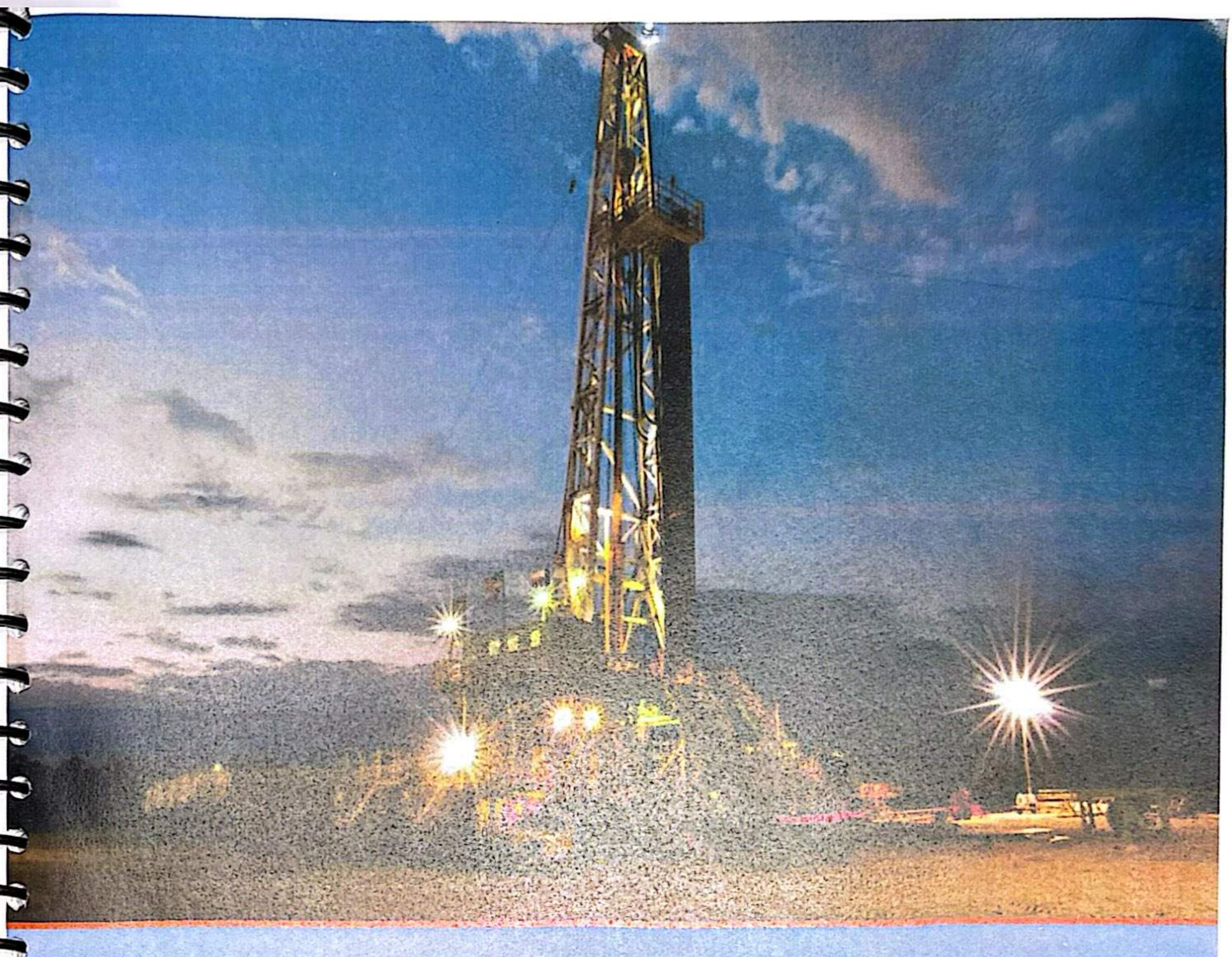

EIA for Oil & Gas Drilling Activities in Missakeswal D&PL, Punjab Province

EIA Report

May 2025

OIL & GAS DEVELOPMENT COMPANY LIMITED

SGS

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SGS Pakistan Pvt. Limited

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Acronyms

APHA	American Public Health Association
ALARP	As Low as Reasonably Practicable)
BHU	Basic Health Unit
Ba	Barium
BOD	Biological Oxygen Demand
CBD	Convention on Biological Diversity
Cd	Cadmium
Cr	Chromium
COD	Chemical Oxygen Demand
CNG	Compressed Natural Gas
CMS	Conservation of Migratory Species of Wild Animals
DCR, s	District Census Reports
DFO	District Forest Officer
DC	Deputy Commissioner
EMP	Environmental Management Plan
EC	Electrical Conductivity
EPA	Environmental Protection Agency
EHS	Environmental Health & Safety
E&P	Exploration & Production
EIA	Environmental Impact Assessment
ERP	Emergency Response Plan
GIIP	Good international industry Practice
GW	Ground Water
HSE	Health, Safety and Environment
Hr	Hour
HEM	Oil & grease
HSE	Health Safety & Environment
Hg	Mercury
EIA	Environment Impact Assessment
IFC	International Finance Corporation

IUCN	International Union of Conservation for Nature
kg	Kilogram
Km2	Square Kilometer
LAA	Land Acquisition Act
LPG	Liquid Petroleum Gas
m	Meter
mg/kg	Milligram per Kilogram
mg/l	Milligram per Litre
mg/m^3	Milligram per Cubic Meter
MW	Mega Watt
NEP	National Environmental Policy
NFPA	National Fire Protection Association
NCCW	The National Council for Conservation of Wildlife
NCS	National Conservation Strategy
NGO's	Non-Governmental Organizations
NEAP-SP	National Environmental Action Plan-Support Programme
OBM	Oil Based Mud
OGDCL	Oil & Gas Development Company Limited
PEPA	Pakistan Environmental Protection Act 1997
PEPC	Pakistan Environmental Protection Council
PM	Particulate Matter
PPE's	Personal Protective Equipment
ppm	Parts per Million
pb	Lead
PPC	Pakistan Penal Code
PCA	Petroleum Concession Agreement
PSA	Production Sharing agreement
PEQS	Punjab Environmental Quality Standards
PEPA	Punjab Environmental Protection Agency
SS	Soil Sample
SDPI	Sustainable Development Policy Institute
SPO	Strengthening Participatory Organization

Se	Selenium
sq. km	Square Kilometre
TDS	Total Dissolved Solids
TSS	Total Suspended Solids
UNDP	United Nations Development Programme
WHO	World Health Organization
WBM	Water based Mud

Executive Summary

This document presents the findings of an Environment Impact Assessment (EIA) carried out by SGS Pakistan (Pvt.) Limited for the proposed Oil & Gas Drilling Activities in Missakeswal D&PL, Punjab Province by Oil and Gas Development Company Limited (OGDCL). It has been prepared to conform the Punjab Environmental Protection Act, 1997 (amended 2017) and review of IEE & EIA regulations, 2022. The proposed project is located in District Rawalpindi, and project activities will be also carried out in tehsil Gujar Khan, Rawalpindi district.

OGDCL is granted Missakeswal D&PL for the purpose of oil and gas development & drilling activities.

The activities associated with the proposed development program will comprise of drilling of development well, associated activities and if successful then tie-in to existing nearby facility in future. Geological and seismic surveys can identify the possibility that petroleum is present, but the only way to ascertain this is to drill a well. If drilling proves fruitful, and the petroleum reservoir is to be commercially exploited, the field has to be developed for oil and/or gas production.

The EIA covers potential effects of the proposed project drilling activities in the project area. Potential impacts on the physical, biological, socio-economic and cultural environment that may arise from the drilling and the mitigation measures to be adopted have been assessed and presented in the report.

The Environment Impact Assessment study ensures that:

All aspects of the existing project area are examined, and data is collected to form a comprehensive environmental and socioeconomic baseline.

All major and minor positive or negative impacts on the environment (physical, biological, social and ecological) during the different stages of project are identified.

A list of mitigation measures covering all possible impacts is included along with their implementation procedures and guidelines.

A detailed Environmental Management Plan (EMP) is provided for sustainable operation of the project and forms an essential part of the EIA document.

For the effective implementation and management of mitigation measures, an Environmental Management Plan (EMP) has been prepared which meets the requirements of the Punjab Environmental Protection Act, 1997 (amended 2017) and review of IEE & EIA regulations, 2022.

In performing of the EIA study, all relevant national and international legislations and regulations have been accounted for. Environmental and socio-economic baseline has

been taken from previous reports, books and other literature available pertaining to project area. The proposed project will involve activities of mobilization, civil works, development of access tracks and campsites, drilling/ testing & well operation, rig demobilization, site restoration (depending on failure or success of the well).

The EIA covers potential effects of the proposed project activities in the project area. Potential impacts on the physical, biological, socio-economic and cultural environment that may arise from the proposed project activities and the mitigation measures to be adopted have been assessed and presented in the report.

On the basis of findings of this EIA study, it is concluded that operation of proposed project will have best performance environmental pollution control system which will averse all the potential adverse effects. Therefore, it will not have any significant adverse impacts on the local population or any segment of environment and by implementation of mitigation measures discussed in this EIA report.

Therefore, it is recommended that the NOC as requested may please be issued by the Punjab Environment Protection Agency so that the project may be started in time.

1 Introduction

This report presents the findings of an Environment Impact Assessment (EIA) carried out by SGS Pakistan (Pvt.) Limited for the proposed drilling activities by OGDCL in Missakeswal D&PL, Tehsil Gujar Khan, District Rawalpindi of Punjab Province, with an objective to maximize the economic production and recovery of oil & gas in project area.

1.1 Project Title and Project Proponents

1.1.1 Project Title

The proposed project to which this (EIA) relates is entitled as "Oil & Gas Drilling Activities in Missakeswal D&PL, Punjab Province". The proposed project falls in tehsil Gujar Khan, district Rawalpindi of Punjab province. A key map showing the location of the project area is shown in Figure 1.1.

1.1.2 Project Proponent

OGDCL being the leading national E&P Company maintains a balanced portfolio of exploratory assets in the established and unexplored areas. In line with its exploration led growth strategy, OGDCL has acquired in-house state-of-the-art technology along with qualified team of professionals to exploit potential exploration targets with minimized risks.

The drilling operations department is responsible for the end-to-end delivery of oil and gas wells, from engineering design and planning to procurement, execution, and operations. The department boasts a highly experienced team of engineers and technologists, with expertise in drilling across challenging lithologies, particularly in northern Pakistan. This team has a proven track record of delivering wells in difficult environments, ensuring the safe and efficient extraction of hydrocarbons. The department adheres to safety protocols and conducts continuous training to protect its assets and the environment during all operations. OGDCL being a low-cost operator is also focused on establishing footprints abroad by undertaking farm-in/farm-out opportunities as wells as acquisition of concessions in domestic and international market. In this respect, the Company is making all out efforts to seek suitable opportunities that will augment the business strengths and deemed financially viable.

OGDCL is determined to carry on its extensive exploration program including fast track seismic data acquisition, processing and interpretation followed by active drilling campaigns to replenish and augment hydrocarbon reserves, ramp up oil and gas production and contribute in the economic development of the country.

1.2 EIA Consultants

The EIA study was carried out by team of SGS Pakistan comprising of environmental specialist, environmental engineers, petroleum engineer, sociologist, environmental chemist and sector

experts with diversified experience on local and international assignments. The detail of the project team deputed on this assignment is attached as Annexure-A.

1.3 Purpose of the Report

EIA is mandatory according to the Punjab Environmental Protection Act 1997 (Amended, 2017). Section 12 (1) of the Punjab PEPA 1997 (Amended, 2017) states that:

"No proponent of a project shall commence construction or operation unless he has filed with the Provincial Agency an initial environmental examination or, where the project is likely to cause an adverse environmental effect, an environmental impact assessment, and has obtained from the Provincial Agency approval in respect thereof".

1.4 Legal Categorization of the Project

In accordance with the Punjab Environmental Protection Act, 1997 (amended 2017) and review of IEE & EIA regulations, 2022, the planned Oil and Gas Drilling Activity in Missakeswal D&PL, comes under Section A i.e. Energy Schedule – II, List of projects requiring an EIA. Therefore, EIA of the project is being carried out.

1.5 Brief Description of Nature, Size, and Location of the Project

The proposed project nature is drilling of oil & gas development well named Missakeswal-05 to maximize the economic production and recovery of oil & gas within Missakeswal D&PL. Based on seismic results, drilling will be carried out by using conventional onshore rotary drilling rig. The project activities will start with the civil works for construction of site, camp set up, rig mobilization, drilling, and completion, stimulation, well testing, operation and demobilization and site restoration.

OGDCL plans to conduct drilling of development well at selected potential location and if drilling becomes fruitful (after verification through examining data collected from coring, logging and well testing), will perform tie-in to existing nearby facility.

The proposed project (Missakeswal-05) is located in Tehsil Gujar Khan, District Rawalpindi, Punjab. Project location map is presented in Figure 1.1.

1.6 EIA Process

1.6.1 Overview of EIA

EIA is a systematic process to identify, predict and evaluate the environmental impacts of proposed actions and projects. The process is applied prior to major decisions and commitments being made. Wherever appropriate, social, cultural and health effects are considered as an integral part of EIA. Particular attention is given to practical implementation of EIA to prevent and mitigate significant adverse effects of proposed undertakings.

1.6.2 Objective of EIA

The overall objective of the EIA is as follows:

- Description of the proposed project, including an estimate of emissions, effluent, waste and consideration of the project alternatives.
- Identify and investigate all impacts of the proposed project on the physical, biological, and socio-economic environment.
- Evaluation of the baseline environmental conditions in the impact zone to provide a basis for assessing the incremental impacts of the proposed project, including existing pollution levels and nuisance conditions.
- Identification and assessment of the potential impacts on the environment during each of the project phases.
- To propose mitigation measures that would help the project proponent in conducting the operation in an environmentally sustainable manner.
- To develop an Environmental Management Plan that would assist the project proponent in the effective implementation of the recommendations of the EIA.

1.6.3 Scope of EIA

This EIA covers the anticipated impacts of drilling activities in Missakeswal D&PL, Punjab. The scope of the EIA includes:

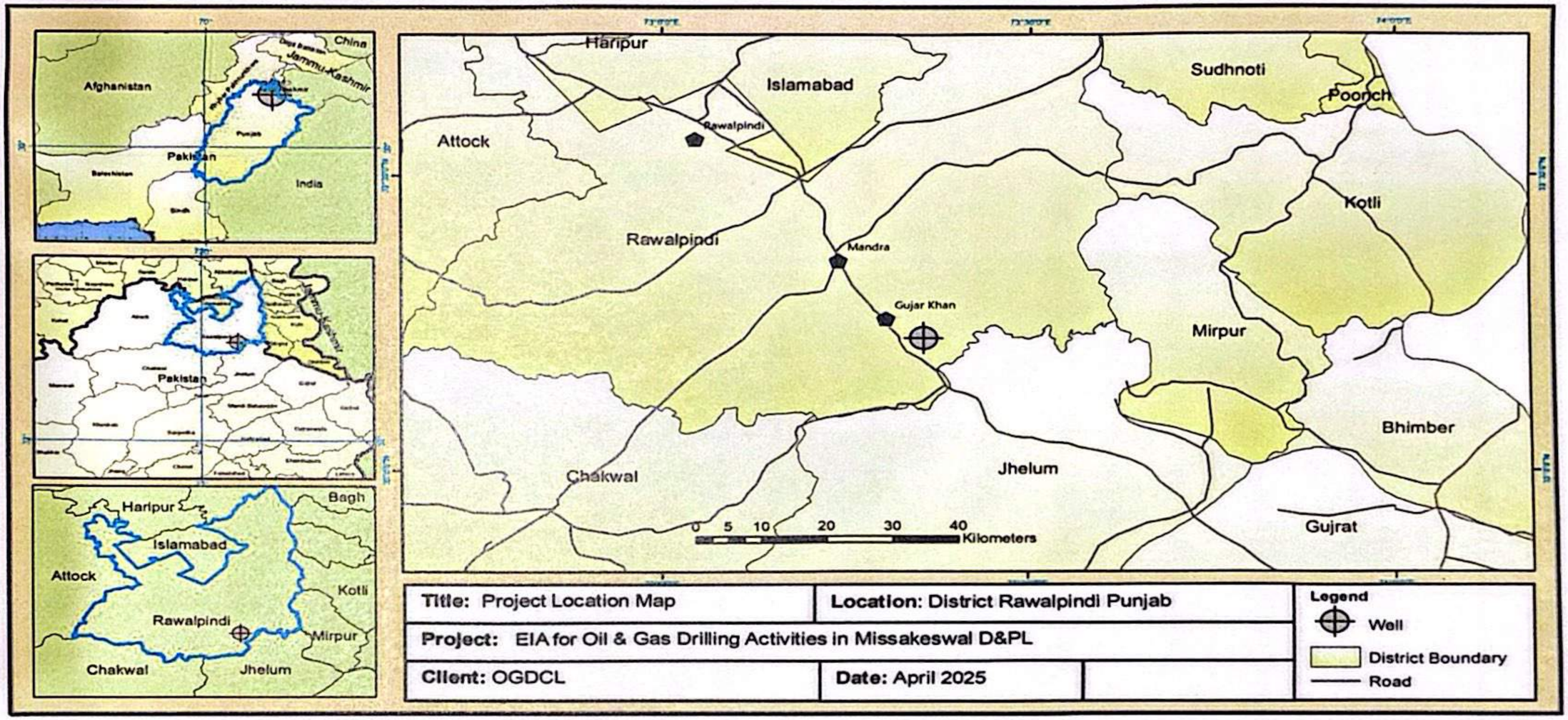
- Drilling activities at the proposed project site
- Relevant off-site construction activities
- Demobilization activities

1.6.4 Spatial Scope

Impacts are assessed within the area of influence of the proposed project defined as:

- Immediate Area of Influence: at immediate footprint of proposed project location.
- Direct Area of Influence: within the proposed project area and its immediate surrounding environment.

