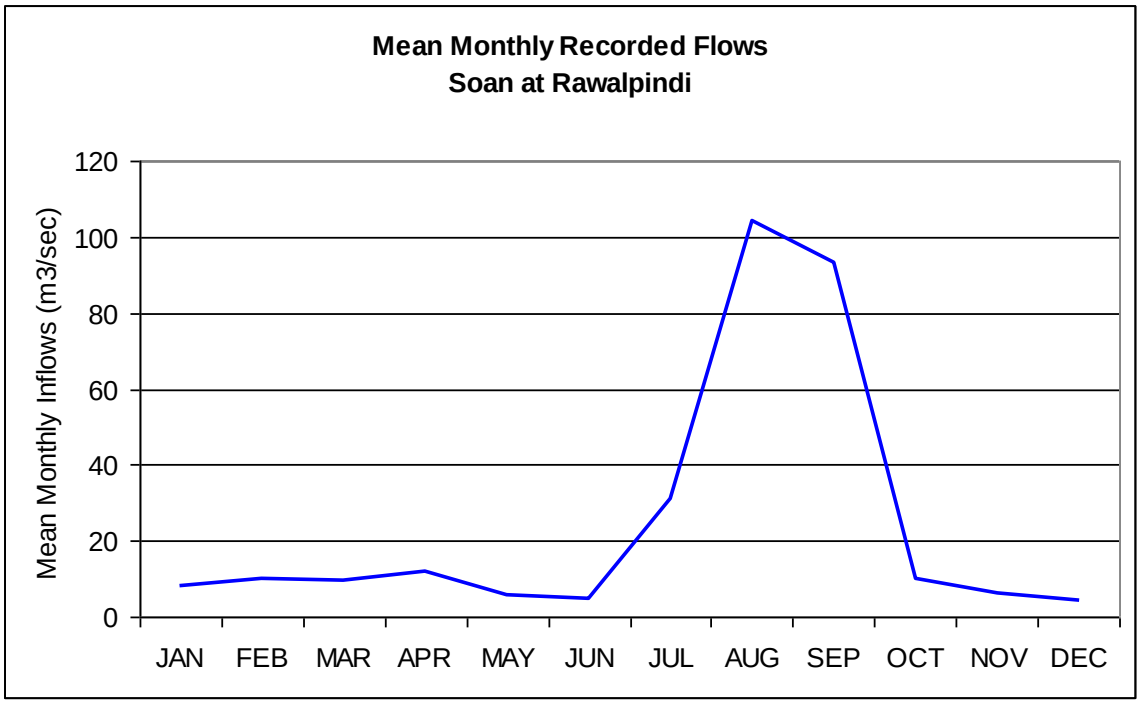



Figure 24. Mean monthly recorded flows of Soan River, Rawalpindi

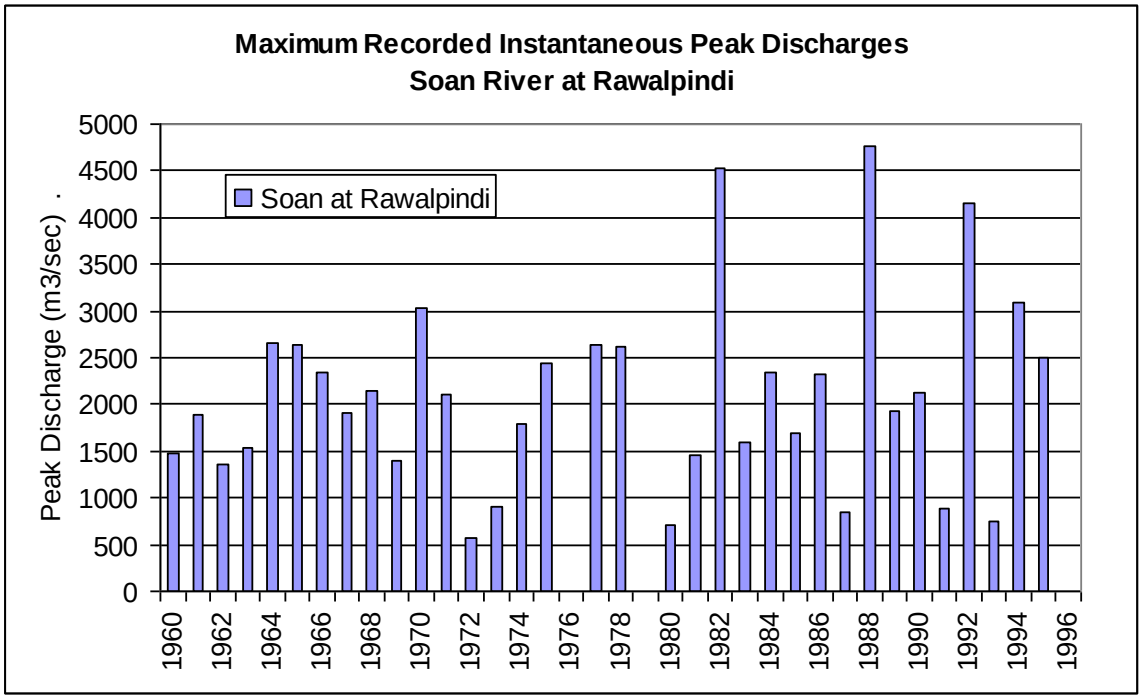



Figure 25. Maximum recorded instantaneous peak discharges Soan River at Rawalpindi

#### 6.1.2.1 Identification of Stream Crossing and their Catchments

Using Satellite Image, Google Earth and Topographic maps stream/canals/nullahs have been identified and their hydraulic characters such as catchment area and its slope etc were determined. These are discussed in the subsequent section.

#### 6.1.2.2 Main Rivers

Main rivers that are included as close proximity to the EMIRATES RESORT APARTMENT BUILDINGS site are listed below:

- Soan near Kuri
- Ling River near Kahuta
- Korang River in southeast

### *6.1.3 Computations of Design Discharges*

Data of major Streams at or near the gauging stations was collected from Punjab Irrigation Department and WAPDA. While collecting the information, following parameters were kept in view:

- Maximum flood discharge for a 100 year return period for the major Kok Bridge.
- Maximum flood discharge for a 25 year return period for the Culverts.

#### 6.1.3.1 Estimation of Design Discharge of Main Rivers

**Soan River**

At this location, design discharge was computed with the help of long term recorded historic data. Flood frequency analysis was employed using Gumbel and Pearson Type III distributions. Flood frequency curves for Soan at Rawalpindi are shown in **Figure 26 & Figure 27.** Summary results of the present analysis are presented in **Table 6.3.** Estimated 100-year peak discharge comes to be 5752 $m^3$/sec. Flood would pass within the Soan banks and no harm is foresighted for the building structure.

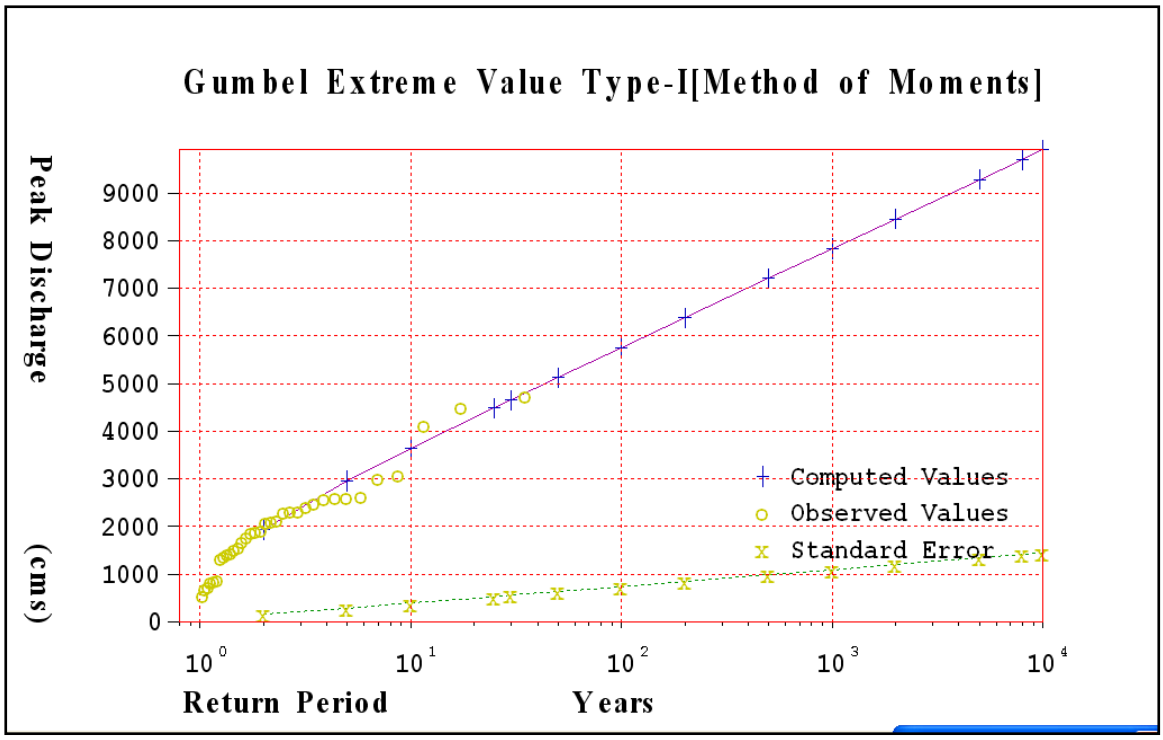



Figure 26. Flood Frequency Curve for Soan River

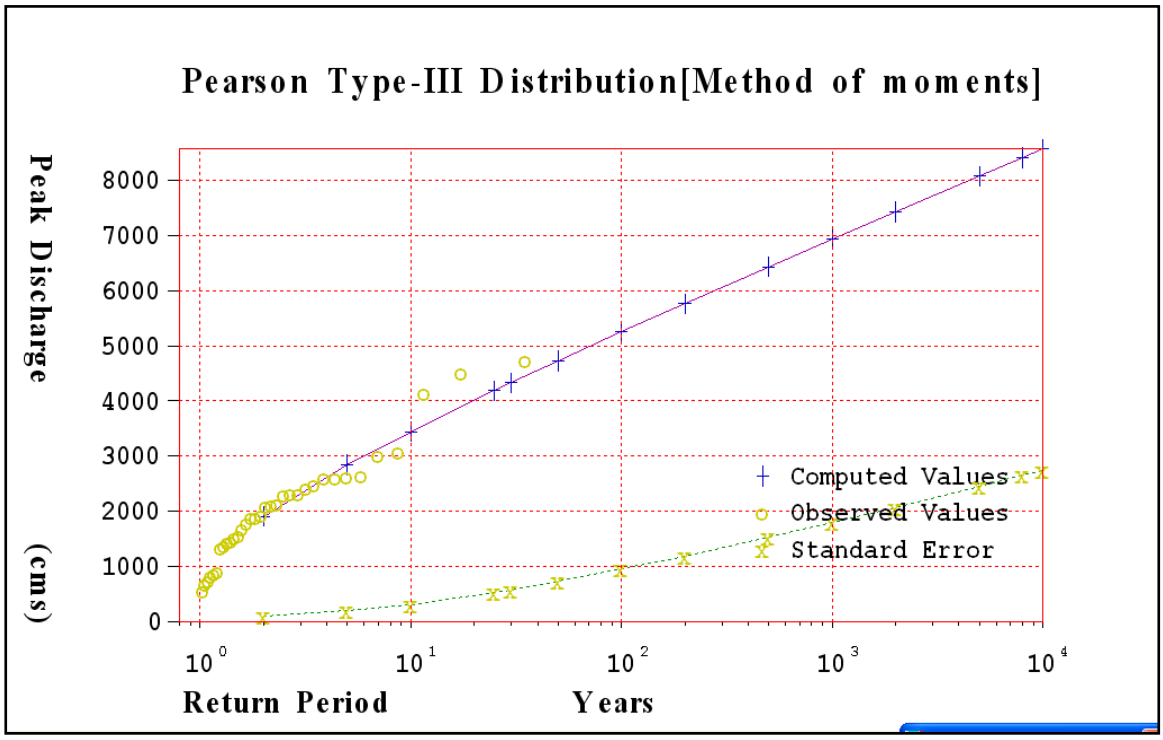



Figure 27. Flood Frequency Curve for Soan River

Table 6.3. Summary results of flood frequency analysis

**Gumbel Extreme Value Type-I Distribution**

| Return Period (Years) | Peak Discharge (m3/sec) | | Soan At Rawalpindi |
|---|---|---|---|
| 2 | | | 1935 |
| 5 | | | 2957 |
| 10 | | | 3634 |
| 25 | | | 4489 |
| 30 | | | 4656 |
| 50 | | | 5123 |
| 100 | | | 5752 |
| 200 | | | 6379 |
| 500 | | | 7207 |
| 1000 | | | 7832 |
| 2000 | | | 8458 |
| 5000 | | | 9284 |
| 8000 | | | 9708 |
| 10000 | | | 9909 |

### Ling River

Ling River is one of the left bank tributary of the Soan River in the close proximity of the EMIRATES RESORT APARTMENT BUILDINGS site. It has a catchment area of 427 $km^2$ up to its confluence with the Soan River. Catchment area of Ling River up to Kahuta is estimated to be 145 $km^2$ and at its confluence with the Soan river has ground elevation 470 m.a.s.l. Flood estimation was carried out with the help of recorded flood data in a similar way as described earlier. Results for Ling River are given below:

**Table 6.4 Summary Results of Flood Frequency Analysis**
**Gumbel Extreme Value Type-I Distribution**

| Period (Years) | Ling River at Kahuta |
|---|---|
| | (m3/sec) |
| 2 | 746 |
| 5 | 1302 |
| 10 | 1670 |
| 25 | 2135 |
| 30 | 2227 |
| 50 | 2481 |
| 100 | 2823 |
| 200 | 3164 |
| 500 | 3615 |
| 1000 | 3955 |
| 5000 | 4745 |
| 10000 | 5085 |

### 6.1.4 Conclusions

EMIRATES RESORT APARTMENT BUILDINGS site in the close proximity of the Nallah and Korang River is quite safe from the risk of over flooding during rainy season. Peak discharges of main rivers were estimated by means of flood frequency analysis using long term recorded flood data. These results for different return periods are presented in the report.

### 6.1.5 Identification of Water Sources

Identification of water sources were carried out with the electrical resistivity soundings surveys (ERSS) at 15 different locations within the premises of EMIRATES RESORT APARTMENT BUILDINGS site. Water well sites were also recommended for the installation of tube-well.

### 6.1.6 Surface Water Quality

Water qualities standards fluctuate depending upon the usage of water i.e. drinking water. Streams contiguous to Main River carry suspended solids, dissolved solids, domestic wastes etc. with them and resulting in surface water pollution. Generally, the quality of water is good.

