Environmental & Social Impact Assessment

Report

Armstrong ZE (Pvt.) Ltd.

R24AZEESA01PD

May 02, 2024

TEKCELLENT (PVT) LIMITED
TECHNOLOGY ENGINEERING KNOWLEDGE MANAGEMENT

Armstrong ZE

Environmental and Social Impact Assessment

Phase II

Armstrong Tyre Manufacturing Plant

Gharo, Sindh

Report

TPL Reference: R24AZEESA01PD

May 02, 2024

Tekcellent Private Limited
Karachi

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Acronyms

ADB	Asian Development Bank
ADM	Air Dispersion Modelling
ADT	Average Daily Traffic
AESC	Areas of Environmental and Social Concern
AoI	Area of Influence
AWS	Automatic Weather Stations
AZE	Armstrong ZE (Pvt.) Ltd.
BATNEEC	Best Available Technology Not Entailing Excessive Cost
BOD	Biological Oxygen Demand
BHU	Basic Health Unit
CAGR	Compound Annual Growth Rate
CCRA	Climate Change Risk Assessment
CFBC	Circulating Fluidized Bed Combustion
CPEC	China Pakistan Economic Corridor
CH	Cultural Heritage
CITES	Convention on International Trade in Endangered Species
CMS	Conservation of Migratory Species
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
E&S	Environmental and Social
EAoI	Environmental Area of Influence
EEA	European Environment Agency
EHS	Environmental, Health, Safety
EIA	Environmental Impact Assessment
ENSO	El-Nino Southern Oscillation
EPA	Environmental Protection Agency
EPC	Engineering, Procurement and Construction
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
ESMF	Environmental and Social Management Framework
ETP	Effluent Treatment Plant
FBC	Fluidized Bed Combustion
FEA	Finite Element Analysis
GIIP	Good International Industry Practices
GDP	Gross Domestic Product
HESCO	Hyderabad Electric Supply Corporation
HH	Household
IFC	International Finance Corporation
ILO	International Labour Organization

IP	Indigenous People
IUCN	International Union for Conservation of Nature
LC	Least Concerned
LNG	Liquefied Natural Gas
LTR	Light Truck Radial
LOS	Level of Service
mbgs	Metre below ground surface
MBT	2-mercaptobenzothiazole
MCHC	Maternity & Child Health Center
MICS	Multiple Indicator Cluster Surveys
MSDS	Material Safety Data Sheet
MPI	Multidimensional Poverty Index
NBC	Nano Blend Compound
NE	Not Evaluated
NEQS	National Environmental Quality Standards
NGO	Non-Governmental Organization
NO_2	Nitrogen Dioxide
NOC	No Objection Certificate
NO_x	Oxides of Nitrogen
O&M	Operation and Maintenance
O_3	Ozone
OEM	Original Equipment Manufacturer
ORP	Oxidation Reduction Potential
PAPs	Project Affected Persons
Pb	Lead
PCB	Poly Chlorinated Biphenyl
PCR	Passenger Car Radial
PDMA	Pakistan Disaster Management Authority
pH	Potential of Hydrogen
PKR	Pakistani Rupees
PM	Particulate Matter
PMD	Pakistan Meteorological Department
PNS	Pattern Noise Simulation
PPD	Phenyl Phenylenediamine
PPE	Personal Protective Equipment
PS	Performance Standards
RHU	Rural Health Unit
RO	Reverse Osmosis
R&D	Research and Development
SAoI	Social Area of Influence
SBCA	Sindh Building Control Authority
SEPA	Sindh Environmental Protection Agency
SEPEZ	Sole Enterprise Special Economic Zone

SEZ	Special Economic Zone
SME	Subject Matter Expert
SMPA	Sindh Master Plan Authority
SO_2	Sulphur Dioxide
SOP	Standard Operating Procedure
SPM	Suspended Particulate Matter
SSGC	Sui Southern Gas Company
SSP	Shared Socioeconomic Pathways
SUPARCO	Pakistan Space and Upper Atmosphere Research Commission
SWL	Static Water Level
TCLP	Toxicity Characteristics Leaching Procedure
TDS	Total Dissolved Solids
TMA	Taluka Municipal Administration
TMQ	2,2,4-trimethyl-1,2-dihydroquinoline
TMTD	Tetramethyl thiuram Disulphide
ToR	Term of Reference
TPH	Total Petroleum Hydrocarbons
TPL	Tekcellent Private Limited
UNFCCC	United Nations Framework Convention on Climate Change
US	United States
VBP	Vehicle Behaviour Prediction
VOC	Volatile Organic Compound
VU	Vulnerable
WASA	Water and Sanitation Agency
WBG	World Bank Group
WEEE	Waste Electrical and Electronic Equipment
WHO	World Health Organization
WMP	Waste Management Plan

Executive Summary

Introduction

Tekcellent Private Limited (TPL) was commissioned by Armstrong ZE ('Proponent' or the 'Client') to undertake an Environmental Social Impact Assessment (ESIA) for a Tyre Manufacturing Plant to be situated along the Gharo-Keti Bandar Highway (N-110), Taluka Mirpur Sakro, District Thatta, in Sindh Province.

Armstrong ZE aims to establish a tyre manufacturing facility to meet growing demand of tyres and reduce dependence on exports. The project has conducted a mandatory EIA in compliance with SEPA regulations, approved in 2022. Following IFC involvement for project funding, ESIA has been requested.

The ESIA has been split into two phases. The first phase comprised of Scoping activity which was completed and the report for scoping activity with reference no. R24AZEESR01PD was submitted to client for review. Based on the scope identified, the phase II of ESIA activity has been conducted. The results of the Phase II are incorporated in this report.

Objectives of the Study

This ESIA has been conducted in line with the IFC Performance Standards, as well as ensuring consideration of relevant best practices, international standards, and guidelines. A detailed description of the policy, legal and institutional framework is provided in Chapter 04 of this report.

The ESIA study aims to thoroughly describe the proposed Project and its alternatives, assess existing environmental and socio-economic conditions, identify sensitive resources, evaluate potential impacts and risks, recommend mitigation measures following the mitigation hierarchy, and present findings in a detailed ESIA Report.

Justification of the Project

The global tyre market is experiencing significant growth, with demand reaching nearly 333.86 billion US dollars and projected to continue increasing at a Compound Annual Growth Rate (CAGR) of 6.3% during the forecast period of 2024-2032. Pakistan's tyre industry is also on the rise, fueled by a surge in vehicle ownership and infrastructure development. In 2023, Pakistan's rubber tyre market reached 29.61 million units and is expected to grow at a CAGR of 8.76% to reach 63.05 million units by 2032. However, the industry faces challenges such as reliance on imported tyres, dominated mainly by Chinese imports, which account for 80% of imports. These imports often come with quality issues, posing a threat to local manufacturers. The Government and State Bank of Pakistan have

taken steps to curb imports, including imposing import taxes. Despite efforts to bolster local production, challenges such as smuggling, shortages of raw materials, and under-invoicing persist, hindering the industry's growth. General Tyres is the sole producer in Pakistan, supplying around 1.200 million tyres annually, but the industry is unable to meet the growing demand, resulting in a significant supply gap. To address these challenges and capitalize on the expanding automotive market, establishing new tyre manufacturing projects in Pakistan is crucial. Such initiatives can enhance local industrial capabilities, create employment opportunities, and contribute to economic growth. Encouraging domestic tyre production not only reduces reliance on imports but also strengthens the country's export potential by redirecting manufacturing activities locally. Thus, investing in the local tyre industry presents a promising opportunity to foster economic development and industrial growth in Pakistan.

Project Description

Project Location

The project site for Armstrong ZE is situated at coordinates 24°42'43.08"N, 67°35'18.99"E along the Gharo-Keti Bandar Highway (N-110), approximately 3 kilometers south of Gharo town, in the Taluka Mirpur Sakro, District Thatta, within Pakistan's Sindh province. Positioned on the periphery of Karachi, roughly 26 kilometers southeast, the site boasts convenient accessibility via the National Highway (N-5).

Project design

The main product of plant is Passenger Car Radial (PCR) tyre. The plant R&D, management, and related technical support shall be acquired from China Woori Tyre. The design focuses on performance balance technology, integrating features such as Pattern Noise Simulation, Vehicle Behavior prediction, Nano Blend compound, and Finite Element Analysis. The operational process involves compounding and mixing, calendaring, bead-wire manufacturing, steel and cord cutting, bead apex formation, tyre building, vulcanization, and final inspection to ensure quality before delivery to the consumer.

Construction Phase:

The construction phase of the Armstrong Tyre Manufacturing Project involves three main stages: construction of labor accommodations and bachelor hostel, utility buildings, and production areas along with infrastructure. The activities encompass site clearance, building construction, installation of utilities, and commissioning. Each phase is outlined with specific timelines and tasks to ensure efficient progress.

Operation and Maintenance Phase:

During the operation and maintenance phase, the focus is on the routine operations of tyre manufacturing, regular maintenance of machinery, inspection of quality control equipment, monitoring and optimization of manufacturing processes, upkeep of utilities and infrastructure, waste management, employee training, and adherence to safety and regulatory standards. Detailed plans for this phase are essential for the sustainable and efficient operation of the manufacturing plant.

Decommissioning Phase:

The decommissioning phase of the Armstrong Tyre Manufacturing Project may involve critical activities such as demolition, site cleanup, waste disposal, worker demobilization, and final site review. This phase is crucial for ensuring environmental responsibility and addressing potential shifts in environmental conditions over the lifespan of the project. A separate Environmental Site Assessment and Environmental and Social Management Plan would be necessary for the decommissioning phase to ensure a thorough and environmentally responsible conclusion to the project.

Resource Requirements:

Construction will employ approximately 528 workers in Phase I, rising to 983 in later phases, prioritizing local hiring. Shamsi Builders manages on-site labor, providing temporary accommodation. Over 500 temporary construction workers will be managed by subcontractors for various tasks.

Raw Material Requirements:

Raw material for construction will be sourced locally while most of raw material for operation phase will be exported from different countries as described in the relevant sections. Armstrong plans to use coal and biomass mixture for firing of boilers. The coal (lignite) is planned to be sourced from Thar coal mines in district Tharparkar of Sindh province. The coal mines are located ~285 km from the project site. The average daily coal consumption is anticipated 25,000 kg while maximum consumption is anticipated at 33,000 kg. The average steam requirement from boiler will be 11 tons per hour.

Water Requirement:

The daily water requirement during the construction phase is stated to be 20,000 gallons per day which will be procured through water tankers. During the operation phase, the project will use groundwater for its operations. The groundwater will be sourced from the fourth aquifer, approximately 100 meters below the ground surface and hydro-geologically separated from the shallow aquifer(s). The project will not use groundwater from shallow depths aquifers. The daily water usage for the project during the operational phase will be

approximately 65,000 gallons. Of this, 42,300 gallons will be used as process water, and 22,700 gallons will be used for on-site domestic purposes (e.g., accommodation areas, kitchens, and lavatories). Approximately 92,800 gallons will be drawn from the deep groundwater aquifer to kick-start the cycle. Subsequently, approximately 60,400 gallons of treated water from the Effluent Treatment Plant (which meets RO feed water standards) will be utilized to maintain the daily water balance requirement, and approximately 32,400 gallons per day will be sourced from groundwater.

Water Management:

The solid waste generated at site as part of Phase I of construction is primarily the kitchen waste and packaging (cement bags) waste, which is transported and handed over to the local municipal administration in Gharo by contractor currently working at the site (Shamsi Builders Ltd.). The wastewater resulting from construction activities in Phase I (primarily from domestic use such as washing, sewage, and catering) is directed to the on-site septic tanks (containments), located outside the catering area and the office block, which houses the washrooms. As the construction would progresses towards Phase II and Phase III, further septic tanks will be constructed by the contractors as per their requirement. The tanks present at site are of 5,000 gallons capacity each, and have not yet reached their maximum capacity. Once the capacity is full, they will be emptied accordingly for subsequent disposal via an approved waste management contractor. The hiring of waste management contractor is currently in the tendering process, as informed by the proponent.

During the operation phase, the proposed tyre manufacturing plant is anticipated to generate several waste streams, notably coal ash, sludge from ETP and septic tanks and wastewater. Coal ash will result from the combustion of coal in coal-fired boilers, in both form, as fly ash and bottom ash residues. Fly ash will be removed from the exhaust gases via wet scrubber, with resultant sludge directed to the coal ash pond for storage and subsequent disposal. Bottom ash will be collected from the bottom hopper, will be temporarily stored inside a dedicated portion for ash storage within the coal storage area (adjacent to the boiler), from where it will be transferred to the coal ash pond. The coal ash pond will feature geo-membrane lining, sandwiched between two layers of concrete, ensuring containment. Subsequently, the ash from the pond will be sold, and transported to predetermined cement manufacturer or block manufacturer for its appropriate disposal. Wastewater from the RO plant, production area, and sanitary areas will be directed to the on-site Effluent Treatment Plan (ETP). Following comprehensive treatment, the treated water will be recycled and re-utilized into the feed water system, mitigating the need for wastewater discharge, as elaborated in detail with water balance in the report. Sludge from the ETP and septic tanks will be methodically cleaned and collected using vacuum trucks designed to pneumatically draw liquids, sludge and slurries into onboard tanks. This method ensures the safe transport of liquid material to the disposal facility. Disposal of

sludge will be entrusted to Sindh EPA approved third-party contractor(s) on fortnightly basis or upon accumulation of sufficient volume of sludge.

Key Findings

Key finding of this Environmental and Social Impact Assessment (ESIA) study include:

- Construction activities may cause soil degradation, compaction, and contamination, while operational processes pose risks to groundwater quality and water resources due to chemical usage and increased water extraction.
- The construction phase of the proposed tyre manufacturing plant may induce air quality impacts, particularly particulate matter pollution and dust generation, stemming from land levelling and transportation activities.
- During the operational phase, air quality impacts from power generation and manufacturing operations are anticipated, characterized by long-term duration, however, based on the results of air pollution modelling, marginal exceedances have been recorded against the WHO Ambient Air Quality Guidelines under extreme modelling scenario for sulphur dioxide and nitrogen dioxide only, while all other pollutants including carbon monoxide and Total Suspended Particulates (TSP) were reported to be within regulatory limits.
- The tyre manufacturing plant also presents potential noise and vibration impacts during both construction and operational phases. Construction activities such as land clearing and transportation may cause short-term, reversible disturbances, while operational noise from machinery and generators could lead to long-term impacts of medium to high significance.
- The daily water requirement during the construction phase is stated to be 20,000 gallons per day. The site management has planned and started procuring water using hydrant/tanker water (a vehicle or trailer used for transporting water from one place to another) sourced from Dhabeji Pumping Station, situated approximately 12 to 15 km northwest of the site. Meanwhile, the on-site water drinking water requirement during the construction phase is being met through bottled water.
- The project will use groundwater for its operations. The groundwater will be sourced from the fourth aquifer, approximately 100 meters below the ground surface and hydro-geologically separated from the shallow aquifer(s). The project will not use groundwater from shallow depths aquifers to avoid impact on the local communities who use this water for drinking and agricultural needs. The daily water usage for the project during the operational phase will be approximately 65,000 gallons. Of this, 42,300 gallons will be used as process water, and 22,700 gallons will be used for on-site domestic purposes (e.g., accommodation areas, kitchens, and lavatories. Approximately 92,800 gallons will be drawn from the deep groundwater aquifer to kickstart the cycle. Subsequently, approximately 60,400 gallons of treated water from the Effluent Treatment Plant (which meets reverse osmosis (RO) feed water

standards) will be utilized to maintain the daily water balance requirement, and approximately 32,400 gallons per day will be sourced from groundwater.

- Increased water extraction from groundwater sources during the operation phase can lead to groundwater depletion and lowering of the water table. Given that the project area has a coastal aquifer, the site has planned on extracting groundwater from deeper levels i.e. from the 4th aquifer rather than utilizing groundwater from shallow aquifer. This approach is chosen to ensure sustainable water usage and to prevent adverse effects on the local hydrology and to the competing users of shallow aquifer(s).
- The proposed Project site is located in Thatta district, which falls under the Indus Delta ecoregion. Within a 10 km radius of the proposed site, there are no legally and/or internationally recognized Protected Areas. The closest Key Biodiversity Area/Protected Area is the Haleji Wildlife Sanctuary and Lake located at a distance of ~19 km northeast from the site. The biophysical environment assessed within the 3 km radius of the proposed Project site, primarily consists of modified habitats, predominantly agricultural land and commercial areas.
- The biodiversity baseline surveys conducted, revealed the presence of 114 plant species within 3 km of the study area, with more than half categorized as ornamental and cultivars. The majority of the documented flora are cultivated by farmers or landowners, while two of them are identified as alien species. Among these, 39 plant species are recognized as wild. None of the species identified on-site and within the study area were found significant under IUCN Red List of species and possess / warrant conservation significance.
- The fauna survey identified 47 avifauna species within the study area, with the majority being resident birds. The Indian River Tern is the sole species identified as Vulnerable under IUCN Red List, which is a resident bird, found abundantly in the broader vicinity, particularly in the Gharo creek area, located ~9 km northwest of the site falling outside the Project Area of Influence.
- No critical habitat has been identified within the Project study area. The closest habitat meeting the criteria for critical habitat is Haleji Lake, located at a distance of ~19 km northeast from the site, thus minimizing the likelihood of impact from the Project activities
- Due to the presence of communities in close proximity, the measures related to community health and safety will be of significant importance to ensure that there are no adverse impacts to community during construction and operation.
- Sourcing of labour primarily during construction will be done locally.
- Activities related to informed consultation and participation with local settlements will be continually undertaken throughout the project lifecycle. Adequacy of grievance redressal mechanism will be ensured throughout the project.
- The ESIA underscores significant concerns regarding tyre manufacturing processes, highlighting risks of air and water pollution, soil contamination, and worker health

hazards. To mitigate these risks, stringent measures are essential, including advanced pollution control technologies, robust waste management practices, and comprehensive worker safety.