Figure 1.1: Project Location Map



1.7 EIA Methodology

The EIA project passes through series of stages prior to report preparation. The EIA process and the approach followed for the proposed project is defined below:

1.7.1 Scoping

Scoping is an early stage of the process and is designed to ensure that the environmental studies provide all the relevant information on:

- The impacts of the project, in particular focusing on the most important impacts
- The alternatives to the project
- Other environmental sensitivities to be addressed at early stage

The EIA process started with the scoping. The purpose of scoping was to identify:

- The important issues to be considered in an EIA
- The appropriate time and space boundaries of the EIA study
- The information necessary for decision-making
- The significant effects and factors to be studied in detail

The scoping was followed by data collection described in subsequent section.

1.7.2 Data Collection

Following literature review and data collection was carried out for EIA:

- A generic description of the proposed project and its related activities was collected from the OGDCL
- Legislative review of the applicable laws, regulations, guidelines and standards from various organizations and literature search
- Baseline of the area's environmental and socio-economic settings was collected through literature search and field surveys

1.7.3 Baseline

The environmental impact is measured through a change in the environment, resulting from a designated action or activity. In order to identify such a change, it is essential to have as complete as practicable understanding of the nature of the existing environment, prior to its interaction with the proposed activity. This translates into the need to characterize the existing baseline environmental conditions, including establishing prevailing conditions for a range of environmental media, particularly air, water, soil and groundwater, flora and fauna and the human environment.

This was achieved through a detailed review of all secondary resources (i.e. existing documentation and literature); and the undertaking of project specific baseline studies and surveys to collect supplementary data in the following areas:

- Geology
- Flora and fauna
- Water quality characteristics
- Soil quality
- Traffic
- Ambient air quality
- Noise conditions
- Socio-economic conditions
- Protected areas
- Archaeology

Both the existing secondary sources and literature studies were conducted and integrated into one coherent description of baseline characteristics.

1.7.4 Stakeholder Consultation

Communities within the project area were consulted during the fieldwork to record their concerns and suggestions.

1.7.5 Evaluation of Alternatives

To establish an environmentally sound preferred option for achieving the objectives of the proposed project, different alternatives including site selection, raw material and technology alternatives were studied in collaboration with the project proponent. Technology selection was made taking into consideration environmentally, economically and socially suitable as well as technically feasible options.

1.7.6 Impact Assessment and Mitigation

The information collected in the previous phases was used to assess the potential environmental impacts of the proposed project activities. The impact assessment approach is provided in Table 1.1. Detailed methodology is included in Chapter 7 of the report. Mitigation measures were evaluated to reduce the impacts of project activities on environment. The issues studied during impact assessment include potential impacts on:

- Physical environment of the area
- Biological environment of the area
- Socio-economic environment of the area.

Table 1-1: Impact Assessment Approach

Impact Characteristics	Categories
Nature of the Impact	**Direct:** The environmental parameter is directly changed by the project. **Indirect:** The environmental parameter changes as a result of change in another parameter.
Duration of the impact	**Short term:** Lasting only till the duration of the project such as noise from the construction activities. **Medium term:** Lasting for a period of few months to a year after the

Impact Characteristics	Categories
	project before naturally reverting to the original condition. **Long term:** Lasting for a period much greater than medium term impacts before naturally reverting to the original condition.
Geographical Location of the impact	**Local:** Within the area of project i.e. operation site and access road. **Regional:** Within the boundaries of the project area. **National:** Within the boundaries of the country. **Global:** Trans-boundary impacts
Timing	Construction Operation
Likelihood of the impact	**High:** High likelihood of occurrence during lifetime of operation, Regular/continuous part of operations. **Moderate:** Moderate possibility of occurrence during lifetime of operation, Periodic/occasional part of operations. **Low:** Unlikely to occur during lifetime of operation.
Reversibility of the impact	**Reversible:** When a receptor resumes its pre-project condition. **Irreversible**: When a receptor does not or cannot resume its pre-project condition.
Significance of the impact	**Major, Moderate, Minor, Negligible and Beneficial** Based on the consequence, likelihood, reversibility, geographical extent, duration, level of public concern and conformance with legislative or statutory requirements.
Consequence severity of impact	**High:** ▫ Serious/catastrophic damage to environment ▫ Direct legislative requirement ▫ Corporate requirement ▫ Serious threat to corporate reputation/profitability/ability to do business. **Medium:** ▫ Measurable damage to the environment ▫ Subject to potential future legislation ▫ Potential to affect reputation/cost ▫ Implication/reduced efficiency **Low:** ▫ Negligible damage to the environment ▫ No risk to business

1.8 Organization of the Report

This report has been structured in the following manner:

Chapter 1 *(Introduction)* gives an introduction of the project and overview of EIA process.

Chapter 2 *(Legal Framework)* gives an overview of policy and legislation along with international guidelines relevant to EIA.

Chapter 3 *(Project Description)* provides the description of the proposed project, its layout plan and associated activities, raw material details and utility requirement.

Chapter 4 *(Project Alternatives)* provides the description of the site alternatives for the proposed project.

Chapter 5 *(Description of Baseline Environment)* provides a description of the micro-environment and macro-environment of the proposed project site. This chapter describes the physical, ecological and socioeconomic resources land of project area and surroundings.

Chapter 6 *(Stakeholder Consultation)* presents the process and finding of stakeholder consultation being carried out for the proposed project.

Chapter 7 *(Impact Assessment and Mitigation Measures)* describes the potential environmental and social impacts of proposed project on the different features of the micro and macro-environment using the matrix method.

Chapter 8 *(Environmental Management Plan)* explains the mitigation measures proposed for the project in order to minimize the impacts to acceptable limits. It also describes implementation of mitigation measures on ground and monitoring of environmental parameters against likely environmental impacts.

Chapter 9 *(Conclusion)* summarizes the report and presents its conclusions.

The last Chapter is followed by the references and series of **Annexes** that provides supporting information.

Chapter 10 *(References)* presents the list of references where secondary data collected.

1.8.1 Proponent Contact Details

Proponent: Oil & Gas Development Company Ltd. (OGDCL)
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Fax: +92-51-2623041; +92-51-2623113-17
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1.8.2 Consultant Contact Details

Consultant: SGS Pakistan Pvt Ltd
Contact: Ammara Naqvi – Manager I & E
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Fax: +92-42-375154420
Email: ammara.naqvi@sgs.com, danial.zaib@sgs.com, shoaib.riaz@sgs.com

2 Legal Framework

This chapter provides an overview of the environmental policies, legislation, and guidelines that may have relevance to the proposed project. These include national environmental policy, legislation and guidelines, and international conventions and guidelines. OGDCL will be required to adhere to the relevant requirements of the policies and legislation during the proposed project activities, which has also been incorporated in the mitigation measures and the EMP provided in the EIA.

2.1 Constitutional Provision

According to the Constitution of Pakistan, the legislative powers lie with the federal parliament and the legislative assemblies of the four provinces of Pakistan. The Fourth Schedule of the constitution provides two lists of issues. One list, the Federal Legislative List, includes issues on which only the federal government has legislative powers. The second list, the Concurrent Legislative List includes issues on which both the federal and the provincial governments have legislative powers. If a legislation passed by a provincial assembly comes into conflict with a law enacted by the national assembly, then according to the constitution, the federal legislation will prevail over the provincial legislation to the extent of the inconsistency. The subject of 'environmental pollution and ecology' is included in the concurrent list of the constitution. Thus, allowing both the federal and provincial governments to enact laws on the subject.

2.2 Framework of Environment and Wildlife Institution in Pakistan

The Federal Ministry of Environment was the main government organization responsible for the protection of environment and resource conservation. It was headed by a federal minister.

The Ministry worked with PEPC, and the Federal and Provincial EPAs formed under the PEPA 1997. The roles, responsibilities and authorities of PEPC and the EPA's have been defined in the PEPA 1997. However, after 18th constitutional amendment, the said ministry has been devolved into provinces and Pakistan Environmental Protection Agency is working under the umbrella of Climate Change Division.

Now, Pakistan Environmental Protection Agency is an attached department of the Climate Change Division and responsible to implement the Pakistan Environmental Protection Act 1997, in the country, an Act to provide for the protection, conservation, rehabilitation and improvement of environment, for the prevention and control of pollution, and promotion of sustainable development. Pakistan Environmental Protection Agency also provides all kind of technical assistance to the Climate Change Division.

The National Council for Conservation of Wildlife (NCCW) is responsible for formulation of national wildlife policies, co-ordination with provincial wildlife department on the implementation of these policies and co-ordination with international organizations on matters related to international treaties/conventions. The NCCW works under the Ministry of Climate Change and is

headed by the Inspector General Forests. NCCW comprises of an advisory council, which is chaired by the Minister of Climate Change and includes representatives from all Provinces, AJK and Northern Areas, NGOs, members of civil society and other federal ministries. A small NCCW secretariat is based in Islamabad handles the day-to-day affairs and the implementation of policies and recommendations of the advisory council. At provincial level almost each province has a wildlife department and a wildlife protection act.

2.3 National Environmental Policies

2.3.1 National Environmental Policy, 2005

The National Environmental Policy (NEP) was approved by the Pakistan Environmental Protection Council (PEPC) in its 10th meeting on 27th December 2004 under the chairmanship of the Prime Minister of Pakistan and thereafter approved by the Cabinet on 29th June 2005.

NEP is the primary policy of Government of Pakistan that addresses the environmental issues of the country. The broad Goal of NEP is, "To protect, conserve and restore Pakistan's environment in order to improve the quality of life of the citizens through sustainable development". The NEP identifies the following set of sectoral and cross-sectoral guidelines to achieve its Goal of sustainable development.

Sectoral Guidelines

Water and sanitation, Air quality and noise, Waste management, Forestry, Biodiversity and Protected areas, Climate change and Ozone depletion, Energy efficiency and renewable, agriculture and livestock, and Multilateral environmental agreements.

Cross Sectoral Guidelines

The NEP suggests the following policy instruments to overcome the environmental problems throughout the country:

- Integration of environment into development planning,
- Legislation and regulatory framework,
- Capacity development,
- Economic and market-based instrument,
- Public awareness and education, and
- Public private civil society partnership,

2.3.2 National Conservation Strategy

Before the approval of National Environmental Policy (NEP) the National Conservation Strategy (NCS) was considered as the Government's primary policy document on national environmental issues. The Strategy approved by the Federal Cabinet in March 1992 and was also recognized by International Financial Institutions, principally the World Bank at the moment this strategy just exists as a national conservation program. The NCS identifies 14 core areas including conservation of biodiversity; pollution prevention and abatement; soil and water conservation; and preservation

of cultural heritage and recommends immediate attention to these core areas in order to preserve the country's environment.

NCS does not directly apply to projects. However, OGDCL should ensure that the project should not add to the aggravation of the 14 core environmental issues identified in the NCS and mitigation measures should be adopted to minimise or avoid any contribution of the project in these areas.

2.3.3 National Environmental Action Plan-Support Programme (NEAP-SP)

The Government of Pakistan and United Nations Development Programme (UNDP) have jointly initiated an umbrella support program called the "National Environmental Action Plan-Support Programme (NEAP-SP)" signed in October 2001 and implemented in 2002. The development objective supported by NEAP-SP is environmental sustainability and poverty reduction in the context of economic growth.

2.3.4 Policy & Procedures for The Filing, Review and Approval of Environmental Assessments

The Policy & Procedures for the Filing, Review and Approval of Environmental Assessments, prepared by the PEPA under the powers conferred upon it by the Pakistan Environmental Protection Act, provide the necessary details on the preparation, submission, and review of the Initial Environmental Examination (IEE) and the Environmental Impact Assessment (EIA). It provides schedules of proposals that require either an Initial Environmental Examination (IEE) or an Environmental Impact Assessment (EIA).

2.3.5 Petroleum Exploration & Production Policy 2012

Government of Pakistan introduced the first petroleum Policy document in 1991. This was then followed by new Petroleum Policies of 1993, 1994, 1997, 2001, 2007 and 2009.

Policy 2009 had to be amended by new Petroleum Policy 2012 as the new market conditions warranted urgent changes required for investment promotion in view of increasing international energy prices. It also reflects the resolve of Government of Pakistan to accelerate exploitation of indigenous natural resources by attracting foreign investment with technology as well as promoting local companies to participate in E&P activities on a level playing field.

The purpose of Petroleum Exploration and Production Policy 2012 is to establish the policies, procedures, tax and pricing regime in respect of petroleum exploration and production (E&P) sector.

The Petroleum Exploration & Production Policy 2012 maintains a system based upon the two different types of agreements to obtain E&P rights in Pakistan:

- For onshore operations, a system based upon a Petroleum Concession Agreement (PCA).
- For offshore operations, a system based upon a Production Sharing Agreement (PSA).

This Policy has incorporated the significant achievements of the Pakistani petroleum industry with established good international oilfield practices.

2.4 Provincial Environmental Legislation

The Legislative assembly of Punjab province reviewed and accepted the PEPA 1997 as Punjab's provincial act with some amendments on 18th April 2012 & 25th October 2017 respectively. This act has been approved to provide protection, conservation, rehabilitation and improvement of the environment for the prevention and control of pollution and promotion of sustainable development in the whole of Punjab.

The definition of environmental law can be derived from the legal definition of 'environment'. In Section 2(x) of the Punjab Environmental Protection Act 1997 (Amended on 2017) environment is defined to include air, water, land, and layers of the atmosphere; living organisms and all organic, inorganic matter; the ecosystem and ecological relationships; buildings, structures, roads, facilities and works; all social and economic conditions affecting community life; and the interrelationship between any of the factors in sub clauses (a) to (f). From this definition, an environmental law can be considered to include all laws that are designed to, or that directly or indirectly affect, the management of natural resources including the control of pollution of these natural resources.

By this definition, environmental laws include a) laws that have been specifically enacted to protect the environment such as the PEPA 2017, and laws relating to subject such as forest, water resources, wildlife, land, agriculture, health, and town planning.