### 6.1.7 Ground Water Quality

Groundwater is the principal source for domestic water supplies in the area. Groundwater table depths, as reported in the literature and manually measured in the field and also by geophysical survey vary from places to places. In EMIRATES RESORT APARTMENT BUILDINGS site it ranges from 80 to 120 feet depth.

### 6.1.8 Ambient Air Quality

Ambient air in the area, in general, is apparently clean, because no major industrial activity exists along the EMIRATES RESORT APARTMENT BUILDINGS site and vehicular traffic, except on the main road leading to Murree from Rawalpindi /Islamabad, is low and relatively less frequent. Monitoring of particulate matter is, however, performed at various locations along the track. The minimum and maximum values of particulate matter over the areas are obtained as 0.25 and 1.00 $mg/m^3$ respectively.

### 6.1.9 Existing Noise Levels

There is no major industry as such along the EMIRATES RESORT APARTMENT BUILDINGS Zone 4-B-2. Therefore noise pollution is at its minimum. These background noise levels range from 37 to 52 dB-A. This range corresponds to a typical calm atmosphere of the rural areas, associated with low levels of vehicular traffic and industrial activities.

### 6.1.10 Existing Land Use

Land use in the area is determined largely by physiography, soils and water availability. Thus, while land may be classified by capability from very good agricultural land, suitable for irrigated agriculture, to poor grazing land (unsuitable - for cropping and not even good for grazing), and further to agriculturally unproductive land (hillocks and cliffs). About 95% of this area is rain-fed (barani) in the Potawar. Microwells tend to exist that supply unlimited quantity of water in the Emirates Resorts.

## 7.0 Executive Summary of Flora and Fauna (Ecological Resources)

The present project is confined to flora and fauna assessment investigations taken as multistep procedure to analyze the environmental considerations at Emirate Resort Murre Expressway, Islamabad near Phulgran that may impact the environment with special emphasis on biodiversity. The survey report is designed to help in identification of possible effects of proposed activity on plant and animal diversity and their survival in long future. The study involves an analysis based on field surveys to determine unique and common plant and animal species existing in the proposed locality and vicinity areas. The proposed study site is composed of major areas characterized by variety of flora and fauna diversity. The investigations of current assessment result out that area is rich with diversity of plant and animal species as compare to barren fields. In overall, land is characterized with hilly areas, nullahs and creeks in nearby vicinity etc. The proposed location has overstory as well as understory vegetation. In findings, it is observed that diversity of plant and animal species in project site includes plant communities and area is rich in diversity of plants with unique species with diverse distribution pattern. Meditation measures coupled with alternative should be taken for protection of environment and its components in proposed site.

## 7.1 Description of the Current project

The present project is confined to descriptive detailed information on biodiversity composition of proposed location of at Emirate Resort at Murree Expressway, Islamabad (Plate 1). It is aimed to comprise a checklist of important plant and animal species along with localities and taxonomic information. The development objective of this project was to assess the flora and fauna information of proposed site where moderating a building's surrounding microclimate naturally through strategic landscaping has the potential to benefit the environment, save energy, save money and provide comfortable living environments. Strategically placed vegetation around a building has long been recognized as a means of cooling. It can reduce temperatures and humidity through shading, evapotranspiration and wind channeling.

In an individual building, architects can create a microclimate boundary by manipulating the building envelope and exterior environment. The planning and development of exterior spaces can reduce the energy consumption of buildings by reducing the impact of some climate factors. If the microclimatic condition around the building is similar to the desired interior conditions, little extra energy is required. Conversely, if the microclimate is significantly different from the desired interior conditions, large amounts of energy may be required for heating or cooling. Awareness and knowledge of the potential of vegetation and fauna to modify microclimate could produce a new way of quantifying the energy saving potential of landscaping. This research was conducted to find the biodiversity around the project site.

## 7.2 Study Site

The Murree Expressway is also known as the Islamabad Murree Muzaffarabad Expressway is a partially operational controlled-access expressway linking Islamabad to Murree in Punjab Province. The expressway passes through Barakahu, Phulgran, Lower topa, Upper topa, Murree, Ayubia, and Phagwari before terminating outside Kohala. Phulgran is a village and union council situated in the Islamabad Capital Territory of Pakistan. Its geographical coordinates are 33° 45' 0" North, 73° 13' 0" East. The sites which we surveyed are located in the Eastern side in Islamabad district nearby Barakahu and Pind Bagwal lies near Phulgran. This research was conducted to find the biodiversity around the at Emirate Resort Murree Expressway project site. An assessment of flora and fauna aspects related to prediction and impact evaluation.

### 7.3 Ecological resources

Ecological resources are defined herein as those that provide necessary but unglamorous system maintenance functions within ecosystems as a result of their role in ecological processes. Ecological functions are frequently overlooked in terms of providing services that are valued by humans. Aside from selected wetland studies, relatively little attention has been given to the valuation of common ecological resources and functions in comparison with their more glamorous cousins (e.g., endangered species or unique wilderness sites). This is particularly true of the nation's semiarid rangelands. Moreover, attention to date has focused mostly on values that are generated through human consumptive and non-consumptive uses (as opposed to environmental functions), which we believe are only one aspect of the social costs and benefits of the functional values of ecological resources (Scott et al., 1998).

### 7.4 Ecological Important and Protected Areas

The term "protected area" refers to any area of land or sea managed for the persistence of biodiversity and other natural processes in situ, through constraints on incompatible land uses. Protected areas are a cornerstone of local, regional, and global strategies for the conservation of biodiversity. However, the ecological performance of these areas, both in terms of the representation and the maintenance of key biodiversity features, remains poorly understood. A large and rapidly expanding literature bears on these issues, but it is highly fragmented, principally comprises particular case studies, and employs a diverse array of approaches. Whether at local, regional, or global scales, a key strategy for protecting biodiversity from such pressures has been the establishment and maintenance of protected areas. Indeed, in recent decades substantial time, effort, and resources have been invested in prioritizing areas for such designation, in the establishment of protected areas, and in their management (Gaston et al., 2008; Hensen and Defries, 2007). The objective measurement of the ecological effectiveness of protected areas should (i) enable more robust claims of conservation successes; (ii) provide opportunities to learn from and respond to conservation successes, failures or inadequacies; (iii) improve the efficiency and effectiveness of conservation action, including future site designation; (iv) make it more difficult for development processes to challenge protected area designations and any associated restrictions; (v) facilitate appropriate, targeted management action at both the local and national level; and (vi)

reduce the potential for scepticism among policymakers, funding agencies, land owners, and others of the long-term value of conservation efforts (Gaston et al., 2006). The flora and fauna is an indispensable component of the urban environment, having a huge importance in the maintenance and functioning of the ecosystems affected by anthropogenic activity

**7.5 Terrestrial Flora**

Life on Earth as we know it would not be possible without the evolution of plants, and without the transition of plants to live on land. Plants dominate the terrestrial environment. Remarkably, a single lineage, referred to here as land plants, but more formally called embryophytes, and sometimes treated as the Kingdom Plantae, accounts for the vast majority of land cover, biomass, and named biological diversity (Delwiche and Cooper, 2015).

Hijazi (1984) reported that *Dodonaea viscosa* was the most common shrub of Margalla Hills National Park. Akbar (1988) analyzing the vegetation of Quaid-i-Azam University campus established seven communities. Khattak and Ahmed (1990) compared the vegetation on the north and south facing slopes of Margalla Hills and reported the presence of *Pinus roxburgii*, *Apluda mutica*, *Quercus incana* community on the north facing slopes and *Acacia modesta-Woodfordia Fruticosa-Dodonaea* community on the south facing slopes.

**7.6 Terrestrial fauna**

Terrestrial fauna is defined as animals living on land or using land (including aquatic systems) for all or part of their lives. Terrestrial fauna includes vertebrate (birds, mammals including bats, reptiles, amphibians, and freshwater fish) and invertebrate (arachnids, crustaceans, insects, molluscs and worms) groups. Fauna habitat is defined as the natural environment of an animal or assemblage of animals, including biotic and abiotic elements, that provides a suitable place for them to live (e.g. breed, forage, roost or seek refuge). The scale at which fauna habitat is defined will depend on the ecological requirements of the species considered. Terrestrial fauna is essential in maintaining the integrity and function of our ecosystems. Many invertebrates, birds and mammals act as pollinators for plants, and help disperse plant seeds and the fruit and spores of fungi. Fauna species can also be used as indicators of environmental health. Many terrestrial faunas are iconic or are of cultural importance to Aboriginal people as spiritual significance or for sources of traditional food.

The fauna of Margalla hills are mainly Indo Himalayan. The birds found here are residents as well as winter migrants from higher altitudes of the north, spring and summer visitor for breeding, and short-day transit species arrive in spring. Margalla has a variety of mammals, they include the Indian leopard, gray goral, barking deer, wild boar, golden jackal, red fox and the porcupine among others. It is also home to a large number of birds such as larks, paradise flycatcher, black partridge, shrikes pheasants, Egyptian vultures, falcons, hawks and eagles. Reptiles such as the Russell viper, Indian cobra and saw-scaled viper are found here.

**7.7 Aquatic Flora**

Wetland flora are photosynthetic organisms, sufficient to observe with the naked eye, that vigorously develop everlastingly or occasionally submerged underneath, suspended on, or growing up throughout the wet plane. A diversity of aquatic plants is necessary in water- ways for preventing excessive erosion and turbidity, and for maintaining the delicate nutrient balance in water, hydro-soil and plants. Pond side vegetation provides habitat for waterfowl, cover for certain species of fish, and increases the density of planktons, the basis of fish production. The aquatic plants are of various types, some are rooted in bottom and are emergent, and others are submerged. Still others are free floating, and some are rooted on the bank of the impoundments, adopting semi aquatic habitat. Lakes and ponds are rich in aquatic flora that constitutes an important resource but in Pakistan these natural resources have not been given due attention, and thus their potential remains unexplored. In addition, aquatic plants can be taxonomically difficult, and Pakistan lacks adequate herbarium material to represent the variability in the development of various organs resulting from plasticity in form and structure in relation to aquatic environment. The peak flowering time of the aquatic flora in Pakistan is generally during the monsoon, but some flower in other seasons while others flower throughout the year.

**7.8 Aquatic Fauna**

Freshwater fauna includes various protozoans, nematodes, nematomorphans , leeches, gastropod and bivalve mollusks, crustaceans, ticks, mites, aquatic i nsects, and fishes. Aquatic fauna pertains to animals that live predominantly in different water forms, such as seas, oceans, rivers, lakes, ponds, etc. Aquatic animals are very much “captives” of their environment.

Freshwater fauna probably originated from primarily aquatic marine animals that settled in freshwater lagoons and river mouths, mainly in tropical zones. The animals in freshwater including those that are primarily aquatic and those that are secondarily aquatic. Plate 1 to Plate 8 shows the different features of the study area.


**Plate 1.** Map of the study area

**Plate 2.** : Panoramic view of Scrub floral vegetation

**Plate.3.**Panoramic view of Shrubby *Dodonaea viscosa*

**Plate 4.** Panoramic view of vegetation along Phulgran, Murree Expressway

**Plate 5.** Floral vegetation at study area

**Plate 6.** Field view of vegetation in study site

**Plate 7.** *Justicia adhatoda* field view

**Plate 8.** Floral diversity along study area

## 8.0 Assessment Methods

### 8.1 Planning

The present study was carried out during different seasons in 2020 in Phulgran area near Murree Expressway, Islamabad. Study involved various experts regarding floristic and fauna composition by visiting study area. Before start of field surveys, proper ethical approval was taken from university ethical committee and official concerned persons were informed. During field surveys, the intellectual property rights were clearly explained to local people. The study was carried out in different sections of expertise on plants and animals' diversity including medicinal plants and animals' species. Before data documentations, local residents were clearly informed.

### 8.2 Field Surveys

The field surveys were carried out by following the standard methods described by Kayani et al. (2015). All available major plant species and some animal's species were recorded for analysis. During documentation, the taxonomic characters of each species, their allied species, habit, habitat and geomorphic conditions were recorded.

### 8.3 Digital Photography

The digital photography of reported species was carried out using digital camera (Model No. DMC-ZS20 S-444 Panasonic, Japan). During field, the localities were visited during 2020 to shot photographs.

### 8.4 Plant identification and Authentication

The collected plant specimen were prepared after drying, preserving and mounting on Herbarium sheets using standard methods described by (Martin, 1995). The identification of reported plant species was carried out using the Flora of Pakistan as well as taxonomists and herbaria of the Quaid-i-Azam University, Islamabad (ISL). Well preserved voucher specimens were deposited to the herbarium for future reference by assigning them specimen accession numbers. The correct taxonomic names and their families were verified from different databases, including the plant list (http://theplantlist.org) and medicinal plant name service at the Kew Botanical gardens (http://mpns.kew.org/mpns-portal).

## 9.0 Survey Findings

### 9.1 Floristic and Fauna Composition

In total, 29 plant species belonging to 17 families were reported during extensive filed surveys. Table 1 presents the detailed information on taxonomic names, plant families, life form and habit of reported plant species at study site. Among reported plant communities, Acanthaceae were found to be dominant with (04 Species) followed by Asteraceae and Fabaceae (3 Species), Apocynaceae, Brassicaceae, Euphorbiaceae and Solanaceae (2 Species) and rest of the families with 1 species each belongs to Amaranthaceae, Boraginaceae, Lamiaceae, Malvaceae, Meliaceae, Plantaginaceae, Primulaceae, Oxalidaceae, Rubiaceae, Spindaceae and Vitaceae. The highest reports of Acanthaceae, Asteraceae and Fabaceae species are undoubtedly due to their vast diversity and richness in study area.

The field survey also reported three animals' species residing along study area. These species including: *Passer domesticus*, *Corvus splendens* and *Uromastyx hardwickii* The detailed descrpition about their morphology, habitat, worldwide distrubution and their common name are given.

### 9.2 Life forms of Plant Species

In life forms, study areas most of the plant species (54%) belongs to herbs while least reported were trees (11%). Meanwhile, 35% plant species were shrubs. There are many reasons about frequent occurrence of herbs in any plant communities. According to Mesfin et al. (2009) and Lulekal et al. (2013), herbs are common in any community due to their ecological amplitude. While according Ayyanar and Ignacimuthu, (2005) and Tabuti et al. (2010), herbs could easily flourish along roadsides, waste lands, home gardens, farms, and in wild. However, to the best of our knowledge, herbs are most commonly found due to their adaptivity in any region and their succession based upon long time existence. Herbs are predominantly reported in floristic studies due to easy accessibility and salience of anthropogenic habitats (Voeks and Leony, 2004). A checklist of plant species is given in Table 9.1.and details description with pictures in Figure 1 through Figure. 29. Local birds and reptiles are shown in Figures 30, 31, and 32.