Key Recommendations

Based on the findings of the Environmental and Social Impact Assessment (ESIA), several key recommendations emerge for Armstrong ZE regarding the proposed project. Firstly, it is advised that the Environmental and Social Management Framework (ESMF) becomes an integral component of the contracts awarded by Armstrong ZE. This move ensures that environmental and social considerations are embedded within project implementation from the outset. Secondly, there is a pressing need for Armstrong ZE to cultivate in-house capacity for environmental and social management, equipping the organization to effectively address relevant issues throughout the project lifecycle. Additionally, strict adherence to the Health, Safety, and Environment (HSE) Policy and Environmental & Social Policy is paramount, showcasing Armstrong ZE's dedication to sustainable practices across its operations. Compliance with pertinent environmental legislation and regulations is also underscored, emphasizing the importance of legal adherence and regulatory compliance. Moreover, continuous engagement with local communities and prioritization of local labor are recommended strategies to foster positive community relations and support regional employment opportunities. By incorporating these recommendations into the ESMF, the proposed tyre manufacturing plant can significantly reduce its environmental impact and promote ethical practices, thus safeguarding both the environment and the interests of neighboring communities.

1. Introduction

1.1 Preface

In the pursuit of sustainable industrial development, the Environmental and Social Impact Assessment (ESIA) plays a pivotal role in ensuring the responsible execution of projects. The proposed project is a tyre manufacturing plant, which reflects a commitment to industrial growth while concurrently recognizing the significance of environmental and social stewardship. The introduction chapter provides an overview of the project's scope, objectives, and key stakeholders, setting the stage for a comprehensive understanding of the subsequent ESIA findings. Armstrong ZE (Private) Limited (hereinafter referred as 'Armstrong ZE') is seeking project finance from International Finance Corporation (IFC) and therefore requires the project to comply with the applicable International Finance Corporation (IFC) Performance Standards (PS) on Environment and Social Sustainability (2012), the World Bank Group (WBG) Environment, Health, and Safety (EHS) guidelines, as well as local Environmental and Social (E&S) laws and regulations. This enables the project to acknowledge the global imperative for sustainable practices.

Tekcellent Private Limited (hereinafter referred to as "TPL") was commissioned by Armstrong ZE for conducting an environmental and social impact assessment (ESIA) in the project area. This report presents the findings of the impact assessment study.

1.2 Description of Proponents

The project proponent is Armstrong ZE (Pvt.) Limited having its roots from Armstrong Tyres, a well-known American tyre brand which was acquired by ZAFCO Group in 2012. The group itself is headquartered in Dubai and is basically world's largest warehousing network and biggest tyre manufacturer and distributor in the Middle East Region. ZAFCO has its presence in Pakistan as Zafar Enterprises (ZE) with its head office based in Karachi with country-wide operations. Zafar Enterprises has an investment size of around PKR 6 billion in Pakistan and has a 50 years of experience in tyre industry.

Zafar Enterprises acquired a land parcel in the Gharo region, out of which 50.25 acres of the land parcel was then transferred to Armstrong ZE (Pvt.) Limited on February 17, 2022 with the intent to establish a Tyre manufacturing Plant. The land was originally allotted by Government of Pakistan on November 14, 1961 to Lieutenant Colonel (Retd.) Shah Muhammad under Defense Forces Conditions by Revenue Officer Ghulam Muhammad Barrage Hyderabad, Sindh, Pakistan. Later on June 06, 2018, his son Captain Shahid Pervaiz sold the land to Logistic Enterprises (Pvt.) Ltd. Subsequently, Logistic Enterprises sold the land to Zafar Enterprises on October 03, 2019. Zafar Enterprises (parent company of Armstrong ZE) acquired the land parcel of 133 acres, out of which 50.25 acres was then transferred to Armstrong ZE (Pvt.) Limited on February 17, 2022 with the intent to establish a Tyre manufacturing Plant. There was no involuntary resettlement involved and there are

no pending legal cases for the land acquisition. The project development will be done in line with National Guidelines on the manufacturing sector and in accordance with International Finance Corporation (IFC) Performance Standards."

1.3 Background

Armstrong ZE (Pvt.) Ltd. is a private company with the objective of establishing a tyre manufacturing facility to meet the growing demand for tyres throughout the country. The proposed tyre manufacturing plant is situated along the Gharo-Keti Bunder Highway (N-110), Gharo, Taluka Mirpur Sakro, District Thatta, in Sindh Province.

The parent company, Zafar Enterprises, owned a total of 133 acres of non-agriculture land. Armstrong has acquired 50.25 acres of this land from Zafar Enterprises, of which 16 acres has been converted to Industrial/ Commercial land, as approved by Town Planning, Sindh Master Plan Authority (SMPA), Hyderabad for establishment of production area of the project as shown in Exhibit 1.1. The remaining 34 acres area is currently being used for building labour accommodation, bachelors' hostel, administration building, offices and parking areas.

In line with the prevailing legislation in the country, Armstrong ZE engaged a local consultant to carry out an EIA as mandated by Section 17 of the Sindh Environmental Protection Agency (SEPA). The EIA study was commissioned, and the report was filed with the Sindh Environmental Protection Agency (SEPA) in April 2022. SEPA issued an approval of the submitted EIA report on June 15, 2022. With the involvement of the International Finance Corporation (IFC) for project funding, an Environmental and Social Impact Assessment (ESIA) has been requested for the project, following the IFC's review and comments on the initial EIA. The ESIA has been split into two phases. The first phase comprised of Scoping activity which was completed and the report for scoping activity with reference no. *R24AZEESR01PD* was submitted to client for review. Based on the scope identified, the phase II of ESIA activity has been conducted and the results of Phase II are incorporated in this report.

1.4 Project Justification

The global tyre market is being driven by the rising demand of the products across the world. Global Tyre demand has reached nearly 333.86 billion US dollars and is projected to continue growing during the forecast period of 2024-2032, with a compound annual growth rate (CAGR) of 6.3%. It is also anticipated to reach 578.75 billion dollars by 2032 (EMR Insights, 2023a).

Currently, Pakistan's tyre industry is experiencing moderate growth due to increasing vehicle ownership in the country (ASD Reports, 2022). In 2023, the Pakistan rubber tyre market reached 29.61 million units. It is expected to reach 63.05 million units by 2032, exhibiting a growth rate CAGR of 8.76% during the projected years of 2024-2032 (EMR Insights, 2023b). This increasing rate of vehicle motorization in Pakistan is currently driving

the demand for tyres within the country. Anticipated demand for all types of tyres is expected to exhibit a rising trend due to the increase in the automotive industry particularly driven by development of China-Pakistan Economic Corridor (CPEC) (ASD Reports, 2022). The current status of the tyre industry in Pakistan encompasses both two-wheeler tyres (such as those used for motorcycles and rickshaws) and four-wheeler tyres (including passenger car tyres, tractors, and buses) as shown in Exhibit 1.2**.**

Industry sources said the annual consumption of tyres in Pakistan is 10 million of which 20% consumption is met by locally-manufactured tyres, while 15% of tyres are imported. The remaining 65% of the demand is met by smuggled tyres (The News International, 2021). Chinese tyres dominate the Pakistani tyre market and accounted for 80% of the imports. However, some of the Chinese tyres are of low-end quality and they offer a shorter lifetime. Additionally, the Government and State Bank of Pakistan has undertaken various steps in recent months to curb the imports. Import taxes have been imposed to domestic manufacturers. Pakistan tyre industry is facing a huge demand and supply gap due to heavy under-invoicing and smuggling of tyres (Akhter, 2022).This dual challenge is compounded by shortages of raw materials, posing serious obstacles for the local tyre industry to survive during ongoing economic condition (Business Recorder, 2023).

In Pakistan, General Tyres is the sole producer of tyre industry and supplying around 1.200 million tyres per year dominating the local demand of end users. As of December 2022, the number of registered vehicles in Pakistan was reported 7,020,803 units as shown in Exhibit 1.2 (CEIC Data, 2022). This increased number of vehicles on the roads necessitates the production of high-quality tyres and a reduction of smuggled tyres, which have been utilized to meet the demand for tyres for these vehicles. For this, the establishment of a new tyre manufacturing project in Pakistan can capitalize on its expanding automotive market, enhance local industrial capabilities, create employment opportunities and contribute to economic growth and development. The project will not only diminish the dependency on imported tyres but also provide a boost in a local GDP. Encouraging tyre production for domestic industrial setups could have a substantial impact on the country's export market by redirecting manufacturing activities to Pakistan.

1.5 Objectives of the ESIA

The objectives of the proposed study are to:

- Provide a detailed description of the proposed Project (including relevant alternatives) in terms of the planned activities and the expected environmental and social aspects associated with the activities.

- Establish the existing state of the environmental and socio-economic conditions and to identify any sensitive resources and receptors.

- Identify and assess the associated and potential environmental and socio-economic impacts and risks of the project, including potential secondary and cumulative impacts.

- Recommend appropriate mitigation measures (adopting the Mitigation Hierarchy, which is a set of guidelines that aim to achieve no overall negative impacts through avoidance, minimization, restoration and offsetting sequential steps) to address the identified impacts of the project.

- Implement a systematic approach to stakeholder engagement to build and maintain a constructive relationship with stakeholders, particularly the directly affected communities.

- Develop an appropriate ESMP to detail how mitigation measures will be implemented and how environmental performance will be managed for the project throughout the Project's life cycle.

- Prepare and submit a detailed ESIA Report presenting clear and concise information on the findings of the ESIA study.

1.6 Scope of work and Methodology

The ESIA study was based on the findings of the scoping phase and the scope was envisioned accordingly. It has been conducted with a multidisciplinary approach including various techniques which are provided in subsequent chapters. The methodology adopted for this study includes:

- Desktop research.

- Reconnaissance survey of the project site by subject matter experts (SMEs) and data collection.

- Identification of scope of work for ESIA study.

- Establishment of environmental and social baseline based on scope.

- Stakeholder engagement and consultation.

- Assessment of environmental and social impact on areas of concern during various project stages.

- Development of environmental and social management plan.

The activity has been undertaken in accordance with IFC guidelines while the methodology envisaged for the ESIA is also illustrated in Exhibit 1.3. The fieldworks conducted for ESIA Phase II includes the following.

Date	*Site Activities*
Environmental and Social Impact Assessment (January 17-March 26, 2024)	• Ambient Air quality monitoring and ambient noise monitoring was carried out from January 31, 2024 to February 2, 2024. • Activity for installation of six on-site monitoring wells to depth of approximately 5 mbgs was carried out as part of baseline soil and groundwater assessment from January 17 to 21, 2024. • Subsequent water sampling from installed monitoring wells was carried out on January 30, 2024. • Hydro-census activity for the identification of the groundwater users and surface water users for baseline was carried out on February 1, 2024. • Stakeholder consultations included consultations with local communities and commercial entities within project AoI and institutional stakeholders have been carried out from February 11 to March 1, 2024. • Traffic survey was carried out on February 20, 2024. • Biodiversity survey for the identification of floral species was carried out in the project AoI on February 15 and 18, 2024. Furthermore, the survey for identification of the faunal species was undertaken on February 16 and 20, 2024. • A water testing of the Gharo Creek was carried out on February 16, 2024. • Activity of Electrical Resistivity Survey was carried on March 26, 2024.

1.7 ESIA Team Composition

The list of team members involved in conducting ESIA study included:

- Syed Masood Ahmed — Technical Oversight
- Maryam Asim Khan — Project Manager
- Asila Ilyas — Project Coordinator
- Amna Bano — Project Technical Lead/Environmental Consultant
- Taha Amerjee — Deputy Project Lead/Environmental Engineer
- Sara Jalal — Sr. Soil & Groundwater/Environmental Engineer
- Sajida Khalid — Social Expert
- Rafi-ul-Haq — Biodiversity Expert
- Manzar Abbas — Flora - Analyst
- Rao Abdul Wadood — Fauna - Analyst
- Naveed Ahmed — Fieldworks In-charge/HSE Manager
- Zubaid Saeed — Sr. Field Geologist
- Ahtisham Ahmed Khan — Sr. Field Chemist

1.8 Limitations of the Study

This Environmental and Social Impact Assessment (ESIA) report for the Armstrong ZE project is based upon site visits, review of project design and documentation, comprehensive review of publicly available documents, and stakeholder consultations. Reliance on publicly available data may introduce potential inaccuracies, and the report incorporates assumptions and predictions to estimate environmental and social impacts. The findings and recommendations are subject to change pending updates, additional client-provided information, or modifications to the project design.

1.9 Document Structure

This document is structured into following sections:

Section 1: Introduction – This chapter provides an overview of the project, the objectives and scope of the ESIA study.

Section 2: Project Description – This chapter descries the technical details of the project which form the basis for conducting environmental and social impact assessment.

Section 3: Analysis of Alternatives – This chapter analyses the potential alternatives for the project.

Section 4: Policy and Statutory Requirements in Pakistan – It describes the legislative, policy and administrative requirements, as well as international good practice requirements applicable to the Project.

Section 5: Environmental Baseline – This chapter discusses the physical, geo-physical and biological environment within the Area of Influence (AoI) of the project.

Section 6: Social and Socio-Economic Baseline – It provides description on social and socio-economic baseline with the macro environment and in the project's AoI.

Section 7: Stakeholder Engagement – This chapter summarizes the stakeholder engagement activities associated with the Project and ESIA process.

Section 8: Environmental and Social Impact Assessment - Describes the methodology adopted for impact assessment, assesses all relevant environmental and socio-economic risks and impacts of the project, including associated and cumulative impacts and proposes mitigation measures.

Section 9: Environmental and Social Management and Monitoring Plan - Presents the outline for development of environmental and social framework of the Project.

Section 10: Conclusions and Recommendations - Summarizes the key findings of the ESIA.

Section 11: References - Contains a list of references used in compiling this ESIA Report.

Exhibit 1.1. Project Boundaries

Legend

Project Boundary (50.25 Acre)

Production Area

Scale: *m* 0 50 100 150 200

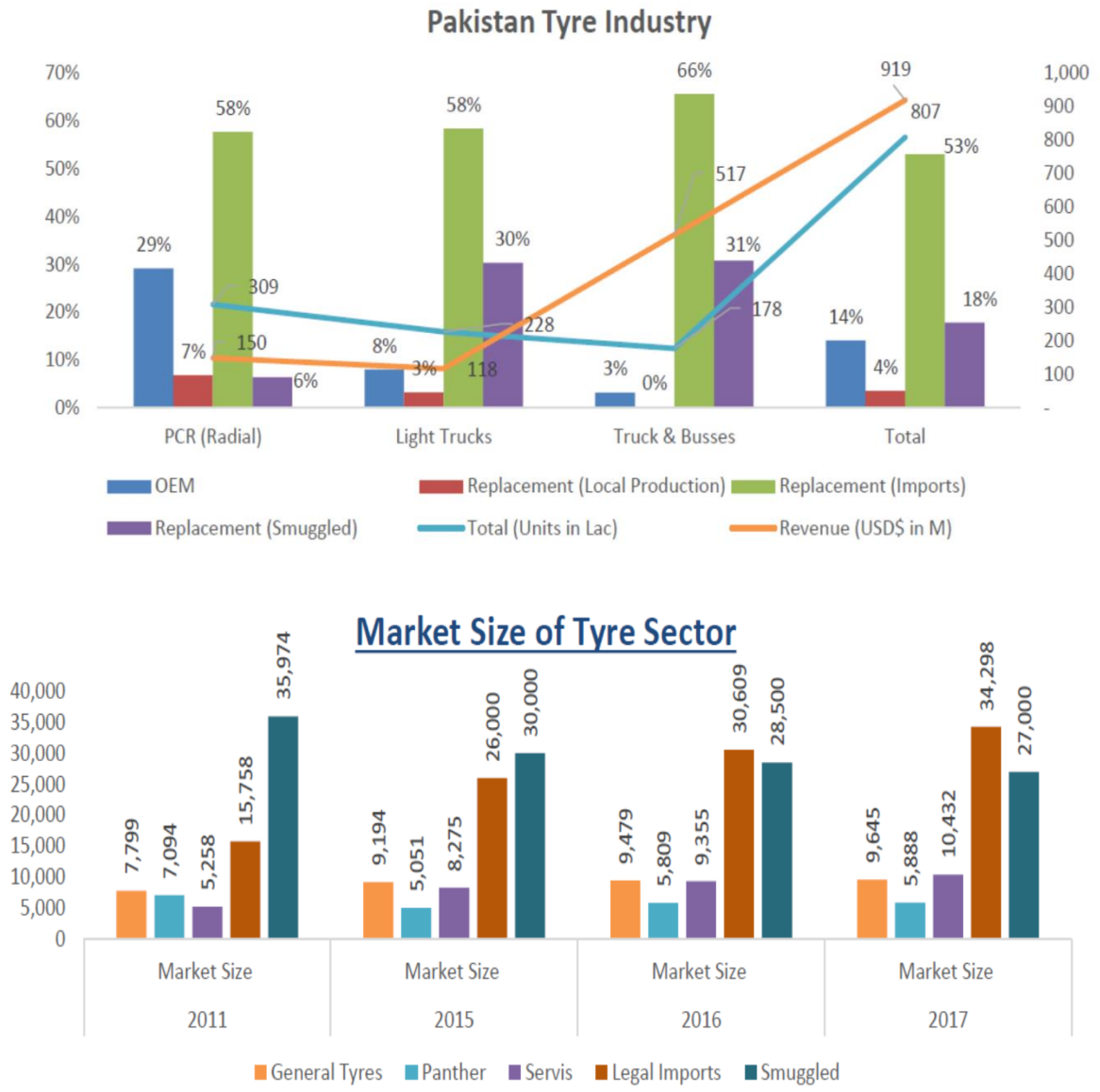
Environmental Social Impact Assesment
Armstrong ZE Tyre Manufacturing Plant