2.4.1 Punjab Environmental Protection Act 1997 (Amended on 2017)

The Punjab Environmental Protection Act, 1997 (PEPA, amended on 2017) is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The PEPA is broadly applicable to air, water, soil, marine and noise pollution, as well as the handling of hazardous waste. Penalties have been prescribed for those contravening the provisions of the Act. The powers of the Provincial Environmental Protection Agency were also considerably enhanced under this legislation, and they have been given the power to conduct inquiries into possible breaches of environmental law either of their own accord, or upon the registration of a complaint.

Under section 12 of PEPA, (1) No proponent of a project shall commence construction or operation unless he has filed with the Provincial Agency an initial environmental examination or, where the project is likely to cause an adverse environmental effect, an environmental impact assessment, and has obtained from the Provincial Agency approval in respect thereof.

PEPA shall review the IEE & EIA and accord approval subject to such terms and conditions as it may prescribe or require. The agency shall communicate within four (04) months its approval or otherwise from the date EIA is filed failing which the EIA shall deemed to have been approved.

2.4.2 Punjab Environmental Protection (Review of Initial Environmental Examination and Environmental Impact Assessment) Regulations, 2022

Punjab Environmental Protection Review of Initial Environmental Examination and Environmental Impact Assessment Regulations, 2022 provide the necessary details on the preparation, submission, and review of the IEE and the EIA reports as required by the section 12 of

Punjab Environmental Protection Act 1997 (amended on 2017). These regulations categorize the projects which require an IEE or an EIA on the basis of anticipated degree of environmental impacts.

Categorization: In accordance with the applicable " Punjab Environmental Protection Review of Initial Environmental Examination and Environmental Impact Assessment Regulations, 2022 ", the planned Oil and Gas Drilling Activities in Missakeswal D&PL, comes under **Subsection 05** i.e. *Oil and gas extraction projects including exploration, production, gathering systems, separation and storage* of **Section A** i.e. *Energy* Schedule - **II** *List of projects requiring an Environmental Impact Assessment.* Therefore, EIA of the project is being carried out.

Preliminary scrutiny: Regulation 8 states that the agency shall review the report and inform within 10 working days to proponent for submission of any additional information at any stage during the review process.

Review: Regulation 10 states that the agency shall review the EIA report within 45 days after issuing confirmation of completeness Under clause (a) of sub regulation (1) of regulation 8. It shall also conduct an experts committee meeting or solicit views from concerned advisory committee.

Validity: Regulation 16 defines the validity period of approval of an IEE or EIA to be three years from date of issue and construction must start within three years of report approval. A three-year extension at a time may be granted upon the agency's discretion with or without the submission of a fresh IEE or EIA.

2.4.3 The Punjab Environmental Quality Standards (PEQS 2016)

One of the functions of Pak EPA under the provision of Pakistan Environmental Protection Ordinance PEPO 1983 was to issue National Environmental Quality Standards for municipal and industrial discharge as liquid effluent and gaseous emissions and motor vehicular exhaust and noise. Pak EPA issued a Statutory Regulatory Order (S.R.O) in 1994. It required all units coming into production after July 1, 1994, to apply immediately with new standards. Those already in operation at the time of S.R.O were required to comply from July 1, 1996. The Pak EPA was not able to implement the NEQS effectively for many reasons, including lack of implementation capacity and resistance from industry.

With the PEPA, 1997 the Pak EPA revised the NEQS with full consultations of the private sector, industrialist, trade and business associations and NGOs. The municipal and liquid industrial effluent standards cover 32 parameters. The standards for industrial gaseous emissions specify limits for 16 parameters and the standards for motor vehicles prescribe maximum permissible limits for smoke, carbon monoxide and noise. Revised standards cover discharge limits for effluents into inland waters, sewage treatment plant and the sea. The NEQS are primarily concentration based. Unfortunately, the limits on industrial effluents are neither industry specific nor do they have any relationship with the quantum of production. The NEQS prohibit dilution, but this can be easily circumvented.

On the other hand, following the promulgation Punjab Act 1997 (Amended 2017), Punjab EPA has notified its Environmental Quality Standards known as —Punjab Environmental Quality Standards 2016. OGDCL is committed to comply with the applicable PEQS with letter and spirit.

One of the functions of the Punjab EPA under the provision of Punjab Environmental Protection Act 1997 (Amended 2017) was to issue PEQS for various pollutants. The PEQS are uniform standards applicable to various situations. At the time of this study, PEPA has published the PEQS for municipal and liquid industrial effluents, ambient air quality, industrial gaseous, noise and automotive emissions standards. Punjab EPA issued several of these environmental standards. These are attached as Annexure B with this report. For liquid effluent, there are 32 parameters showing permissible levels of pollutants before its discharge into sea, inland water & septic tanks. For gaseous emissions, there are 16 parameters. The Punjab Environmental Quality Standards for Ambient Air, drinking water Quality and Noise (SO(G) EPD/7-26/2013) are also in force and their compliance is mandatory. PEQS for Soil Quality, Groundwater Quality etc. have not been proposed so far.

2.4.4 National Environmental Quality Standards (Self-Monitoring and Reporting by Industry) Rules, 2001

These rules classify the industrial units for monitoring and reporting their liquid effluent and gaseous emissions into three and two categories, respectively. According to each category they define the priority parameters to be monitored and reported to PEPA according to a specific frequency based on working conditions. This monitoring and reporting are in addition to the monitoring conditions as required by the conditions of approval of EIA. The sampling for testing must be carried out according to Environmental Samples Rules, 2001 and be sent to PEPA certified environmental testing laboratories only.

2.5 The Forest Act 1927

This act is applicable to all regions of Pakistan. It includes procedures for constituting and managing various types of forests, such as reserved forests and protected forests. The act empowers the provincial forest departments to declare any forest area as reserved or protected.

The act empowers the provincial forest departments to prohibit the clearing of forests for cultivation, grazing, hunting, removing forest produce, quarrying and felling, lopping and topping of trees, branches in reserved and protected forests. It also defines the duties of forest related public servants, and penalties for any infringement of the rules.

Project drilling activities area does not contain any reserved forest, although forest department has been informed about development activities and all activities will be implemented such that impacts shall be minimized, conservation practices shall be adopted and appropriate mitigation measures, to mitigate the impacts, have been suggested in the EIA report.

2.6 Cutting of Tress (Prohibition) Act, 1975

This Act prohibits cutting or chopping of trees without permission of the Forest Department. Proponent shall ensure that no trees are cut within the Right of Way of the proposed project, except deemed necessary and with the approvals of associated department.

2.7 Petroleum Act 1934

This act regulates the import, transport, storage, production, refining and blending of petroleum and other flammable substances. The federal government issues licenses and may make rules to regulate the import, transport, and distribution of petroleum (Section 4). The law requires that all containers carrying "dangerous petroleum" (highly flammable) bear a warning (Section6). The act also contains provisions regarding the testing and quality control of petroleum products (Section 14ff.). All powers remain with the federal government.

2.8 Canal and Drainage Act, 1873

Canals are defined as channels, pipes and reservoirs constructed and maintained by the Government for the supply for storage of water. Under section 27 of the Act a person desiring to have a supply of water from a canal for purposes other than irrigation shall submit a written application to a Canal Officer who may, with the sanction of the Provincial Government give permission under special conditions.

2.9 The Mines Act 1923

This act, which is largely administrative in nature, regulates mining operations and mine management, and contains provisions regarding the health, safety and working conditions of mine labor. The power to make rules lies with the "appropriate government" (Section 29), defined as the federal government in the case of mines extracting radioactive material, oil, gas and flammable substances, and the provincial government for all other mines.

2.10 Regulation of Mines and Oil Fields and Mineral Development (Government Control) Act, 1948

This act regulates the development of mines, oilfields, and mineral deposits. The federal government makes rules related to the development of mines and nuclear substances, oilfields, and gas fields, while provincial governments make rules related to other minerals and their extraction. This Act provides for enforcement of rules related to the storage and distribution of "mineral oils", the establishment of prices at which mineral oils may be bought or sold and any matter ancillary and incidental to the objectives set out in the act.

2.11 Exploration and Production Rules, 1986

The 1986 Exploration and Production Rules address environmental concerns, and require operators to "prevent pollution, avoid accumulation of trash and prevent damage to the environment and surroundings."

2.12 Antiquities Act 1975 & The Punjab Heritage Foundation Act, 2015

The protection of cultural resources in Pakistan is ensured by the Antiquities Act of 1975. Antiquities have been defined in the Act as ancient products of human activity, historical sites, or sites of anthropological or cultural interest, national monuments etc. The act is designed to protect antiquities from destruction, theft, negligence, unlawful excavation, trade and export.

The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area, which may contain articles of archaeological significance.

The project area for the EIA contains no notified archaeological site as protected under this act. Furthermore, the project site is unlikely to contain any buried antiquity. However, the project staff will be instructed before ground preparation and earthworks to report any archaeological artifact or what may appear to be an archaeological relic to the project management. In case of such a discovery, appropriate action will be taken.

2.13 Land Acquisition Act, 1894

The Land Acquisition act (LAA) of 1894 amended from time to time has been the policy governing land acquisition, resettlement, and compensation in the country. The LAA is the most commonly used law for acquisition of land and other properties for development projects. It comprises of 55 sections pertaining to area notifications and surveys, acquisition, compensation and appointment awards and disputes resolution, penalties, and exemptions.

2.14 Pakistan Penal Code (1860)

The Pakistan Penal Code (1860) authorizes fines, imprisonment or both for voluntary corruption or fouling of public spring or reservoirs so as to make them less fit for ordinary use.

The Pakistan Penal Code (PPC) 1860 deals specifically with the pollution of water in Chapter XIV on public health and safety. Here, "fouling" or "corrupting" the water of a public spring or reservoir is listed as an offence, punishable with up to three months in prison and/or a fine of 500 rupees (Section 277). This provision is limited in scope, since it applies only to reservoirs and public springs, and the terms "fouling" and "corrupting" are not defined. But provisions of PEPA 1997 (Sections 6 and 7) and the NEQS may be applied to facilitate enforcement of Section 277. Other sections of this chapter may be interpreted to include the protection of water resources, including Section 268 on public nuisance, Section 269 on negligence likely to spread infectious disease, and Section 284 on negligent conduct with respect to the possession and handling of poisonous substances.

Similarly, Chapter XVII on offences against property contains certain provisions that may be interpreted to include the protection of water resources. Sections 425–440 deal with "mischief", defined as damage to property resulting in destruction or loss of utility. Section 430 provides specifically for mischief caused to irrigation works, while Section 431 deals with damage to roads, bridges, rivers or channels. Meanwhile, Chapter XXIII, Section 511 on attempted offences could also be interpreted to include offences related to the "fouling" or "corrupting" of water.

Under Section 278 of the PPC, the punishment for "making [the] atmosphere noxious to health" is a maximum fine of 500 rupees. In addition, certain sections of Chapter XIV on public health and safety concerning "public nuisance" may be interpreted to include air and noise pollution from vehicles, as well as emissions (Sections 268, 278, 290 and 291).

2.15 Explosive Substances Act 1908

This law regulates the possession and use of explosive substances, including materials for the manufacture of explosives as well as machinery, tools and materials that can be used to cause an explosion (Section 2). Causing an explosion is punishable with a maximum sentence of life in prison, whether or not the event causes any injury to persons or damage to property (Section 3).

The same maximum penalty applies to making or possessing explosives with intent to cause an explosion (Section 4). Although the law does not specify conditions under which it is legal to possess explosive materials, possession of such substances for a purpose that is not "lawful" is an offence (Section 5), implying that some form of regulatory mechanism is to be put in place.

Powers under this act have been delegated to provincial governments, which may restrict or allow the courts to proceed with the trial of suspected offenders (Section 7). The 1908 law deals exclusively with causing explosions or intent to cause explosions.

2.16 Explosives Act 1884

This law deals with manufacture, possession, sale, use and transport of explosives. The government may prohibit the manufacture, possession or import of any explosive substance, except with a license (Section 5), or ban outright the manufacture, import or possession of any material deemed to be of "so dangerous character that it is "expedient for the public safety" to impose such restrictions (Section 6). Under this law, the maximum penalty for illegally manufacturing, possessing, or importing explosives is 5,000 rupees.

The government may declare any substance deemed particularly dangerous to life or property, owing to its explosive properties, or any of the processes involved in its manufacture to be an explosive within the meaning of this act (Section 17). Such materials may include a wide range of chemical substances that are explosive in nature, although the term "dangerous" itself has not been defined. No regulatory compliance measures are introduced for the handling of hazardous materials.

2.17 Punjab Wildlife (Protection, Preservation, Conservation and Management Act,1974 (Amended on 2007)

No person shall be in possession of any wild animal unless he be in possession of a certificate of lawful possession granted in respect thereof by the officer authorized in this behalf, provided that any person importing any wild animal, trophy or meat of a wild animal of a kind specified in the Second Schedule in accordance with the provisions of this Act or acquiring such animal, trophy or meat in accordance with the terms of a permit issued under this Act shall apply to the authorized officer for such certificate within thirty days from the date of importing or acquiring the animal, trophy or meat.

2.18 National Environmental Guidelines

2.18.1 The Pakistan Environmental Assessment Procedures 1997

The Pakistan Environmental Protection Agency prepared the Pakistan Environmental Assessment Procedures in 1997. They are based on much of the existing work done by international donor agencies and Non-Governmental Organizations (NGO's). The package of regulations prepared by PEPA includes:

- Policy and Procedures for Filing, Review and Approval of Environmental Assessments.
- Guidelines for the Preparation and Review of Environmental Reports.
- Guidelines for Public Consultation.
- Guidelines for Sensitive and Critical Areas; and
- Sectoral Guidelines for various types of projects.

2.18.2 Guidelines for Operational Safety, Health and Environmental Management, December 1996

These guidelines are the outcome of a study commissioned by the Directorate General Petroleum Blocks, Ministry of Petroleum and Natural Resources, Government of Pakistan. The guidelines list down the relevant laws related to the operational health, safety and environment and also recommends environmental controls and management practices to be adopted in O&G exploration projects.

2.18.3 Guidelines for Public Consultation

These guidelines are a part of a package of regulations and guidelines. It provides assistance throughout the environmental assessment of project by involving the public which can lead to better and more acceptable decision-making.

2.18.4 Sectoral Guidelines for Environmental Reports Oil & Gas Exploration and Production

The guideline will assist proponents to identify the key environmental issues that need to be assessed as well as mitigation measure and alternatives that need to be considered in the actual EIA.

This guideline deal with Oil & Gas projects which involved exploration or production of oil and gas. The environmental issues discussed in this guideline are specific to exploration or production activities of oil and gas and all such projects should address these issues. The degree and relevance of the issues will vary from proposal to proposal. The matters identified in this guideline should provide guidance for the preparation and assessment of most exploration and production proposals.

2.19 International Guidelines

2.19.1 World Bank Guidelines on Environment

The principal World Bank publications that contain environmental guidelines are listed below:

- Environmental Assessment-Operational Policy 4.01. Washington, DC, USA. World Bank 1999.
- Environmental Assessment Sourcebook, Volume I: Policies, Procedures, and Cross-Sectoral Issues. World Bank Technical Paper Number 139, Environment Department, the World Bank, 1991,

The first two publications provide general guidelines for conducting EIA/IEEs, and address EIA/IEE practitioners as well as project designers. While the Sourcebook in particular has been designed with Bank projects in mind and is especially relevant for the impact assessment of large-scale infrastructure projects, it contains a wealth of useful information, for environmentalists and project proponents.

The Sourcebook identifies a number of areas of concern, which should be addressed during impact assessment. It sets out guidelines for the determination of impacts, provides a checklist of tools to identify possible biodiversity issues and suggests possible mitigation measures.

Possible development project impacts on different areas such as wild lands, wetlands and forests are also identified, and mitigation measures suggested.

2.19.2 IFC Performance Standards

International Finance Corporation (IFC), a member of the World Bank Group, is the largest global development institution focused on the private sector in developing countries. IFC's Sustainability Framework applies to all investments and advisory clients whose projects go through IFC's credit review process.

IFC's Performance Standards define clients' roles and responsibilities for managing their projects and the requirements for receiving and retaining IFC support. The standards include requirements to disclose information. The Performance Standards may also be applied by other financial institutions electing to apply them to projects in emerging markets.