**Table 9.1: Checklist of Plant species**

| S. No | Plant Species | Family | Life Form |
|---|---|---|---|
| 1. | *Albizia lebbeck* (L.) Benth. | Fabaceae | Tree |
| 2. | *Alternanthera pungens* Kunth | Amaranthaceae | Herb |
| 3. | *Anagallis arvensis* L. | Primulaceae | Herb |
| 4. | *Barleria cristata L.* | Acanthaceae | Herb |
| 5. | *Bauhinia variegate* L. | Fabaceae | Tree |
| 6. | *Capsella bursa-pastoris* (L.) Medik. | Brassicaceae | Herb |
| 7. | *Carissa spinarum* L. | Apocynaceae | Shrub |
| 8. | *Cayratia trifolia* (L.) Domin | Vitaceae | Shrub |
| 9. | *Cestrum nocturnum* L. | Solanaceae | Shrub |
| 10. | *Dicliptera bupleuroides* Nees | Acanthaceae | Herb |
| 11. | *Dodonaea viscosa* (L.) Jacq. | Sapindaceae | Shrub |
| 12. | *Euphorbia helioscopia* L. | Euphorbiaceae | Herb |
| 13. | *Euphorbia hirta* L. | Euphorbiaceae | Herb |
| 14. | *Hamelia patens* Jacq. | Rubiaceae | Shrub |
| 15. | *Helianthus annuus* L. | Asteraceae | Herb |
| 16. | *Justicia adhatoda* L. | Acanthaceae | Shrub |
| 17. | *Justicia japonica* Thunb. | Acanthaceae | Herb |
| 18. | *Malvestrum coromandelianum* (L.) Garcke | Malvaceae | Herb |
| 19. | *Melia azedarach L.* | Meliaceae | Tree |
| 20. | *Mentha spicata* L. | Lamiaceae | Herb |
| 21. | *Nasturtium officinale* R.Br. | Brassicaceae | Herb |
| 22. | *Nerium oleander* L. | Apocynaceae | Shrub |
| 23. | *Oxalis corniculata* L. | Oxalidaceae | Herb |
| 24. | *Senna occidentalis* (L.) Link | Fabaceae | Shrub |
| 25. | *Solanum surattense* Burm. f. | Solanaceae | Herb |
| 26. | *Sonchus asper* (L.) Hill | Asteraceae | Herb |
| 27. | *Trichodesma indicum* (L.) Lehm. | Boraginaceae | Herb |
| 28. | *Veronica-anagallis-aquatica* L. | Plantaginaceae | Herb |
| 29. | *Xanthium strumarium* L. | Asteraceae | Shrub |

## 1. *ALBIZIA LEBBECK*(L.) BENTH.

**Figure 1.** *Albizia lebbeck*

| | | |
|---|---|---|
| **Synonym** | : | *Acacia lebbeck* (L.) Willd. |
| **Common Name** | : | Indian siris |
| **Distribution in World** | : | Algeria, Egypt, Afghanistan, Bermuda, Australia |
| **Distribution in Pakistan** | : | Karachi, Abbottabad, Karak, Mianwali, Swabi |
| **Flowering Period** | : | April-May |
| **Morphological Description** | : | *Albizia lebbeck* is a species of *Albizia*, native to Indomalaya, New Guinea and Northern Australia and widely cultivated and naturalised in other tropical and subtropical regions. English names for it include lebbeck, lebbek tree, flea tree, frywood, koko and woman's tongue tree. The latter name is a play on the sound the seeds make as they rattle inside the pods. It is a tree growing to a height of 18–30 m tall with a trunk 50 cm to 1 m in diameter. The leaves are bipinnate, 7.5–15 cm long, with one to four pairs of pinnae, each pinna with 6–18 leaflets. The flowers are white, with numerous 2.5–3.8 cm long stamens, and very fragrant. The fruit is a pod 15–30 cm long and 2.5-5.0 cm broad, containing six to twelve seeds. Its uses include environmental management, forage, medicine and wood. |

## 2. *ALTERNANTHERA PUNGENS* KUNTH

**Figure 2.** *Alternanthera pungens*

| | | |
|---|---|---|
| **Synonym** | : | *Achyranthes leiantha* (Seub.) Standl. |
| **Common Name** | : | Khaki weed |
| **Distribution in World** | : | Ecuador, India, Spain, China, South Africa |
| **Distribution in Pakistan** | : | Murree, Kotli, Haripur, Attock, Charsadda |
| **Flowering Period** | : | October-November |
| **Morphological Description** | : | Prostrate mat-forming perennial herb, stout vertical rootstock. Stem and branches terete, striate, densely villous with long, white hairs. Leaves broadly rhomboid-ovate to broadly oval,1.5-4.5 x 0.3-2.7 cm, rounded to subacute at the apex, narrowed below to a petiole up to 1 cm long, glabrous. Inflorescences sessile, axillary, solitary, globose 0.5-1.5 cm long and 0.5-1 cm wide. Tepals extremely dissimilar; the 2 outer (abaxial) deltoid-lanceolate, 5 mm, very rigid, outer 2 nerves meeting above to join the excurrent, pungently mucronate midrib; inner (adaxial) tepal oblong, and adaxial tepals with small tufts of glochidia and barbed whitish bristles the lateral tepals each with a large tuft about the center of the midrib. Stamens 5, all with anthers. Ovary compressed, squat, narrowed below, style very short. Fruit orbicular, rounded above, 2 mm. Seed discoid, 1.25 m, brown, shining faintly reticulate. |

## 3. *ANAGALLIS ARVENSIS* L.

**FIGURE 3** *ANAGALLIS ARVENSIS*

| | | |
|---|---|---|
| **Synonym** | : | *Anagallis arvensis* f. *caerulea* (L.) Lüdi |
| **Common Name** | : | Red scarlet |
| **Distribution in World** | : | Iran, Bangladesh, Nepal, Afghanistan, Srilanka |
| **Distribution in Pakistan** | : | Charsada, Karak, Mardan, Lakki Marwat, Bannu. Islamabad, |
| **Flowering Period** | : | November-April |
| **Morphological Description** | : | *Anagelus arvensis* is an annual herb, decumbent to the erect stem. Leaves opposite-decussate, sessile, pale green, 10-15 x7-11 mm, ovate-oblong, gland-dotted, and minutely papillose. The flower is red or blue color, solitary axillary, 1.3-2.4 (-3.4) cm long, glandulose, and nodding in bud condition. Calyx of the flower is campanulate, subacuminate, ovate-lanceolate, and lobes 3.4-4 mm long. Corolla of the flower is obovate, rotate, glandular stipulate, and lobes 4-6 mm long. The stamen filaments are 2-2.4 mm long, glandular, reddish-pink color, anther is 2 mm long and basifixed. The ovary is 2 mm broad, globose; style 1-2.3 mm is long, persistent and pinkish color. Stigma is capitate. All the floral parts i.e. petals, stamen, carpels, ovary is clear and can be easily differentiated into each other. |

## 4. *Barleria cristata L.*

**Figure 4.** *Barleria cristata*

| | | |
|---|---|---|
| **Synonym** | : | *Barleria alba* Lodd. |
| **Common Name** | : | Philippine Violet |
| **Distribution in World** | : | Burma, California, South Arizona, Burma, China |
| **Distribution in Pakistan** | : | Abbottabad, Muzaffarabad, Islamabad, Jhelum, Rawalpindi. |
| **Flowering Period** | : | October-November |
| **Morphological Description** | : | An erect, up to 1.5 m tall, much branched, unarmed shrub-let. Leaves with 1-2 cm long, hairy petiole; lamina elliptic-oblong to lanceolate, 3-12.5 cm x 1-3.5 cm, hairy both surfaces, attenuate, entire, apically acute-acuminate. Flowers purple blue or pink or white, 4.5-5 cm long, in short, 1-5-flowered, axillary or terminal spikes; bracts lanceolate, 8-12 mm long, bristly on margins, scabrous, acute; bracteoles absent. Calyx deeply 4-cleft, outer 2 lobes much larger than the inner pair, ovate-lanceolate, 1.5-2.5 cm x 6-8 mm, acuminate, hairy, inner 2-lobes linear, 7-8 mm long, pointed. Corolla glandular-pubescent outside, tube 3.5-4 cm long, infundibuliform, up to 2 cm long. Filaments hairy, anthers oblong, 3 mm long. Ovary oblong-conical; style 4 cm long. Capsule ellipsoid, 1.5-2 cm long, glabrous, pointed at the base and apex, 4-seeded. Seeds orbicular, 4 mm across, appressed hairy. |

## 5. *Bauhinia variegate* L.

**Figure 5.** *Bauhinia variegata*.

| | | |
|---|---|---|
| **Synonym** | : | *Bauhinia chinensis* (DC.) Vogel |
| **Common Name** | : | Orchid tree |
| **Distribution in World** | : | Bhutan, Vitenam, Bangladesh, India, Singapore, Spain |
| **Distribution in Pakistan** | : | Murree, Shangla, Malakand, Azad Kashmir |
| **Flowering Period** | : | April-May |
| **Morphological Description** | : | It is a small to medium-sized tree growing to 10–12 meters (33–39 ft) tall, deciduous in the dry season. Leaves; 10–20 centimeters (3.9–7.9 in) obcordate shaped, long and broad, rounded, and bilobed at the base and apex. Flowers; conspicuous, bright pink or white, 8–12 centimeters (3.1–4.7 in) diameter, with five petals. Pollen are elongated, approximately 75 microns in length. The fruit is a seedpod 15–30 centimeters (5.9–11.8 in) long, containing several seeds. The seedpod dries completely on the tree, and when mature begins to twist into a helix or corkscrew shape, ultimately exploding open with a very audibleto deliver its seeds into the environs. This is a very popular ornamental tree in subtropical and tropical climates, grown for its scented flowers and also used as a food item in Indian cuisine. |

## 6. *CAPSELLA BURSA-PASTORIS* (L.) MEDIK.

**FIGURE 6.** *CAPSELLA BURSA-PASTORIS*

| | | |
|---|---|---|
| **Synonym** | : | *Bursa abscissa* (E.G.Almg.) Druce |
| **Common Name** | : | Shepherd's purse |
| **Distribution in World** | : | Ethiopia, Iraq, Japan, Bulgaria, Russia, California |
| **Distribution in Pakistan** | : | Dir Kohistan, Swat, Haripur, Chitral, Gilgit |
| **Flowering Period** | : | March-June |
| **Morphological Description** | : | Annual or biennial, up to 45 cm tall, erect, glabrous or hairy with simple or branched hairs. Basal leaves rosulate, very variable, usually pinnatifid (lyrate to almost entire), 5-8-jugate, shortly stalked, usually up to 8 cm long, 2 cm broad; cauline leaves smaller, sessile. auricled and clasping the stem. Racemes many flowered, up to 30 cm long in fruit. Flowers 2.5 mm across, white; pedicels up to 18 mm long in fruit, spreading. Sepals 1.5 mm long, l mm broad. Petals c. 2.5 mm long, 1 mm broad, obovate-oblong, cuneate. Stamens 1.5: 2 mm long. Siliculae obcordate-triangular, 5-9 mm long, 4-6 mm broad; valves usually with straight margins; apical notch wide, V-shaped ; style 0.5 mm long, hardly or not exceeding the notch; septum c. 1 mm broad, seeds 6-12 in each locule, 1 mm long, oblong-elliptic, pale brown. |

## 7. *CARISSA SPINARUM* L.

**Figure 7.** *Carissa spinarum*

| | | |
|---|---|---|
| **Synonym** | : | *Carissa opaca* Stapf ex Haines |
| **Common Name** | : | Granda |
| **Distribution in World** | : | Srilanka, Burma, India, Myanmar |
| **Distribution in Pakistan** | : | Abbottabad, Murree, Margalla Hills and Azad Kashmir |
| **Flowering Period** | : | April-June |
| **Morphological Description** | : | Shrub, up to 3.5-meter, evergreen, branches glabrous, spines arising between the petiole, straight or bifurcate, sharp, hard, 2.5-3.5 cm long, young shoots with milky juice. Leaves glabrous, opposite, elliptic, ovate or rounded, 1.25x.7-2 cm, acute-mucronate, apiculate, rarely obtuse, coriaceous; shining green above, paler, puberulous; petiole 2.5 mm long. Flowers white or light rose, sweet scented, 2 cm across. Peduncle 1.25 cm long, usually 3 flowered; pedicel 2.5 mm long; bracts small, subulate, 1 mm long. Calyx 2 mm long, lobes lanceolate, acuminate, puberulous. Corolla tube slender, 8-12 mm long, lanceolate, acute overlapping to the right, in bud, spreading. Stamens inserted at the top of corolla tube. Ovary one ovuled; stigma slightly bifid. Berry somewhat ellipsoid or sub-globose, 6-8 mm long, dark purple when ripe, with milky juice, edible. |

## 8. *CAYRATIA TRIFOLIA* (L.) DOMIN

**FIGURE 8.** *CAYRATIA TRIFOLIA*

| | | |
|---|---|---|
| **Synonym** | : | *Vitis trifolia* L. |
| **Common Name** | : | Bush Grape |
| **Distribution in World** | : | Myanmar, China, Nepal, Western Australia, Bangladesh, |
| **Distribution in Pakistan** | : | Islamabad, Salt Range, Lasbela, Havelian, Swat |
| **Flowering Period** | : | July-September |
| **Morphological Description** | : | A weak herbaceous climber, woody at base, stem more or less succulent, compressed, densely and shortly pubescent; tendril leaf opposed much branched, wiry, not spirally coiled, ending in adhesive disc. Leaves pinnately trifoliate, petiole 2-5 cm long, pubescent; leaflets ovate or obtuse, crenate-serrate, lateral leaflets slightly oblique or obtuse, pubescent on both side, somewhat fleshy and thick, 3-6 x 2-3 cm, lateral ones smaller, petiolate, petiole 2-8 mm long, stipule oblong 3 mm long. Inflorescence axillary, leaf opposed dichotomous cymes. Peduncle 4-7 cm long, pubescent. Flower green 2.5 x 2 mm, pedicel 2 mm calyx obscure, truncate. Petals 4, greenish white, spreading, 2 x 1 mm, oblong. Disc 4 lobed, adnate to the base of ovary, style stout, subulate, 1 mm long; stigma discoid. Berry black, globose, 3-4 seeded 1 cm across. Seeds triangular, rounded, linear tubercle, wedged shaped at the face. |