Project Boundary

Drawing:	---	**Ship to:**	-
Revision:	*0*	**Co-ordinates:**	*24°42'39.24"N*
Source:	*TPL Field Survey*		*67°35'9.26"E*
Date:	*January 11 to January 12, 2024*		
Client:	*Armstrong ZE (Pvt.) Ltd.*		

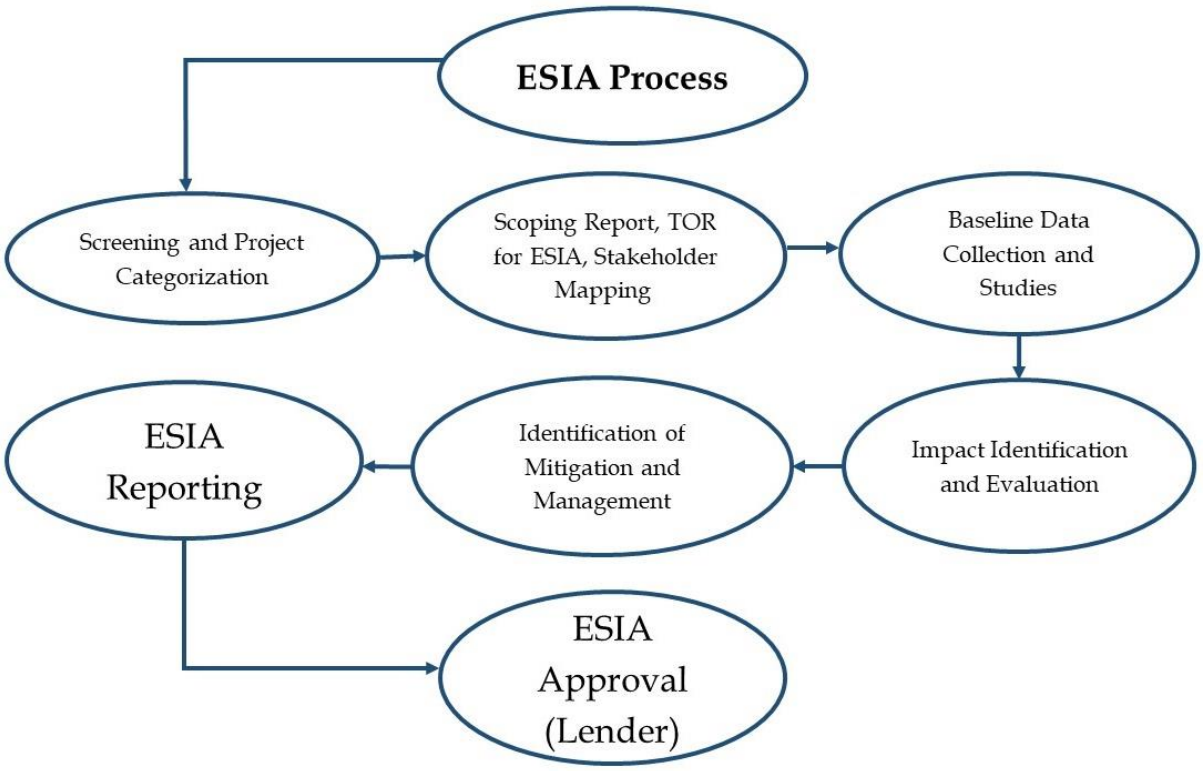
TEKCELLENT (PVT) LIMITED
TECHNOLOGY ENGINEERING KNOWLEDGE MANAGEMENT

Exhibit 1.2. Status of Tyre Industry in Pakistani Market



Source: PBIT, 2019

Exhibit 1.3. Methodology adopted for ESIA Activity



2. Project Description

2.1 Introduction

The chapter discusses the comprehensive project description, providing a detailed overview of the proposed tyre manufacturing project situated in Gharo. This section serves as a foundational narrative, outlining the project's purpose, scope, and key components. This chapter provide insights into the project's design, technological aspects, and the anticipated socio-economic footprint. The Project Description serves not only as a guide to the physical infrastructure but also as a narrative that bridges the gap between vision and realization. Through a meticulous exploration of the project's intricacies, this chapter aims to provide a holistic understanding of the Tyre Manufacturing Project, laying the groundwork for subsequent assessments and analyses.

2.2 Project Location

The project site of Armstrong ZE is located at 24°42'43.08"N, 67°35'18.99"E along the Gharo-Keti Bunder Highway (N-110), approximately 3 km south of Gharo town, Taluka Mirpur Sakro, District Thatta, in the Sindh province of Pakistan. Coordinates of the project boundary are as follows:

Points	Latitude	Longitude
AZE-1	24°42'47.99"N	67°35'07.69"E
AZE-2	24°42'48.72"N	67°35'31.78"E
AZE-3	24°42'38.38"N	67°35'31.22"E
AZE-4	24°42'38.19"N	67°35'07.84"E

The satellite imagery of the project area is provided in Exhibit 2.1.

The area is located on the outskirts of Karachi approximately 26 km southeast and can easily be accessed through National Highway (N-5). The overall land use of the project land and its surroundings along with key receptors is shown in site locality map given in Exhibit 2.2.

2.3 Project Phases

The project activities can be divided into three (3) major categories including Planning, Design and Pre-Construction; Construction Phase; and Operation and Maintenance Phase.

2.3.1. Planning, Design and Pre-construction Phase

The design phase is pivotal as the ESIA outcomes shape the Project's progression. Throughout this stage, project planning, decision-making, and adjustments persisted in alignment with the insights obtained from the ESIA.

a. Current Project Design

As communicated by Armstrong ZE (Pvt.) Ltd., the plant has a daily capacity of manufacturing 5,000 tyres in the first phase, which will be increased to 10,000 tyres in the second phase (85% capacity utilization). The 85% capacity utilization reflects a tyre plant's maximum operational efficiency over a year, including shutdowns, repairs, maintenance, and overhaul days. The facility has been developed to accommodate essential machinery and operations, ensuring tyre production that meets international standards and quality. This contains separate facilities for raw material storage, processing, completed goods storage, and display. The infrastructure also includes loading docks and transportation terminals to ensure efficient distribution of manufactured items.

b. Project Design Components

The main elements of the Project planning, design and pre-construction, and their inclusion in the environmental and social appraisal comprise construction of the following:

- Raw material storage area
- Carbon Black feeding area
- Tyre building machines and equipment setting area
- Finished good storage area, and
- Docking area

Other supporting facilities that will be as per the construction plan include the following:

- Worker's facilities, including labour accommodation and bachelor's hostel
- Dining areas
- Waste warehouse
- Sulphur and oil storage areas, coal yard and lubricating oil warehouse
- General sub-station and refrigeration and air compressor stations
- Machine shop and spare parts warehouses
- Boiler room and tyre testing R &D laboratory
- Fire station, and
- Fuel dispenser area

The plant layout is illustrated in Exhibit 2.3**.**

c. Project Design and Technology

The Plant R&D and technical support shall be operated by China Woori Tyre Service Company. While the design would incorporate Korean technology, the new product will be

developed on performance balance technology (Armstrong ZE, 2022a), which includes the following:

- **Pattern Noise Simulation (PNS) –** To reduce low and high frequency noise and reduce internal and external noise levels
- **Vehicle Behaviour Prediction (VBP) –** To enhance tyre safety performance on high speed and predict tyre cornering and line changes and performance etc.
- **Nano Blend Compound (NBC) –** To provide full-life performance during using, balancing tyre braking, wear, R/R, endurance performance in full-life.
- **Finite Element Analysis (FEA) –** To predict tyre natural frequency, shock memory, control tyre shake and vibration from road.

d. Utilities Supporting Facilities

For electricity, a 4 to 7 MW connection will be acquired from private power distribution company, K-Electric. Initially, a 4.9 MW connection will be acquired from K-Electric as part of Phase I, and the remaining electricity will be procured in Phase II. Additionally, for back-up power, two diesel gensets of 1.8 MW each will be utilized on-site.

Presently, the site does not have access to Sui Southern Gas Company's (SSGC) gas supply. During consultation with the SSGC, their representatives explained the process of application for connection and laying of pipelines. However, it was also stated that despite SSGC facilitating the process of acquiring gas connection, they cannot ensure security of supply; therefore, they advised Armstrong ZE to use alternative sources.

The requirement and specifications of utilities that will be installed as part of this project is provided in Exhibit 2.4 and the layout of utilities as designed is given in Exhibit 2.5**.**

2.3.2. Construction Phase

As of writing of the report, construction activity has commenced for the Labour Accommodation and Bachelor's Hostel after receiving the NOC from SEPA. The timeline for completion of both activities is until July 2024.

As per the information received from Armstrong ZE, the plant commissioning date is expected anytime during December 31, 2024 to January 31, 2025; the plant trial-run or start-up is expected in February 2025, while the plant's Commercial Operation Date (COD) is expected in March 2025.

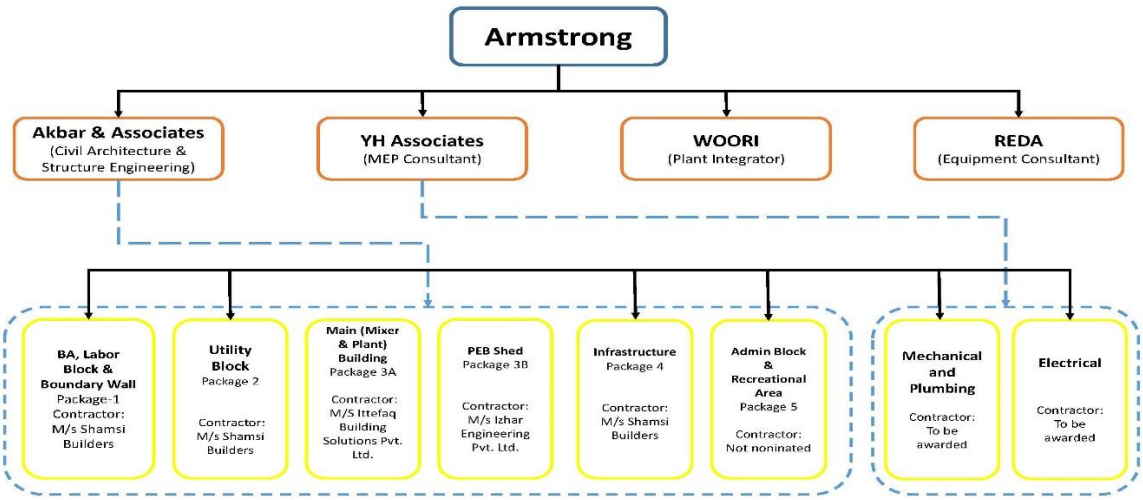
The project management has indicated that the construction will tentatively be completed in the following three phases:

- Phase I – Bachelors and Labour Accommodation (*construction works have already commenced by the selected contractor, Shamsi Builders*)

- Phase II – Utility Buildings (*tender for technical and commercial solution were floated to pre-qualified bidders*)
- Phase III – Production Area and Infrastructure (*tender for drawings and contract documents were prepared by the proponent and issued to pre-qualified bidders*).

a. EPC and O&M Contractors

Armstrong ZE has assumed the responsibility of overall Project Management including design, construction, completion, and commissioning of the tyre manufacturing plant. There is no EPC contractor employed on the Project, and Armstrong ZE is handling and managing all the contractors. As of now, the proponent has taken Phase I contractors (Shamsi Builders) on-board for Package-1, who are involved in the civil works of Labour Accommodation, Bachelor's Hostel and Boundary Wall. The other contractors to be employed in the construction phase are under the finalization stage as shown below.



b. Construction Phase Activities

The activities to be performed during the construction phase will include the following:

- Site clearance, dewatering, excavation, foundation works and backfilling. *The groundwater dewatered during excavation works will be stored in the settlement ponds to reduce the sediment loading before safe disposal into the Sim Nullah. Also, the excavated material will be backfilled after the laying of foundation and since this is Greenfield site, therefore, no debris waste is expected to be generated.*
- Construction of labour accommodation and bachelor's hostel.
- Construction of manufacturing building and offices, roads and parking areas.
- Construction of auxiliary facilities such as equipment and supplies storage area; water storage tanks, fuel storage tanks, soak pits etc.
- Installation of water, electricity, gas and drainage systems.
- Construction of warehouse for raw material, finished goods and coal yard.

- Installation of tyre manufacturing area.
- Construction of wastewater treatment plant and waste storage areas.
- Commissioning.

c. Human Resource Requirement

The proponent will be employing around 528 employees during the Phase I of construction, which is estimated to increase to around 983 over the next phase. During the peak construction phase, the labour will be accommodated in the porta cabins that have been provisioned in the site existing plan, as indicated in **Attachment A**. Emphasis will be given towards employment of the local population. Each civil contractor will be responsible to provide man-power. Currently, the labour contracted by Shamsi Builders are working on-site, which are provided with temporary accommodation, food, water and other arrangements as necessary.

In addition to direct employment for plant operations, temporary construction workforce of more than 500 workers will also be brought at and managed at the site by the various subcontractors. Armstrong ZE will ensure that housing and accommodation arrangements provided by all contractors comply with the Construction Labour Management Plan developed as part of ESMF and IFC/EBRD Worker Accommodation Guidelines.

d. Raw Material

The materials required for the construction phase will be acquired locally and will include:

- Approximately 25,000 ton of cement and 5,000 ton of steel for construction of Reinforced Cement Concrete (RCC) Structures of the factory.
- Approximately 51,000 cubic meter of crush (coarse aggregates) and 42,000 cubic meter of sand for mixing with concrete to attain specified strength of structures.
- Water for concrete mixing.
- Approximately 2.5 million blocks.
- Around 30,000 square meter of cold applied bitumen for waterproofing of below plinth structure.
- To facilitate transportation within facility, around 19,000 square meter of pavers will be used.
- Approximately 200,000 litres of paint for finishing of grey structures.
- Almost 100,000 cubic meter of moorum for backfilling to attain the finished floor level.
- Approximately 200 square meters of geotextile membrane for coal ash pond.

e. Water Consumption

The daily water requirement during the construction phase is stated to be 20,000 gallons per day. The site management has planned and started procuring water using hydrant/tanker water (a vehicle or trailer used for transporting water from one place to another) sourced from Dhabeji Pumping Station, situated approximately 12 to 15 km northwest of the site. Meanwhile, the on-site water drinking water requirement during the construction phase is being met through bottled water.

f. Waste Management

The expected waste to be generated from the on-site construction activities will include the following.

SOLID WASTE	**CLASSIFICATION**
Scrap material	Non - Hazardous
Scorched rubber	Hazardous
Packaging	Non - Hazardous
Coal ash and boiler slag	Hazardous
Particulate matter	Hazardous
Sludge	Hazardous
Rejected / Used RO membrane filters	Hazardous
Used oil or waste oil	Hazardous
Waste Electrical and Electronic Equipment (WEEE)	Hazardous
Contaminated soil	Hazardous
POTENTIAL LIQUID WASTE	**CLASSIFICATION**
Sanitary waste	Non-Hazardous
Accidental fuel and oil or lubricants spills	Hazardous

Currently, the solid waste generated at site as part of Phase I of construction is primarily the kitchen waste and packaging (cement bags) waste, which is transported and handed over to the local municipal administration in Gharo by contractor currently working at the site (Shamsi Builders Ltd.).

The wastewater resulting from construction activities in Phase I (primarily from domestic use such as washing, sewage, and catering) is directed to the on-site septic tanks (containments), located outside the catering area and the office block, which houses the washrooms. As the construction progresses towards Phase II and Phase III (see ***Section 2.3.2***), further septic tanks will be constructed by the contractors as per their requirement.

The tanks present at site are of 5,000 gallons capacity each, and have not yet reached their maximum capacity. Once the capacity is full, they will be emptied accordingly for subsequent disposal via an approved waste management contractor. The hiring of waste management contractor is currently in the tendering process, as informed by the proponent.

2.3.3. Operation and Maintenance Phase

The activities for the operations and maintenance phase will include the following:

- Routine operations of tyre manufacturing.
- Routine maintenance of production machinery and equipment.
- Regular inspection and calibration of quality control and testing equipment.
- Continuous monitoring and optimization of manufacturing processes.
- Inspection and maintenance of utilities, including water, electricity, and gas systems.
- Ongoing upkeep of infrastructure, buildings, and roads.
- Management of waste disposal and environmental compliance.
- Training programs for employees on safety protocols and best practices.
- Periodic audits to ensure adherence to regulatory and safety standards.

a. Raw Material

The list of raw materials required for manufacturing process as provided in the feasibility report is given in Exhibit 2.6**.**

Based on the list of raw materials provided in the feasibility report, on-site management of hazardous substances encompasses the storage and handling of materials such as Zinc Stearate, 2,2,4-trimethyl-1,2-dihydroquinoline (TMQ), and phenyl phenylenediamine (6PPD). These substances are integral to tyre manufacturing and are classified as hazardous according to the OSHA Hazard Communication Standard 2012 (29 CFR 1910.1200).

It is indicated in the site plan that there will be an on-site storage tank for storing fuel (likely to be diesel). However, the quantities have not been finalized yet. Any fuel, oil, or other hazardous solid, liquid, or gas that are stored on-site will be contained in an appropriately secure location, with bunding. Any contaminated from this area will be taken off-site for disposal.

Other raw materials required for heating and cooling for the manufacturing operations, include:

Coal

Armstrong plans to use coal and biomass mixture for firing of boilers. The coal (lignite) is planned to be sourced from Thar coal mines in District Tharparkar of Sindh province. The coal mines are located ~285 km from the project site. Armstrong will ensure that transportation of coal shall comply with all the safe handling measures and IFC General

EHS guidelines for Thermal Power Plants. The coal is planned to be stored in a dedicated yard adjacent to the boiler room for the continuous feeding of fuel in the boiler.