The eight Performance Standards establish standards that the client is to meet throughout the life of an investment by IFC or other relevant financial Institution.

- Performance Standard-1: Social and Environmental Assessment and Management System.
- Performance Standard-2: Labor and Working Conditions.
- Performance Standard-3: Pollution Prevention and Abatement.
- Performance Standard-4: Community Health, Safety and Security.
- Performance Standard-5: Land Acquisition and Involuntary Resettlement.
- Performance Standard-6: Biodiversity Conservation and Sustainable Natural Resource Management.
- Performance Standard-7: Indigenous People.
- Performance Standard-8: Cultural Heritage.

2.19.3 IFC Environmental, Health & Safety Guidelines

IFC has also developed Environmental, Health, and Safety (EHS) Guidelines. These guidelines are technical reference documents with general and industry specific examples of Good International Industry Practice (GIIP).

The EHS Guidelines are required to adhere by IFC clients under Performance Standard 3 on Pollution Prevention and Abatement.

2.20 International Conventions & Treaties

2.20.1 International Convention on Biodiversity

The International Convention on Biodiversity was adopted during the Earth Summit of 1992 at Rio de Janeiro. The Convention requires parties to develop national plans for the conservation and sustainable use of biodiversity, and to integrate these plans into national development programmes and policies. Parties are also required to identify components of biodiversity that are important for conservation, and to develop systems to monitor the use of such components with a view to promote their sustainable use.

2.20.2 The Convention on Conservation of Migratory Species of Wild Animals, 1979

The Convention on the Conservation of Migratory Species of Wild Animals (CMS), 1979, requires countries to take action to avoid endangering migratory species. The term "migratory species" refers to the species of wild animals, a significant proportion of whose members cyclically and predictably cross one or more national jurisdictional boundaries. The parties are also required to promote or co-operate with other countries in matters of research on migratory species.

The Convention contains two appendices. Appendix I contain the list of migratory species that are endangered according to the best scientific evidence available. For these species, the member states to the Convention are required endeavor to:

- Conserve and restore their habitats.
- Prohibit their hunting, fishing, capturing, harassing and deliberate killing.
- Remove obstacles and minimize activities that seriously hinder their migration.
- Control other factors that might endanger them, including control of introduced exotic species.

Appendix II lists the migratory species, or groups of species, that have an unfavorable conservation status as well as those that would benefit significantly from the international cooperation that could be achieved through intergovernmental agreements.

2.20.3 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)

This convention came into effect on 03 March 1973 in Washington. In all 130 countries are signatory to this convention with Pakistan signing the convention in 1976. The convention requires the signatories to impose strict regulation (including penalization, confiscation of the specimen

etc.) regarding trade of all species threatened with extinction or that may become so, in order not to endanger further their survival.

The Convention contains three appendices. Appendix I include all species threatened with extinction which are or may be affected by trade. The Convention requires that trade in these species should be subject to strict regulation. Appendix II include species that are not necessarily threatened presently but may become so unless trade in specimens of these species is subject to strict regulation. Appendix III includes species which any contracting party identifies as subject to regulations in trade and requires other parties to cooperate in this matter.

2.20.4 International Union for Conservation of Nature and Natural Resources (IUCN) Red List

The red list is published by IUCN and includes those species that are under potential threat of extinction. These species have been categorized as:

- Endangered: species that are sent to be facing a very high risk of extinction in the wild in the near future, reduction of 50% or more either in the last 10 years or over the last three generations, survive only in small numbers, or have very small populations.
- Vulnerable in Decline: species that are seen to be facing a risk of extinction in the wild, having apparent reductions of 20% or more in the last 10 years or three generations.
- Vulnerable: species that are seen to be facing a high risk of extinction in the wild, but not necessarily experiencing recent reductions in population size. categories.
- Data Deficient: species that may be at risk of extinction in the wild but at the present time there is insufficient information available to make a firm decision about its status.

2.21 International and National Environment and Conservation Organizations

International environmental and conservation organization's such as IUCN and the Worldwide Fund for nature (WWF) have been active in Pakistan for some time. Both these organizations have worked closely with government and act in an advisory role with regard to the formulation of environmental and conservation Policies. Since the convening of the Rio Summit, a number of national environmental NGO's have also been formed, and have been engaged in advocacy, and in some cases, research. Most prominent national environmental NGO's, such as the Sustainable Development Policy Institute (SDPI), Strengthening Participatory Organization (SPO), Shehri, and are the members of the Pakistan National Committee (PNC) of IUCN.

As mentioned earlier, environmental NGO's have been particularly active in advocacy, as proponents of sustainable development approaches. Much of the government's environmental and conservation policy has been formulated in consultation with leading NGO's, who have also been involved in drafting new legislation on conservation.

3. Project Description

This chapter includes the description of drilling activities for the proposed project in Missakeswal Development & Production Lease (D&PL), located in tehsil Gujar Khan district Rawalpindi - Punjab. The development well for which drilling is planned is referred to as Well Missakeswal-05. The salient features of the project are discussed to the extent that they relate to potential environmental and social impacts.

3.1 Overview of Project

OGDCL's strategic initiative to enhance the oil and gas production within the Missakeswal D&PL involves drilling of development well. This comprehensive attempt includes various developmental activities such as constructing well site, campsite, access track, and installing flow lines to link successful well with the existing hydrocarbon gathering and production system.

The designated project area lies within the administrative boundaries of tehsil Gujar Khan district Rawalpindi, Punjab province. OGDCL has finalized the well coordinates based on detailed geophysical survey and referenced to the World Geodetic System (WGS84) datum. The surface location (coordinates) of the proposed well is presented in below Table 3.1, and project location map is presented in Figure 3.1.

Table 3-1 Tentative Location of Proposed Well

Proposed Well ID	Latitude	Longitude
Well Missakeswal-05	33° 13' 29.389" N	73° 21' 33.769" E

3.2 Project Objectives

Core objective of the proposed drilling activities is

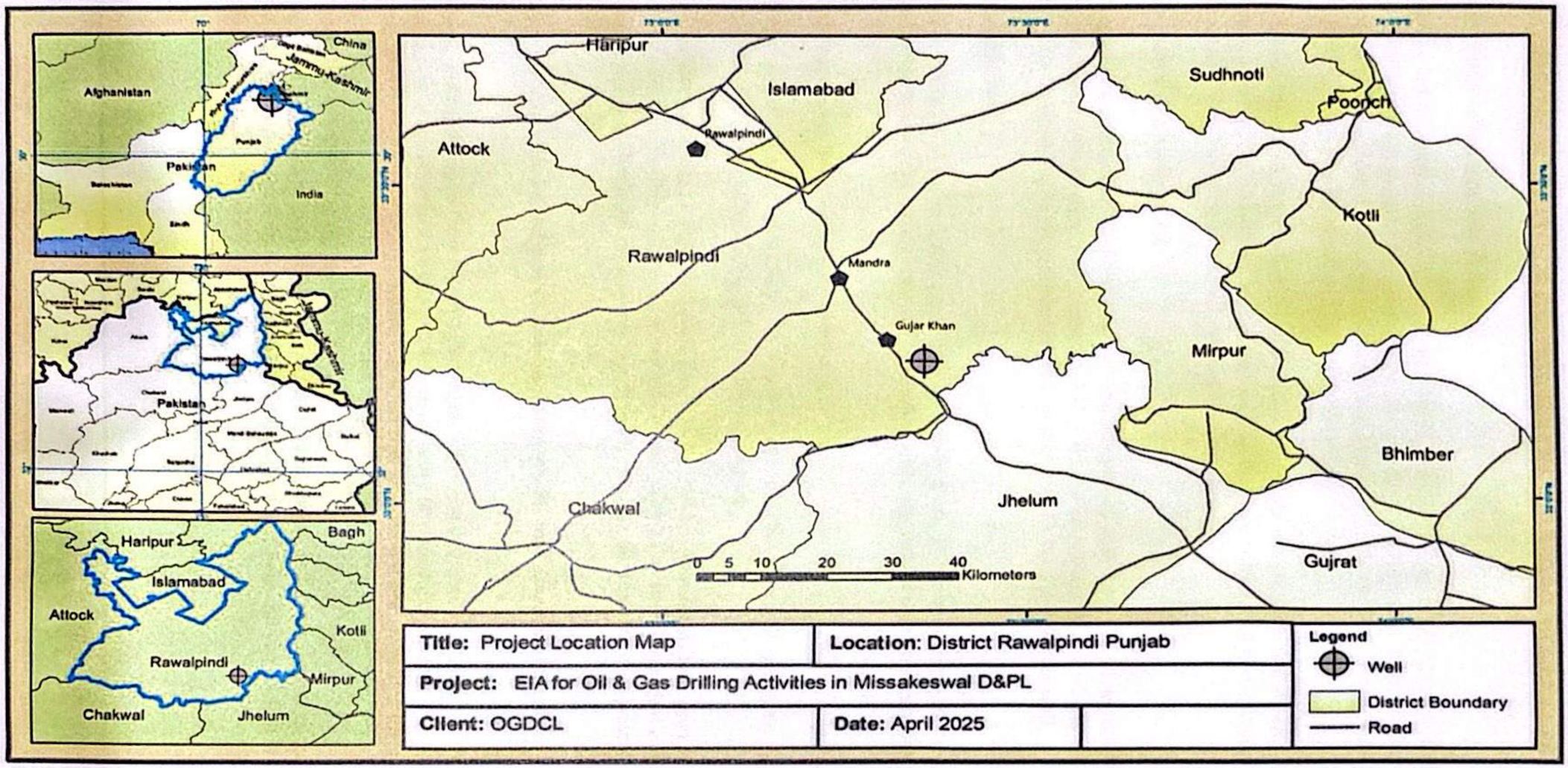
- Exploration and exploitation of new oil and gas reserves through drilling of development well based on the promising geological features retrieved through previous seismic surveys
- To enhance the production of hydrocarbons in order to reduce energy deficiencies of Pakistan

The above objectives will be met by:

- Achieving the planned total depth (TD) of ~ 2,200 m for the planned well
- Acquiring petro-physical data of the targeted reservoir by maintaining mud log; and

Allowing for possible future DST, completion running and production.

Figure 3-1: Project Location Map



3.3 Proposed Project Phases and Activities

To enhance the production from Missakeswal D&PL, OGDCL intends to carryout drilling development Well (Missakeswal-05) within the project area in different phases. There is one well planned in Missakeswal D&PL that is titled as Well Missakeswal-05. The location of well is decided on the basis of geological information and desired production objectives.

For Well Missakeswal-05 to be drilled, the activities will include site selection and development, mobilization, drilling and completion, stimulation, well testing, demobilization and site restoration. These activities have been detailed in the following sections.

3.3.1 Site Selection and Development

This stage of the proposed drilling program involves selection of well location and activities that provide necessary infrastructure and support facilities for the subsequent stages of the drilling program. The total duration of site construction is estimated to be 10 -12 weeks for the well.

a) Site Selection

This is the first stage in the well drilling process. The drilling site will be selected on the basis of geological information. The selected site will be offset to avoid any sensitive environmental features if so required.

b) Development of Well and Camp Site Area

Before the commencement of drilling, the selected site will be developed according to the requirements of the selected drilling rig and well drilling program.

A single cement pad will be constructed at the centre of the site to support the drill rig, mud pumps and ancillary equipment. Pits will be excavated around the periphery to store water, drill cuttings, wastewater, and solid waste and flare pit where necessary. A typical drill site layout is presented in Figure 3.2.

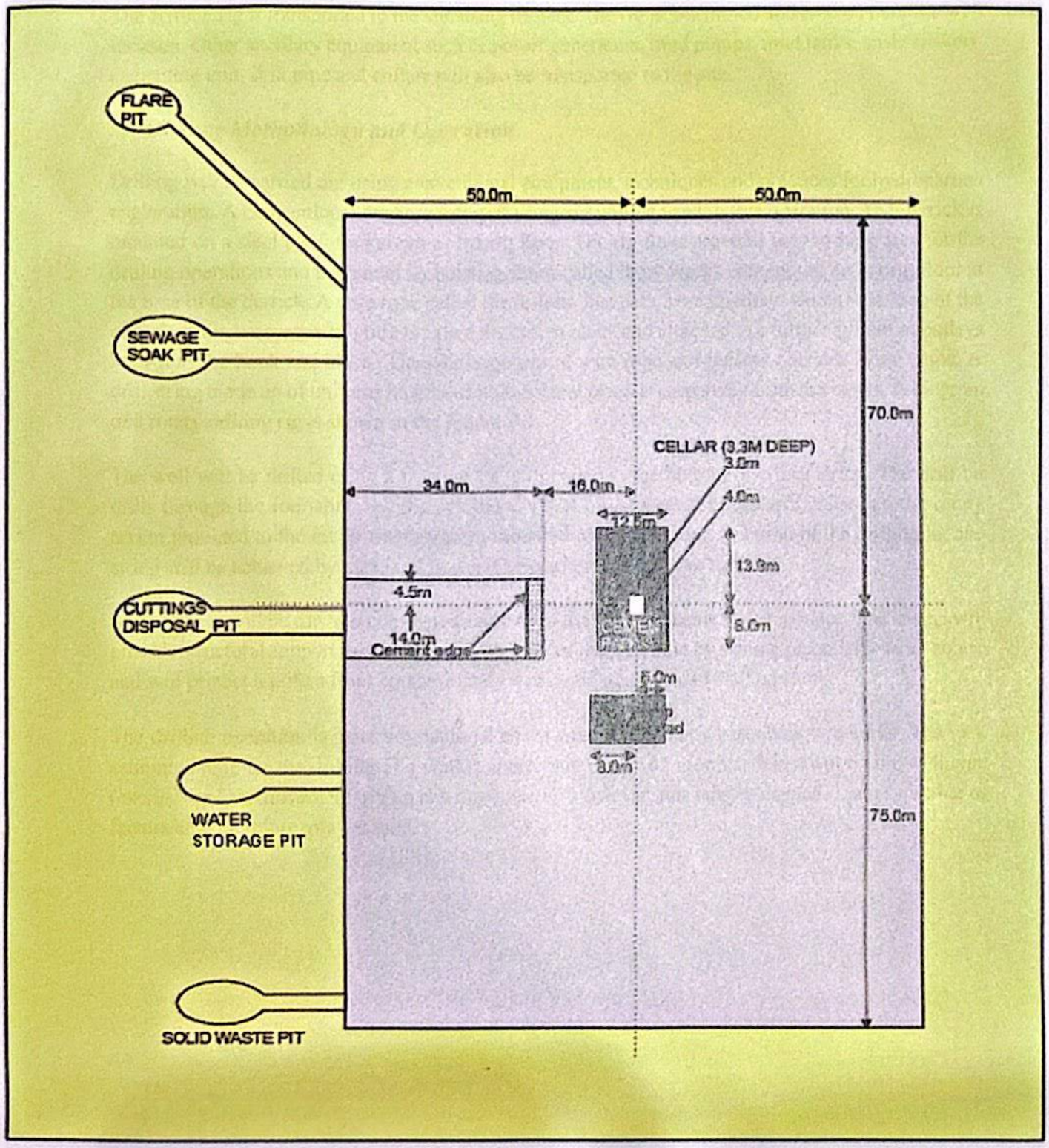
A campsite is also needed to support drilling operations and for well development, activities will include:

- Clearing and Levelling of the area using bulldozers, tractors and graders
- Construction of a reinforced concrete pad to support heavy or vibrating equipment
- Construction of auxiliary facilities such as an equipment and supplies storage yard, drilling mud pits, water pits, flare pits, septic tanks and soak pits
- Construction of the drilling rig pad
- A rig camp consisting of portable cabins, kitchens, mess rooms, bathrooms, laundries etc. for which limited construction works including levelling, grading, filling and compaction will be performed

c) Development of Access Route

This stage of the operation is largely dependent on the final well location, which is not along an existing major road thus it will be required to modify existing or develop a new track by grading and compaction.