## 9. *Cestrum nocturnum* L.

**Figure 9.** *Cestrum nocturnum*

| | | |
|---|---|---|
| **Synonym** | : | *Cestrum graciliflorum* Dunal. |
| **Common Name** | : | Lady of the night |
| **Distribution in World** | : | Mexico, India, Costa Rica, Brazil, Cuba, Korea |
| **Distribution in Pakistan** | : | Mardan, Charsada, Fatah Jhang, Rawalpindi |
| **Flowering Period** | : | July-November |
| **Morphological Description** | : | Stem is the dark green more divided adult stem is pilose with straightforward many hairs stalk gland typically there from side to side out. Leaves; lanceolate, oblong, varied size 5.6 -10.5 cm long, Margin whole apices acuminate to acute. Mutually surface glabrescent, frequently petiole size 0 .7- 1.2 cm long. Leaf; terminal and auxiliary or racemes spicate long 11 cm elongated axes shortly pilose . Flowers are also delicate with well-built pilose and glandular hairs pedicle mostly erect 0.6-2.7 mm lengthy. Calyx is tubular green light 2.3- 1.5 mm lobes unequal or equal triangular 0.6 -0.8 mm acute glabrescent with ciliate margin. Corolla is the green, cream, yellow appear and tubular 1.8-2.7 cm elongated. Stamen; filaments free 2-4 mm, 1.4 mm, at position adulation anther also brown 0.7-0.8mm. Ovary mostly green shape is ovoid 1.3 -1.8 mm, stigma is size is 0.8-1.2 mm long. Seed is also per berry 5-7 number |

## 10. *DICLIPTERA BUPLEUROIDES* NEES

**FIGURE 10.** *DICLIPTERA BUPLEUROIDES*

| | | |
|---|---|---|
| **Synonym** | : | *Dicliptera roxburghiana* var. *bupleuroides* (Nees) C.B.Clarke |
| **Common Name** | : | Thorowax Foldwing |
| **Distribution in World** | : | Bangladesh, Bhutan, China, India, Nepal, Afghanistan |
| **Distribution in Pakistan** | : | Rawalpindi, Islamabad, Shogran, Buner, Chakwal |
| **Flowering Period** | : | March-October |
| **Morphological Description** | : | An erect, up to 90 cm, much branched herb with hairy twigs. Leaves on 4-20 (-25) mm long petioles; lamina elliptic-ovate to lanceolate, (1-) 1.5-6 (-12) x (0.6-) 1-2.5 (-6) cm, thinly soft pubescent to glabrate, basally cuneate, entire, acuminate. Flowers pink with purplish tinge, 1.2-1.5 cm long, in terminal and axillary clustered cymes; bracts variable in shape, obovate, elliptic-oblong or linear-lanceolate, 5-10 mm long, thinly pubescent, 1 or 3-nerved, cuneate entire, obtuse to acute, mucronate or not, ciliate, cilia white, multicellular or absent; bracteoles linear-lanceolate, nearly as long as calyx lobes. Calyx lobes linear, 6-7 mm long. Capsule clavate, stipitate, 6 mm long, puberulous or glabrate. Seeds verrucose. |

## 11. *DODONAEA VISCOSA* (L.) JACQ.

**FIGURE 11.** *DODONAEA VISCOSA*

| | | |
|---|---|---|
| **Synonym** | : | *Dodonaea arabica* Hochst. & Steud. |
| **Common Name** | : | Switch sorrel |
| **Distribution in World** | : | North America, China, India, Uganda, Europe |
| **Distribution in Pakistan** | : | Shangla, Islamabad, Malakand, Abbottabad, Kurram Agency |
| **Flowering Period** | : | January-March |
| **Morphological Description** | : | An evergreen shrub up to 5 m tall; young parts covered with a yellow, viscid resin. Leaves sub-sessile, oblanceolate to spathulate, 3-9 cm long, 0.5-2 cm broad, glabrous, entire, sub-acute to apiculate. Panicles terminal, 3 cm long; flowers greenish yellow; pedicel 4-8 mm long. Sepals 3-5, connate at the base, ovate, 3 mm long, puberulous; persistent. Stamens 6-8, free, rudimentary in the female flower; anthers subsessile, oblong, 2-5 mm long, sparsely hairy at the tip. Disc annular, cushion shaped. Ovary triquetrous, 2.2 mm long, 3-locular, sparsely hairy, rudimentary in the male flower; style 3 mm long, minutely papillose; stigma 3-fid. Capsule 12-14 mm long, 15-19 mm broad, 2-4 valved; valves membranous, light brown, green or maroon, winged at the back. Seed sub-globose, 4 mm long, black. |

## 12. *Euphorbia helioscopia* L.

**Figure 12.** *Euphorbia helioscopia*

| | | |
|---|---|---|
| **Synonym** | : | *Tithymalus obovate* Raf |
| **Common Name** | : | Sun spurge |
| **Distribution in World** | : | China, Iran, Oman, Poland, Srilanka, Chile |
| **Distribution in Pakistan** | : | Rawalpindi, Islamabad, Mardan, Karak Attock, and Bannu |
| **Flowering Period** | : | January-July |
| **Morphological Description** | : | This is fleshy annual herbs, erect sparingly up to 49 cm tall but most common is 12-28 cm tall. The leaves of such a plant are alternative, short petiolate which is 1-3 mm long, rounded at the apex, obtuse, (1-2 x 0.4 to 1.4 x 2) cm, serrulate at apex, and tapered the base, deciduous and leaving scars. The inflorescence is umbel shape, leaves -5, whorled, and upper stem leaves. Such a plant is ovate transversely glands and garnishes in color. The fruit of such a plant is roundly trilobite, deep groves, and subglobose, 2.4-3 x 2.4-3.4 mm. Style of the flower is recurved, spreading and united. The stigma of the flowers is bipartite and slightly swollen. Seeds of the plant are strongly reticulate, obtusely, brown and apiculate. Seeds ovoid, 2 x 13 mm, strongly reticulate, dark brown, obtusely apiculate with a flat, adpressed, transversely ovate caruncle. |

## 13. *EUPHORBIA HIRTA* L.

FIGURE 13. ***EUPHORBIA HIRTA***

| | | |
|---|---|---|
| **Synonym** | : | *Chamaesyce hirta* (L.) Millsp. |
| **Common Name** | : | Garden spurge |
| **Distribution in World** | : | Ghana, Indonesia, Yemen, Colombia, Australia |
| **Distribution in Pakistan** | : | Gujrat, Kotli, Haripur, Swat, Bahawalpur, Mianwali |
| **Flowering Period** | : | July-December |
| **Morphological Description** | : | An erect-ascending hispid sparingly branched annual herb up to 60 cm; hairs multicellular, drying yellow. Petioles 1-3 mm long. Leaf-blades rhombic-ovate to rhombic-lanceolate, 1-5 x 0.5-1.8 cm, subacute or obtuse, asymmetrically cuneate or rounded-cuneate at the base, serrulate at least in the upper part, with c. 2 pairs lateral nerves from near the base running up the blade, bright green, often purplish-tinged, above, pale green beneath. Stipules subulate, 1-2 mm long. Cyathia aggregated together into dense axillary pedunculate clusters 0.5-1 cm across; peduncle 0.5-1 cm long. cyathial glands and their appendages minute. Fruits sharply trigonous, 1 x 1 mm, smooth, adpressed-pubescent. Seeds 0.8 x 0.5 mm, ovoid-quadrangular, with a few shallow transverse ridges on each face, grey when mature, otherwise pinkish, e-carunculate. |

## 14. *Hamelia patens* Jacq.

**Figure 14.** *Hamelia patens*

| | | |
|---|---|---|
| **Synonym** | : | *Hamelia patens* var. *patens* |
| **Common Name** | : | Firebush. |
| **Distribution in World** | : | Brazil, Cuba, Argentina, Colombia, Costa Rica |
| **Distribution in Pakistan** | : | Rawalpindi, Peshawar, Swabi, Multan, Sukkur |
| **Flowering Period** | : | June-January |
| **Morphological Description** | : | Evergreen shrub or small tree, up to 3 m, young branches angular, pubescent-puberulous or villous. Stipules 3-4 mm long. Leaves in whorls of 4, 3-12 x 2-4 cm, elliptic, oblong or oblong-ovate, glabrous-tomentose beneath, glabrate-glabrous above, rarely sparsely hairy, acute or acuminate, entire. Inflorescence terminal, compound scorpoid cymes. Flowers 2-3 cm long, scarlet, pedicel 1 mm long. Hypanthium bell shaped, 4.5 mm long, pubescent, lobes minute, deltoid. Corolla red to red-orange or yellow, tubular, 1.5 cm long, 5-ridged, shortly 5-lobed. Stamens 5, filaments adnate near the middle of the corolla-tube, 3 mm long. Ovary surrounded by thick conical disc. Style 1.5 mm long. Fruit ellipsoid-oblong or globose, berry, 8 mm long, red in colour. Seeds brown or yellowish brown. |

## 15. *HELIANTHUS ANNUUS* L.

**Figure 15.** *Helianthus annuus*

| | | |
|---|---|---|
| **Synonym** | : | *Helianthus annuus* subsp. *annuus* |
| **Common Name** | : | Sunflower |
| **Distribution in World** | : | Spain, Austria, Turkey, Uzbekistan, Switzerland |
| **Distribution in Pakistan** | : | Sahiwal, Multan, Peshawar, Dera Ismail, Jhelum, Lakki Marwat |
| **Flowering Period** | : | July-January |
| **Morphological Description** | : | Annuals, 100-300 cm. Stems erect, usually hispid. Leaves mostly cauline, mostly alternate; petiole 2-20 cm; blade ovate-lanceolate to ovate, 10-40 × 5-40 cm, abaxially usually hispid, base cuneate to sub cordate or cordate, margin serrate. Capitula 1-9; peduncles 2-20 cm; involucres hemispheric or broader, 15-40 mm in diameter; phyllaries 20-30, ovate to ovate-lanceolate, 13-25 × 5-8 mm, rarely glabrate or glabrous, usually gland-dotted, margin usually ciliate, apex abruptly narrowed, long acuminate; paleae 9-11 mm, 3-toothed, middle teeth long acuminate, glabrous or hispid. Ray florets 17-30; lamina 25-50 mm. Disk florets 150-1000; corollas 5-8 mm, lobes usually reddish, sometimes yellow; anthers brownish to black, appendages yellow or dark. Achenes 3-5 mm, glabrate; pappus of 2 lanceolate scales 2-3.5 mm plus 0-4 obtuse scales 0.5-1 mm. |

## 16. *Justicia adhatoda* L.

**Figure 16.** *Justicia adhatoda*

| | | |
|---|---|---|
| **Synonym** | : | *Adhatoda vasica Nees* |
| **Common Name** | : | Malabar Nut |
| **Distribution in World** | : | Indo-Pak subcontinent, Sri Lanka, |
| **Distribution in Pakistan** | : | Rawalpindi, Islamabad, Jhelum, Mirpur Azad Kashmir |
| **Flowering Period** | : | March-September |

**Morphological Description**

An erect much branched, gregarious, evergreen shrub, up to 2 (-2.5) m. Stem; quadrangular to nearly terete, young shoots greyish pubescent. Leaves with 1.5-3.5 cm long petioles; lamina elliptic-lanceolate, 10-20 x 3.5-8 cm, glabrous above, pubescent, basally attenuate, entire, acuinate. Flowers white, 3 cm long, nearly sessile, axillary spikes, up to 10 cm long, 2.5-3 cm broad; bracts leafy, broadly elliptic, 1.5-2.5 x 1-1.5 cm, pubescent; bracteoles elliptic oblong to lanceolate, 1-1.5 x 0.3-0.5 cm, acute, minutely pubescent. Calyx 5-lobed, lobes linear-lanceolate, 6-10 x 2 mm, acute, imbricate. Corolla pale-white, tube 1.2-1.5 cm long, throat villous, limb 2-lipped, shortly bifid. Stamens 2, filaments 1-1.5 cm long, anthers oblong, basally apiculate. Ovary oblong, 3 mm long, style 2-2.5 cm long. Capsule stipitate, broadly clavate,

2.5 cm long, 4-seeded, pubescent. Seeds ± orbicular, 2-3 mm across, glabrous.

## 17. *Justicia japonica* Thunb.

**Figure 17.** *Justicia japonica*

| | | |
|---|---|---|
| **Synonym** | : | *JUSTICIA SIMPLEX D. DON* |
| **Common Name** | : | N/A |
| **Distribution in World** | : | Thailand, Nepal, India, Srilanka, |
| **Distribution in Pakistan** | : | Abbottabad, Azad Kashmir, Murre |
| **Flowering Period** | : | August- January |
| **Morphological Description** | : | An erect, up to 50 cm herb, with quadrangular, zigzag, ribbed, strigose twigs. Leaves with 3–5 mm long, hairy petiole; lamina elliptic-lanceolate, 2.5–4.5 cm x 7–12 mm, scabrous above, entire, apex acute, base cuneate. Inflorescence sessile or stalked, cylindrical, 3–6 cm long. Flowers pink or purplish-pink, 8 mm long; bracts elliptic-ovate, 3–4 mm x 1.5–2 mm, scarious with green midrib, pilose; bracteoles narrower and akin to bracts. Calyx usually deeply 4–lobed, rarely 3–lobed due to reduction lobes lanceolate, 4 mm long, scarious margined, long hairy. Corolla tube 3 mm long, narrow, glabrous outside, upper lip 3 mm long, slightly bilobed, hairy outside, 3 |

mm long, hairy outside, shorty 3–lobed. Staminal filaments 2 mm long, basally dilated, anthers oblong 0.6–0.7 mm long. Ovary oblong, 1.5 mm long, pubescent; style filiform, 4 mm long, basally hairy.

## 18. *Malvestrum coromandelianum* (L.) Garcke

**Figure 18.** *Malvestrum coromandelianum*

| | | |
|---|---|---|
| **Synonym** | : | *Malva coromandeliana* L. |
| **Common Name** | : | Prickly malvaestrum |
| **Distribution in World** | : | China , India , Japan ,South America, Srilanka |
| **Distribution in Pakistan** | : | Kasur, Kotli, Mardan, Islamabad, Sheikhupura, Bannu |
| **Flowering Period** | : | April-September |
| **Morphological Description** | : | *Malvastrum coromandelianum* is an erect, woody, annual herb, or undershrub, 60 to 90 cm tall. The main stem is straight and hairy, and root of this plant is tap root. The length of the stem is 9.95cm the width of the stem is 0.3cm. The leaf blade is ovate-lanceolate, petiolate (0.7 to 3 cm), pilose, with lanceolate stipules (5 to 7 mm), dentate margins, and acute apex. Leaves are simple and hirsute; the margins of the leaves are dentate. Length of the leave is 3.5-4cm and the width is 1.9 to 2 cm. The flower is solitary axillary with pilose pedicel (3 to 5 mm). The |

calyx is cup-shaped (5 to 7 mm) and accrescent. Petals are yellow and ovate. The fruit is schizocarpic with reniform, 8 to 12 tricuspid mericarps.