Prior to the purchase of coal, a third party quality testing will be carried out for the consignment of coal. Based on the literature review, the expected coal specifications is as follows:

Parameters	Average Quality
Moisture	45.71 %
Ash	9.69 %
Volatile Matter	25.00 %
Fixed Carbon	19.6 %
Gross Calorific value, kcal/kg (kJ/kg)	2,984 (12,491)
Low Calorific value, kcal/kg (kJ/kg)	2,630 (11,011)
Carbon (C)	33 %
Hydrogen (H)	2.7 %
Nitrogen (N)	0.5 %
Oxygen (O)	7.02 %
Sulphur (S)	1.38 %

The expected coal consumption in the proposed boiler is provided below:

Parameters	Values
Coal Consumption (Max)	33,000 Kg/day
Coal Consumption (Normal)	25,000 Kg/ day
Steam Generation Capacity	15.0 TPH (Average)
Steam Requirement	11 TPH (Average)

Water

The project will use groundwater for its operations. The groundwater will be sourced from the fourth aquifer, approximately 100 meters below the ground surface and hydro-geologically separated from the shallow aquifer(s). The project will not use groundwater from shallow depths aquifers. The daily water usage for the project during the operational phase will be approximately 65,000 gallons. Of this, 42,300 gallons will be used as process water, and 22,700 gallons will be used for on-site domestic purposes (e.g., accommodation areas, kitchens, and lavatories). Approximately 92,800 gallons will be drawn from the deep groundwater aquifer to kickstart the cycle. Subsequently, approximately 60,400 gallons of

treated water from the Effluent Treatment Plant (which meets RO feed water standards) will be utilized to maintain the daily water balance requirement, and approximately 32,400 gallons per day will be sourced from groundwater.

b. Waste Management

The tyre manufacturing process and its auxiliaries involve the utilization of various materials and compounds, resulting in generation of both hazardous and non-hazardous waste streams. During operations, typical wastes expected to be generated from the project activities are presented below.

Solid Waste	**Potential Sources**	**Classification**
Scrap material	Shaping and Finishing operations	Non - Hazardous
Waste rubber	Rubber moulding operations	Non - Hazardous
Packaging	Raw material and finished products	Non - Hazardous
Scorched rubber	Mixing, milling, calendaring, and extruding	Hazardous
Coal Ash and Boiler Slag	Coal combustion in Boilers	Hazardous
Particulate Matter	Bag filters in compounding areas, Banbury's, and grinders	Hazardous
Sludge	Effluent Treatment Plant (ETP)	Hazardous
Rejected / Used RO membrane filters	Effluent Treatment Plant (ETP)	Hazardous
Used Oil or Waste Oil	Maintenance activities	Hazardous
Waste Electrical and Electronic Equipment (WEEE)	Maintenance activities	Hazardous
Contaminated Soil	Accidental Spillages	Hazardous
Wastewater	**Potential Sources**	**Classification**
Odour	Inadequate wastewater management	Non-Hazardous
Suspended solids	Vulcanizing	Non-Hazardous
High TDS Reject water	RO plant	Potentially Hazardous
Oil and grease	Centrifuges	Hazardous
Trace metals	Cleaning of fresh latex receiving ponds	Potentially Hazardous
Additives and Solvents	Effluent arising from dipped latex rubber products	Hazardous
Hot water	Heating and cooling activities	Potentially Hazardous
Accidental spillages	Storage and Handling	Hazardous
Potential Gaseous Emissions	**Potential Sources**	**Classification**
Fugitive Dust Emissions	Pre-weighing of additives where chemicals kept in open storage in compounding area	Toxic

	Loading of chemicals into internal mixer	Toxic
Particulate Emissions	Surface grinding activities	Toxic
VOCs emissions	Use of solvents in various capacities during the entire manufacturing process. Extensive Vulcanization - to impart the desired properties to the rubber	Toxic
Sulphur dioxide (SO_2)	Rubber Curing	Toxic

The major waste streams generated by the proposed project include the following:

(i) Coal Ash

Coal ash, also known as the Coal Combustion Residuals (CCRs), is a solid residue generated from the burning of coal in coal-fired boilers (US EPA, 2014)[1]. The combustion residues include the fly ash and bottom ash.

Fly ash is a by-product of combustion, primarily composed of fine particles. Fly ash will be removed from exhaust gases, the collection of which is facilitated through a Wet Scrubber, as detailed in ***sub-section iii*** of this Section. The sludge from the Wet Scrubber will be directed to the coal ash pond for storage and subsequent disposal.

Bottom ash includes slag and particles that are coarser and heavier than fly ash that is too large to be carried up into the smokestacks, therefore, settled in the bottom of the coal furnace. It will be collected in the bottom hopper from where it will be conveyed through screw conveyor to a dedicated portion for ash storage within the coal storage area (adjacent to the boiler). It will be in an enclosed, stain-less steel conveyor that will remove ash from the bottom hopper automatically without any manual intervention, as illustrated in Exhibit 2.7 and Exhibit 2.8.

Temporary Coal Ash Storage

The coal storage yard has a designated compartment for the storage of coal ash with a limited capacity to accommodate four (4) to five (5) days of ash, which will be transported via covered trucks to the proposed coal ash pond.

Coal Ash Pond

Coal ash pond is proposed along the south-western site boundary as illustrated in the ***Site Layout, Attachment A***. The reserved area for coal ash pond will be 12 m x 12 m of 3 m depth with a storage capacity of up to thirty (30) days. The ash pond will be the concrete structure,

[1] https://www.epa.gov/coalash/coal-ash-basics | https://www.epa.gov/coalash/coal-ash-reuse

the flooring of which will be comprised of a layer of geo-membrane, sandwiched between two layers of concrete, as illustrated in ***Attachment B***.

To ensure proper management of coal ash, following precautionary measures have been considered by the proponent:

1. Provision of geo-membrane lining in the pond to prevent ash leachate infiltration into the groundwater;

2. Sprinkling of RO reject water on coal ash to avoid any particulate emissions;

3. Planting native species along the Project boundaries to further control the particulate emissions**;**

4. Mechanical compaction in time once the ash and slag is conveyed to the coal ash pond;

5. Development of groundwater monitoring and corrective action plans during operation phase of the plant, as tabulated in the ***Section 4.4.4*** provided in the ESMF.

Coal Ash Disposal

The ash will be sold and transported to a pre-determined cement manufacturer or block manufacturing facility for its appropriate disposal. The guidelines for transportation are provided in Waste Management Framework as ***Appendix D*** in ESMF.

(ii) Wastewater

The Project aims to minimize the raw water utilization by treating wastewater and storing it for reuse, thus achieving its zero-wastewater discharge objective. The water balance diagram is provided in ***Attachment C***, which exhibits the water balance of the project. It outlines the daily generation of 61,857 gallons of wastewater, from three primary sources which are as follows:

1. **RO Reject Water:** The estimated daily RO reject volume generated on-site will be 27,857 gallons per day (30% volume of feed water), with a TDS concentration of approximately 4,000 mg/l. Out of this, 22,00 gallons/day will be directed to ETP. While, remaining of 5,857 gallons/day of RO reject water will be sprinkled over the ash pond for suppression purposes.

2. **Domestic Wastewater:** It has been estimated that a total of 13,500 gallons of wastewater will be generated daily from kitchen, accommodation areas and lavatories which will be processed initially in the septic tanks, before being routed to the ETP.

3. **Production Area Wastewater:** A total of 25,500 gallons of wastewater will be generated daily from the production area, which will be directly routed to the ETP for treatment.

The treatment process will encompass several stages, initiating with wastewater collection in the storage pond, followed by oil and gas removal, pH regulation, coagulation, chemical and biological treatment, and clarification. Subsequently, treated wastewater will be transferred to the product pond from where it will be directed to the ultrafiltration (UF) and reverse osmosis (RO) treatment, ensuring the suitability of water to be reused in the production process. After treatment, approximately 60,434 gallons/day of recycled water will be routed to the feed water system, thus this will achieve zero-wastewater generation. Armstrong ZE has confirmed that the ETP and RO plant are adequately designed to achieve the demonstrated water balance.

It will be ensured by the proponent that the wastewater treated by the ETP will comply with the Sindh Environmental Quality Standards (SEQS) as well as the guidelines outlined by the International Finance Corporation (IFC).

(iii) Sludge from ETP and Septic Tanks

It has been estimated that 2 m^3 per day sludge from ETP and 0.2m^3 per day sludge from septic tanks will be generated. The sludge will be cleaned and collected using vacuum trucks. The pump is designed to pneumatically suck liquids, sludges and slurries into the tank of the truck. This enables the safe transport of the liquid material to the disposal facility.

It has been decided that the sludge from the ETP and septic tanks will be cleaned and disposed of as per "*IFC General EHS Guidelines on Water and Sanitation for Sludge Treatment*" by Sindh Environmental Protection Authority (SEPA) approved third-party contractor(s) on fortnightly basis or whenever the sufficient amount of sludge will be accumulated. Refer to the water balance diagram and proposed ETP layout provided in ***Attachment C***.

(iv) Storm water Management

Storm water includes any surface runoff and flows resulting from precipitation, drainage, or other sources. In order to reduce the need for storm water treatment, the following principles, in compliance with IFC guidelines on Wastewater and Ambient water quality will be applied for the Project.

- Storm water will be separated from process and sanitary wastewater streams in order to reduce the volume of wastewater to be treated prior to discharge.
- Surface runoff from process areas or potential sources of contamination will be prevented. Where this approach is not practical, runoff from process and storage areas will be segregated from potentially less contaminated runoff.
- Runoff from areas without potential sources of contamination should be minimised (e.g., by minimising the area of impermeable surfaces) and the peak discharge rate should be reduced (e.g., by using vegetated swales and retention ponds).

- Where storm water treatment is deemed necessary to protect the quality of receiving water bodies, priority will be given to managing and treating the first flush of storm water runoff where the majority of potential contaminants tend to be present. Normal case will consider the disposal of neutralized wastewater and of de-oiled storm water to the existing plant pond.

- Oil water separators and grease traps will be installed and maintained as appropriate at refuelling facilities, workshops, parking areas, fuel storage and containment areas. Oil Skimmer has been foreseen inside each first rain sump to remove the majority of the oil, while the remaining will be removed through a Coalescing Plate Separator.

Sludge from storm water catchments or collection and treatment systems may contain elevated levels of pollutants and should be disposed in compliance with local regulatory requirements, in the absence of which disposal has to be consistent with protection of public health and safety, and conservation and long-term sustainability of water and land resources.

(v) Air Emissions

The main sources of air emissions in the plant will include the boiler operations running 24/7 and the two-backup diesel Gensets that will be operated in case of a power outage only. The key environmental pollutants of concern have been considered from the 24/7 boiler operations only, which will include sulphur dioxide (SO_2), oxides of nitrogen (NO_x), and particulate matter. The potential impacts of these pollutants are discussed in detailed in ***Section 8.4.2***.

There are engineering controls provisioned in the boiler design which will significantly reduce the emissions from the boiler, as detailed below.

Wet Scrubbers

In order to comply with IFC Guidelines and local regulatory guidelines for ambient air quality as given in Chapter 4, the site has deployed wet scrubbers as an engineering control in its plant boiler design. Wet scrubbers are used to remove pollutants from flue gas, resulting from the combustion of fuel in the boiler, mainly coal. The working principle of wet scrubber involves the flue gas from the boiler entering the scrubber and passing through an area that is sprayed with the scrubbing fluid flowing in the opposite direction. Through a series of chemical reactions, pollutants, such as particulate matter, SO_x and NO_x, are removed from the flue gas, and pollutant-free clean gas exits through the top of the scrubber. The sludge will be removed from its basin, as required.

SO_2 is removed through a neutralization reaction, and NO_x is dissolved in water, which later has to be treated. Typically, wet scrubbers have efficiencies of approximately 95% for particulate matter removal, 90-95% for SO_2 removal and around 60-70% for NO_x removal.[2,3]

Dust Collectors

Dust collectors are a type of air pollution control equipment that are designed to purify and filter hazardous dust and fine particulate contaminant matter, and maintain and improve air quality. The proposed project will use cartridge dust collectors in the production area that will have centrifugal type fan, heavy duty bag type cartridge filters and automatic shaking systems. The pollutants will be collected in the bins of dust collectors and clean air will be discharged into the atmosphere. Air containing dust from the main production area will move through the duct to the dust collector room, where using centrifugal fans, it will be pumped into the dust collectors. The clean air will pass through the filter and will be vented into the atmosphere. Generally, cartridge filters have an efficiency of 99%.[4]

[2] https://www.epa.gov/air-emissions-monitoring-knowledge-base/monitoring-control-technique-wet-scrubber-particulate-0

[3] https://www.epa.gov/sites/default/files/2021-05/documents/wet_and_dry_scrubbers_section_5_chapter_1_control_cost_manual_7th_edition.pdf

[4] https://www.isystemsweb.com/how-does-a-cartridge-type-dust-collector-work/

(i) Fire Protection System

Design Conditions

A comprehensive fire protection installation will be meticulously designed, supplied, installed, and commissioned to provide effective coverage where needed. The firefighting installation will be complemented by a robust fire detection and alarm system.

Buildings Design

The design of buildings will prioritize minimizing internal fire spread and mitigating risks to surrounding areas, especially focusing on exposure protection. Escape routes and emergency exits will be clearly marked with coloured signs and lights, subject to the Engineer's approval. Design features for all fire preventive measures will be coordinated to integrate seamlessly with existing and new building systems.

Standards, Rules, and Regulations

The design, installation, and testing will adhere to the latest editions of NFPA Codes and Standards and Factory Mutual Standards. Equipment and materials supplied for the firefighting, control, and alarm installation will be approved by recognized authorities such as VDS German Standards, Factory Mutual (FM), F.O.C. British Standards, or Underwriter's Laboratory (UL). All warning signs and equipment intended for operation by firefighting personnel will bear inscriptions in English and the local language.

Scope of Supply

The system will be complete and fully functional, including all necessary equipment for firefighting purposes and ensuring the safe and reliable operation of various systems. The scope of work will encompass:

- Draining and Stirring equipment
- Water supply installation
- Underground fire service main
- Sprinkler systems
- Water spray fixed system
- Hydrants, hose, and standpipe
- Fire detection and alarm systems
- Portable fire extinguishers

Fire Preventive Measures

a) Non-Combustible and Fire-Resistant Building Structure:

Newly erected buildings will be constructed of non-combustible or fire-resistant materials. Exposed steel structures will achieve a fire resistance of at least 90 minutes, preferably through concrete application.

b) Fire Zones in New Buildings:

Buildings will be subdivided into fire zones separated by fire-resistant walls, ceilings, and doors, providing 60, 90, or 120 minutes of fire resistance. Various areas, including floors, staircases, switchgear rooms, control rooms, and basements, will form independent fire zones.

c) Drainage:

Adequate drainage piping will be provided throughout sensitive areas to prevent water damage in case of fire. Transformers will be installed on concrete foundations with surrounding basins to contain oil discharge.

d) Stairs and Escape Routes:

Stairwells will be constructed as fire-resistant escape routes, equipped with separate ventilating systems to prevent smoke ingress.

Design Description:

Outdoor protection systems will adhere to NFPA standards, with underground fire mains preferably made of steel. Design data will ensure operational reliability and safety, with provisions for future plant expansions.

Portable Fire Extinguishers:

Portable extinguishers will comply with NFPA standards, distributed strategically in buildings for easy access. Dry chemical extinguishers will be preferred, with CO2 extinguishers installed in areas with electrical equipment.

Firefighting Installations

a) General Design Features:

Equipment and materials will be selected to prevent or limit damage under adverse conditions and comply with international standards. Special attention will be given to protecting power transformers against fire hazards.

b) Water Supply Installation and Fire Fighting Pumps:

Water supply for firefighting systems will be provided by NFPA-compliant fire pumps capable of maintaining uniform pressure. Jockey pumps will be installed to compensate for leakage.

c) Unit Purchase:

Fire pump units will be purchased under unit contracts, ensuring compliance with standards and satisfactory performance upon installation.

(ii) Operational Process Flow

The manufacturing process of the Passenger Car Radial (PCR) tyres as discussed in the Project's feasibility study report is explained in the following subsections. The process flow is also provided in Exhibit 2.9.

Compounding and Mixing Process

Carbon Black, natural/ synthetic rubbers, oil, additives and accelerators are mixed and processed together in an internal mixer, leading to the formation of rubber film.

Calendar Machine

The extrusion pressure of the roller of calendar is used to cover the surface of textile fabric and steel cord with final compound to produce a certain specification of carcass / steel belt. This is a five-step process, in which all the tyre components and subassemblies are prepared:

- Extrusion Section: Rubber film is put into the extruder machines, leading to the formation of semi-finished rubber components including the tread, the side wall, the shoulder apex etc.
- Calendaring Section: The calendar machine pastes the thin layer of rubber on both sides if the steel cord. The steel cord is then used to make the whole casing of the PCR tyre.
- Bead-wire Manufacturing System: Manufacturing of bead-wires takes place and the rubber compound is coated all around the wires. This component forms part of the tyre, which enables it to be mounted on the metal rim.
- Steel Cord Cutting Section: Based on the required parameters including length, width and angle, the steel cord is cut.
- Bead Apex Section: The extruder machine extrudes the triangle rubber strip and joins it with the bead-wire subassembly.

Tyre Building Process

In this step, the Tyre Building Machine assembles all the tyre components, after which the tyre is referred to as the "green tyre".

Vulcanisation Process

The green tyres are now placed into the mould of the curing process. The press utilises steam and heat to cure the green tyre, which transforms the pliable material to a less pliable, long-lasting state. At this point, the tyres have the appearance of a finished product in terms of pattern, design and tread. Thereafter, the tyres are sent to the final inspection area.