Figure 3-2: Typical Drilling Site Layout (not to scale)



3.3.2 Mobilization, Drilling and Completion, Stimulation and Well Testing

Upon completion of site development activities, mobilization of the rig and related machinery and equipment commences. This is followed by the drilling operation and at the completion of drilling, fracture stimulation may be performed. After stimulation the testing of well will be carried out. The estimated duration of this sequence could take up to 12 - 20 weeks for the well.

a) Rig Mobilization

The drilling rig is transported to the site using trailers. The rig is assembled and erected over the well location. Other ancillary equipment such as power generators, mud pumps, mud tanks, shale shakers, cementing unit, drill pipe and collars will also be transported to the site.

b) Drilling Methodology and Operation

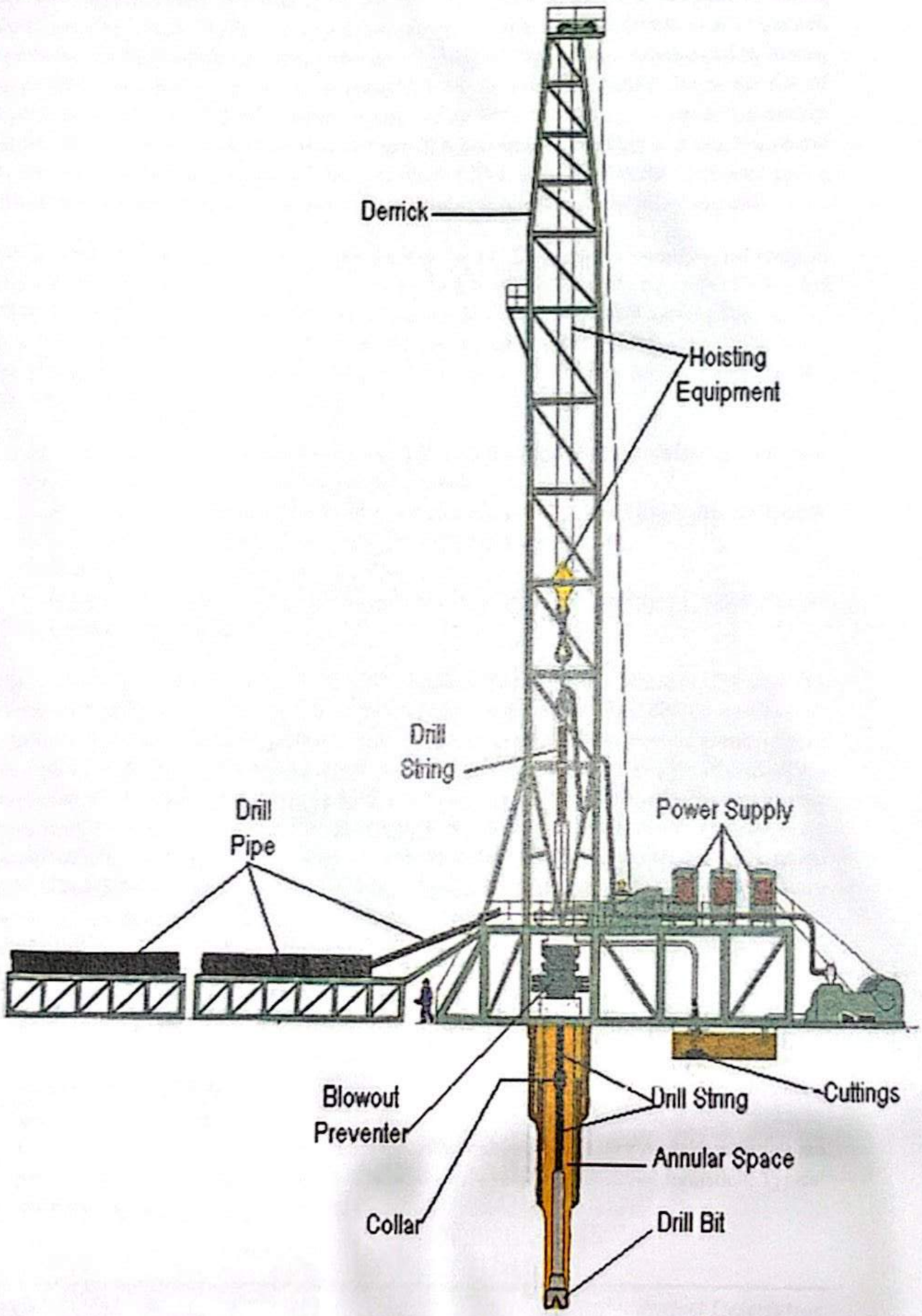
Drilling will be carried out using conventional equipment, techniques and practices for hydrocarbon exploration. A conventional onshore rotary drilling rig will be used in this operation. The derrick is mounted on a steel platform known as the rig floor. The rig floor provides the working area for the drilling operations and personnel. A hoisting drum called draw works is mounted on the rig floor at the base of the derrick. A wire rope called the drilling line pass from the draw works to the top of the derrick through a system of pulleys called the crown block and attached to a further system of pulleys known as the hook and block. The whole system of wire rope and pulleys operates like a crane. A drill string made up of uniform lengths of hollow steel pipes is suspended from the hooks. A diagram of a rotary drilling rig is shown in the Figure 3.3.

The well will be drilled using a rotating bit, suspended at the bottom of a drill string. The drill bit drills through the formations by the combined effect of the weight of the drill collar and the rotary action provided to the bit by a rotary table mounted on the rig floor. Rotation of the drilling bit and string will be achieved by means of powerful electric motors on the surface.

Steel casings will be run into completed sections of the well and cemented into place. The casing will provide structural support to maintain the integrity of the well hole by sealing potentially weak zones, and will protect aquifers from contamination that could occur due to drilling fluids.

The drilling operation is generally undertaken on a round-the-clock basis with two shifts. The total estimated time for the drilling of a well is approximately 02-05 months, dependent on the well type (exclusive of rig movement, rig up and down days). However, this largely depends upon a number of factors and, therefore, may extend.

Figure 3-3: Diagram of a Rotary Drilling Rig



c) *Drilling Mud*

The conventional process of drilling oil and gas well uses a rotary drill bit that is lubricated by drilling fluids known as "mud". Usually, two major categories of mud are used for drilling of oil or gas well are oil-based mud (OBM) and water-based mud (WBM). Oil based mud is formulated by mixing chemicals with diesel, which is not considered to be environment friendly due to the risk of contamination of sub- surface formations during drilling and the generation of oily drilled cuttings which require specialized handling and treatment. A water-based mud system is generally used due to the above-mentioned impacts of OBM and thus WBM has environmental preference and is therefore considered to be the preferred option. In current project mostly WBM will be used.

As the drill bit grinds downward through the rock layers, producing fragments, which range in diameter from 10's of microns to 1-2cm, depending largely on the nature of the rock (McFarlane and Nguyen, 1991) and generates large amounts of ground-up rock known as drill cuttings. Drilling mud is pumped through the drill string down to the drilling bit and is returned to the drill rig in the space (or annulus) between the drill string and the casing Figure 3.5. Drilling mud is used during the operation to serve the following functions.

- The hydrostatic pressure generated by the mud's weight controls the downhole pressure and prevents formation fluids from entering the well bore.
- It removes the rock cuttings from the bottom of the hole and carries them to the surface and when circulation is interrupted it suspends the drill cuttings in the hole.
- It lubricates and cools the drill bit and string.
- It deposits a mud cake on the wall of the well bore effectively sealing and stabilizing the formations being drilled.

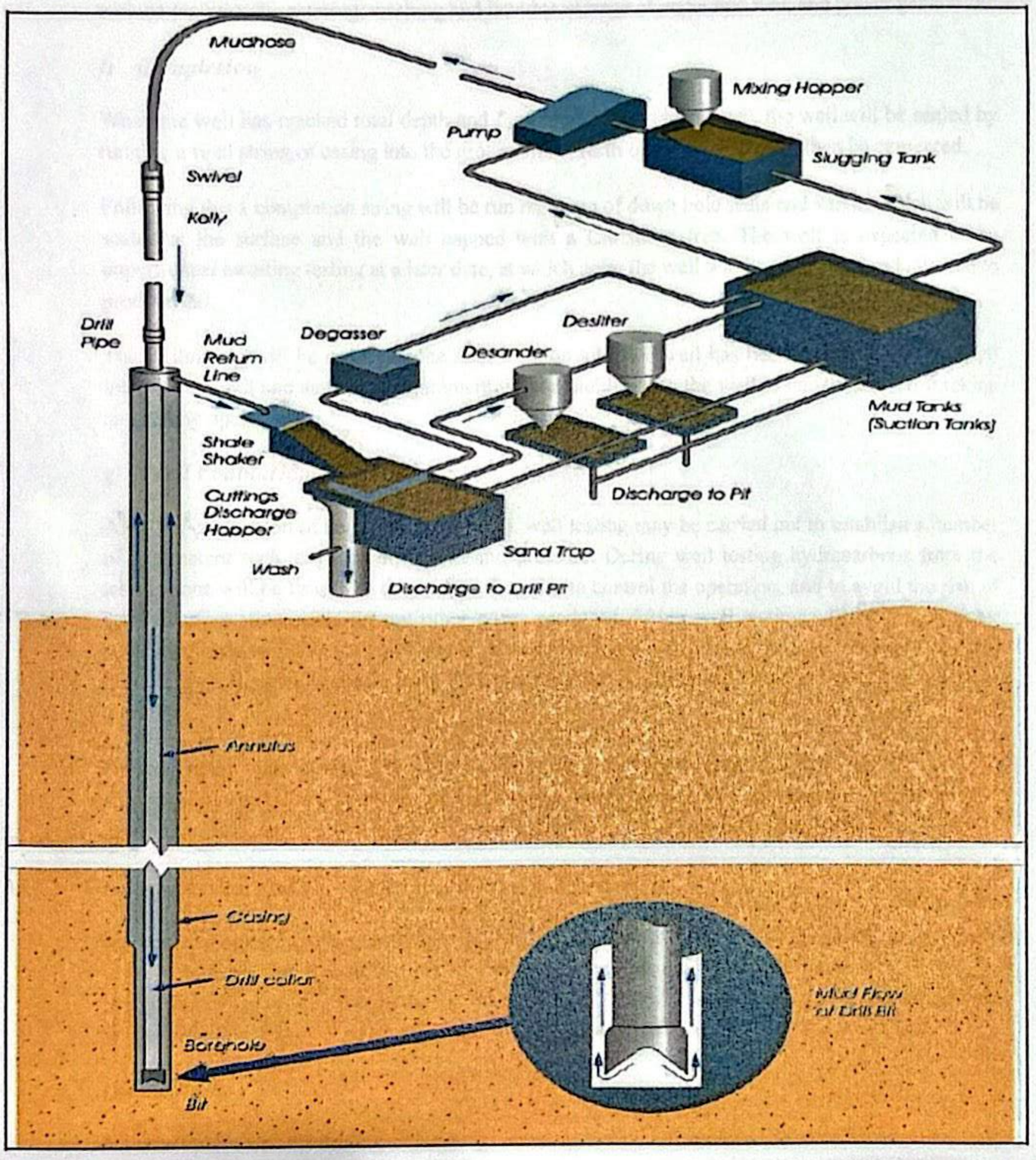
The mud is recycled and maintained in good condition throughout the operation. The mud and suspended cuttings are processed on the surface through screens called "shale shakers" to maximise recovery of the mud. The recovered mud is then generally passed through a desander to remove sand particles and, if necessary, subsequent treatment is provided by a centrifuge or desilter. This additional equipment removes the fine colloidal solids, the particles too small to be removed by the conventional equipment, which if allowed to build up can make the mud too viscous. If the viscosity is not controlled at source a proportion of the mud would have to be discharged and the remainder diluted with oil and/or water. The composition of the mud depends on the geology of the well and will change as the well progresses. A water-based drilling mud will be used during the operation. A variety of additives are also used for specific purposes as an example in Water Based muds these additives serve the following functions:

- **Fluid loss control.** The layer of mud on the wall of the well bore retards the passage of liquid into the surrounding rock formation. Bentonite is the principal material for fluid loss control although additional additives such as starch and cellulose, both naturally occurring substances, are also used.
- **Lost circulation.** Naturally occurring fibrous, filamentous, and granular or flake materials are used to stop lost circulation when the drill bit enters a porous or fractured formation. Typical materials include ground nut shells and mica.

- **Lubricity.** Normally the drilling mud alone is sufficient to adequately lubricate and cool the bit. However, under extreme loading, other lubricants are added to prevent the drill string from becoming stuck.
- **pH control.** Caustic and lime increase the pH of the mud to between 9 and 10. This ensures the optimum performance of the mud and controls bacterial activity.
- **Pressure control.** Barite is generally used as a weighting agent to control downhole pressure.

Typically, a single well may lead to 1000 - 4000 m^3 of cuttings and muds depending on the nature of cuttings, well depths, hole diameter and rock types (CEF 1998). The drilling mud will consist of slurry of formation cuttings suspended in a liquid phase. Certain additives such as bentonite, barite and salts will be used for initial mud formulation and subsequent changes as required during the operation. The exact constituents and concentrations will be finalized before the drilling operation. The quantity of drilling mud used, and the cuttings generated will depend upon the well geology, depth of the well, and other operating factors.

Figure 3-4: Schematic Diagram of Mud Recycling System



d) Disposal of Drilling Wastes

Conventional drilling waste management involves discharging the mud and cuttings into a lined waste pit. The waste management system is considered to be technologically and environmentally the most preferred option. The drill cuttings and mud will be disposed of at the well site within HDPE lined waste pits. These pits will be closed by providing a top-soil cover at the time of site restoration.

e) Accommodation

During the drilling and completion operation, accommodation for an average of about 200 to 220 rig crew will be arranged in a campsite. The camp area in addition to workforce accommodation will include facilities for catering, washing and laundry, storage of water and fuel, and power generation.

f) Completion

When the well has reached total depth and final logging has taken place, the well will be sealed by running a final string of casing into the ground in the form of a liner. This will then be cemented.

Following this a completion string will be run made-up of down hole seals and valves which will be sealed at the surface and the well capped with a Christmas tree. The well is expected to be unperforated awaiting testing at a later date, at which point the well will be perforated and allowed to produce gas.

The drilling rig will be moved to the next location after the well has been completed and a Well Intervention unit and associated equipment will be mobilised to the well to undertake well fracking and testing operations.

g) Well Evaluation and Testing

After the completion of the drilling operation, well testing may be carried out to establish a number of parameters such as gas composition and pressure. During well testing hydrocarbons from the testing zone will be flowed to the surface. In order to control the operation, and to avoid the risk of accident, formation gases or any other gases produced during well testing will be flared under controlled conditions. These gases will be flared from the end of a flare line laid horizontally on the ground, and extending to the flare pit. Any formation water will be separated and discharged into the mud pit.

Fracking operations may be carried out in order to improve the production from the well. This entails pumping large quantities, approximately 1500 cubic metres, of special water based fluid into the well to open up flow paths in the reservoir rock and allow the well to produce more efficiently.

3.3.3 Demobilization and Site Restoration

The primary objective of this activity will be to ensure responsible waste management occurs on site so as not to present any undue risk to the physical, biological or human environment. At the conclusion of the drilling programme a demobilization plan will be implemented. This will provide for the orderly withdrawal of all personnel, and the removal of all unfixed drilling equipment.

Demobilization

After completion of the drilling and testing operation, the rig will be dismantled and demobilized off the site. The well head will remain in situ, but all other equipment and materials will be removed from the well site.

Site Restoration

Eventually all concrete and brick masonry structures will be demolished, with the exception of the cement pads as they will be needed for any future workover activity, any fencing will be taken off from the well site (except around the Christmas tree to establish a safe distance). All pits will be restored except one per well for future work over activities. The site will also be restored to its original condition as close as possible by carrying out the following activities

- Breaking all the concrete structures and utilizing for back filling of pits or provided to locals for reuse
- Removing all chemicals, drums, etc. from the well sites and transporting them to the existing junkyards in the concession
- Removing any fencing and access gates in case of a dry well
- The construction base camp and rig camp are restored

After work has been completed in an area, a restoration and rehabilitation crew will be mobilized to ensure that the affected areas are left in a condition that is as close to their original state as possible. The team will ensure no debris or trash is left behind.