## 19. *Melia azedarach L.*

**Figure 19.** ***Melia azedarach***

| | | |
|---|---|---|
| **Synonym** | : | *Azedara speciosa* Raf. |
| **Common Name** | : | White cedar |
| **Distribution in World** | : | Ethiopia, Bangladesh, Kuwait, Portugal, Texas |
| **Distribution in Pakistan** | : | Hafizabad, Buner, Malakand, Soon Valley, Attock |
| **Flowering Period** | : | March-April |
| **Morphological Description** | : | *Melia azedarach* is a small to medium, deciduous tree from 6 to 35 meters in height. The bark is brown with narrow furrows which give a striped appearance. The leaves are twice-compound (bipinnate) with oval to elliptical-shaped leaflets from 20 to 70 mm long and are dark green in color. The pink to lilac flowers is star-shaped, about 18 mm in diameter and have a chocolate scent. They occur in conspicuous clusters from the leaf axils. The flowers are followed by yellow clusters of fruit which are poisonous if eaten by humans and animals although many birds seem partial to them and are not affected. *M. azedarach* is monoecious (separate male and female flowers, but |

on the same plant). It produces very large numbers of bird-dispersed seed. The seeds maintain their viability for up to two years. *M. azedarach* regenerates rapidly from seed and by suckering.

## *20. Nerium oleander* L.

**Figure 20.** *Nerium oleander*

| | | |
|---|---|---|
| **Synonym** | : | *Nerium oleander* subsp. *kurdicum* Rech.f. |
| **Common Name** | : | Oleander |
| **Distribution in World** | : | Italy, India, Iraq, Syria, Oman, Lebanon, Bermuda |
| **Distribution in Pakistan** | : | Jhelum, Islamabad, Mardan, South Waziristan, Tank, Pishin |
| **Flowering Period** | : | October-January |
| **Morphological Description** | : | An erect evergreen shrub branches glabrous with milky juice, young branches green. Leaves 10-15 x 1-2 cm, linear-lanceolate, tapering at both ends, acuminate, thick coriaceous, midrib prominent, nerves numerous, petiole 5-7.5 mm long. Flowers white, pink or dark red, single or double in cultivated, form, fragrant 3-4 cm across, peduncle and pedicel hairy, bracts small, 5-7.5 mm long. Calyx c. 6.25 mm long, divided into 5 linear, acute lobes, hairy with gland at the base inside. Corolla tube 1.8 cm long, hairy within, throat narrow, ending in five twisted petals, tips rounded, corona of 5 scales near the throat |

of the corolla, cleft into 4-7 linear segments. Stamen included, filament short, Anthers connivant and adherent to stigma, connectives hairy, produced upward into thread-like hairy appendages. Ovary with two distinct carpels, style filiform, thickened upward; stigma two lobed. Fruit 12-20 cm x 7:5 mm long.

## 21. *OXALIS CORNICULATA* L.

**FIGURE 21.** *OXALIS CORNICULATA*

| | | |
|---|---|---|
| **Synonym** | : | *Acetosella corniculata* (L.) Kuntze |
| **Common Name** | : | Creeping woodsorrel |
| **Distribution in World** | : | West Indies, Texas, Morocco, Afghanistan |
| **Distribution in Pakistan** | : | Chakwal, Malakand, Buner, Haripur, Kotli |
| **Flowering Period** | : | January-May |
| **Morphological Description** | : | Oxalis corniculata is bushy in nature and creates a mat forming structure in its growing areas. The top portion of the plants are erected weakly smooth or bushy. They are branching from the bottom and rooted at the nodes. The root is dark brownish, thin, branched, soft; with no odor and taste. The leaves of the plants are trifoliate, thin and heart shaped. The leaflets have a distinct apical indention. Along the stem the leaves are arranged alternately, and leaflets have reticulate venation. The stem of the plant is slender in shape and covered with soft short hairs. The internodes are 5 to 9 cm in length. It is sour in taste and smells like acidic. The flowers are 6-12 mm wide and have 5 yellow petals. The fruits are a capsule, 1-1.5 cm long, cylindrical, pointed and ridged. The seeds are oval in outline, rounded, basally pointed, flattened, light brown and have a surface distinctly ridged. |

## 22. *SENNA OCCIDENTALIS* (L.) LINK

**Figure 22.** *Senna occidentalis*

| | | |
|---|---|---|
| **Synonym** | : | *Cassia occidentalis* L. |
| **Common Name** | : | Coffee senna |
| **Distribution in World** | : | Libya, Nigeria, Hong Kong, Bhutan, China, Barbados |
| **Distribution in Pakistan** | : | Mirpur, Bahawalpur, Islamabad, Lahore, |
| **Flowering Period** | : | October-March |
| **Morphological Description** | : | An undershrub up to 2 m tall, sometimes an annual. Leaves stipulate, stipules 4-6.5 mm, acuminate, caducous. Leaves 12-20 cm long, leaflets 3-5 pairs, opposite, petiole 1 mm, lamina 2.5-9 cm long, 1.2-3.3 cm wide, lanceolate or ovate-lanceolate or narrowly to broadly elliptic, apex acute, rounded at the base, glabrous on both the sides. Inflorescence pedunculate, axillary, corymbose raceme forming terminal panicles, peduncle 0.3-0.8 mm. Flowers yellow, 1.2 cm across, pedicel 5-10 mm long, bracteate, bracts 7-1 cm long, ovate, oblique, acuminate, glabrous, caducous, white. Calyx 1 cm long, divided up to base, glabrous, oblong, obtuse, white, tinged with pink. Corolla 1.2 cm long, oblong-obovate, obtuse. Stamens 10, 3 lower longer than 4 lateral stamens, 3 staminodes. Pods 9-12.5 cm long, 7-8 mm wide, slightly falcate, compressed. Seeds 20-30, ovoid, compressed, 6-6.5 mm long, 5 mm broad, rounded at the tip. |

## 23. *Solanum surattense* Burm. f.

**Figure 23.** *Solanum surattense*

| | | |
|---|---|---|
| **Synonym** | : | *Solanum jacquini* Willd. |
| **Common Name** | : | Wild eggplant |
| **Distribution in World** | : | Afghanistan, North Africa, China, Burma and Australia. |
| **Distribution in Pakistan** | : | Kotli, Chakwal, Nar desert, Malakand, Haripur |
| **Flowering Period** | : | August to October |
| **Morphological Description** | : | Prostrate, diffuse prickly herb; prickles up to 15 mm long, yellow. Stem; profusely branched, somewhat zig zag, the young branches clothed with dense satellite and tomentose hairs and branches glabrous to stellate pubescent. Leaves 30-80 x 25-50 mm, elliptic oblong, sinuate to deeply lobed, dark green above; lobes unequal, obtuse or acute, often toothed or lobulate. Flowers; bluish pink in extra-axillary racemes, 2-4, purple; on peduncle cymes. Peduncle 10-20 mm long. Calyx lobes 5 mm long, acute, prickly. Corolla limb 2-2.8 cm broad; lobes 5 acute, 10-12 mm long, ovate-triangular. Anthers 7.5 mm long, elongated. Berry globose, green with white stripes, yellow when ripe, 15-20 mm broad. Seeds circular, discoid, numerous smooth to faintly reticulate. |

## 24. *Sonchus asper* (L.) Hill

**Figure 24.** *Sonchus asper*

| | | |
|---|---|---|
| **Synonym** | : | *Sonchus asper* (L.) Vill. |
| **Common Name** | : | Prickly sow-thistle |
| **Distribution in World** | : | Turkey, Iran Canada, Brazil and USA |
| **Distribution in Pakistan** | : | Fateh Jhang, Attock, Gujranwala, Muzaffarabad, Islamabad |
| **Flowering Period** | : | January to April |
| **Morphological Description** | : | This plant is a spring or summer annual that becomes 1-3 inches tall, branching sparingly in the upper half. The stems are dull green, round, and smooth. They have rather conspicuous longitudinal veins and are usually hairless, although occasionally the upper stems and flowering stalks have a few hairs. The alternate leaves are up to 10" long and 3½" across, but more commonly they are about half this size or less. Leaves may be pinnatifid, or they may lack significant lobes along the margins, in which case they are broadly lanceolate. The hairless leaves are glabrous, and they tend to be folded upward along the central vein. The upper stems terminate in clusters of 1-5 composite flowers on rather short stalks. Each flower is about 2/3" (16 mm.) across when fully open, consisting of numerous yellow ray florets. The base of each flower is covered with dull green bracts and is it rather short – only about 1/3" (8 mm.) in length. |

## 25. *TRICHODESMA INDICUM* (L.) LEHM.

**Figure 25.** *Trichodesma indicum*

| | | |
|---|---|---|
| **Synonym** | : | *Trichodesma amplexicaule* Roth |
| **Common Name** | : | Indian Borage |
| **Distribution in World** | : | Thailand, Philippines, Afghanistan, India |
| **Distribution in Pakistan** | : | Mastung, Rawalpindi, Poonch, Salt range, Murree |
| **Flowering Period** | : | Throughout year |
| **Morphological Description** | : | An annual herb with spreading and densely hairy branches; hairs dimorphic; shorter ones thin, appressed, up to 0.3 mm long; longer ones stiff, up to 0.6 mm long with smaller bases. Leaves oblanceolate to lanceolate, 3.5-8.5 x 0.6-2.0 cm, amplexicaul or nor; middle cauline ones the largest, hairy on both surfaces, the upper surface with hairs up to 1.8 mm long. Inflorescence terminal, lax, few-flowered. Bracts leafy. Pedicel 10-25 mm long. Flowers mauve to pinkish blue or lilac. Calyx 5-partite, hairy, 10-12 mm long, base ± auricled; lobes oblong, narrowed towards apex. Corolla exceeding calyx length, infundibuliform, sparesely hairy on outside; lobes suborbicular, subacuminate. Anthers hairy, aristate-the connectives later twisting together. Nutlets 4-5 mm long, ovoid, smooth, white to bluish. |

## 26. *XANTHIUM STRUMARIUM* L.

**Figure 26.** *Xanthium strumarium*

| | | |
|---|---|---|
| **Synonym** | : | *Xanthium abyssinicum* Wallr. |
| **Common Name** | : | Rough cocklebur |
| **Distribution in World** | : | Kenya, Japan, Turkey, Russia, Arizona, Fiji |
| **Distribution in Pakistan** | : | Haripur, Kurram Agency, Kotli, Sialkot, Mardan |
| **Flowering Period** | : | June-October |
| **Morphological Description** | : | Annual herb approximately 20–90 cm in height, its stems are erect, branched, often speckled with purple and have short white hairs scattered across the surface. Leaves are green, cauline, mostly alternate (proximal 2–6 sometimes opposite) with petiole, which are 5–20 cm long and 4–16 cm wide; the shape of blades are lanceolate, linear, ovate, orbicular-deltate, or suborbicular, and both surfaces are hirtellous or strigose, usually with gland-dotted, margin entire or toothed. The capitula are discoid, whose female (proximal) or functionally male (distal) are in racemiform to spiciform arrays or borne singly (in axils). The female capitula are elliptic, 2–5 mm in diameter; Male capitula are saucer-shaped, 3–5 mm in diameter. The achenes are black, fusiform, obovoid, enclosed in the hardened involucre, with two hooked beaks and hooked bristles |

## 27. *Nasturtium officinale* R.Br.

**Figure 27.** *Nasturtium officinale*

| | | |
|---|---|---|
| **Synonym** | : | *Sisymbrium nasturtium-aquaticum* L. |
| **Common Name** | : | Watercress |
| **Distribution in World** | : | U.S, Europe, North America and temperate Asia |
| **Distribution in Pakistan** | : | Sialkot, Hazara, Rawalpindi, Abbottabad, Sargodha, Islamabad, Mansehra, Multan. |
| **Flowering Period** | : | April-July |
| **Morphological Description** | : | Perennial, rhizomatous, 10-80 cm long, procumbent and rooting below at the nodes, ascending or floating, glabrous green, rarely with scattered simple hairs. Leaves lyrate-pinnate; lower stalked with 1-5 leaflets; upper sessile, auricled at the base, and with 5-9 leaflets; terminal leaflet suborbicular or broadly cordate; lateral leaflet entire to sinuate-toothed. Racemes 10-25-flowered, lax, up to 20 cm long in fruits. Flowers 4 mm across, white; pedicels up to 10 mm long in fruit, spreading, horizontal or slightly deflexed. Sepals 2 mm long. Petals 4-5 mm long, 2 mm broad. Stamens c. 2:3 mm long. Siliquae oblong, subcylindrical, 10-20 mm long, 2-2.5 mm broad, often slightly upcurved, glabrous, faintly veined, finely headed due to the pressure of seeds on valves; style 0.5-1 mm long with depressed stigma; seeds many, biseriate, ovoid, 1 mm long with 25 polygonal depressions on each face. |

## 28. *Mentha spicata* L.

**Figure 28.** *Mentha spicata*

| | | |
|---|---|---|
| **Synonym** | : | *Mentha viridis* (L.) L. |
| **Common Name** | : | Spearmint |
| **Distribution in World** | : | Africa, Europe, Asia, India, North America, Indonesia. |
| **Distribution in Pakistan** | : | Sialkot, Mansehra, Abbottabad, Rawalpindi, Islamabad, Faisalabad |
| **Flowering Period** | : | June-October |
| **Morphological Description** | : | It is a Perennial, herbs, no hairs are present, fragrant. Stems erect, ascending, 32-60 cm, it is branched. Stems is quadrangular, surface is slightly glabrous. Quadrangular stem is most important distinctive feature which is glabrous. Leaves are green in color, opposite, oblong to lanceolate simple, 2.5-7 x 1-2.5 cm borders are dentate, apex is acute type, base rounded base is present. Small flowers, shaped in groups, spikes are terminal, 3-6 cm, light purple or whitish corolla is present. Calyx is of gland dotted texture. Sometimes ciliate hairs are visible. Fruit is nut which is dark greenish to brown. Plants have very pleasant fragrance. Flower is creamy white in color. |

## 29. *Veronica-anagallis-aquatica* L.

**Figure 29.** *Veronica-anagallis-aquatica*

| | | |
|---|---|---|
| **Synonym** | : | *Veronica catenata* Pennell |
| **Common Name** | : | water speedwell |
| **Distribution in World** | : | America, France, Asia Europe, North Africa |
| **Distribution in Pakistan** | : | Sialkot, Hazara, Rawalpindi, Islamabad, Abbottabad, Swat, Baluchistan. |
| **Flowering Period** | : | March-May |
| **Morphological Description** | : | It is a herbaceous and perennial. It may exhibit hairs on the surface also on their axes of inflorescence. Straight type of stems is present. It is also succulent and branched ranges 12-42 cm high. Foliage is sessile. Leaves are arranged oppositely, inflorescence is simple raceme, blue colored petals are present. They exhibit opposite arrangement, grasp the opposite portion where the foliage bases come close. Elliptical leaf blade is present 3-6×2-3.5, apex is acute type. Slightly serrate margins are present. Axillary type racemes, found present which measured up to 5-12 cm, comprise of various flowers 15-26. |

## A. *Corvus splendens*

**Figure 30.** *Corvus splendens*

| | | |
|---|---|---|
| **Common Name** | **:** | House crow |
| **Global Distribution** | **:** | India, Egypt, Bhutan, Kenya, Bangladesh, Yunnan |
| **Habitat** | : | *C. splendens* is a committed commensal to man, never living far from human settlements. It does, however, move into surrounding farmland and along seashores, estuaries and large rivers to forage. |
| **Morphological Description** | : | *C. splendens* is a typical crow, generalist, omnivorous, opportunistic and intelligent but, uniquely, it is a specialist urban commensal of man, very gregarious and aggressive. A medium sized crow, length 40 cm and weight 245-371 g, with relatively long legs and bill. Grey nape, sides of head and breast, though the shade of grey varies in different races; otherwise glossy black, but juveniles are duller. Bill and legs black, eyes black brown. Sexes similar though males are somewhat larger. C. splendens nests mainly in large trees close to human habitation. It pairs for life and is a more or less solitary nester, so several nests may be located in one large tree. A very familiar bird in towns and villages, and areas of cultivation. It shows two-toned appearance with paler nape, neck and breast. The adult has gloss to black of plumage, and ‘collar’ is well defined. Juvenile lacks gloss, and ‘collar’ is |

duskier and less well defined.