Final Inspection Process

The tyre initially undergoes the visual inspection check, after which it is tested for uniformity, which is called the Uniformity Test Machine. The dynamic balance test is performed after the uniformity test, which is performed on the Dynamic Balance Machine. Finally, the tyres are passed through the X-ray test performed on the X-ray Machine. After the inspection is complete, the good quality tyres are sent to the Finished Goods storage warehouse for delivery to customers.

2.3.4. Decommissioning Phase

The decommissioning phase of the Armstrong Tyre Manufacturing Project will encompass critical activities, including demolition, site clean-up, waste disposal, demobilization of workers, and a final site review. The typical age of a tyre manufacturing plant can vary based on factors such as technological advancements, maintenance practices, and market demand. However, many tysre manufacturing facilities are designed to have a lifespan ranging from 20 to 40 years or more. It is important to note that during this time frame, periodic upgrades, maintenance, and equipment replacement may occur to keep the facility in line with evolving industry standards and environmental regulations.

After a certain number of years, some older plants may face challenges related to outdated technology, increased maintenance costs, or difficulty meeting modern efficiency and environmental standards. At this point, companies might consider either substantial renovations or the construction of a new, more advanced facility. It is also worth noting that market conditions and global economic factors can influence the decision to invest in new facilities or extend the life of existing ones.

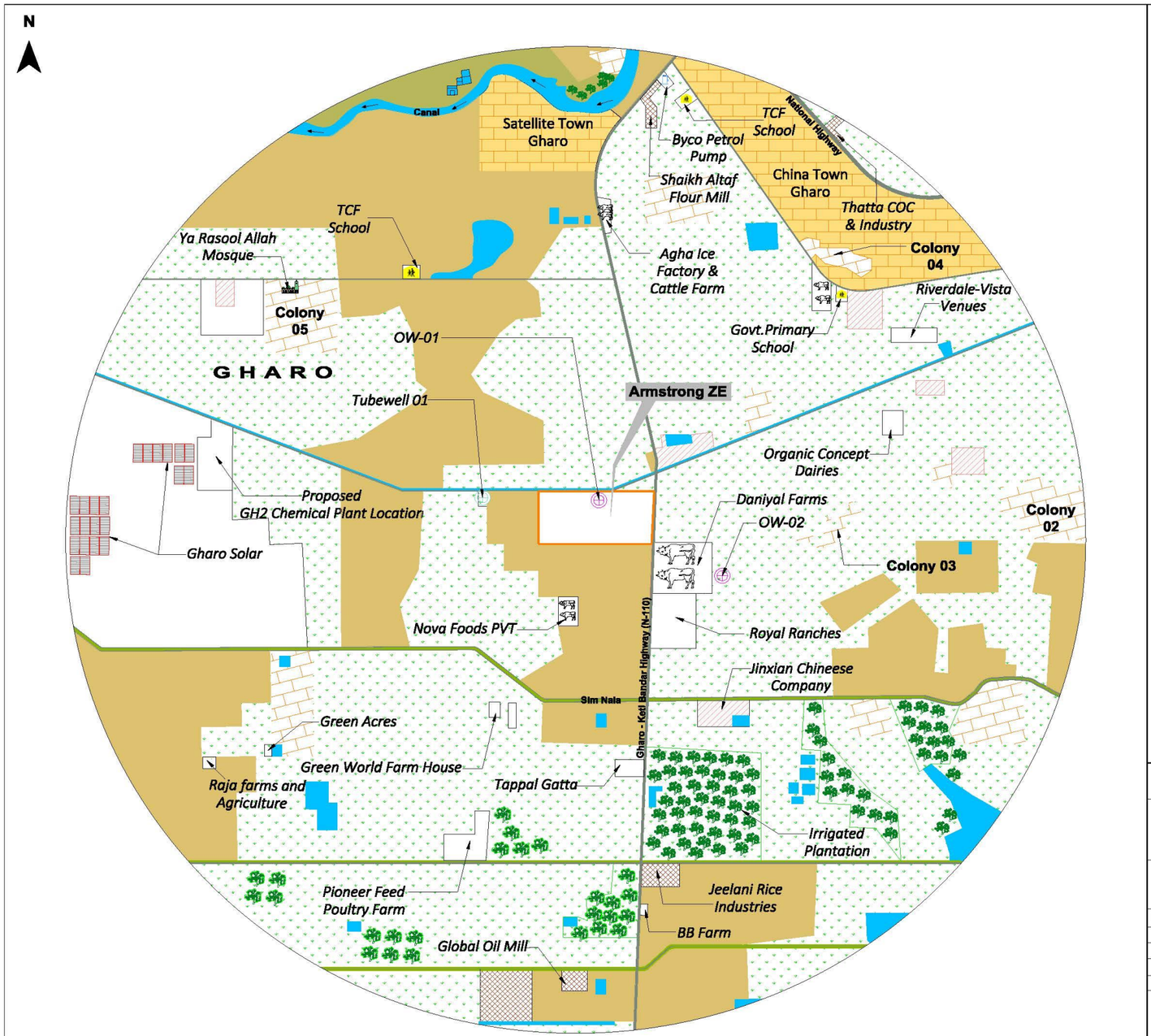
At the end of the project's life, a separate Environmental Site Assessment (ESA) process must be conducted. This requirement further warrants the development of a distinct Environmental and Social Management Plan (ESMP) specifically tailored for the decommissioning phase to cater for safe disassembly/demolition, in accordance with the measures recommended in the plant/equipment manual. This ensures a thorough and environmentally responsible conclusion to the project, addressing the potential shifts in environmental conditions over the years.

2.4. Project Organization Structure

The Project Organization Structure is given in Exhibit 2.10.

Exhibit 2.1. Project Location

Exhibit 2.2. Site Locality Map



Legend

- Agricultural / Green Area
- Barren Land / Open Land
- Canal / Water Pond
- Cattle Farm
- Commercial Area
- Deep Well
- Educational Institution
- Fish Pond
- Industrial Area
- Mosque
- New Plot Area
- Coconut / Date Orchard
- Petrol Pump
- Project Boundary
- Radius — 3 km
- Residential Area
- Road
- Solar Panel
- Storm Water Drain
- Trees
- Tube Well
- Waterlogged and Saline Waste Land

Scale: m 0 400 800 1200 1600

Environmental Social Impact Assesment
Armstrong ZE Tyre Manufacturing Plant

Site Locality Map - 2023

Drawing: ---	**Ship to:** -
Revision: 0	**Co-ordinates:** 24°42'39.24"N
Source: TPL Field Survey	67°35'9.26"E
Date: January 11 to January 12, 2024	
Client: Armstrong ZE (Pvt.) Ltd.	

TEKCELLENT (PVT) LIMITED
TECHNOLOGY ENGINEERING KNOWLEDGE MANAGEMENT

Exhibit 2.3. Layout of Armstrong ZE Tyre Manufacturing Plant

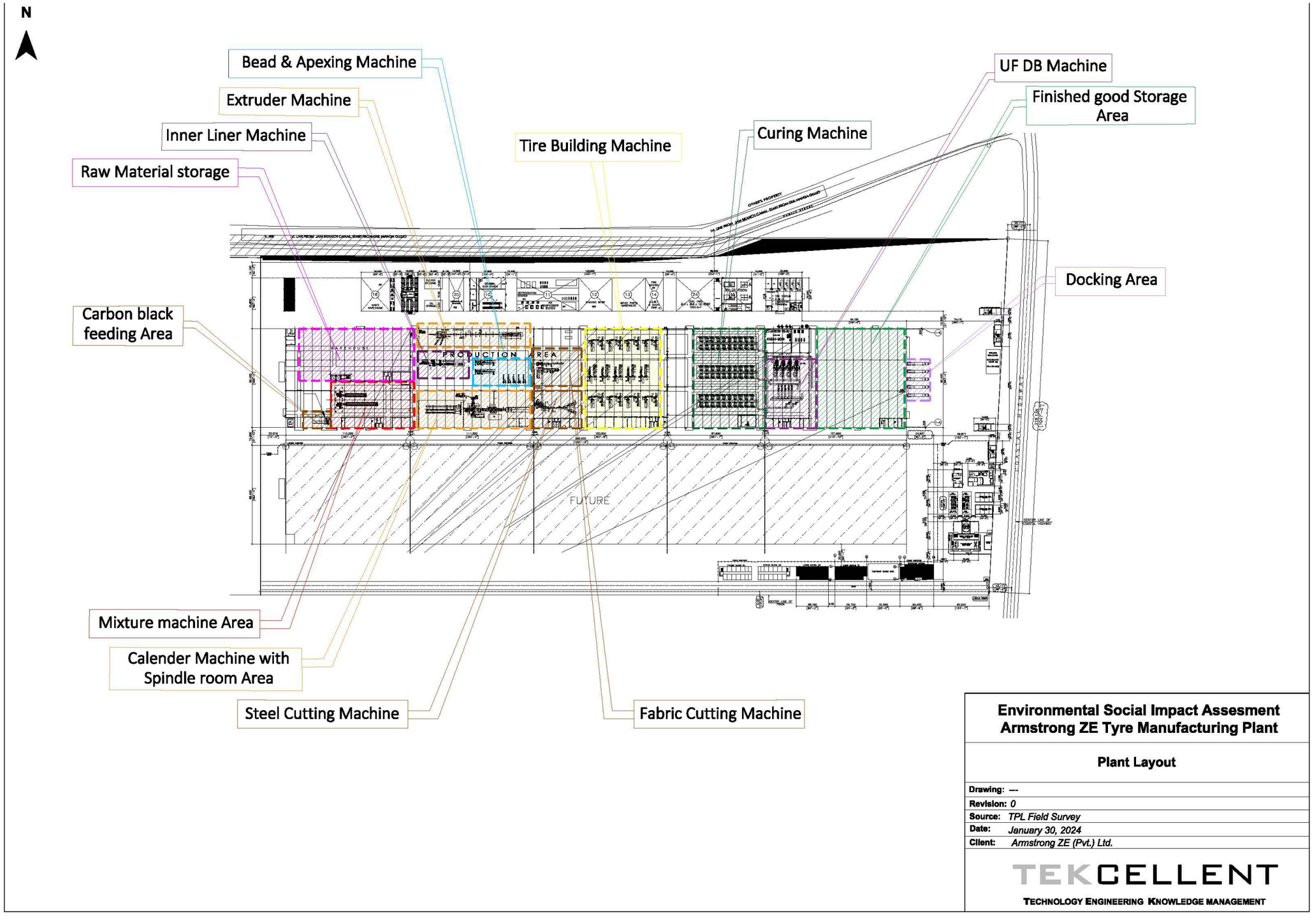


Exhibit 2.4. List of Utilities

S. No.	*Description*	*Capacity*	*Quantity*
1.	Genset (complete set)	1.8 MW	2
2.	Boiler	15 TPH @ 2 MPa	2
3.	Air compressor	132 kW	2
4.	Air compressor	250 kW	2
5.	Steam absorption boiler	750 RT	2
6.	Hot water absorption chillers	300 RT	1
7.	Centrifugal pumps	400 GPM @ 200′	3
8.	Centrifugal pumps	932 GPM @ 100′	3
9.	Centrifugal pumps	932 GPM @ 200′	3
10.	Centrifugal pumps	1,587 GPM @ 100′	3
11.	Fire pump	1,500 GPM @ 150 Psi	2

Source: Project Process Flow and Description, (AZE, 2022b)

Exhibit 2.5.Layout of Utilities

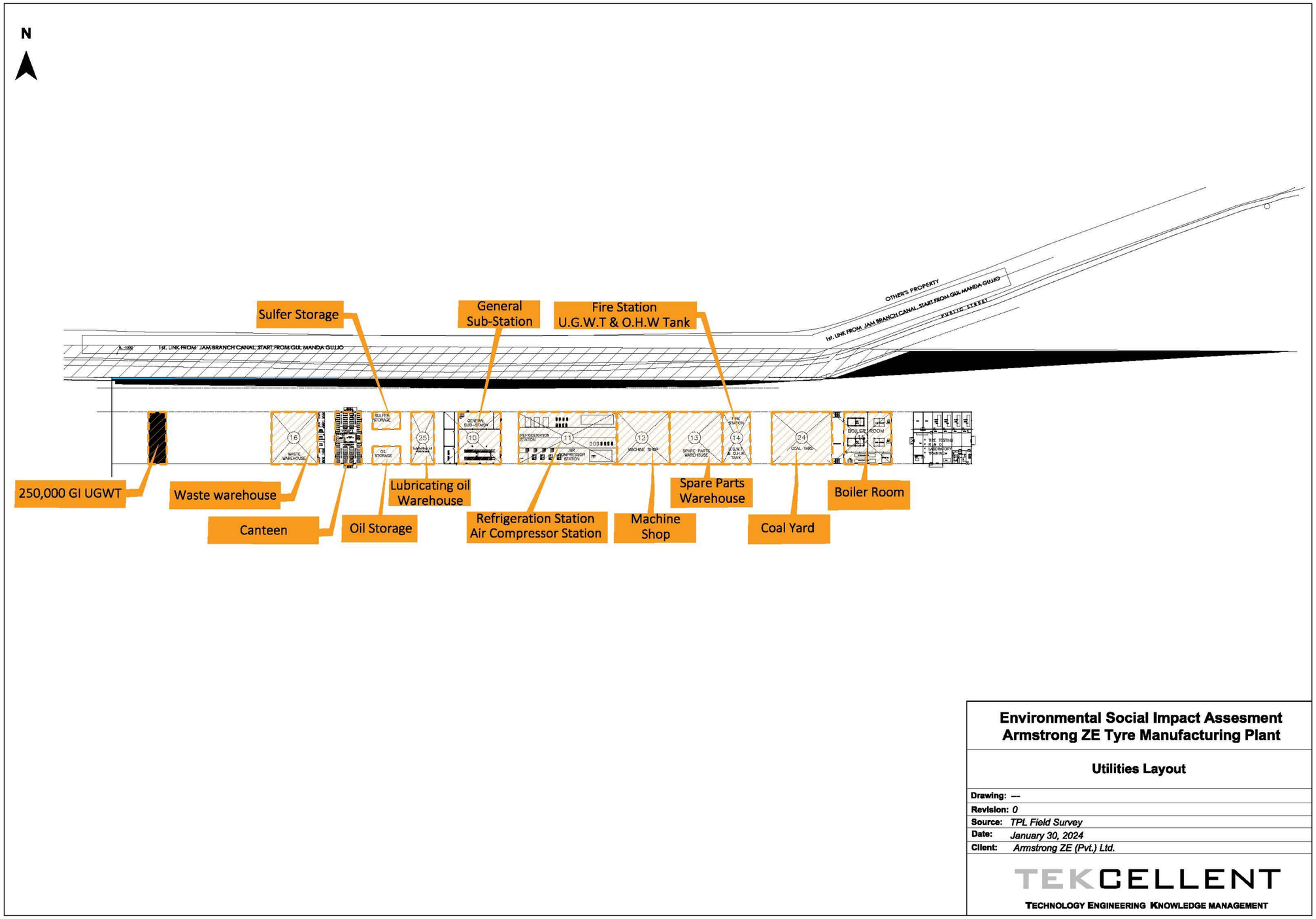


Exhibit 2.6. List of Raw Materials

CAS No.	Chemical Name	Estimated Quantity (tons/5000 tyres)	Supplier Location	Process where it is used
9003-55-8	Styrene Butadiene Rubber (SBR)	2117.5	China	Mixing
9003-17-2	Butadiene Rubber (BR)	1732.5	China	Mixing
9006-04-6	Natural Rubber (NR)-20	2887.5	Thailand	Mixing
9006-04-6	Natural Rubber (NR)-10	539	Thailand	Mixing
68081-82-3	Chlorobutyl Rubber	924	China	Mixing
1333-86-4	Carbon Black (CB) - N234	596.75	China	Mixing
1333-86-4	Carbon Black (CB) - N330	1155	China	Mixing
1333-86-4	Carbon Black (CB) - N339	1155	China	Mixing
1333-86-4	Carbon Black (CB) - N660	1155	China	Mixing
112926-00-8	Silica	1155	China	Mixing
57-11-4	Stearic Acid	154	China	Mixing
1314-13-2	Zinc Oxide	154	China	Mixing
40372-72-3	Organo Silane-Si69	38.5	China	Mixing
120-78-5	Accelerator-MBTS	57.75	China	Mixing
95-31-8	Accelerator - TBBS	57.75	China	Mixing
25265-71-8	Accelerator - DPG	19.25	China	Mixing
95-33-0	Accelerator - CBS	38.5	China	Mixing
4979-32-2	Accelerator - DCBS	19.25	China	Mixing
135-57-9	Dibenzamido Diphenyl Disulphide (DBD)	3.85	China	Mixing
108-46-3	Meta-Dihydroxybenzene (Resorcinol)	1.925	China	Mixing
17796-82-6	Cycloehexylthiopthalamide (CTP)	3.85	China	Mixing
27253-31-2	Cobalt Neodecanoate	19.25	China	Mixing
100-97-0	Hexamethylene Tetramine Diisodecylphthalate (HMT DIDP)	9.625	China	Mixing
3089-11-0	Hexamethoxy Methylene Melamine (HMMM)	1.54	China	Mixing
7704-34-9	Sulphur	154	China	Mixing
7704-34-10	20% Oil Treated (LOW PCA) Sulphur	115.5	China	Mixing
8012-95-1	Parrafinic RPO	96.25	China	Mixing
64742-10-5	Rae Oil	154	China	Mixing
9003-35-4	Phenol Formaldehyde Resin	9.625	China	Mixing
63231-60-7	Microcrystalline Wax	57.75	China	Mixing
64742-43-4	Refined Parrafine Wax	57.75	China	Mixing
26780-96-1	Trimethyl Dihydro Quinoline (TMQ)	115.5	China	Mixing

CAS No.	Chemical Name	Estimated Quantity (tons/5000 tyres)	Supplier Location	Process where it is used
793-24-8	Phenyl-Phenylenediamine (6 PPD)	173.25	China	Mixing
113669-95-7	Polyester Fabric	770	China	Calendering
24993-04-2	Nylon Fabric	192.5	China	Calendering
7439-89-6	Bead Wire	1347.5	China	Calendering
7439-89-6	Steel Cord	962.5	China	Calendering