3.4 Project Schedule

The project duration of any drilling operation may increase if any operational problems are encountered. The planned project schedule is within or up to 01 years.

The typical schedule of activities for each well is expected to be as follows:

- Site construction – 10 to 12 weeks
- Mobilization, Drilling and Completion, Stimulation and Well Testing – 12 - 30 weeks

3.5 Resource Requirement

3.5.1 Staffing

It is expected that around 200 to 220 rig crew will be required for drilling operation. Preference will be given to locals for unskilled jobs during project activities.

3.5.2 Supplies

The average water requirement per day during the drilling operations will be 20 - 25 cubic meters.

Existing water wells are planned to be used during drilling operation and as per requirement may also procured from locals/ owner of tube well(s) and transportation will be done through bowsers. Water pits will be used to hold a reserve volume in case of high usage. Water conservation practices will be practiced to reduce the water consumption.

During the construction, material such as the gravel, aggregate, steel, cement, sand for well site construction will be required.

General supplies transported will include camp supplies (food, etc), fuels, oils and chemicals, and equipment maintenance parts. Project personnel will travel to and from the rig in smaller vehicles, mostly four-wheel drive pickups. A typical list of vehicle for similar project activity is as follow:

- fuel transport vehicles
- water transport vehicles
- heavy trucks for mobilization/demobilization
- 10 – 12 light trucks, and
- drilling rig

Diesel will be the primary fuel during the construction and drilling operations required for power generation (Electricity requirements approx. 1000 kW) and vehicles. The estimated average daily consumption is approximately 3500 – 5000 litres per day during drilling operations. Diesel will be procured locally, and a tank lorry will deliver it to the site storage facility.

3.6 Environmental Considerations

In light of the project description presented in Section 3.3 to 3.5, the significant environmental considerations to be assessed from an EIA standpoint are listed below and have been considered further for impact assessment and mitigation.

Air emissions - Point sources such as standby generators, vehicles; fugitive sources such as oil storage tank, and similarly construction and drilling activities could be source of air emissions.

Wastewater – The impact of wastewater from different sanitary wastewater and its disposal need to be assessed. .

Groundwater – Sustainability of local aquifer due to abstraction of water.

Noise – Noise from different equipment's and its impacts to nearby community.

Hazardous waste – Handling and disposal of hazardous waste such as drilling waste, oil and chemical etc.

Chemicals – Handling of hazardous chemicals and products, and providing safeguards in the form of emergency response plans.

Physical scarring of the Landscape – the movement of vehicles and human activity during the project activities could disturb the landscape of the project area.

Damage to Natural Vegetation – The construction activities could cause some temporary impact to natural vegetation of the project area.

Oil Spillage –There is a potential of oil spillage if the proper engineering control will not be implemented.

Waste – the campsite activities will generate domestic non-hazardous solid waste and campsite activities will also generate clinical waste.

Dust and Particulate – dust and particulate could be generated from generator and vehicular emissions, vehicular movement, construction and drilling activities.

3.7 Health, Safety, Security and Environmental Management Standards

The construction and drilling contractors will have to meet the requirements of Health, Safety and Environmental (HSE) management standards of OGDCL. OGDCL Health, Safety and Environment Policy underscores commitment on prioritizing health and safety of all its employees, contractors and visitors involved in its activities and confers overriding commitment towards minimizing impact of its activities on the natural environment.

4. Project Alternatives

This Chapter describes alternatives considered and proposed for the project execution. It includes a discussion of the alternatives their criteria for selection, comparison and selection of an option that can be practicable within the defined economic, social and environmental constraints. Project Alternatives were evaluated taking into consideration the principles of sustainable development and other defined criteria. Sustainable development is a pattern of resource use that aims to meet human needs while preserving the environment so that these needs can be met not only in the present, but in the indefinite future. This evaluation explains the selection of appropriate option that was required to ensure optimal results within defined set of economic, environmental, health and safety constraints. In particular it outlines the following project options:

- Alternative-I 'No Development Option'
- Alternative II 'Site Option - Site Selection Criteria'
- Alternative-III 'Technology Option'

4.1 Alternative-I 'No Development Option'

The "No Development" alternative is required to ensure the consideration of the original environment without any development. This is necessary for the decision-makers in considering all possibilities. The development will have a minimal effect on the physical environment. This development alternative entails that the proposed development is not constructed on the project site, thus result in the site being left as is. Geographically the Missakeswal D&PL is located in the area, which is abundant in energy sources and there is a need to explore local resources to cut the burden of heavy import bills on the Economy of Pakistan. It has become imperative for the country to explore indigenous resources. The present scenario supports the project in order to provide the means to locate the oil and gas reserves within the country which will help in optimizing the resources according to the rising demand so it has been determined that the 'No Development' option can be eliminated.

The 'No-Development' option, if taken, will prevent the country from exploring the potential to significantly increase its oil and gas production. The proposed drilling operation offers a chance to move Pakistan towards producing increased self-generation and decrease on dependency of imported oil and gas. Other impacts of the 'No-Development' option would be loss in employment and infrastructure development in the project area, as the project is likely to create jobs and improve the existing infrastructure of the area. From the environmental point of view, this option would result in a loss of opportunity in further improvement of the environmental management of the area, through generation of environmental baseline data, and the mitigation and monitoring plans.

4.2 Alternative-II 'Site Option-Site Selection Criteria'

Keeping in view the environmental, social, and economic aspects of the development, several locations were considered for the proposed project. Most feasible option in the context of environment and economic sustainability was considered for further development. The site for oil or gas exploration is chosen after extensive geological and land surveying, and not every concession area necessarily shows promise. The proposed area is considered an attractive area for further oil and gas development activities for the reason that it has existing oil and gas production. The proposed site is considered highly desirable due to the following considerations:

- The area planned for development does not exist in National Park or any wildlife sanctuary.
- The proposed area is considered an attractive area for further oil and gas exploration activities.
- No natural vegetation, no topsoil, no waterflow, no nearby sensitive areas at proposed project site.

Trap/Structure

When a porous reservoir rock forms an anticline deep in the subsurface, it may trap migrating hydrocarbons. The presence of such a structure at depth is indicated by surface geological studies and confirmed by recording seismic surveys.

Reservoir Rock

This is a porous rock capable of holding hydrocarbons within its pores. These rocks can be limestone or sandstone.

It is thus, the consideration of the above criteria resulted in the selection of the preferred site. No further site location alternatives are considered in the EIA process.

4.3 Alternative - III 'Technology Option'

The study evaluated following technology options for selection:

4.3.1 Drilling Technologies

Coiled Tubing

A relatively modern drilling technique involves using coiled tubing instead of conventional drill pipe. This has the advantage of requiring less effort to trip in and out of the well (the coil can simply be run in and pulled out while drill string must be assembled and dismantled joint by joint while tripping in and out). Additionally, the coiled tubing is stripped into and out of hole, providing a hermetic seal around the coil and, if desired, allowing the well to flow during drilling operations. Instead of rotating the drill bit by using a rotary table or top drive at the surface, it is turned by a downhole motor, powered by the motion of drilling fluid pumped from surface.

However, there are some disadvantages of coiled tubing technology as follows:

- Coiled tubing cannot rotate so it is not a good option if there is a risk of differential sticking.
- The tubing is prone to fatigue.
- Control and safety concerns in high-pressure wells with large volumes of pressurized gases at surface in the exposed.
- Also of concern is depth control and reach limitations for horizontal drilling applications.
- Tighter controls on operating conditions and handling methods are required in coiled tubing applications than are normally applied when using conventional drill strings.

Slim hole Drilling

The oil and gas well drilling method "Slim Hole Drilling" (micro hole or small hole) is one of the most cost-effective methods of oil and gas reserve development. It involves drilling smaller diameter holes and using small diameter production casing and tubing. The use of small diameter well bore reduces the overall cost of exploration drilling and reserve development. According to DOE (1999), slim hole wells are defined as wells in which at least 90% of the hole has been drilled with a bit six inches or less in diameter. Although slim hole technology has been available since the 1950s, it was not commonly used because the small diameter well bore restricted stimulation, production, and other downhole manipulations.

Slim hole drilling technology can cut the drilling and completing costs significantly. However, the cost savings achieved from slim hole drilling can be offset by increased mechanical failures, reduced lateral hole length and lack of directional control. Factors that affect operations and economics in slim hole drilling are as following:

- One of the disadvantages for slim hole drilling is drill string failures associated with use of small diameter tubulars. The reduced weight of slim hole drill pipe makes the drill string mechanically weaker than its conventional equivalent.
- Tool joint failure is another problem for slim hole drilling. Because of small and thin tubulars and joints, they are-inherently weaker and have a tendency to bellying and twist-offs, particularly in deeper holes.
- Kick detection is a difficult issue for slim hole drilling because a unit of reservoir gas entering a slim hole annulus will occupy a much greater height than in conventional wells. This can result in maximum allowable pressure in the casing being approached faster than in a conventional well.
- Another disadvantage for slim hole drilling is decreasing in penetration rates, especially for roller cone bits.

- Depth is a key limiting factor when considering slim hole well design.
- Borehole integrity and instability are other concerns for slim hole drilling. Because of small annul space between drill string and wellbore, the pressure loss is larger than conventional drilling.
- One major limit of slim hole horizontal drilling has been the inability to effectively transmit weight to the bit.

Conventional Rotary Drilling

The conventional process of drilling oil and gas wells uses a rotary drill bit that is lubricated by drilling fluids or muds. As the drill bit grinds downward through the rock layers, it generates large amounts of ground-up rock known as drill cuttings. This technology is discussed in detail in Chapter 3, Section 3.3.2. Its advantages include:

- Most rock formations can be drilled.
- Water and mud support unstable formations.
- Operation is possible above and below the water-table.
- Possible to drill to depths of over 40 meters.
- Possible to use compressed air flush.

Disadvantages of rotary drilling are:

- Requires capital expenditure in equipment.
- Water is required for pumping.
- There can be problems with boulders.
- Rig requires careful operation and maintenance.

4.3.2 Technology Selection

- Conventional Onshore Rotary Drilling proposed by OGDCL has been historically used for the drilling of oil and gas wells. Other drilling techniques discussed above include coiled tubing and slim holes. Despite some environmental gains in the use of coiled tubing and slim holes (reduced well site area, reduced waste volumes etc.), both techniques seem to share a number of technical disadvantages and operational limitations. Advantages of the two techniques therefore do not outweigh their disadvantages. Conventional Onshore Rotary Drilling technique proposed by OGDCL is therefore evaluated to be the best alternative.
- This project can be the gateway towards economic development and prosperity in the area. The most important point is that the land is already in a degraded piece of land with

significant agricultural practices in the area which is a positive sign for sustainability of the environment. No heavy land clearing work would be involved for construction phase.

- The no-project alternative is the option of not implementing the activity or executing the proposed activities. Assuming that the storage and distribution facility will not be developed at the proposed site, the opportunity to improve the efficiency in the logistical fuel supply chain would be lost. The site is currently unoccupied, and the economic stimulus and potential which the proposed activities have to create would not be harvested. As discussed in subsequent sections, there are no significant negative environmental impacts anticipated from the proposed activities, which through the no project option, are likely to be contained. If we think about no project scenario from socioeconomic perspectives, then it would lead to improper use of the existing resources available locally. Additionally, potential for employment would be retained because all categories of the labor required for the project operation are available locally, conveniently, plentifully and at affordable cost.

5. Description of Environmental Baseline

This chapter provides a comprehensive overview of the existing environmental and socioeconomic conditions of the project area and its surrounding regions. The project area, as defined in this document, includes the geographical region where project-related activities will be carried out. This comprises the proposed project site, its immediate surroundings, and any area that may be affected directly or indirectly by the project's positive or negative externalities in the long term. The environmental impacts of any activity or process associated with the project will be assessed based on deviations from the baseline or pre project conditions. The baseline assessment focuses on three main components:

- Physical Environment,
- Biological Environment,
- Socioeconomic Environment.

The physical environment encompasses the natural characteristics of the project area, including topography, geology, climate, air and noise quality, and water resources. A detailed assessment has been conducted through field surveys, air and noise monitoring, as well as soil and water quality analysis, with particular attention given to environmentally sensitive features such as water bodies, landforms, and critical habitats that may be impacted by the project.

The biological environment includes the flora, fauna, and ecosystems present within and around the project site. The baseline study emphasizes biodiversity, covering plant and animal species, habitat quality, and the presence of any protected or endangered species. Field investigations and consultations with environmental experts and relevant authorities have been undertaken to evaluate the ecological significance of the area and potential effects of the project on local biodiversity.

The socioeconomic environment involves an analysis of the social and economic conditions of the communities in the project's vicinity. It includes demographic information, land use patterns, economic activities, infrastructure, education, and healthcare facilities. Special consideration is given to social concerns such as livelihoods, population density, and the presence of vulnerable groups. The socioeconomic baseline has been developed through a combination of literature reviews, field surveys, and consultations with local residents, government departments, and other key stakeholders.

The information presented in this chapter is based on a multi source approach that includes desktop studies, literature reviews, field investigations, and laboratory analyses. This is further supported by data gathered through extensive consultations with government agencies and other relevant institutions. This comprehensive methodology ensures the accuracy and reliability of the baseline data, which forms the foundation for evaluating the potential environmental and social impacts of the proposed project.