## B. *Passer domesticus*

**Figure 31.** *Passer domesticus*

| | | |
|---|---|---|
| **Common Name** | **:** | House sparrow |
| **Global Distribution** | **:** | Taiwan, Italy, Finland, Mexico, Newzeland |
| **Habitat** | : | House sparrows may evict native birds from their nests and out-compete them for trophic resources. For the most part, *P. domesticus* is always found around man-made structures and lives around cities, towns and farms. It is non-migratory |
| **Morphological Description** | : | A small bird, it has a typical length of 16 cm (6.3 in) and a weight of 24–39.5 g (0.85–1.39 oz). Females and young birds are colored pale brown and grey, and males have brighter black, white, and brown markings. The male house sparrow (*Passer domesticus*) has a brown back with black streaks. The top of the crown is grey, but the sides of the crown and nape are chestnut red. The chin, throat and upper breast are black, and the cheeks are white. Females and juveniles are less colorful. They have a grey-brown crown and a light brown or buff eye stripe. The throat, breast and belly are greyish-brown and unstreaked. Despite their small size, house sparrows are quite aggressive. House sparrows are known for |

displacing native species through competition by out-competing them for trophic resources.

## C. *Uromastyx hardwickii*

**Figure 32.** *Uromastyx hardwickii*

| | | |
|---|---|---|
| **Common Name** | : | Indian spiny tail lizard |
| **Global Distribution** | : | Afghanistan, India, |
| **Habitat** | : | Generally found in firm ground rather than pure sand dunes, Hardwicke's spiny-tailed lizard is often found living in colonies, sometimes on the outskirts of villages. |
| **Morphological Description** | : | Head very short, broad, much arched. Body depressed, with a fold on each side of the back. Scales minute, equal. Tail short, broad, depressed; upper part with cross bands of compressed, conical scales, separated by other rings of granular and smooth square scales; beneath covered with square, smooth, imbricate scales. Femoral pores distinct. crodont dentition, with the premaxillary bone forming in adult specimens a sharp, tooth-like structure replacing the incisive teeth. Tail scalation arranged in distinct whorls, which are separated by 1–6 rows of intercalary scales dorsally. |

## 10.0 Botanical relative abundance and vegetation

Botanical relative abundance of vegetation represents the information on taxonomic status of the plant communities. Abundance in any plant community shows the distribution pattern and relative count of the plant species in study area based upon critical vegetation analysis carried out in various years based upon seasons. However, on preliminary bases, Abundance can be determined using floristic surveys.

### 10.1 Special Habitats

A habitat is a special place where organism lives to complete their life activities. It acts as home for organisms while in various place some habitats are considered as special. Special habitat represents unique place wherefrom organisms are benefitted. In present flora assessment at Murree Expressway, Islamabad various special habitats were observed providing lifeline to plants, animals and their associated organisms.

### 10.2 Conclusions

The present study provides the floristic and fauna composition of the Emirate Resort, Murree Expressway, Islamabad. Based upon observations, the study area is characterized by dense vegetation including some seasonal herbs, shrubs and trees that are also found in allied areas. The fauna study site also categorized by diverse species. The study area seems to be suitable for proposed project. The planning and development can reduce the energy consumption of buildings by reducing the impact of some climate factors. Awareness and knowledge of the potential of vegetation and fauna to modify microclimate could produce a new way of quantifying the energy saving potential of landscaping. It is recommended that described species should be planted and cultivated in facility area for sustainability of the habitats. Such mitigations will be beneficial for facility as well as natural habitats in the area.

### 10.3 Recommendations

- Suitable sites for plantations should be identified in line with proper site selection and site species-matching criteria
- Preliminary management including further investigation of suspected defects that require more detailed ecological assessment and potential for wildlife.
- Contributions by local communities to design of management plans should be accommodated.
- Surveillance or hypothesis-driven monitoring covering different habitat types, with sampling carried out in regular intervals

- Determination of the types and impacts of anthropogenic activity to be monitored, which will affect site selection

During construction, impacts to the site will be minimized by the delineation of the works area. The works area should be kept to the smallest area possible, with the remaining being exclusion zone to act as a fauna refuge.

### 10.4. Aquatic Flora

There are no permanent natural wetlands in the area, which can act as habitat for wild aquatic vegetation. Aquatic plant communities, therefore, are not ecologically significant in the EMIRATES RESORT APARTMENT BUILDINGS site or surroundings.

## 11.0. Human and Economic Development

### 11.1 Population and Communities

Land is mostly owned by Emirates Resort Apartment Buildings. In general, intermittent houses could be seen outside the acquired land, where about 35 inhabitants are living outside the project area. As such large population and communities do not exist that is supposed to suffer after the induction of EMIRATES RESORT APARTMENT BUILDING.

### 11.2 Industry

No industrial activity is found in the area.

### 11.3 Potable Water Supply

Groundwater is used for all domestic purposes, in the Project area. The Korang River is another source of water available. The quality of groundwater in most area is acceptable. Under the circumstances, filtration plant may not be needed. Disposal waste water will be processed through septic tanks.

### 11.4 Sanitation

Proper sanitation has been planed by means of septic tanks. At some places, animals are kept inside houses. They can also be the source of transferring diseases and parasites to the occupants.

### 11.5 Domestic and Drinking Water Standards

Groundwater shall be used as potable water that will be extracted from deep-seated tube-wells of 400 to 450 feet depth.

Water samples shall be periodically checked through authorized laboratories and treatment provided if needed. Drinking water must be treated as per PEPA (Pakistan Environment Protection Agency) guidelines.

Centralized drinking water treatment plant is planned if the groundwater is not found satisfactorily as per drinking water standards.

Separate drinking water piping shall run throughout the project operation and it will also be provided to drinking water fountains, kitchens and wherever needed.

## 12.0 QUALITY OF LIFE VALUES

### 12 .1 Socioeconomic Values

During the last two decades, the socio-economic structure of the area has considerably changed. The people living in the nearby villages in the vicinity of EMIRATES RESORT APARTMENT BUILDINGS are essentially working class, shopkeepers, agriculturists but their holdings are too small to provide subsistence. The people also find it difficult to maintain large number of cattle. Ploughing by bullocks has been replaced by mechanical methods to the tune of 90%. Each family prefers to rear a few cattle or some goats mainly for milk. Herds of goats and sheep have almost disappeared except joint herds. The practice of stall feeding is limited. Browsing by bakerwals has been permitted by the government in right-free areas causing an adverse pressure on the forests.

People mostly depend on domestic firewood from forests, as only a small part of their requirements is met from private lands. Uses of bottled gas in villages and piped gas in the towns have greatly reduced dependence on forests for fire wood.

Economy of the major population, about 83% depends on Agriculture that is farming, forests, and Agriculture business. Highest average income was earned by those who have business in addition to agriculture but agriculture still remains dominant profession and source of income in the study area.

### 12.2 Public Health

Clean environment will be provided by the management of the Emirates Resorts and all international laws of environments will be adopted during and after the construction of High Rising Towers. Air pollution will be minimized so as to avoid respiratory diseases or allergies symptom.

#### 12.2.1 Transport and Communications

Emirates Resorts Building will be easily accessible and well connected through metalled roads. Hence, transport is easily accessible. An express Murree Road cum motorway runs parallel to the newly proposed Emirates Resorts Builings Apartment.

#### 12.2.2 Archaeological and Historical Resources

None of the monuments or sites, of archaeological or historical importance exists in the vicinity of the Emirates Resorts Builings Apartment

### 12.2.3 Recreational Areas and Resources

No recreational site of regional or national importance is found in the area. There is no any tourism activity observed in the nearby vicinity.

### 12.2.4 Cultural Values

The area has a mix blend of urban and rural culture of traditions and the local people have their own principle and choice for a village site house, family, dress and ornaments, weddings, Childbirth, death ceremonies, cultural functions, festivals and socio-religious belief. The local ladies are more dynamic and laborious in comparison to the gents. The people of the area are very much close to natural vegetation, both in their habitat and livelihood. So, the people of the area have empirical observations of nature and by communicating with other people of their culture, they get indigenous knowledge about the local resources. They are, thus gaining the indigenous knowledge generation after generation from their ancestors. The plant and plant materials available from the nearly area are used as food fodder, medicine, veterinary medicines, timbers, households, oilseeds and also for socio-religious and other purposes. Similarly, local people in various villages of the area gathered indigenous medicinal plants in different seasons of the year for marketing, personal use and whole community use with in the area. So, in this way, the Ethnic knowledge of wild and cultivated plant use is interactely linked to local culture and history.

# 13.0 SCREENING OF POTENTIAL ENVIRONMENTAL IMPACTS AND MITIGATION MEASURES

## 13.1 Screening Procedures

The environmental Impact assessment (EIA) of the Project is conducted, principally, within the framework of Pakistan Environmental Protection Act 1997, Pakistan Environmental Assessment Procedures (2000) and World Bank's guidelines.

## 13.2 Environmental Impacts Matrix

Generally environmental impact matrices are prepared to present, at a glance, the overall profile of environmental impacts of the project. A typical matrix screens all the components of the Project against environmental parameters such as physical, biological and social at both the construction and the operation stages. In these

matrices, the environmental parameters are shown on horizontal axis and the Project components on vertical axis. A qualitative indicator, denoting its intensity and significance, represents each impact.

## 13.3 Permanent and Continual Environmental Problems

Construction of the Emirates Resort Buildings Apartment will not cause environmental problems with reference to location, design, construction and project operations. Other than that no physical environment, biological environment, and social environment will be disturbed. Environmental problems attached to each environmental setting are described in the following sections.

### 13.3.1. Environmental Impacts on the Physical Environment

#### 13.3.1.2 Environmental Problems due to Project Location

The Project area is located in an area where there will be no loss of private and public physical assets including buildings, village infrastructure, roads, electricity distribution network, high transmission (HT) electricity lines, telephone network, and Sui gas transmission lines.

#### 13.3.1.3 Environmental Problems due to Design / Development of Scheme

Design of the project will be made environmentally friendly so that it will have less impact on the vegetations, groundwater, and surface water resources. However, some plants / vegetations may need to be removed during levelling of the topographic of land. Due to the development of the High speed Train Track, there will be no effect on the climatic conditions and no climate change effect will result due to the project.

#### 13.3.1.4 Environmental Problems due to Construction Phases

In construction stage of the Emirates Resort Building Apartments, Land will be developed and the slopes of the ground will be made stable. Therefore the natural slopes, which are a source of erosion at certain locations, will become stable. However, some minor dust will be produced during the construction phases due to movement of heavy duty machineries. Blasting may need to be made in the hilly terrain to smooth the surfaces.

#### 13.3.1.5 Environmental Problems due to Project Operations

The project will cause positive impacts on the surface water hydrology of the Emirates Resorts Building Apartments. During the construction phases, ground will be levelled

and landmass will be removed; hence, it will reduce the sediment inflow into the nearby downstream (Rivers),. During the project operations, number of machineries will be moving around that may produce noise pollution and vibrations. The principal sources of noise and vibration, during the project operation, due to the induction of the Emirates Resorts Building Apartments shall be the following:

- Excavation for sewage and storm water channel network
- Construction of Roads
- Construction of high rising Apartment Buildings
- Levelling of surface terrain
- Movement of heavy duty machinery

The noise levels during these activities may range 70 to 82 dB-A or far below that limit.

#### 13.3.1.6 Potential Environmental Enhancement Measures

That would include implementation of moderate-scale environmental measures to mitigate the minor problems related to project operations. Emirates Resorts Building Apartments will be constructed on modern infrastructure and it will attract inhabitants to buy these apartments (both commercial and domestic) for purposes of comfortly living accommodation. In this perspective it is expected, that construction of the Emirates Resorts Buildings Apartments would add to the beauty and modern facility in the area of Phullgaran..

## 14.0 Additional Considerations

That will include the following components of the project area:

### 14.1. Geological Resources

There will have some environmental problems on the Geological Resources of the area especially in the hilly terrain where the rock masses need to be removed for the development of open surface. Geological features may be disturbed but before their removal, geological mappings will be made to keep record of the geological succession. Apparently this area along the corridor is not considered to have potential for petroleum or mineral resources. On the basis of this information, it can safely be concluded that impacts on minerals and fossil fuel resources are not possible.

### 14.2. Seismological Conditions

As stated earlier that the project is located in reasonably active seismic zone. However, October 8, 2005 earthquake of the magnitude of 7.6 in the region has changed the seismic trend of last 100 years. It is proposed that seismic factors (building codes) should be considered during the construction of the buildings with the help of detail study and the track should be made earthquake proof. .

#### 14.2.1.1. Groundwater Hydrology

The subsurface water present in the form of aquifers exists in moderate quantity in the Potowar Terrain and can be exploited during construction phase. A detail investigation needs to be carried out at later stage to see the impact on groundwater, if it will be extracted in the form of tube-wells. The groundwater investigations by Electrical Resistivity Sounding Survey will also set the depth of water wells, their discharge and spacing in the area. Drilling well needs to be drilled at specific sites recommended in the electrical resistivity survey (ERSS) report. At least twenty (2~3) proper deep-seated tube-well (400 to 450 feet depth) needs to be installed in order to supply good quality of water for the construction purpose, drinking, and other facilities.