Exhibit 2.7. Schematic Diagram of Coal Ash Removal System

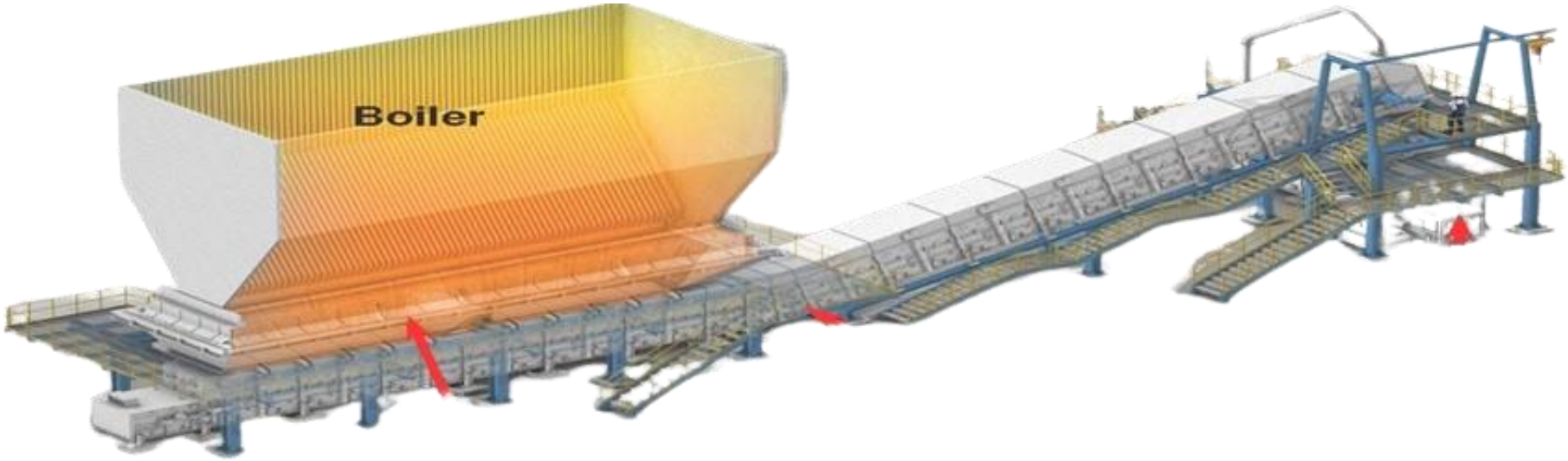


Exhibit 2.8. Typical Screw Conveyer Design

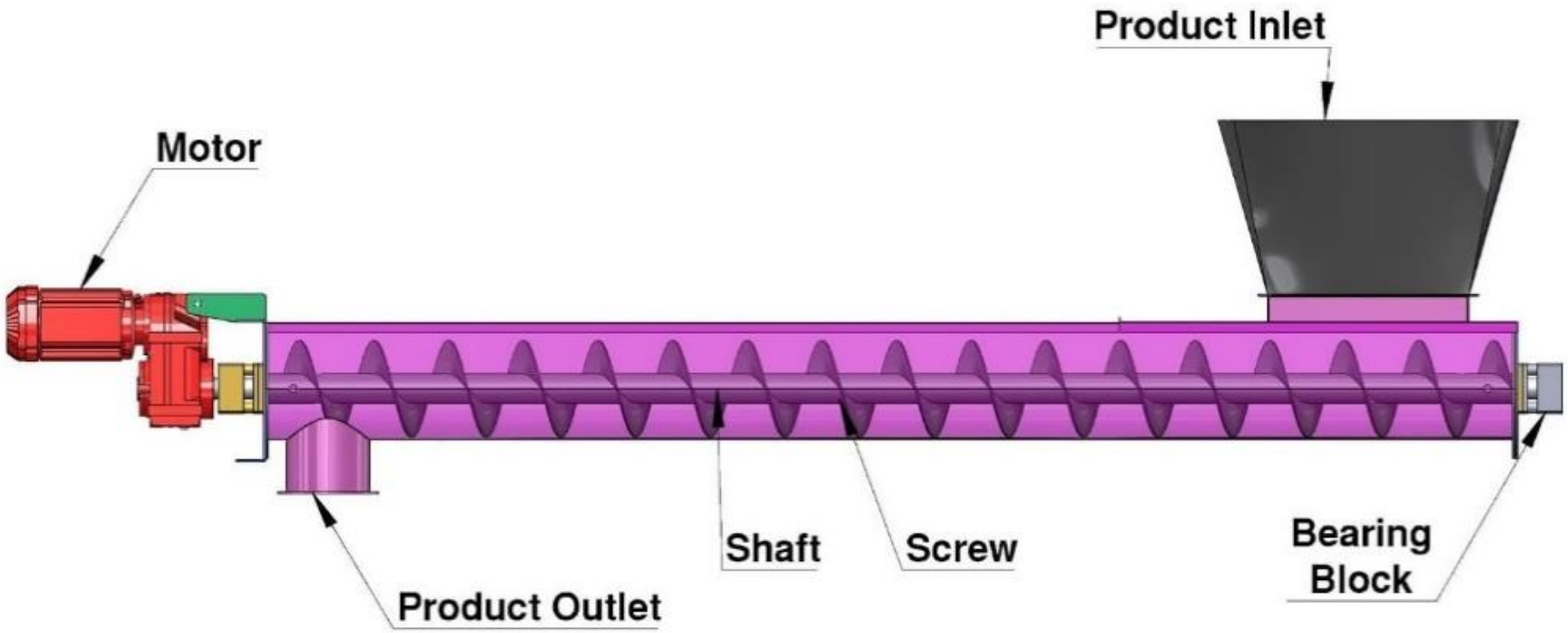
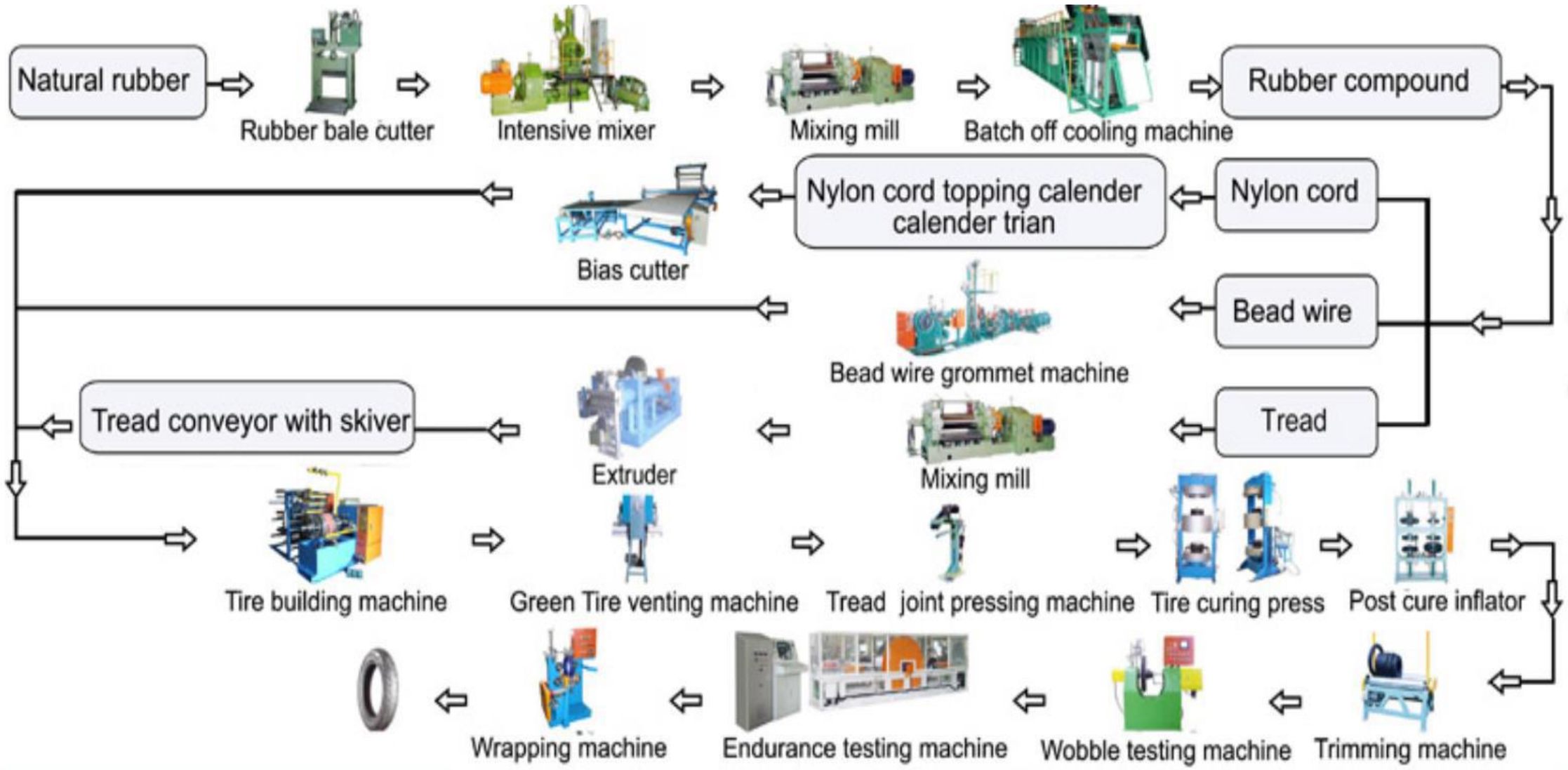
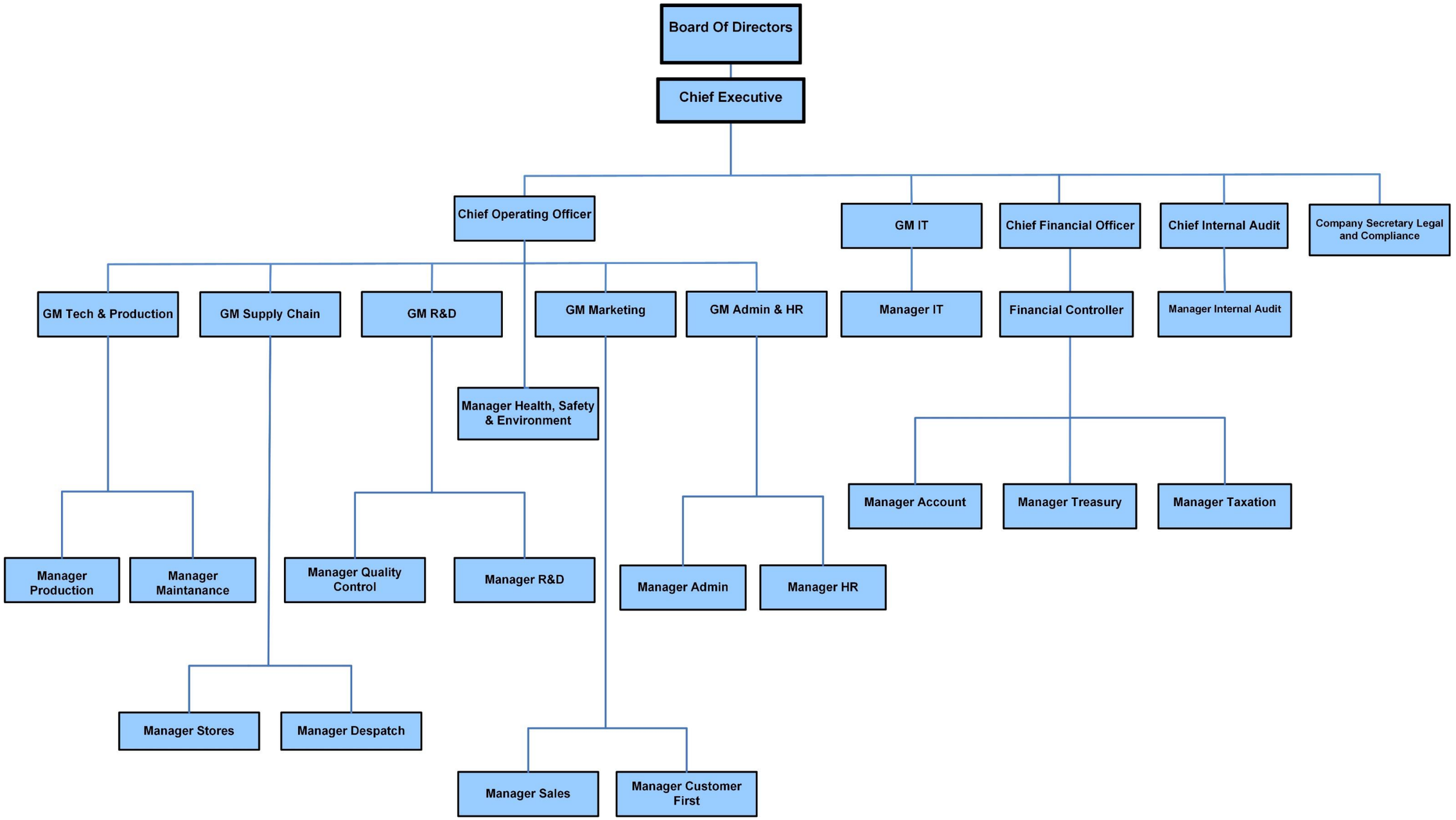


Exhibit 2.9. Operational Process Flow of Tyre Manufacturing Industry



Source: Feasibility Report (AZE, 2022b)

Exhibit 2.10. Project Organization Structure



3. Analysis of Alternatives

3.1. Introduction

This section discusses various project alternatives that were considered during the design phase. Alternatives illustrate and contrast the environmental implications and consequences of different options available to achieve the proposed objective. The alternatives have been organized in three broad categories: management, siting and technical alternatives.

3.1.1. Location Considerations

The location of the project was selected on the basis of a number of factors including:

- Proximity to ports
- Availability of required land
- Distance from urban and rural population
- Distance from ecologically protected areas
- Proximity to the road networks and major highways.

The location selected for the proposed tyre manufacturing project is situated along the Gharo-Keti Bunder road, strategically positioned at an optimal distance from National Highway 5. This location choice aims to avoid unnecessary traffic congestion while enabling convenient distribution of manufactured tyres to Karachi and other major cities across Pakistan. No land acquisition was required, as the project's land was already acquired by the proponent through purchase. Being the first project under the Sole Enterprise Special Economic Zone (SEPEZ), the site holds particular significance. Notably, the land designated for the project has no existing settlements, making it preferable from a social perspective as no physical resettlement will be necessary.

Considering the proposed project site's location, it benefits from existing infrastructure and facilities, including well-established roads that the project can utilize. Other significant advantages of locating the project include proximity to the port for easy access to importing materials, favourable soil conditions, sufficient availability of land, and proximity to the road network for transportation of equipment, materials, and products. Moreover, the site is at a safe distance from ecologically sensitive areas, and environmental and social impacts can be adequately managed and controlled without any major concerns. Positive relations have been established with the host and neighbouring communities.

3.1.2. Alternative Locations

Two alternative locations were considered for the project site before selecting the current one. The first location was Port Qasim, which was abandoned due to unavailability of land. The second option, the National Industrial Park, was discarded because of the requirement

to transfer the land after project completion, making financing impossible without land title. Therefore, no further consideration will be given to alternative locations in this Environmental and Social Impact Assessment (ESIA).

3.2. Technological Considerations

Steam generation in the project will be achieved through boilers. Circulating Fluidized Bed Combustion (CFBC) boiler was selected as the boiler combustion technology to be used in the proposed project. Fluidized Bed Combustion (FBC) is a technique used to combust coal by suspending it in a flow of gas within a bed of heated particles. In this process, air or gas is evenly distributed and directed upward through a bed of finely divided solid particles, such as sand, which are supported by a fine mesh. At low velocities, the particles remain undisturbed. However, as the velocity of the air or gas is gradually increased, a point is reached where the individual particles become suspended in the air stream, creating a state known as 'fluidized' bed. Fine particles of coal that are partially burned, along with ash and bed material, are transported with the flue gases to the upper sections of the furnace and subsequently directed into a cyclone. Within the cyclone, the heavier particles separate from the gas and descend into the cyclone's hopper. These particles are then recycled back to the furnace for further combustion, thus giving rise to the term "Circulating Fluidized Bed Combustion (CFBC)." Meanwhile, the hot gases from the cyclone proceed to the heat transfer surfaces before exiting the boiler (BrightHub, 2022).

CFBC has been a commercially viable option due to its capability burn a wide diversity of fuels, including low-grade fuels, while maintaining high combustion efficiency. More advantages of using CFBC include SO_x emissions, which can be controlled by in furnace limestone injection, and NO_x reduction, achievable by low temperature combustion.

Coal with biomass as the secondary fuel is selected as the fuel for the boilers in the proposed project. The benefits of the fuel mix of coal and biomass are ease of availability, lignite coal is available in abundant quantity in Sindh and Pakistan, while rice husk, the type of biomass selected, can be bought from agricultural lands present in the country. Biomass is generally seen as a carbon-neutral energy source. The selected ratio of coal and biomass is 70:30.

The coal to biomass ratio for combustion in the boiler has been finalized in consideration of the required fuel quantities and the furnace design. Due to lower heating value, rice husk will be required in larger quantities and thus the furnace design (parameters / dimensions) is a limiting factor in the usage of rice husk.

Another factor limiting the biomass quantity is the inconsistency in the supply of biomass. At present, rice husk has been considered as the biomass source for the boiler. There are other alternatives (with better heating values) which will also be considered during the operations phase, depending upon availability and establishing a consistent supply chain. This would enable the increase in biomass ratio and reduce the usage of lignite.