5.1 Physical Environment

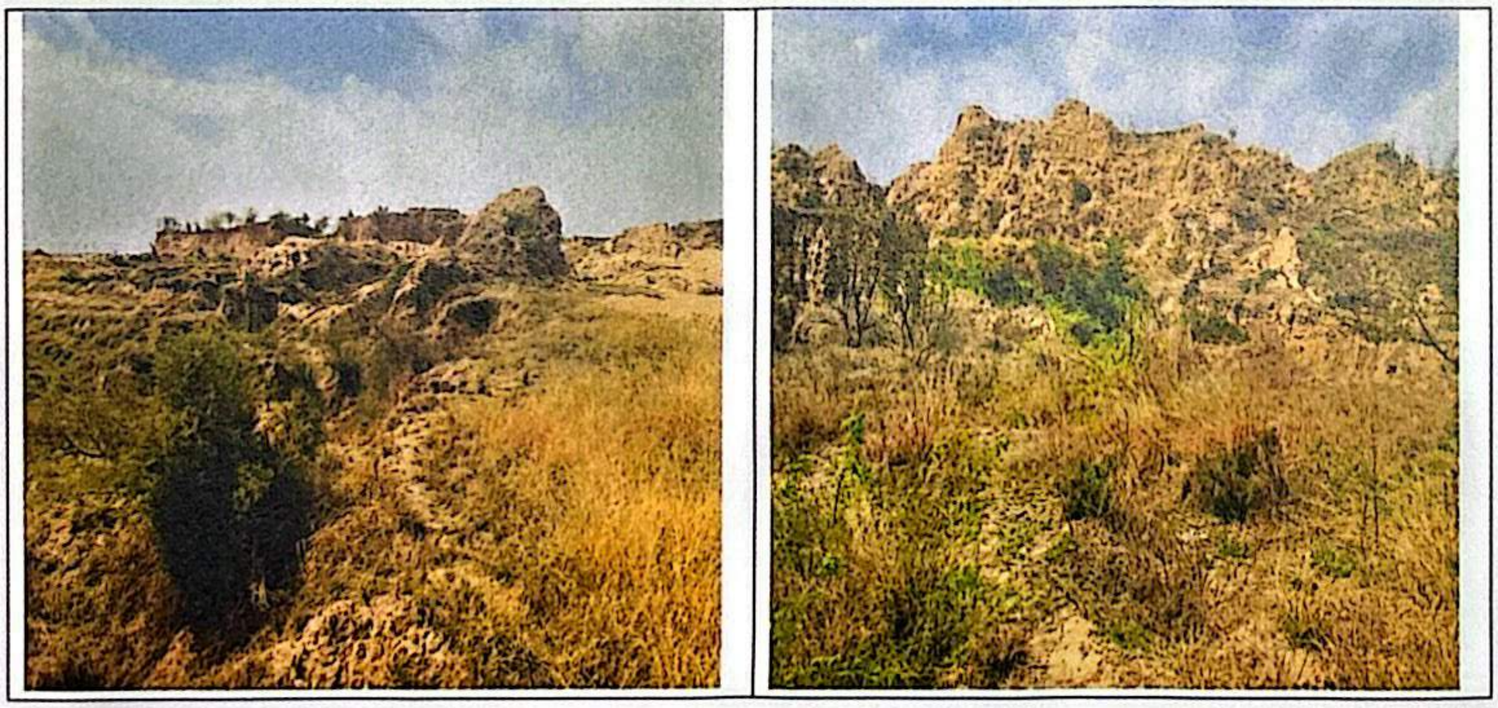
5.1.1 Topography

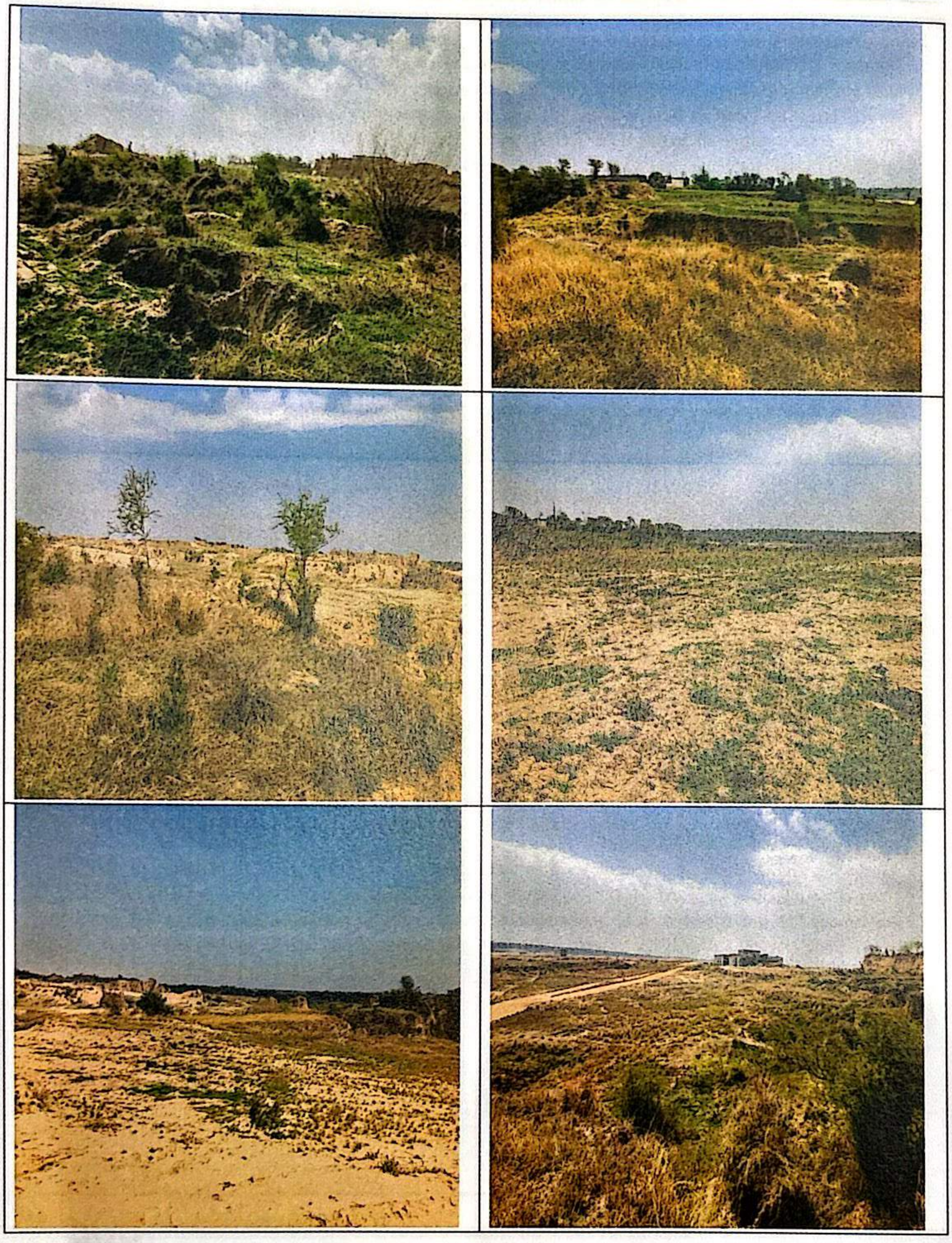
The Missakeswal Development and Production Lease (D&PL) area, located within Gujar Khan Tehsil of Rawalpindi District in Punjab Province, Pakistan, is situated on the Pothohar Plateau. This region is characterized by its undulating terrain, with elevations ranging from approximately 325 meters to 632 meters above sea level, and an average elevation of about 488 meters. The landscape comprises rolling hills, dissected plateaus, and interspersed plains, typical of the Pothohar Plateau. The area features a mix of loamy and sandy loam soils, which are generally well-drained and suitable for various land uses.

The Pothohar Plateau is bounded by the Jhelum River to the east, the Indus River to the west, the Kala Chitta Range and Margalla Hills to the north, and the Salt Range to the south. This positioning contributes to the region's distinct topographical features, including its varying elevations and the presence of significant geological formations. The area's terrain and geological characteristics make it a significant site for hydrocarbon exploration and drilling activities. Gujar Khan has been recognized for its substantial oil and gas reserves. Notably, the Tobra oil field, located approximately 10 kilometers from Gujar Khan, was discovered in 2002 and has been producing significant quantities of crude oil. The Missakeswal area itself is a major source of energy, supplying several cubic meters of gas daily and extracting large quantities of oil. The development of these resources plays a vital role in the local and national economy, contributing to energy security and employment opportunities.

Gujar Khan Tehsil is the largest in Rawalpindi District by land area and has a population exceeding 100,000 as of the 2023 census. The region is predominantly Punjabi-speaking, with a rich cultural heritage and a strong tradition of military service, earning it the moniker "Land of the Shaheed." The local economy is a mix of agriculture, remittances from overseas Pakistanis, and employment in the oil and gas sector. The development of drilling activities in Missakeswal is expected to further enhance economic opportunities and infrastructure development in the area.

Figure 5-1: Topography of the Project Area





5.1.2 Seismicity

Pakistan is situated along a tectonically active zone, lying at the intersection of the Indian and Eurasian plates. As a result, the country is prone to frequent seismic activity. Seismological data indicate that hundreds of low to moderate intensity tremors occur annually, although most are minor and cause little to no structural damage. The Pothohar Plateau, including Gujar Khan, is part of the northern foreland basin of the Indian Plate and is known for its complex geological structures, including folds and faults resulting from the Himalayan orogeny. The region has a history of seismic activity, necessitating careful geological assessments for drilling operations. The area is also part of the Upper Indus Basin, which has been a focus for hydrocarbon exploration due to its favorable geological formations.

Based on Probabilistic Seismic Hazard Assessment (PSHA) and Peak Ground Acceleration (PGA) values, Pakistan has been divided into five seismic zones under the **Building Code of Pakistan – Seismic Provisions (2007)**. These zones represent varying degrees of seismic risk, as summarized below:

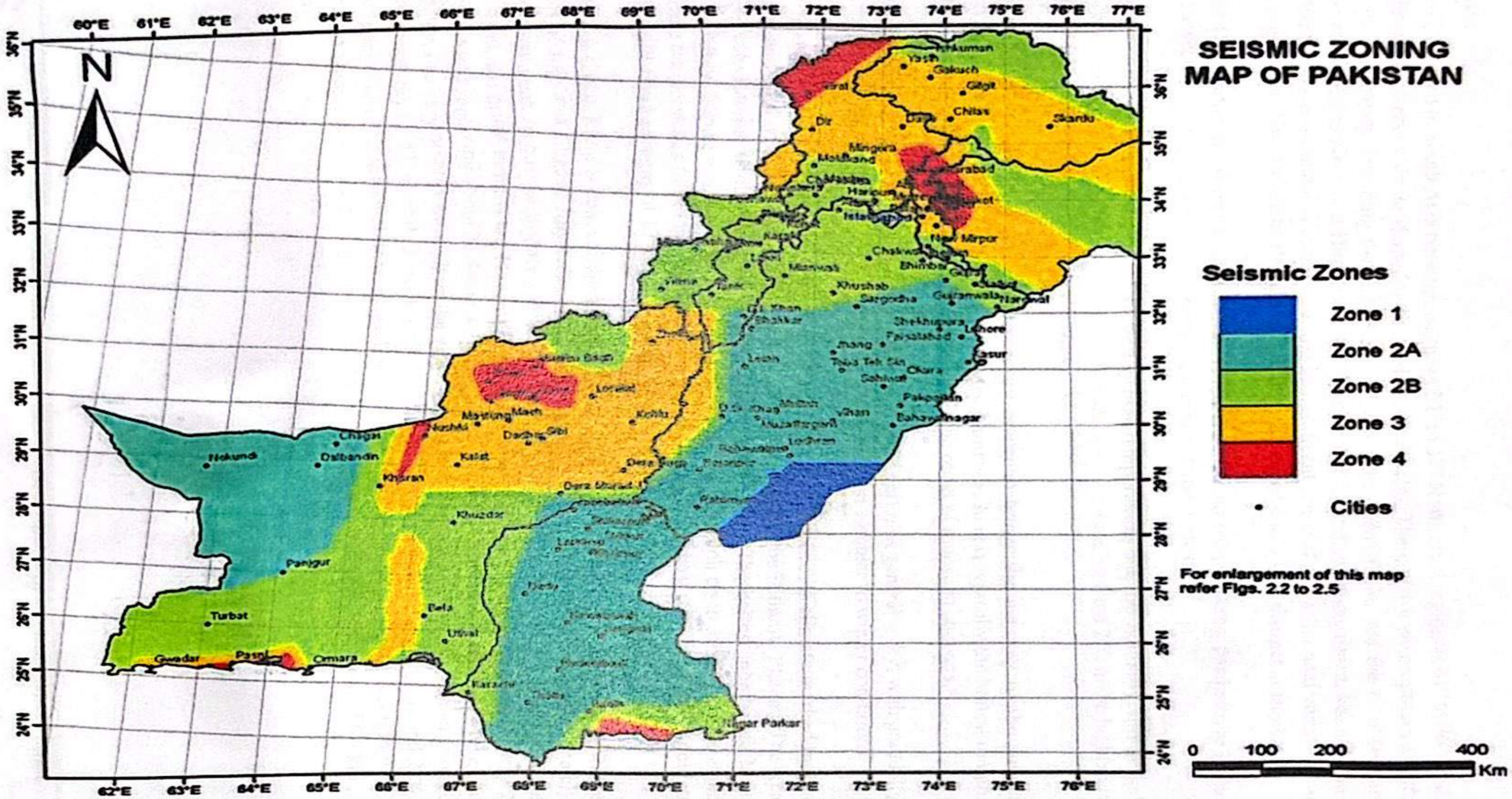
Table 5-1: PGA Values of Seismic Zones of Pakistan

Seismic Zone	PGA (g)
Zone 1	0.05 to 0.08
Zone 2A	0.08 to 0.16
Zone 2B	0.16 to 0.24
Zone 3	0.24 to 0.32
Zone 4	> 0.32

According to the seismic zoning map of Pakistan, the proposed project site falls within Seismic Zone 2B, which corresponds to a peak horizontal ground acceleration (PGA) range of 0.16 to 0.24g. This places the site within a moderate seismic risk category.

To ensure structural safety and resilience, all relevant provisions outlined in the Building Code of Pakistan – Seismic Provisions (2007) have been incorporated into the project's design. These include specifications for soil and foundation characteristics, structural configurations, load considerations, and appropriate seismic design coefficients. The Seismic Zoning Map of Pakistan, which visually delineates these zones, is presented in Figure 5-2.

Figure 5-2: Seismic Zoning Map of Pakistan



5.1.3 Climate

Pakistan, situated in South Asia between latitudes 24° to 37° North and longitudes 61° to 76° East, experiences a diverse climate shaped by its varied topography. The country encompasses a wide range of landscapes, including the Balochistan Plateau, the Indus Plain, and the mountainous regions of the Hindu Kush and Himalayas. Unlike much of the Indian subcontinent, Pakistan has a predominantly continental climate, resulting in significant regional and altitudinal variations in weather patterns. The climate of Pakistan is broadly categorized into four distinct seasons:

Winter (December to March): This season is marked by cold temperatures, particularly in the northern regions, where snowfall is common in the mountainous areas.

Pre-Monsoon (April to May): Characterized by high temperatures and low humidity, this period often sees sporadic rainfall. Temperature extremes are common, ranging from 2°C in the highlands to over 46°C in the southern and central plains.

Monsoon (June to September): The southwest monsoon brings the majority of the annual rainfall, although its distribution across the country is uneven. June is typically the hottest month, with temperatures frequently exceeding 45°C before the onset of monsoon showers.

Post-Monsoon (October to November): This transitional period is generally dry, with gradually cooling temperatures and clear skies as the country shifts from summer to winter conditions.

Gujar Khan, located in the Rawalpindi District of Punjab, experiences a climate marked by hot summers and mild winters, largely influenced by its positioning on the Pothohar Plateau. The area displays considerable temperature variations throughout the year. The hottest months are May, June, and July, during which average daytime temperatures can reach up to 39°C (102°F), while nighttime temperatures fall to around 26°C (79°F). In contrast, January stands out as the coldest month, with average highs of 17°C (63°F) and lows of 6°C (43°F).

Rainfall in Gujar Khan is concentrated primarily during the monsoon season, particularly in the months of July and August. July receives an average of 194.1 mm of rainfall over approximately 14 days, whereas August is slightly wetter, with an average of 203.5 mm over 13 days. On the other hand, the driest months are November and December, each recording an average of only 2 rainy days and receiving about 23.4 mm and 20.1 mm of rainfall, respectively. Humidity levels in the region also vary notably throughout the year. August is the most humid month, with an average relative humidity of 72%, while June records the lowest humidity levels, averaging around 22%. Wind speeds follow a seasonal trend as well, with May being the windiest month, averaging 11.7 km/h, and December experiencing the calmest conditions with an average wind speed of 6.7 km/h. (Source: worldweatheronline.com).