#### 14.2.1.2 Agricultural Lands

The people of the area are essentially agriculturist and their main occupation is farming. Practically the whole population (83%) resident in rural areas and large proportion of the urban population is either engaged in or dependent on agriculture. They cultivate various crops such as Groundnut, Maize, Rice, Mustard, Potatoes, Sugarcane, Tobaco and wheat etc. Large part of the area is cultivated by vegetables such as cauliflower, cabbage, Gourds, Melons, Radish, Turnip and other green vegetables that is coriander, fenugreek, spinach etc. People of the area also planted the fast growing trees such as *Bombex ceiba, Eucalyptus camaldulensis, Dalbergia sissoo, Morus* sp*, Melia azedarach* etc. for timber and fuel wood consumption. Apricot, Black Plum, Figs, Guava, Mulberry, Orange, Pomegranate etc are cultivated for fruits by local people of the area.

However, high speed train track will be extended within the limited area of corridor, and therefore the environmental problems on agriculture will be negligible.

## 15.0 Socio-economic Impacts

### 15.1 Impacts on Displaced Population

No local population is likely to be displaced from the project area.

### 15.2. Impacts on Archaeological and Historical Resources

No such resources are present within the acquired land for the project. None of the monuments or sites, of archaeological or historical importance was found.

### 15.3 Impacts on Local Public Health

Due to the clean environment provided by the management of the Emirates Resorts Buliding Apartments, it will reduce the common diseases like malaria and flu. Social Order

The impacts on the social and cultural order, of the communities living within the Project area, would be much more pronounced after the implementation of the high speed train track.

### 15.4 Impacts on Ecological Environment

The affect on the ecology of the area will be negligible due to comparatively small area.

### 15.5. Impacts on Protected Areas like Reserve Forest

Ecological important areas like reserve forest are not within the project area. The impact in the perspective of the size of the Project is insignificant.

### 15.6 Impacts on Terrestrial Fauna

No internationally threatened animal species are reported to exist in the project area. Terrestrial fauna present in the surrounding hill forests would not be affected significantly by the Project.

### 15.7 Impacts on Aquatic Fauna

The Rivers and its tributaries are the principal natural habitat of aquatic fauna, mainly fish. No such habitats exist within the area. The Korang River is located at least 1 Km away in the southeast of the projecy area. No impact is expected on this account after the implementation of the project.

### 15.8 Impacts on Terrestrial Flora

Fruit and other trees are not present in the area therefore, no effect will be foresighted with the construction of Emirates Resorts Buildings Apartment. No rare or endangered plant species are identified in the area.

## 16.0 Additional Considerations during Construction Phase

### 16.1 Air Pollution

Construction activities, particularly at large scale, invariably result into pollution of the ambient air. In case of the construction of Emirates Resorts Buidlings Apartments , the following would be the major potential sources of the fugitive particulate matter (PM) emissions to the atmosphere:

- Removal of earthen materials or its filling.
- Open storage of construction materials like earthen materials and sand, blown by wind and dumping operations
- Road construction including land clearing, excavation, dumping, spreading, and compaction
- Movement of machinery, equipment and construction materials transport vehicles over unpaved roads and areas
- Transport vehicles, mostly using diesel as fuel

The dust emissions from the above sources and operations is of small scale and limited level and would not cause a public health hazards and nuisance, to the communities located, close to areas of operation. Much of the fugitive dust generated by development activities consists of relatively large size particles, which are expected to settle within a short distance from their source.

**Table 16.0** provides the Impacts of Air Pollutants on Environment (E) and Human Health and Life (HL)

**Table 16.0**

**Impacts of Air Pollutants on Environment (E) and Human Health and Life (HL)**

| Parameter | | Impact |
|---|---|---|
| Particulate | E | Damage to plants by choking the leaf pores and restricting photosynthesis |
| Matter | | Global cooling of earth by reflecting back the solar radiation |
| | | Impairment of atmospheric visibility affecting transportation safety |
| | | Deterioration of aesthetic quality of atmosphere, land and water |
| | | Soiling of materials, physical properties and infrastructure |
| | HL | Increase in the frequency of respiratory infections such as bronchitis |
| Carbon | HL | Heart attack, by reducing the oxygen carrying capacity of blood |
| Monoxide | | Birth defects including mental retardation and impairment of fetus growth |
| | | Dizziness, headache and nausea |
| | | Increase in reaction time of the drivers, a threat to the road safety |
| Oxides of | E | Chlorosis and Plasmolysis in plants |
| Sulfur | | Damage to materials and property, by acid rains, resulting from oxidation of sulfur oxides to sulfuric acid, after reacting with water vapors |
| | HL | Serious lung damage, particularly in sulphate form |
| | | Respiratory diseases like Chronic bronchitis |
| Oxides of | E | Formation of photochemical oxidants |
| Nitrogen | | Damage to materials and property, by acid rains, resulting from oxidation of oxides of nitrogen to nitric acid, after reacting with water vapors |
| | | Retardation of growth in plants |
| | HL | Reduction in oxygen carrying capacity of blood |
| | | Impairment of olfactory sense and night vision |
| | | Dryness and roughness of the throat |
| VOC | | Formation of photochemical oxidants |
| Photo | E | Leaf discoloration and cell collapse in plant |
| Chemical | | Damage to rubber, textiles, paints and other materials |
| Oxidants | HL | Severe eye, nose and throat irritations |
| | | Severe coughing and shortness of breath |

## 16.2 Noise Pollution and Vibration

Major sources of noise and vibration from the Project, during its development phase, would be the following:

- Rock blasting activities by means of explosives in case of rock formation
- Operation of heavy machinery and equipment for roads and plotting

For reference and comparison, the NEQS noise level limit (for vehicles) is 85 dB-A, at a distance of 7.5 meters from source. In general, noise impacts due to blasting cannot be assessed by using conventional prediction techniques, since blasting activities are not continuous (Blasting may not be needed as most of the soil is levelled and no solid rocks are exposed on land surface).

Noise is considered as an interference to and imposition upon comfort, health and the quality of life. Noise may have both physiological as well as psychological effects on human beings.

### 16.3 Surface Water Quality

The surface water like streams and nullahs may get polluted from the following potential sources, if proper control measures are not exercised:

- Wastewater disposal from the construction of Emirates Resorts Buidling Apartment.
- Disposal of solid waste

The extent of surface water pollution would very much depend upon the implementation of pollution control measures. It is proposed that a proper treatment of disposal water be made prior to its disposal.

### 16.4 Disposal of Solid Waste

Following would be the major sources of solid waste, associated with the construction of Emirates Resorts Building Apartments

- Domestic solid waste from living employees facilities
- Construction debris and waste during construction (temporary)
- Waste construction chemicals

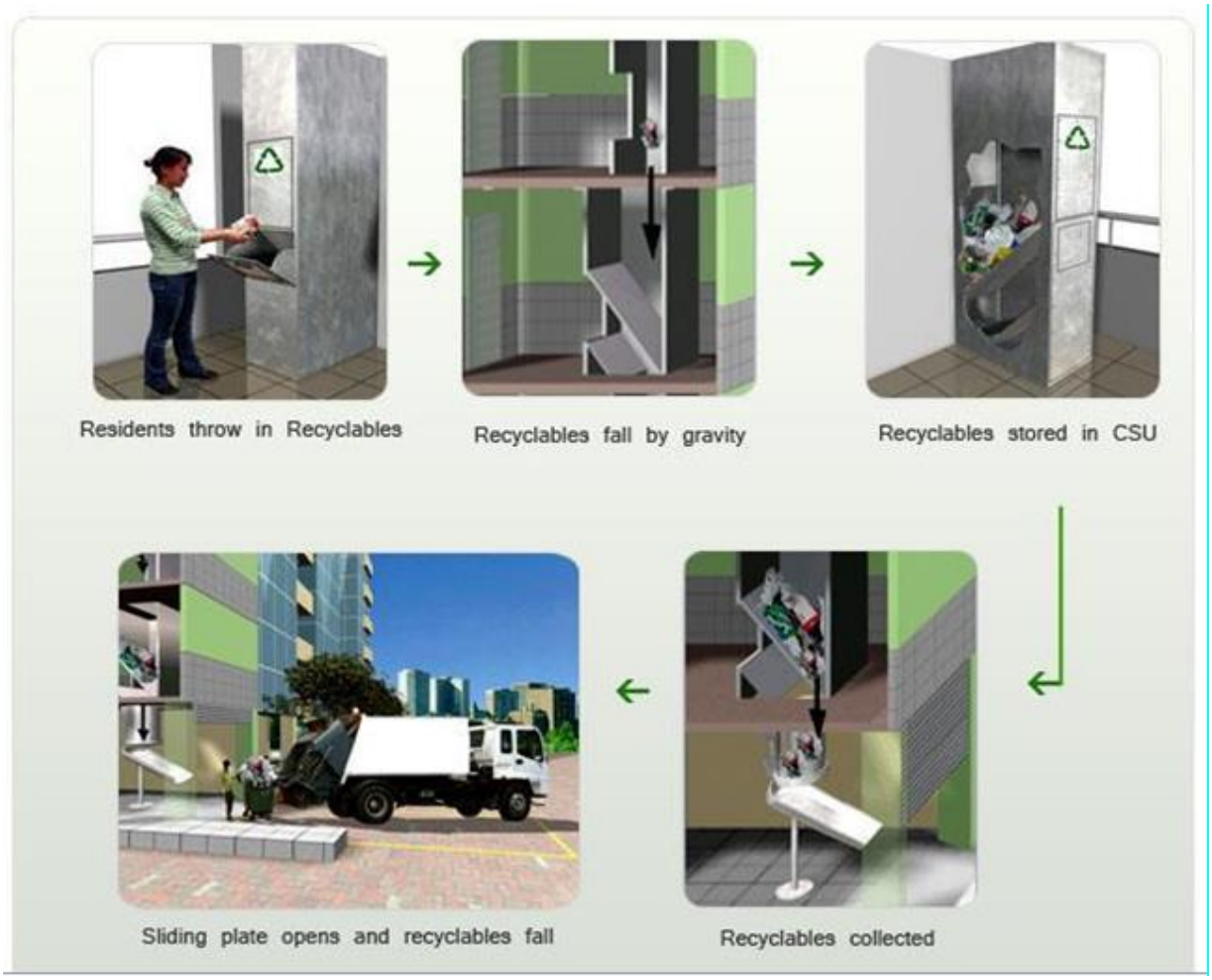
The extent of environmental impacts of the solid waste would depend upon their disposal practices. Indiscriminate disposal of solid waste would lead to surface as well as groundwater pollution. It is proposed to transport the solid waste to a landfill area for its proper disposal.

## 17.0 Garbage Chute System

We will introduce garbage chute system in our buildings which allows residents to dispose of items on their floor. A garbage chute system is a long vertical space

passing by each floor in a building. It includes a door on each floor where residents can dispose of their garbage into the chute. This door is usually contained in a small room on each floor. Garbage placed in the chute drops to a compactor or dumpster at the bottom. All waste then finally collected by trucks from dumpster, that will be disposing of to the nearest disposal site

This system will effectively manage the garbage disposal requirements of high-rise buildings and their residents.




## 17.1 Use of Flammable Materials and Explosives

Explosives may require for the following purposes in the Project:

- For excavation of rocks to level the ground, as the soil is consolidated at several locations in the hilly terrain.

Major flammable materials, to be used include diesel, furnace oil, petrol and kerosene.

These materials present little risk to the environment, if properly transported, stored and used; otherwise they are potentially very dangerous. Improper storage and handling practices for these flammable and explosive materials can pose dangers of fire and blasts in the area.

## 17.2 Impacts on Local Economic Conditions

There would be significant positive impact on the local economic conditions owing to the following factors:

- Increase in local employment level, with relatively higher earning levels
- Increase in commercial activities in the area, particularly food business, shopping, trade and transport

## 17.3. Impacts on Public Health and Safety of the Local Population

Due to the development of the area, public health and safety of the local population will have a positive effect.

## 17.4 Impacts on Water Availability

For the supply of water for the project, special measures will be adopted. Therefore water availability for the local community will be increased and benefited.

# 18. ENVIRONMENTAL IMPACTS MITIGATION MEASURES

This section presents proposed measures for mitigating the potential environmental impacts (if any) of the project. Ways and means are also proposed for reducing/mitigating the impacts.

## 18.1 Mitigation Measures for Socioeconomic Impacts

### 18.1.1 Development Plan of Housing Scheme

Socio-economic surveys of the Emirate Resort Area show that the local area is slightly deficient in following services:

- Public health facilities
- Educational facilities
- Potable water supply
- Improved sanitary and waste disposal facilities

Due to the development of Emirates Resort Area, the above-mentioned facilities will be improved. Therefore no measures are suggested.

### 18.1.2 Employment for the Locals

Local population can only provide unskilled labour to the project during development of the Emirates Resort Buildings Apartment. The contractors bring most of the skilled and semi-skilled persons for the project from other areas. It is proposed that the project proponents should make it part of the contract for the contractor to hire 20% unskilled labour from the local area.

## 18.2 Mitigations for Ecological Environment

### 18.2.1 Drainage in the Conveyance Canal Corridor

At present areas are drained through natural drainage slopes and system. The construction of Emirates Resorts Building Apartments will become a small barrier for the drainage of the area. The channel design for storm water should ensure that the drainage system of the area should not be disturbed rather it should further improve the existing drainage system.

## 18.3 Environmental Monitoring Program and Institutional Requirement

### 18.3.1 Environmental Monitoring

Environmental monitoring program needs to be developed during the project operations to control and appropriate disposal of the produced solid and liquid wastes.

**a) Disposal of Lubricants**

Different kinds of lubricants for oiling, greasing and fuelling of machineries and equipment will be used during development phase. The conventional disposal method for the used lubricants and waste chemicals is to throw it in a ditch/water pit. This practice is environmentally unfriendly, and may cause negative impacts on the soil quality. Therefore, all depleted lubricants will be sent back to the suppliers for recycling or otherwise environmentally safe disposal. These materials ought to be stored, carried and handled properly. Careful handling of fuel should be monitored to avoid surface contamination.

**b) Solid Waste Management**

Residential and commercial areas may produce some solid waste that would be collected manually and should be stored in containers. It shall be transported and disposed as per advice of the local authorities. Sanitary landfill is one of the most popular methods for the safe disposal of solid waste. Recycle able waste shall be transported to the place of recycling.

### 18.3.2 Water Quality Related Mitigation Measures

Domestic sewage at residential facilities can result in pollution of surface water if not treated. In order to allay the concentration of pollution caused by sewage water; treatment of the waste is recommended before transmitting it to streams. According to PEPA 1997, BOD of all the surface discharges from domestic or industrial wasters should not exceed 80 mg/l. Therefore sewage should be treated either by septic tanks or activated treatment process. Sewerage system should be provided for collection, treatment and disposal of sewage. The sewage should not be let exposed in open areas, which may cause health hazards.

The scheme shall have its own sewerage system. The sewerage from residential units shall be collected in connection chambers for flow at adequate gradient in RCC pipes for its final collection at centralized location. The sewerage so collected shall be treated in the Sewerage Treatment Plant (STP).