The biomass resources are often scattered and the feedstock acquisition becomes a logistical challenge. At present, there is no formal agri-waste aggregation mechanism present, especially in the Sindh Province and the main issue for agricultural residue is the collection, aggregation and transportation from multiple fields to the site. Industrial (agri) waste such as bagasse and rice husk are aggregated in some areas and sufficient quantities may be obtained from a single / select sources, however distances and transportation costs may pose challenges.

Seasonality has a major effect on the agricultural biomass availability, agricultural residues are only available during the crop-harvesting season. Single type of agri-waste will not be available year-round, hence sufficient storage will be provisioned to meet the requirements during off-seasons, and/or a potential of utilizing a mix of waste would also be explored. The biomass traders and mill owners are usually not willing to divulge much information without any firm commitment from the buyers. However, as per the information available the prices are usually spot-based and can be subject to variability even on a daily basis, so long-term contracts will have to be considered to secure the volumes and lock the prices.

In consideration of these challenges in the local landscape for biomass, efforts will be put in to secure consistent supplies and plan the reduction of lignite accordingly.

3.2.1. Alternatives Considered

Natural gas was the other type of fuel that was considered, its benefits include lower carbon dioxide (CO_2) emissions and it is more efficient than coal. However, the availability of natural gas is not present at the selected project location hence it was not considered further.

Traditionally, many tyre manufacturers have employed fire-tube boilers. In these systems, hot gas generated by combustion passes through a series of tubes housed within a cylindrical shell containing water. Steam is produced as heat is transferred from the hot gases to the water through the tubes. However, these systems can require several hours to warm up before steam production begins, resulting in increased downtime and higher fuel costs. Additionally, fire-tube boilers exhibit slower response times to fluctuations in load.

Water-tube boilers comprise a series of water-filled tubes arranged within a rectangular or cylindrical frame. These tubes traverse a furnace where hot gases are generated through combustion. Steam is generated through heat transfer between the hot gases flowing through the tubes and the water contained within them. Unlike fire-tube boilers, water-tube boilers can produce steam within minutes of start-up, conserving resources, reducing fuel costs, and extending equipment lifespan. Furthermore, they boast higher steam generation rates and can withstand higher pressure applications, rendering them better suited for the rigorous demands of the tyre manufacturing process.

However, the advantage of using CFBC lies in its effectiveness for burning low-grade coal, which is important as mostly lignite coal is available in Pakistan (Cai et al., 2017). CFBC technology is recognized for its fuel flexibility and high combustion efficiency. CFBC boilers

can also handle fuels that are difficult to burn, and they're designed to resist tube corrosion, wear, and ash adhesion (Sumitomo, n.d.). This makes them suitable for high-temperature, high-pressure steam conditions, which are often required in industrial processes. Hence, CFBC boiler technology is considered for the project.

3.3. No Project Alternative

According to ESIA standards, it's essential to include a "No Project Alternative" when evaluating different project options. Pakistan's tyre industry is experiencing continuous growth, resulting in a significant disparity between demand and supply within the sector. Challenges such as shortage of raw materials and the influx of smuggled tyres further worsen the situation. Meeting the rising demands of transportation and automotive manufacturing necessitates consistent investments across various segments of the automotive industry. Not addressing this issue will only widen the gap between supply and demand. The primary drawbacks associated with the no-go alternative include the loss of opportunity to meet the increasing tyre demand and the loss of potential employment opportunities and local development. However, it is deemed unreasonable to pursue this alternative further in the Environmental and Social Impact Assessment (ESIA) process.

4. Policy, Legal and Regulatory Framework

4.1 Introduction

This section discusses the policy, legal and administrative framework as well as institutional set-up relevant to the environmental and social assessment of the proposed Tyre Manufacturing Factory by Armstrong ZE (Pvt.) Ltd. Key Guidelines on proposed project includes:

- Applicable environmental and social regulations and policies in Sindh province and Pakistan
- Institutional framework for the implementation of the regulations
- International standards and international conventions
- Applicable permits and license requirements

The applicable regulatory framework has been provided with the objective to be used by Armstrong ZE (Pvt.) Ltd. to develop a comprehensive legal register for the project. This register will be regularly monitored for the compliance of the entire project with the applicable regulatory framework, international standards and industry best practices.

Armstrong ZE will adhere to all the relevant national legislations, international conventions, IFC Performance Standards, World Bank General and Sector specific EHS Guidelines and ensure their conformance by their own staff as well as contractors and sub-contractors throughout the project life cycle.

4.2 Administrative and Institutional Framework

A well-established framework for environmental management exists in Pakistan where environmental issues are governed at three levels viz. Federal, Provincial and Local Government. At Federal level, the Ministry of Environment oversees the affairs of the environment in the country and deals with environment and biological resources. Within the ministry, the National Conservation Strategy unit established in 1992 is responsible for overseeing the implementation of the strategy.

The Constitution of Pakistan 1973 divided the legislative powers between the federal government and the provinces by delineating two legislative lists in Schedule IV. These include Federal Legislative List and Concurrent Legislative List. The Federal List enumerated subjects on which the federal alone could legislate while on the concurrent list both the central government and the provinces were entitled to legislate, but the Federal law prevails. Environmental pollution and ecology were one of the topics included in concurrent legislative list. With the dissolution of concurrent list under the 18th amendment, provinces were provided exclusive autonomy to look after environmental issues, Sindh Environmental

Protection Agency is responsible to look after matters related to environment in Sindh province.

4.3 Applicable Local Environmental Regulations

A list of applicable policies and national legislations on environmental protection, land acquisition and resettlement, forest clearance, wildlife, and labour laws is given in Exhibit 4.1.

4.4 Local Environmental & Social Permitting and Status

Exhibit 4.5 present the relevant environmental and social licenses and approvals required for the project operation.

4.5 International Conventions, Protocols, and Agreements

4.5.1 International Finance Organization (IFC) Requirements

The IFC Performance Standards serve as a tool to manage environmental and social risks and impacts for the development projects. These suggest ways to identify impacts and affected stakeholders and provide processes for management and mitigation of adverse impacts and establish a benchmark that the client is required to meet throughout the life of an investment by IFC or other relevant financial institution. These standards along with their applicability on project is listed in Exhibit 4.2. The project activities will additionally comply with IFC's General and Sectoral EHS Guidelines to manage environmental, health and safety issues of the project during the project life cycle.

4.5.2 International Labour Organization (ILO) Conventions

Pakistan has been a member of the ILO since 1947 and has thus ratified 36 conventions. Of these 33 are in force, whereas 3 have been denounced. The fundamental conventions which are being implemented across Pakistan through applicable labor laws are presented in Exhibit 4.3.

4.5.3 International Standards, Convention and Treaties

Applicable international Conventions ratified and signed by Pakistan have been presented in Exhibit 4.4.

4.6 Relevant and Applicable EHS Standards

To meet IFC Standards, the Project shall comply with Pakistan's environmental, social, health and safety laws and associated IFC/ World Bank Group Guidelines. The Project requires adoption of these standards as part of the Project development, whereby when prescribed limits of standard parameters are different in local and international guidelines, the more stringent standards will be implemented. The comparison of local standards with World Health Organization (WHO) guidelines as used in IFC's General EHS Guidelines is given in Exhibit 4.6 and Exhibit 4.7 and the emissions from rubber products provided in

IFC's EHS Guidelines for Metal, Plastic and Rubber Products Manufacturing are given in Exhibit 4.8. Any other requirement that might emerge as part of the applicable regulatory regimes will be listed and compliance addressed accordingly.

Exhibit 4.1. List of Applicable National and Local Legislations

S. No.	*Requirements*	*Year*	*Construction*	*Operation*	*Decommission*	*Brief Description*
1	Sindh Environmental Protection Act	2014	✓	✓	✓	Legislation in Sindh, Pakistan, aimed at safeguarding the environment by regulating and controlling activities that may cause pollution or environmental degradation. ***AZE** initially obtained an EIA approval from SEPA in 2022 which was further extended. The EIA approval provides specific conditions that are to be complied with through the project lifecycle. The applicable sections to this project include: **Section 11(1), Section 11(2), Section 11(3), Section 12, Section 13, Section 14, Section 15, Section 17(1), Section 21, Section 22, and Section 23.***
2	Sindh Environmental Protection Agency (Environmental Assessment) Regulations	2021	✓	✓	✓	Regulations under the Sindh EPA, outlining procedures for environmental assessments to evaluate potential impacts of development projects. *To fulfill this requirement, an environmental impact assessment was carried out for Armstrong ZE Tyre Manufacturing Factory as the project falls under **Schedule III** - Projects requiring an EIA.*
3	Sindh Environmental Quality Standards (Self-Monitoring and Reporting by Industry) Rules	2016	✓	✓	✓	Rules specifying environmental quality standards and procedures for self-monitoring and reporting by industries in Sindh, ensuring compliance with environmental norms. *Project will be required to comply with the monitoring requirements prescribed in its NOC issued by SEPA.*

S. No.	*Requirements*	*Year*	*Construction*	*Operation*	*Decommission*	*Brief Description*
4	Pakistan Environmental Protection Ordinance	1983	✓	✓	✓	The first piece of legislation in form of national ordinance providing the legal framework for environmental protection, pollution control, and conservation efforts across Pakistan.
5	Pakistan Penal Code	1860	✓	✓	✓	Penal code for all offences charged in Pakistan including provisions related to environmental offenses and penalties for actions that harm the environment.
6	National Climate Change Policy	2021	✓	✓	✓	The policy outlines comprehensive strategies and initiatives to mitigate environmental impact, adapt to climate challenges, and foster sustainable development across all sectors.
7	Sindh Climate Change Policy	2022	✓	✓	✓	The policy sets a regional roadmap for sustainable development, emphasizing adaptation, mitigation, and resilience strategies in the face of climate challenges.
6	National Environmental Policy	2005	✓	✓	✓	A comprehensive policy outlining Pakistan's strategic approach to environmental management, conservation, and sustainable development at the national level.
7	National Conservation Strategy	1992	✓	✓	✓	National-level strategy in Pakistan addressing conservation challenges, emphasizing sustainable resource use, and promoting biodiversity conservation for long-term environmental health.
8	Sindh Wildlife Protection Ordinance	2002	✓	✓	✓	Legislation in Sindh, Pakistan, designed to safeguard wildlife by regulating hunting, poaching, and trade of endangered species.
						*The site for the **AZE** project does not have any ecological sensitivity and the nearest protected area is Haleji Wildlife Sanctuary, 19 kilometers from the*

S. No.	*Requirements*	*Year*	*Construction*	*Operation*	*Decommission*	*Brief Description*
						Project site.
9	Land Acquisition Act	1894	✓	X	X	A legal framework outlining the procedures and compensation mechanisms for acquiring land for public purposes in Pakistan.
10	The Forest Act	1927	X	X	X	Legislation governing the sustainable management, conservation, and utilization of forests in Pakistan. ***AZE*** *Project does not require diversion of forest land and removal of any forest as it is located on an open land with sparse vegetation of native species.*
11	Cutting of Trees (Prohibition Act)	1992	✓	X	X	An Act prohibiting unauthorized cutting of trees to prevent deforestation and promote sustainable forestry practices. *The project will not require removal of any trees.*
12	The Sindh Irrigation Act	1879	✓	✓	✓	Legislation in Sindh, Pakistan, regulating the distribution and management of irrigation water to support agricultural activities. *There is a freshwater canal passing through the north-western side of project boundary. Provisions of this Act will be duly considered during project implementation to prevent any damage to the canal.*
13	The Canal and Drainage Act	1873	✓	✓	✓	An act outlining the regulations and management practices for canals and drainage systems to optimize water usage in agriculture.
14	The Antiquities Act	1975	✓	X	X	Legislation aimed at protecting and preserving archaeological and cultural heritage by regulating excavation and export of antiquities. *The project site does not have any cultural sensitivity in the vicinity to require protection, hence, the provisions of this law therefore do not apply on the project.*
15	Sindh Cultural Heritage Act	1994	✓	X	X	Legislation in Sindh focusing on the preservation and promotion of cultural heritage, including historical sites and artifacts.

S. No.	*Requirements*	*Year*	*Construction*	*Operation*	*Decommission*	*Brief Description*
						None of the sites protected under this law are found in the vicinity of project site.
16	Building Code of Pakistan, Fire Safety provisions	2016	✓	✓	✓	Fire safety provisions within the national building code of Pakistan, ensuring safety standards in construction and occupancy.
17	Hazardous Substance Rules	2014	✓	✓	✓	Regulations addressing the handling, transportation, and disposal of hazardous substances to prevent environmental and health risks. *Hazardous waste generated during the whole project cycle have to be disposed through SEPA approved and authorized contractors.*
18	Non-degradable plastic product rules	2014	✓	✓	✓	Rules governing the production, use, and disposal of non-degradable plastic products to mitigate environmental impact.
19	The Boilers and Pressure Vessels Ordinance	2002	✓	✓	X	Legislation regulating the design, construction, and operation of boilers and pressure vessels in Pakistan for safety and efficiency.
20	Sindh Drinking water Policy	2017	✓	✓	✓	A comprehensive policy framework in Sindh addressing the provision, quality, and accessibility of drinking water for the population.
21	Sindh Sanitation Policy	2017	✓	✓	✓	A policy outlining strategies and measures for sanitation improvement in Sindh, Pakistan.
22	Sindh Solid Waste Management Act	2014	✓	✓	✓	Legislation in Sindh focusing on the management and disposal of solid waste to address environmental and health concerns. *Any type of solid waste generated from the project **AZE** will be managed in accordance to the relevant provision of this regulations.*
23	Sindh Wastewater Management Ordinance	2002	✓	✓	✓	Legislation governing the treatment and disposal of wastewater to protect water resources and public health in Sindh.

S. No.	*Requirements*	*Year*	*Construction*	*Operation*	*Decommission*	*Brief Description*
24	Provincial Motor Vehicle Act	2014	✓	✓	✓	Legislation regulating the use, registration, and safety standards of motor vehicles within the provincial jurisdiction.
25	Special Economic Zones Rules	2013	✓	✓	✓	Rules outlining the establishment and operation of special economic zones to promote economic development and investment.
				Labour Laws of Pakistan		
26	Sindh Factories Act	2015	✓	✓	✓	Legislation in Sindh regulating the working conditions, safety, and welfare of workers employed in factories.
27	Sindh Occupational Health and Safety Act	2017	✓	✓	✓	Legislation ensuring the health and safety of workers in Sindh, Pakistan, by establishing standards and guidelines for occupational environments.
28	Sindh Industrial Relations Act	2013	✓	✓	✓	A legal framework in Sindh governing industrial relations, including collective bargaining, dispute resolution, and workers' rights.
29	Government of Pakistan Labour Policy	2010	✓	✓	✓	A policy framework outlining the government's approach to labor issues, employment, and workers' rights at the national level.
30	Worker's Compensation Act	1923	✓	✓	✓	Legislation providing compensation to workers for injuries or illnesses arising out of or during the course of employment.
31	The Minimum Wage Ordinance	1961	✓	✓	✓	Legislation establishing the minimum wage standards for workers in various sectors, ensuring fair remuneration.
32	The West Pakistan Minimum Wages for Unskilled Workers Ordinance	2015	✓	✓	✓	Legislation setting minimum wage standards for unskilled workers in West Pakistan, modified for Sindh, to address regional considerations. *Project will need to comply with the requirements regulations pertaining to wages of unskilled workers in phases where local labor is employed.*

S. No.	*Requirements*	*Year*	*Construction*	*Operation*	*Decommission*	*Brief Description*
33	Employees' Social Security Ordinance	1965	✓	✓	✓	Legislation establishing a social security system for employees, providing benefits such as medical, maternity, and old-age coverage.
34	Industrial and Commercial Employment (Standing Orders) Ordinance	1968	✓	✓	✓	Legislation requiring employers to define employment terms, conditions, and procedures through standing orders, ensuring workplace transparency.
35	Worker Welfare Fund Ordinance	1971	✓	✓	✓	Legislation creating a fund to support the welfare of workers, funded by contributions from employers.
36	The Employment of Children Act	1991	✓	✓	✓	Legislation prohibiting the employment of children in certain occupations and processes, safeguarding their rights and well-being.

