TERMS OF REFERENCE
FOR GEOLOGICAL, GEOTECHNICAL AND STRUCTURAL INVESTIGATIONS
FOR BUILDINGS AT BIODIVERSITY PARK MURREE

1.0 INTRODUCTION

Murree Biodiversity Park (MBP) is one of the four parks established by Environmental Protection Department (EPD), Government of Punjab under an Annual Development Programme. The project was carried out with the objective to preserve, protect, and grow different species of flora and fauna along with all types of allied biological life-forms in the parks. Murree Biodiversity Park is located at Chitta More near Sunny Bank, Murree, in Rawalpindi District. The park was developed through an EPC Contract by International Union for Conservation of Nature (IUCN).

EPD engaged Engineering Consultancy Services Punjab (Pvt.) Ltd. (ECSP) for providing Third Party Evaluation services for completed work at site. ECSP submitted Final Report of Third Party Evaluation in January 2015 comprising principal findings and recommendations, indicating rectifications/improvements required in MBP. It was recommended by ECSP in Third Party Evaluation Report that Geotechnical Investigations should be conducted (if not done previously) to analyze and recommend remedial measures for soil stability against land sliding in the park area. It was learnt from Third Party Post-completion Final Report that Geotechnical Investigation Report was not made available.

As part of works for the Murree Biodiversity Park, following buildings were constructed:

- Main Entrance, Ticketing and Gallery Building
- Cafeteria and Toilets Building

The above mentioned buildings in the MBP are reportedly showing signs of structural distress, either due to differential settlements in the foundation or movement of soil mass beneath foundations.

In order to investigate and propose mitigation measures in detail, EPD intends to acquire the following services:

1. Investigation of the reported structural distress and differential settlements in the above mentioned buildings;
2. Proposal for appropriate remedial measures to arrest the reported structural distress and differential settlements;
3. Review of existing Structural Design and recommendations for buildings stability;
4. Verification of As-built Drawings of MBP.

The problem is to be viewed from the perspectives of Geotechnical as well as Structural Engineering.

Murree area has been prone to large and frequent landslides. It is, therefore, quite possible that the structural distress and deformations in the buildings are result of ground movements in the general area. For this very reason, the Geotechnical Investigations
gain precedence over other Structural Investigations to ascertain the cause of distress in the buildings. A two pronged approach is proposed to investigate the matter with following components:

- **Geotechnical investigations** to assess whether ground movements are responsible for distress in tile buildings or there are any other factors which are contributing to such movements.

- **Structural Investigations** to assess the extent of distress in the buildings and its possible causes by analyzing building foundations for any deficiencies in structural design.

Based on the above investigations, the consultant would suggest suitable remedial measures.

2 **PROPOSED METHODOLOGY FOR GEOTECHNICAL/GEOLOGICAL STUDIES**

The consultant’s methodology for Geotechnical Investigations shall comprise detailed field investigations and laboratory testing to assess global stability of the site and to determine the technical requirements for design of foundations.

These investigations and tests would necessarily include:

1. Surface Geological Mapping and Landslide Hazard Studies (Task-1)
2. Geotechnical Studies (Task-2, on the basis of data collected in Task-1) including field investigations and tests.

Field work and laboratory testing shall be performed through an independent well reputed firm. All field works and laboratory testing shall be supervised by the consultant. Field and laboratory testing data shall be analyzed and foundation design parameters shall be developed. The entire work shall be documented and submitted to the Client for record and reference.

Field investigation shall be started immediately after signing of Contract Agreement.

3 **SCOPE OF WORK**

3.1 **Surface Geological Mapping and Landslide Hazard Studies**

Following shall be the scope of work for Geological/Geotechnical studies:

a) Geological mapping for the identification and distribution of litho logical units, faults, liniments, major joints or any other important structural feature having significant impact on the study objectives.

b) Identification of other potential geological and geotechnical hazards with remedial measures suggested.

c) Characterize the landslide, their type/range of ground movement such as rock falls, deep failure of slopes, shallow debris flow, slump, cut-bank, etc. identification of their primary driving force, contributing factors affecting the original slope stability, pre-conditional factors, and building up sub-surface conditions that make the areal slope prone to failure.
d) Highlight and characterize slope instability factors, such as groundwater, pore-water pressure of the soil, soil structure, earthquake loads, unplanned construction, etc. with their remedial measures and typical engineering design for the slope stability.

e) Prepare overall Geological assessment of the project area.

3.2 Geotechnical Studies

a) Prepare and execute a comprehensive plan for geotechnical investigations on the basis of data collected and desk studies conducted in Task-I, which shall necessarily include:

b) Field investigations shall include:
   i. Drilling of boreholes in overburden and continuous core drilling in bedrock
   ii. Performance of SPT/CPT test in overburden soils
   iii. Manual excavation of test pits
   iv. Collection of rock/soil samples for appropriate laboratory testing
   v. Prepare program of laboratory testing and follow up
   vi. Analysis of field and laboratory testing data
   vii. Evaluation of geotechnical parameters
c) Installation and monitoring of following instruments with real-time monitoring:
   i. Surface settlement markers
   ii. Piezometers
d) All investigation and testing shall be carried out using internationally adopted/accepted equipment, techniques and procedures.

e) Preparation of Geotechnical Investigation Report.

3.3 Structural Investigations and Studies

Structural Investigations will be carried out to assess the current condition of the building facilities and to identify the mechanisms which are contributing to the distress in the buildings. Reportedly, very limited amount of information is available about the design details of the buildings and the types of foundations provided. To assess the type and size of the foundations provided, pits are proposed to be excavated at few locations near the building perimeter. Tests would be carried out to ascertain whether the materials used in construction meet the applicable codes and standards.

In addition to the carrying out tests on the buildings, computer based structural analyze of the building facilities shall also be carried out with the aim of identifying any structural deficiencies and devising remedial measures.

4.0 Duration of the Study

Time required for the geotechnical and geological studies is estimated as 2 months, including field, laboratory testing and desk studies. A report on study and its findings shall also be submitted at the end of study. This time period would commence after the award of the Contract.