Packaged unit of STP (Figure. 28) for 0.983 cusec discharge to be provided on site, and treated water to be disposed off in Nullah directly from units.

The treatment of sewerage shall be done in accordance with the design criteria as per CDA Zoning Regulations.

The Hydraulic Statement for determining the RCC pipe diameters shall be worked out with the help of Manning's equation:

$$V = 1.486/N \times R^{2/3} \times S^{1/2}$$

Where

V = Velocity in Ft/ Sec

N = 0.013

R = Area/Perimeter

S = Slope per 1000 ft

| No. of Plots | Population | | Avg. Per Capita Water Use | Other Use | Avg. Flow | |
|---|---|---|---|---|---|---|
| | H.H.S. | Total | lgpcpd | lgpd | lgpd | cusec |
| 450 | 4 | 1800 | 70 | - | 572.81 | 0.234 |

| Peak Factor | Peak Flow | Allowance for filtartion @ 5% | Total Discharge |
|---|---|---|---|
| | cusec | cusec | cusec |
| 4.00 | 0.94 | 0.05 | 0.983 |

Figure 28. Packaged unit of STP

### 18.3.3 Ambient Air Quality Related Mitigation Measures

Presently the air quality of the project area is good but development activities will invariably result into pollution of the ambient air. Fugitive particulate matter (PM) emissions to the atmosphere can be caused by excavation, dumping of earthen materials and storage of sand materials in uncovered form, blown by wind and vibration. Gases emitting from generators are also a source of air pollution.

The dust emissions from the above sources and operations would cause some public health hazard and nuisance to the communities located close to areas of operation, particularly when these emissions get released at the ground level, with less chances of diffusion.

Likely pollutants are carbon monoxide (CO), oxides of sulphur ($SO_X$), oxides of nitrogen ($NO_X$) and volatile organic compounds (VOC) etc.

Sprinkling of water should be performed during construction stages. Chimneys and particulate scrubber should be provided to the plants generating particulate matter. Moreover, masks should be provided to drivers and operators of vehicles and construction machinery.

### 18.3.4 Noise and Vibration Related Mitigation Measures

Rock blasting activities, movement of construction materials transport vehicles etc. can cause noise at project site. NEQS noise level limit (for vehicles) is 85 dB-A, at a distance of 7.5 meters from source. The noise levels should be kept under this permissible limit, otherwise these may cause unusual blood pressure variation, physical fatigue, hearing impairment and, in acute cases, permanent hearing loss, rupture of ear drum etc.

### 18.3.5 Measures for Preservation of Flora and Fauna

During development phase the flora and fauna will face serious threat due to the movement of project traffic and other related activities. Especially there is a threat that the whole vegetation cover of the project area will be denuded. It is proposed that this potential damage should be mitigated after developing the parks in the area.

## 19.0 Institutional Requirements

Institutional requirements involve building up trained staff that would cater for environment friendly atmosphere during and after the project operations. Trained staff will include health, safety and environment (HSE) personnel with good background and experience to make the zero injury during the project operations.

Following specialized studies need to be conducted at the time of detail designing of the project:

- Groundwater profile of the project area with focus on availability of the resource.
- Post October 8, 2005 earthquake seismological profile of the project area especially for high rising buildings.

## 20.0 PROPOSED LAYOUT PLAN

The layout plan and landuse distribution with respect to main Expressway leading to Murree Emirates Resort Zone-4-B-2 is comprised of Building 1: 18 floors, Building 2: 21 floors, Building 3: 25 floors, Building 4: 20 floors, Building 5: 13 floors and Commercial has ground + 1 floor.

### 20.1 Compliance with CDA by Laws

Parameters of CDA for high rise development with passenger and cargo lift in Zone 4-B-2 are met such as requirement of maximum area of 50 kanal for which permission can be granted, ground coverage of 40%, and maximum number of storeys and height of buildings with lifts as mentioned in section 20.0.

### 20.2 Roads and Circulation

The concept of road hierarchy is indicated in the physical plan. Standards of CDA for providing major and minor roads have been followed while designing efficient and effective circulation for apartment buildings.

### 20.3 Major Roads

Major roads are traffic collector roads and are linked with Secondary roads at convenient locations. The Main Boulevard of 60 feet width is provided. This road definitely helps to achieve smooth flow of traffic movement in the scheme area

### 20.4 Secondary Roads

Secondary roads of 50 ft have been provided. Major purpose is to act as boundary of each neighborhood blocks. Secondary roads collect traffic volumes from neighborhood units and link it to primary roads.

## 21.0 GRAVEYARD

Details of graveyard area is along with other details is provided in the following Table 21.1. & Table 21.2.

**Table 21.1:- Graveyard Area**

| | | |
|---|---|---|
| **General Calculations** | | |
| Total Area of Scheme | 50.00 | Kanals |
| | 6 | Acres |
| F.A.R | 1 : (to) 5 | |
| Total Covered Area | 250 | Kanals |
| | 1,361,250 | Sft |
| Size of one Apartment | 1,200 | Sft |
| Total No. of Apartments | 1,134 | Apt |
| HouseHold Size | 4 | Persons |
| Total Population | 4,538 | Persons |
| Population Density | 726 | Persons Per Acre |
| **Grave Yard Area Required** | | |
| Death Rate (2017) | 6.994 | per thousand |
| Rotational Time for one grave | 40 | years |
| Number of graves required for one rotation | 279.76 | |
| Gross Size of One Grave | 54 | Sq. ft. |
| Area Required | 15,107 | Sq. ft./1000 persons |
| | 2.77 | Kanal/1000 persons |
| | 0.35 | Acres/1000 persons |
| At average urban density of 508 persons/acre area required for 3.83 Acres of land | 1.57 | Acres |
| | 12.59 | Kanals |
| Percentage of total | 25.18 | % |
| Area required for graveyard | 12.59 | Kanals |

**Table 21.2:- Mortlity Rate in Islamabad**

| | | |
|---|---|---|
| Mortlity Rate in islamabad (2017 census) | 6.3 | per thousand |
| | | |
| Rotational Time for one grave | 40 | years |
| | | |
| Number of graves required for one | 252 | |
| Rotation | | |
| Gross Size of One Grave | 54 | Sq. ft. |
| | | |
| Area Required | 13,608 | Sq. ft./1000 persons |
| | | |
| | 2.50 | Kanal/1000 persons |
| | | |
| | 0.31 | Acres/1000 persons |
| | | |
| At average urban density of 470persons/acre area required for 3.83Acres of land | 0.56 | Acres |
| Percentage of total (%) | 14.68 | |

Sponsor undertakes that they will provide the site for graveyard within a radius of 10 km away from the project site.

## 22.0 CONCLUSIONS AND RECOMMENDATIONS

This section presents the major conclusions and key recommendations of the Environmental Impact Assessment that has been conducted in line with the relevant guidelines provided by the Pak EPA. The EIA study has been carried out to identify and assess the potential environmental and social impacts of the proposed construction of the EMIRATES RESORT APARTMENT BUILDINGS at the foothill and plan topography. EIA contains description of the project, detailed seismology studies with its implications on structures with reference to peak ground acceleration, hydrological studies, impact of high level flooding to EMIRATES RESORT APARTMENT BUILDINGS , flora and fauna, and potential environmental impacts and their mitigation.

### 22.1 Conclusions

Environmental criteria adopted for the construction Apartment Building maximum of 28 storey at EMIRATES RESORT Mouza Phulgarn Murree Expressway Zone 4-B-2 is comprised of three sub-criterions:

- Physical environmental impacts criterion
- Ecological environmental impacts criterion
- Socio-economic environmental criterion

Environmental impacts were classified in three negative and three beneficial environmental impacts categories i.e. high, moderate, and low.

Following is the conclusion statement of the study on the basis of screening environmental impacts through the environmental criteria:

*"The project does not cause any critical environmental negative impact due to which the project could be dropped. Project causes many important high and moderate impacts under the physical and socio-economic criterions for which proper mitigations exist and can be implemented. Project causes low ecological environmental impacts on the basis of the information available to the consultants."*

Following are the criterion specific conclusions of the study:

## 22.2 Physical Environmental Impacts Criterion Conclusion Statements

- Natural physical indicators such as climate, rainfall, temperature, wind, evaporation, topography, drainage, topsoil, physiography, and geology of the area are suitable for the development of Emirates Resort Apartment Buildings

- Seismological studies carried out in detail have indicated that the NW Himalayas fold and thrust belt, Pakistan is seismically active with a number of faults. Among them a total of 45 faults are active. The site of EMIRATES RESORT APARTMENT BUILDINGS , which lies in Potwar Seismic Zone of this belt, is in the influence of 14 active faults (Table 5.4). However, the construction of any structure at the site would be safe by considering the design parameters with PGA (Peak Ground Accelaration) values ranging from 0.08g-0.44g.

- EMIRATES RESORT APARTMENT BUILDINGS site in the close proximity of the Local Nallah and Korang is quite safe from the risk of over flooding during rainy season. Peak discharges of main rivers were estimated by means of flood frequency analysis using long term recorded flood data. These results for different return periods are presented in the report.
- EMIRATES RESORT APARTMENT BUILDINGS is placed at the alluvial sandstone (Murree) deposits that are recharged by the Rainfall and Local Nallah. In regional sense, geology of the area includes the Salt range rises from the Punjab Plains forming an impressive escarpment that mainly trends east-west in the east. It swings to NNW in the west and form a garland like feature. Towards north, it is separated from Kala Chitta Range with the intervening Potwar Plateau.

- Project will cause positive impacts through better management controls of the floodwaters during rainy seasons.

### 22.1.1 Ecological Environmental Impacts Criterion Conclusion Statements

- No endangered species of flora and fauna exist in the project area.

- Ecological impacts were predominantly determined on the basis of secondary information.

### 22.1.2 Socio-economic Environmental Impacts Criterion Conclusion Statements

- None of the monuments or sites, of archaeological or historical importance, exists in the scheme area.
- Local people will be benefited by hiring them for employment during the construction phase.
- Peoples are likely to purchase these Apartments constructed in a modern way technology by the EMIRATES RESORT APARTMENT BUILDINGS
- EMIRATES RESORT APARTMENT BUILDINGS is located at scenic and beautiful environmental surroundings and would attract lots of buyers from the surroundings of rural and urban areas.

## 22.2 Recommendations

Following is list of major specific recommendations:

- Establish the right of the locals on the 20% unskilled & skilled jobs created by the project, and operationalize the right by incorporating this as a standard clause in the contract document of the contractors during development stage.
- Implement storm water management, provision of septic tanks, and sewage disposal measures in the EMIRATES RESORT APARTMENT BUILDINGS area.
- Adopt proposed mitigations for disposal of lubricants, solid and liquid waste management, prevention and treatment of wastewater, air pollution control and treatment, noise control, and preservation of flora and fauna.

## 23.0 Questionnaire set filled by the Local Stockholders

Questionnaire set filled by the local Stockholders on different environmental issues is also attached herewith.

## APPENDIX: Photographs

Characteristic Rocks along the Expressway

*Parthenium hysterophorus* an exotic species

Kuri Area

Field survey by Environmentalists

A source of water by traditional tube well

*Solanum surratense* a dominant species

A view of scrub vegetation

A type of clay soil near Soan River

Habitat of duck in the Soan River

*Nelumbo nucifera* an aquatic plant

A view of soil erosion

A view of waste material / garbage dump in open land

Local impoundment by recharge of Soan & Ling Rivers

*Cordial oblique* an endangered species

*Uromastix hardwickii*

Local impoundment by River recharge

Land scaping

Grass hopper

Lower plants

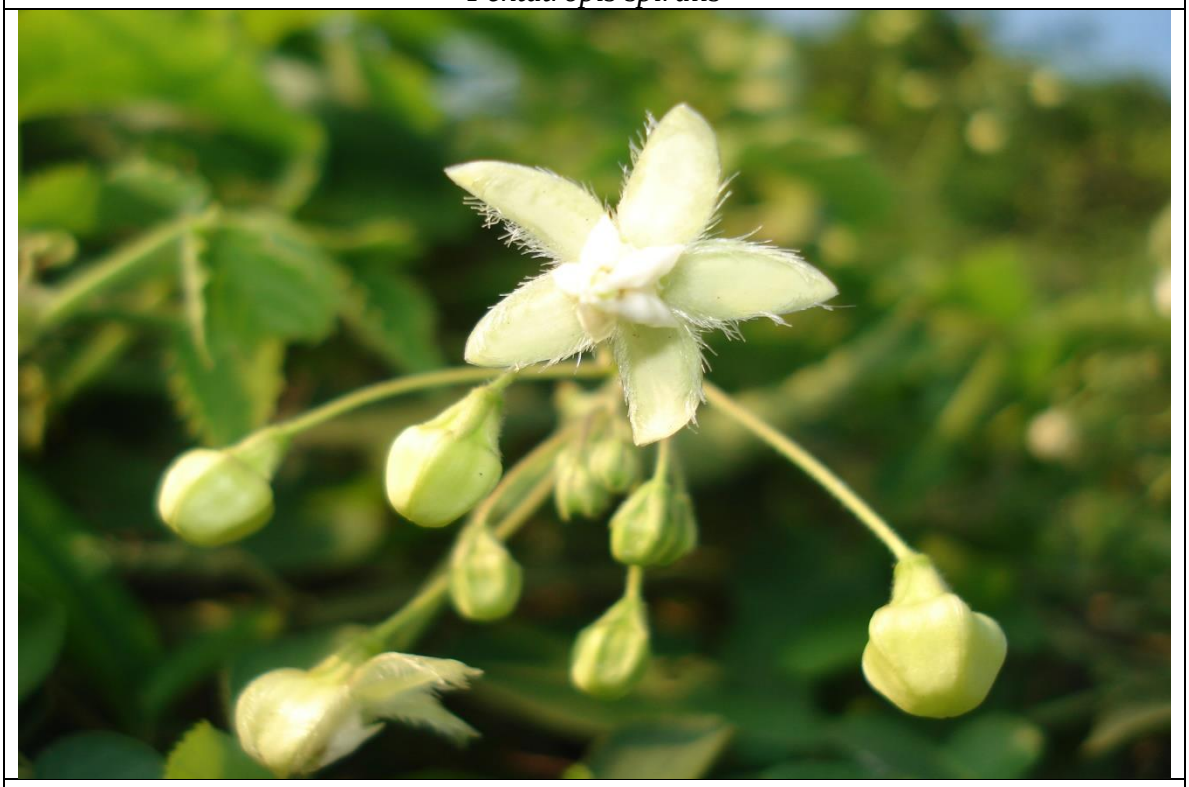
Lichens

Water erosion

*Lantana alba*

Wind erosion

*Pentatropis spiralis*



*Pergularia demia*

*Capparis spinosis*

*Sida alba*

*Euschernia crepis*

*Euschernia crepis* a pollution absorbing species

*Wattakaka vulubalis*

*The Soan River, closer view*