Figure 5-3: Temperature Profiles of Project Area

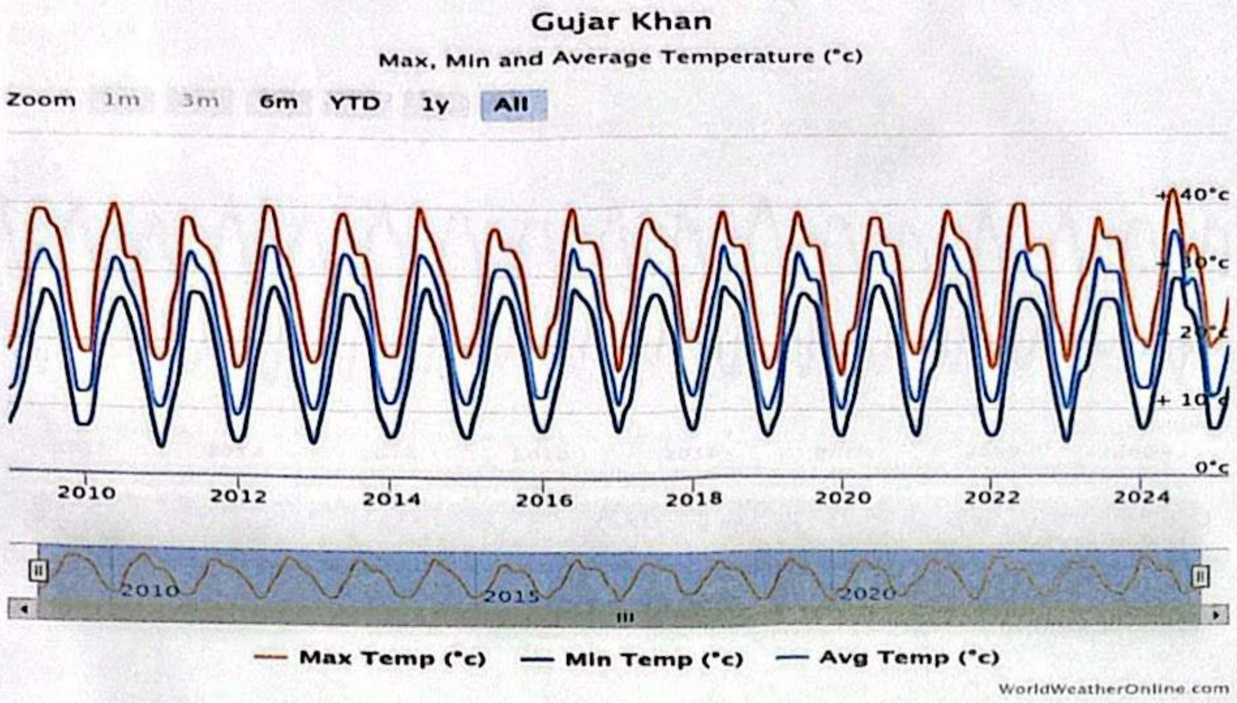


Figure 5-4: Average Rainfall Profiles of Project Area

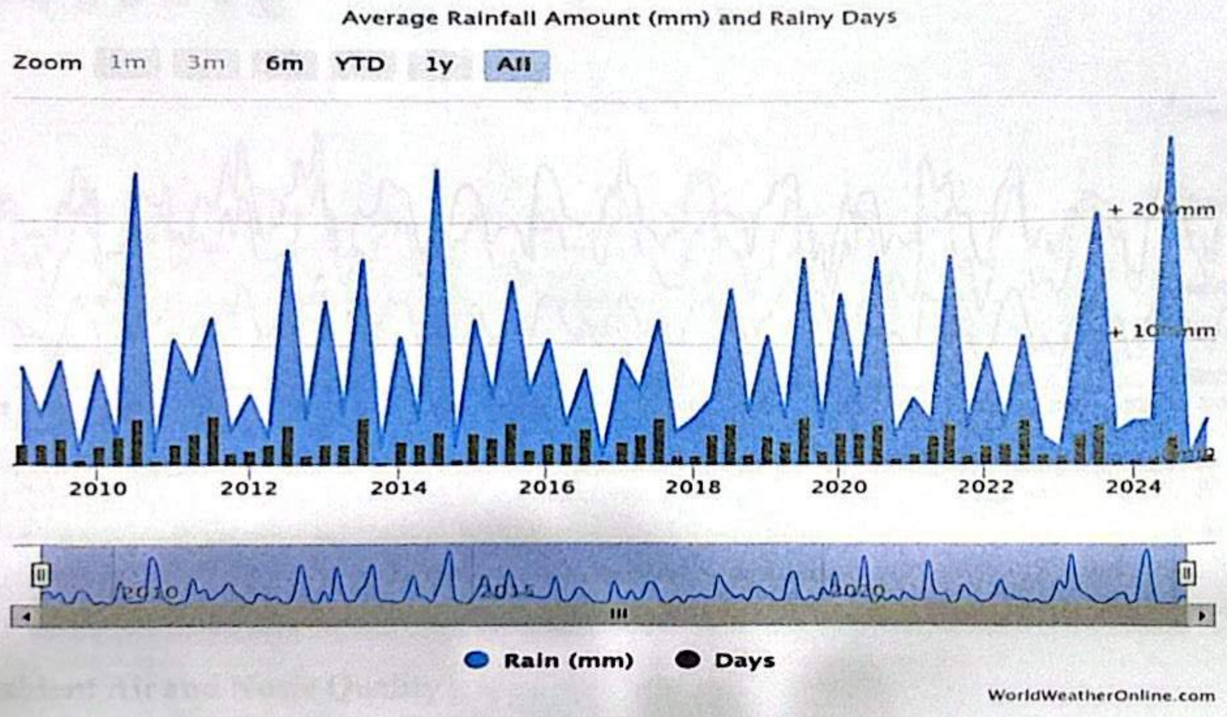


Figure 5-5: Average Pressure Profiles of Project Area

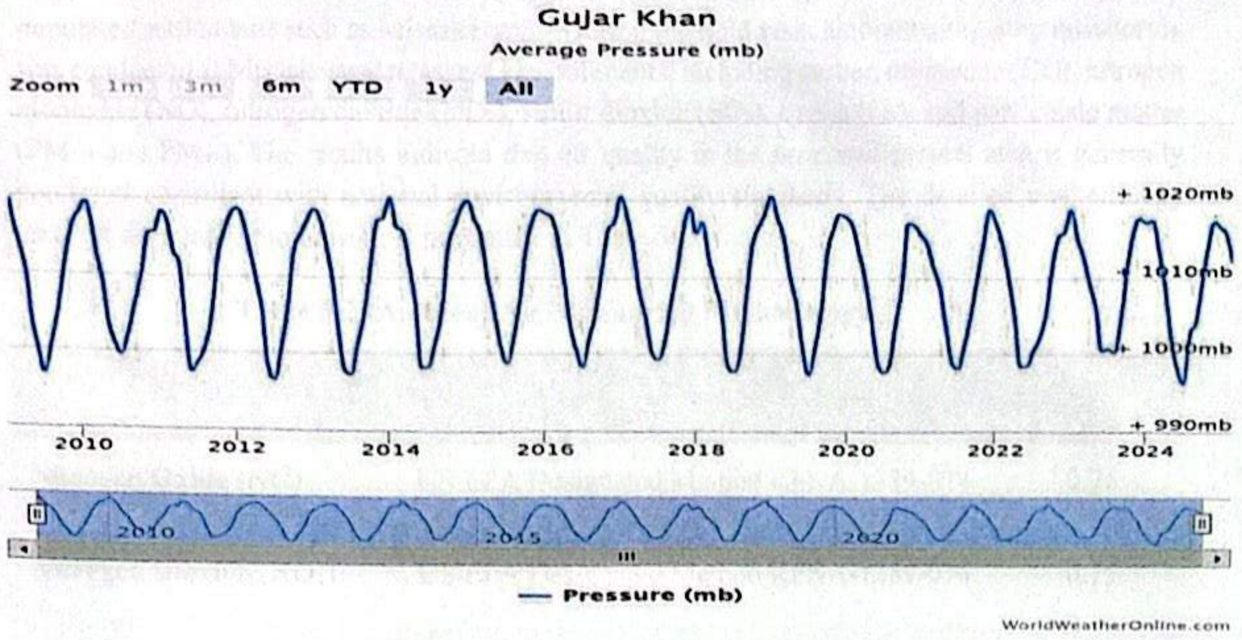
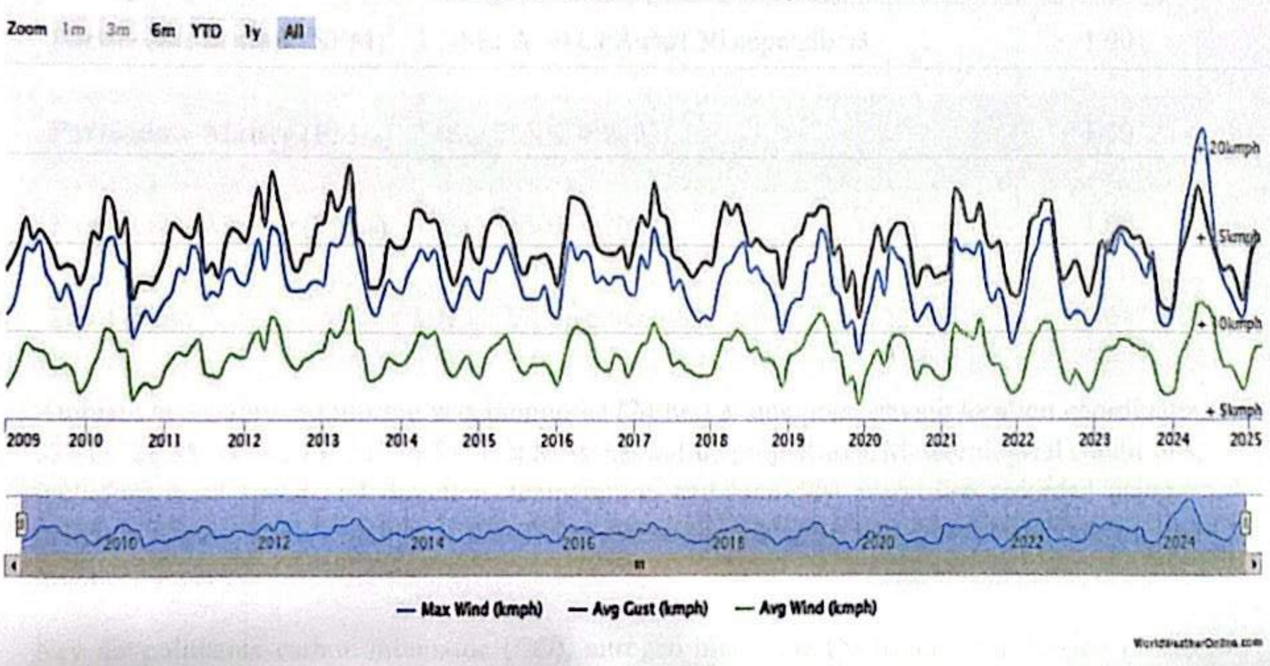


Figure 5-6: Average Wind Speed of Project Area



5.1.4 Ambient Air and Nosie Quality

Air Quality

Air quality in the project area is generally within permissible limits, with localized pollution primarily observed along roadways, attributed to vehicular emissions and the use of firewood for domestic purposes. Diesel powered trucks and buses, often poorly maintained, contribute to the emission of particulate matter and unburnt hydrocarbons. Additionally, dust generated from dry climatic conditions and unpaved surfaces further impacts local air quality. However, due to the

absence of significant industrial activity and the area's low population density, overall air pollution levels remain low and are restricted to specific zones. The project area encompasses sparsely populated settlements such as Missakeswal. During the field visit, ambient air quality monitoring was conducted at Missakeswal to assess key pollutants, including carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO_2), sulfur dioxide (SO_2), ozone (O_3), and particulate matter ($PM_{2.5}$ and PM_{10}). The results indicate that air quality in the proposed project area is generally good and compliant with national environmental quality standards. The detailed methodology used for air quality monitoring is presented in Table 5-2.

Table 5-2: Ambient Air Monitoring Methodology

Parameter	Methodology	LDL
Nitrogen Oxide (NO)	US EPA Designated Method RFNA-1289-074	0.75
Nitrogen Dioxide (NO_2)	US EPA Designated Method RFNA-1289-074	0.75
Sulfur Dioxide (SO_2)	US EPA Designated Method ESQA-0486-060	1.3
Carbon Monoxide (CO)	US EPA Designated Method RFCA-0981-054	0.1
Ozone (O_3)	USEPA Designated Method EQOA-0880-047	1.96
Particulate Matter (SPM)	USEPA 40 CFR Part 50 appendix B	1.00
Particulate Matter ($PM_{2.5}$)	ISO 21501-4:2007	1.00
Particulate Matter (PM_{10})	ISO 21501-4:2007	1.00
Lead (Pb)	High Volume Sampler	0.01

Ambient air quality monitoring was monitored (24 hrs) at one point having location coordinates 33° 13' 28.85" N and 73° 21' 33.51" E at Missakeswal-05 project area. Meteorological conditions, including wind speed and direction, temperature, and humidity, were also recorded using a meteorological station installed at the site to assess prevailing air movement trends during the monitoring period.

Key air pollutants carbon monoxide (CO), nitrogen monoxide (NO), nitrogen dioxide (NO_2), nitrogen oxides (NO_x), sulfur dioxide (SO_2), and particulate matter (TSP, PM_{10}, and $PM_{2.5}$) were monitored near the proposed project site. The monitoring was carried out for a continuous 24-hour duration in accordance with standard environmental assessment protocols.

The recorded data were compared with the Punjab Environmental Quality Standards (PEQS) for ambient air quality. The results indicate that concentrations of all monitored pollutants were within the permissible limits established by PEQS, confirming that the ambient air quality in the project area is satisfactory.

A summary of the ambient air quality monitoring results is provided in Table 5-3.

Table 5-3: Ambient Air Quality Results of the Project Area

Parameter	Unit	Average Monitoring Result	Limits as Per PEQS
Nitrogen Oxide (NO)	(µg/ m^3)	3.70	40 µg/ m^3
Nitrogen Dioxide (NO_2)	(µg/ m^3)	7.19	80 µg/ m^3
Sulfur Dioxide (SO_2)	(µg/ m^3)	1.28	120 µg/ m^3
Carbon Monoxide (CO)	(mg/m^3)	1.19	5 mg/m^3
Ozone (O_3)	(µg/ m^3)	19.3	130 µg/ m^3 (For 1 hour)
Particulate Matter (TSP)	(µg/ m^3)	143.5	500 µg/ m^3
Particulate Matter ($PM_{2.5}$)	(µg/ m^3)	29.1	35 µg/ m^3
Particulate Matter (PM_{10})	(µg/m^3)	75.1	150 µg/m^3
Lead (Pb)	(µg/ m^3)	<1.0	1.5 µg/ m^3

Noise Monitoring

There is no continuous major source of noise in the proposed project area. Due to the intermittent and low intensity nature of existing noise sources, it can be concluded that overall noise pollution in the area is minimal.

Noise level measurements were conducted during the field survey using a calibrated sound level meter to ensure accuracy and compliance with standard measurement tolerances. The recorded noise levels are presented in Table 5-4 and 5-5, while the locations of noise monitoring are (Point1: 33.2244N 73.3582E, Point2: 33.2242N 73.3616E and Point3: 33.2225N 73.3611E).

Although current noise levels are within acceptable limits, it is recommended that noise monitoring be continued during project activities. This will help assess any potential increases in noise levels relative to the baseline conditions established during the initial survey.

Table 5-4: Results of Noise Monitoring (Day Time)

Location	Noise Level in (dB) (Avg)	PEQS
Mohra Ferozan Village	41.93	65
Temporary Security Camp New Metro City	40.31	65
Near Proposed Well	41.93	65

Table 5-5: Results of Noise Monitoring (Nighttime)

Location	Noise Level in (dB) (Avg)	PEQS
Mohra Ferozan Village	39.45	55
Temporary Security Camp New Metro City	40.16	55
Near Proposed Well	39.45	55

5.1.5 Hydrology

The Rawalpindi region is primarily influenced by the Soan River and its tributaries, including the Korang River and Lai Nullah. The Soan River, a significant tributary of the Indus River system, originates from the Pothohar Plateau near Murree and flows southwest through the Rawalpindi District before merging with the Indus River. It plays a vital role in draining the region and supports both surface runoff and seasonal flows, particularly during the monsoon. The Korang River, originating in the Margalla Hills, serves as a major tributary of the Soan and passes through key areas of Islamabad and Rawalpindi. It also supplies water to the Rawal Dam, which is a crucial source of drinking water for the twin cities of Islamabad and Rawalpindi. The Lai Nullah, although a smaller tributary, is of particular importance due to its location in highly urbanized zones. It channels stormwater and untreated wastewater from densely populated areas of Rawalpindi and Islamabad, contributing significantly to the pollution load in the region's waterways. These rivers and streams are flanked by various seasonal nullahs that carry runoff from the surrounding catchment areas during periods of heavy rainfall. While the Soan and Korang rivers have historically been used for irrigation, increasing anthropogenic pressures have severely compromised their water quality. Untreated domestic sewage, industrial effluents, and agricultural runoff are major contributors to water pollution in the region. Studies have revealed that water samples collected from the Soan River and its tributaries, particularly downstream of urban centers, often exhibit elevated levels of pollution and frequently exceeding National Environmental Quality Standards (NEQS). The degradation of water quality in these rivers underscoring the urgent need for the implementation of wastewater treatment infrastructure, stricter pollution controls, and integrated watershed management strategies. The surface water