Exhibit 4.2. IFC Performance Standards (PS)

S. No.	*Requirements*	*Year*	*Construction*	*Operation*	*Decommission*	*Brief Description*
1	IFC PS 1- Assessment and Management of Environmental and Social Risks and Impacts	2012	✓	✓	✓	Underscores the importance of managing social and environmental performance throughout the life of a project (any business activity that is subject to assessment and management). *The project will be required to establish an Environmental and Social Management System, conduct stakeholder engagement appropriately through informed consultation and participation activities, devise and implement a grievance redressal mechanism to address the concerns of stakeholders that may arise due to the project at any stage of its lifecycle.*
2	IFC PS 2- Labour and Working Conditions	2012	✓	✓	✓	Recognizes that the pursuit of economic growth through employment creation and income generation should be balanced with protection for basic nights of workers. *The project will be required to comply with the provisions of PS 2 to manage aspects related to labour, their remuneration, accommodation, health and safety and other related aspects.*
3	IFC PS 3- Resource Efficiency and Pollution Prevention	2012	✓	✓	✓	Recognizes that increased industrial activity and urbanization often generate increased levels of pollution to and, water, and land that may threaten people and the environment at the local, regional, and global level. *It requires the project to adopt strategies for energy efficiency, water conservation, and pollution prevention throughout the construction and operational phases of the project.*
4	IFC PS 4- Community Health and Safety	2012	✓	✓	✓	Recognizes that project activities, equipment, and infrastructure often bring benefits to communities including employment, services, and opportunities for economic development. *It addresses the potential risks to communities arising from the project activities.*

S. No.	*Requirements*	*Year*	*Construction*	*Operation*	*Decommission*	*Brief Description*
5	IFC PS 5- Land Acquisition and Involuntary Resettlement	2012	X	X	X	Outlines that involuntary resettlement refers both to physical displacement (relocation or loss of shelter) and to economic displacement (loss of assets or access to assets that leads to loss of income sources or means of livelihood) as a result of project-related land acquisition. *The land acquisition has not resulted in any physical or economic displacement.*
6	IFC PS 6- Biodiversity Conservation and Sustainable Management of Living Natural Resources	2012	✓	✓	✓	Recognizes that protecting and conserving biodiversity—the variety of life in all its forms, including genetic, species and ecosystem diversity – and its ability to change and evolve, is fundamental to sustainable development. *It requires implementation of measures to avoid, minimize, and mitigate adverse effects on surrounding ecosystems, habitats, and species*
7	IFC PS 7- Indigenous People	2012	X	X	X	Recognizes that indigenous People, as social groups with identities that are distinct from dominant groups in national societies, are often among the most marginalized and vulnerable segments of the population. *The identified communities in the project vicinity are not categorized as indigenous communities.*
8	IFC PS 8- Cultural Heritage	2012	X	X	X	Recognizes the importance of cultural heritage for current and future generations. *No cultural heritage sites have been identified within the surroundings of project site.*

Exhibit 4.3. List of Applicable ILO Conventions

S. No.	*Requirements*	*Year*	*Construction*	*Operation*	*Decommission*	*Brief Description*
1	C182 - ILO Worst Forms of Child Labor Convention	1999	✓	✓	✓	Addresses the elimination of the worst forms of child labor, including slavery, trafficking, and hazardous work, ensuring protection for all children.
2	C138 - ILO Minimum Age Convention (No. 138) Minimum age specified ; 14 years	1973	✓	✓	✓	Sets the minimum age for employment at 14 years, with specific provisions for developing countries to establish a higher age in certain hazardous work.
3	C111 - ILO Discrimination (Employment and Occupation) Convention	1958	✓	✓	✓	Aims to eliminate discrimination in employment and occupation based on factors such as race, gender, religion, and social origin, promoting equal opportunities.
4	C105 - ILO Abolition of Forced Labor Convention	1957	✓	✓	✓	Focuses on the complete elimination of all forms of forced labor, emphasizing the importance of eradicating this grave violation of human rights.
5	C100 - ILO Equal Remuneration Convention	1951	✓	✓	✓	Promotes the principle of equal remuneration for men and women workers for work of equal value, addressing gender-based wage discrimination.
6	C098 - ILO Right to Organize and Collective Bargaining Convention	1949	✓	✓	✓	Ensures the right of workers and employers to organize and engage in collective bargaining, fostering freedom of association and labor rights.
7	C087 - ILO Freedom of Association and Protection of the Right to Organize Convention	1948	✓	✓	✓	Guarantees the right of workers and employers to form and join organizations of their choice, protecting freedom of association and collective bargaining.
8	C029 - ILO Forced Labor Convention	1930	✓	✓	✓	Addresses the prohibition and elimination of forced or compulsory labor in all its forms, emphasizing the protection of workers' fundamental rights.

Exhibit 4.4. List of Applicable International Standards, Convention and Treaties

S. No.	*Requirements*	*Year*	*Construction*	*Operation*	*Decommission*	*Brief Description*
1	Equator Principles IV	2020	✓	✓	✓	Financial industry benchmark for determining, assessing and managing environmental and social risk in projects.
2	Sustainable Development Goals	2016	✓	✓	✓	Set of 17 global goals adopted by the United Nations to address various social, economic and environmental challenges, aiming to achieve a more sustainable and equitable world by 2030.
3	Paris Agreement	2015	✓	✓	✓	International treaty within the United Nations Framework Convention on Climate Change (UNFCCC) that seeks to limit global warming to well below 2 degrees Celsius above pre-industrial levels, with efforts to limit it to 1.5 degrees, through nationally determined contributions and global cooperation on climate action.
4	IFC Performance Standards	2012	✓	✓	✓	Set of social and environmental standards applied by the International Finance Corporation to guide private sector investments in developing countries.
5	Biodiversity Action Plan	2000	✓	✓	✓	An internationally recognized program addressing threatened species and habitats designed to protect and restore biological systems.
6	Kyoto Protocol	1997	✓	✓	✓	International treaty that sets binding emissions reduction targets for developed countries to address climate change.
7	IUCN Red List of Threatened Species	1996	✓	✓	✓	Provides information about range, population size, habitat and ecology, use and/or trade, threats, and conservation actions that will help inform necessary conservation decisions.
8	Convention for Biological Diversity	1992	✓	✓	✓	Represents the conservation of biological diversity, the sustainable use of its components, and the fair and equitable sharing of benefits arising from the use of genetic resources.

S. No.	*Requirements*	*Year*	*Construction*	*Operation*	*Decommission*	*Brief Description*
9	Basel Convention	1989	✓	✓	✓	Regulate the transboundary movement and disposal of hazardous wastes to minimize environmental and health risks.
10	Montreal Protocol	1987	✓	✓	✓	International treaty designed to protect the ozone layer by phasing out the production and consumption of ozone-depleting substances.
11	The Convention of Conservation of Migratory Species of Wild Animals (CMS)	1979	✓	✓	✓	International treaty aiming to conserve migratory species and their habitats through collaborative conservation measures.
12	Convention on International Trade in Endangered Species of Wildlife Fauna and Flora (CITES)	1973	✓	✓	✓	International agreement regulating the international trade of endangered species to ensure their survival in the wild.
13	The Convention on Wetlands of International Importance, Ramsar	1971	✓	✓	✓	Global treaty dedicated to the conservation and sustainable use of wetlands, recognizing their ecological importance.

Exhibit 4.5. Licenses/ Permits required for Armstrong to meet compliance

S. No.	*Licenses/ Permits Required*	*Authoritative Institution*	*Brief Description*
1	Environmental Impact Assessment (EIA)	Sindh Environmental Protection Agency (SEPA)	Section 17 of Sindh Environmental Protection Act, 2014 requires project proponents to file environmental assessments in accordance with Sindh Environmental Protection Agency (Environmental Assessment) Regulations, 2021. The project falls under Schedule III of the act in the category C – Manufacturing and processing in the sub-category "synthetic resins, plastic and man-made fibers". Project submitted an EIA report to SEPA in 2022 which was duly approved by the agency.
2	No Objection Certificate (NOC) for construction	SEPA	An NOC was granted to proponent after the approval of EIA report with reference no. SEPA/2022/04/08/EIA/353/518/2022
3	Approval for Conversion of Land Use from Non-Agricultural to Industrial/ Commercial	Town Planning, Sindh Master Plan Authority (SMPA)	Armstrong ZE applied for conversion of land-use from agricultural to non-agricultural, then to industrial/ commercial and approval was granted (Ref. no. DTP/Thatta-A/C-36/667 and DTP/Thatta-A/C-86/197 respectively)
4	Approval for Building Plan	Sindh Building Control Authority (SBCA)	The building plan was submitted to SBCA Office of Regional Director, Hyderabad and received approval (Ref. no. RD/SBCA/Hyd(Reg)/Thatta-05/2023).
5	NOC for Water Supply and Sewerage	Taluka Municipal Administration (TMA), Mirpur Sakro	Armstrong ZE applied for NOC from TMA to have approval on land conversion and proposed layout and was granted approval (Ref. no. DTP/Thatta-A/C-36/670)

S. No.	*Licenses/ Permits Required*	*Authoritative Institution*	*Brief Description*
6	NOC for Electrification	Hyderabad Electric Supply Corporation (HESCO)	Armstrong ZE applied for NOC from Manager (P&E), HESCO to have approval on land conversion and proposed layout and was granted approval (Ref. no. DTP/Thatta-A/C-36/668)
7	NOC for Sui Gas Connection	Sui Southern Gas Company (SSGC)	Armstrong ZE applied for NOC from SSGC to have approval on land conversion and proposed layout and was granted approval (Ref. no. DTP/Thatta-A/C-36/669)
8	NOC for hazardous waste management	SEPA	To be acquired.

Exhibit 4.6. Comparison of Ambient Air Quality Standards

Pollutant	*Averaging Period*	*SEQS Limits (µg/m³)*	*IFC/WHO Guidelines[5] (µg/m³)*
Sulphur Dioxide (SO_2)	Annual[6]	80	-
	24 hours[7]	120	125 (Interim target-1) 50 (Interim target-2) 20 (guideline)
	10 minutes	-	500 (guideline)
Nitrogen Oxide (NO_x)	Annual	40	-
	24 hours	40	-
Nitrogen Dioxide (NO_2)	Annual	40	40 (guideline)
	24 hours	80	-
	1 hour	-	200 (guideline)
Ozone (O_3)	8-hours	-	160 (Interim target-1) 100 (guideline)
Suspended Particulate Matter (SPM)	1 hour	130	-
	Annual	360	-
	24 hours	500	-
Respirable Particulate Matter (PM_{10})	Annual	120	70 (interim target-1) 50 (Interim target-2) 30 (Interim target-3) 20 (guideline)
	24 hours	150	150 (interim target-1) 100 (Interim target-2) 75 (Interim target-3) 50 (guideline)
Respirable Particulate Matter ($PM_{2.5}$)	Annual	40[8]	35 (interim target-1) 25 (Interim target-2) 15 (Interim target-3) 10 (guideline)
	24 hours	75	75 (interim target-1) 50 (Interim target-2)

[5] WHO Air quality guidelines: global update 2005 adopted by IFC General EHS Guidelines

[6] Annual arithmetic mean of minimum 104 measurements in a year was taken twice a week, 24-hourly and at uniform interval.

[7] 24-hourly/ 8-hourly values should be met 98% in a year, 2% of the time. It may exceed but not on two consecutive days.

[8] Annual Average limit of 40 µg/m³ or background annual average concentration plus allowable allowance of 9 µg/m³, whichever is lower.

Pollutant	*Averaging Period*	*SEQS Limits (µg/m³)*	*IFC/WHO Guidelines[5] (µg/m³)*
Lead (Pb)	Annual	1	37.5 (Interim target-3) 25 (guideline) -
	24 hours	1.5	-
Carbon Monoxide (CO)	8 hours	5 mg/m³	-
	1 hour	10 mg/m³	-

Exhibit 4.7. Comparison of Effluent Discharge Standards

Parameters	*SEQS Limits*		*IFC General EHS Guidelines (mg/l)*
	Into Inland Water (mg/l)	*Into Sewage Treatment Plant (mg/l)*[9]	
Temperature 40°C or above[10]	≤3°C	≤3°C	≤3°C
PH	6 to 9	6 to 9	6 to 9
BOD_5 at 20°C	80	250	-
COD[11]	150	400	250
TSS	200	400	50 25 (electroplating)
TDS	3500	3500	-
Oil and Grease	10	10	10
Phenols	0.1	0.3	0.5
Chloride	1000	1000	-
Fluoride	10	10	20
Cyanide	1	1	1
An-ionic detergents[12]	20	20	-
Sulphate	600	1000	-
Sulphide	1	1	1
Ammonia	40	40	10 20 (electroplating)
Pesticides[13]	0.15	0.15	-
Cadmium	0.1	0.1	0.1
Chromium[14]	1	1	0.5
Copper	1	1	0.5
Lead	0.5	0.5	0.2

[9] Applicable only when and where sewage treatment is operational and BOD_5=80 mg/L is achieved by the sewage treatment system.

[10] The effluent should not result in temperature increase of more than 3°C at the edge of zone where initial mixing and dilution take place in the receiving body. In case zone is defined, use 100 meters from the point of discharge.

[11] Assuming minimum dilution 1:10 on discharge, lower ratio would attract progressively stringent standards to be determined by the Sindh Environmental Protection Agency. By 1:10 dilution means, for example that for each one cubic meter of treated effluent, the recipient water body should have 10 m^3 of water for dilution of this effluent.

[12] Modified Benzene Alkyl Sulphate – assuming surfactant as biodegradable.

[13] Pesticides include herbicide, fungicides and insecticides.

[14] For all individual metals (italicized), Subject to the total toxic metals discharge should not exceed level of total toxic metals.

Parameters	*SEQS Limits*		*IFC General EHS Guidelines (mg/l)*
	Into Inland Water (mg/l)	*Into Sewage Treatment Plant (mg/l)*[9]	
Mercury	0.01	0.01	0.01
Selenium	0.5	0.5	-
Nickel	1	1	0.5
Silver	1	1	0.2
Total toxic metals	2	2	-
Zinc	5	5	2
Arsenic	1	1	0.1
Barium	1.5	1.5	-
Iron	8	8	3
Manganese	1.5	1.5	-
Boron	6	6	-
Chlorine	1	1	-
Aluminium	-	-	3
Tin	-	-	2
Total Nitrogen	-	-	15
Total Phosphorus	-	-	5
Volatile Organic Halogens (VOX)	-	-	0.1

Exhibit 4.8. Air Emission Levels for Metal, Rubber and Plastic Products

Pollutant	*Process*	*IFC EHS Guidelines for Metal, Plastic and Rubber Products Manufacturing (mg/m^3)*
Volatile Organic Compounds (VOC)	Surface Cleaning	20-75[15]
	Metal and Plastic Coating	100 (for solvent consumption up to 15 ton/year) 75 (for solvent consumption more than 15 ton/year) 50 (drying processes)
	Rubber Conversion	20[16]
Total Organic Compounds (TOC)	Rubber Vulcanization	80
Volatile Halogenated Hydrocarbons	Metal Surface Treatments	20
Particulate Matter	Metal Surface Treatments	5
Particulate Matter	Plastic Processing	3
Hydrogen Chloride	-	10
Nitrogen Oxides[17]	-	350
Ammonia	-	50

[15] As 30 minute mean for contained sources. 20 mg/Nm3 for waste gases from surface cleaning using VOCs classified as carcinogenic, mutagenic or toxic to reproduction (risk phrases R45, R46, R49, R60, R61) with mass flow greater than or equal to 10 g/hour; and / or halogenated VOC classified with risk phrase R40 and having a mass flow greater than or equal to 100 g/hour); 75 mg/Nm3 for waste gases from other surface cleaning.

[16] Facilities with solvent consumption greater than 15 tons/year.

[17] Dry air at 11 percent O_2

5. Environmental Baseline

5.1 Introduction

This section comprises an overview of existing physical, ecological, and environmental conditions of the project area to provide a background on the basis of which impacts are assessed for the proposed plant. This baseline includes information on all the receptors that were identified for their potential to be impacted by the project.

5.2 Area of Influence (AoI)

The project area for the tyre manufacturing plant covers the entirety of the 50.25 acres of the parcel designated for setting up the project, which would include the production area, waste warehouse, coal yard, sulphur and oil storage, green area, labour accommodation, bachelor's hostel and proposed area for future expansion.

According to the guidelines provided in IFC PS 1, a project's AoI encompasses the following:

- The areas likely to be affected by:
    - The project and the client's activities and facilities that are directly owned, operated or managed (including by the contractors/subcontractors) and that are a component of the project.
    - Impacts from unplanned and unpredictable developments caused by the project that may occur later or at a different location.
    - Indirect project impacts on biodiversity or on ecosystem services upon which the livelihood of the Affected Communities is dependent.
- Associated infrastructure and facilities, which would not have been constructed specifically for gas supply or expanded if the project did not exist and without which the project would not be viable.
- Cumulative impacts that result from the incremental impact, on areas or resources used or directly impacted by the project, from existing, planned or reasonably defined developments at the time the risks and impacts identification process is conducted.

Based on the aforementioned guidelines, the project's primary area of influence covers the project footprint in the Gharo area, within 3 km radius of the project. This is to encompass sensitive environmental and social receptors in the area.

5.3 Environmental Area of Influence (EAoI)

5.3.1 Primary EAoI

The Areas of Influence for direct impacts include the physical and biological components that are affected by the project footprint due to physical space where the project activities of

Armstrong ZE occur. Given the nature of impacts that could arise from a tyre manufacturing factory that could affect the physical and biological environment, a primary EAoI of 3 km is selected for this study.

5.3.2 Secondary EAoI

The area of indirect influence contains transit routes used by the vehicles, personnel and heavy machinery during the various project stages. It also include areas close to the project where fauna can be disturbed and repelled during the construction and operational period as a result of machinery noise, personnel movement, vehicle noise and / or generators, among others.

5.4 Approach and Methodology

The key sources of information presented in describing the Study Area, include primary data collected through site visits and stakeholder consultations and secondary data including published and publicly available information.

5.5 Administrative Profile and Geographical Boundaries of District Thatta

The project is located in Tehsil (sub-district or taluka) Mirpur Sakro of District Thatta in Sindh Province of Pakistan. Administratively, it falls under Hyderabad division (GoS, 2022b). The District is located in southern part of the Sindh province between 24.5° to 25.5° latitude and 66.5° to 68° longitude. The district is characterized by its proximity to the Arabian Sea and encompasses a mix of urban and rural areas. Earlier, the district was comprised of nine (9) tehsils, however, in 2013, the district was split into two administrative districts and Sujawal, one of its tehsil was granted the status of a district comprising of five tehsils. The new modified Thatta district has an area of 7,705km^2 and is comprised of four (4) tehsils, Thatta, Mirpur Sakro, Keti Bunder and Ghora Bari (G. Solangi et al., 2019) as shown in Exhibit 5.1. The district has 4 urban centers, 55 union councils and 655 revenue villages. Geographically, the district is bounded by District Dadu on North, Badin and Hyderabad district on east, Rann of Kutch and the Arabian Sea on South and Karachi on the west. Tehsil Mirpur Sakro in which project is located covers an area of 2,958km^2 (PBS, 2017a).

5.6 Physical Baseline

5.6.1 General Topography

Thatta District has a varied geographical area with an average elevation of Thatta district >200m in the northern part while southern is almost equal to mean sea level of near Keti Bunder (DDMA, 2017) as shown in Exhibit 5.2. The north-western region of the district known as Kohistan has hilly area, including the Makli Hills, an extension of the Kirthar Range with limestone composition and valleys ornamented with grass or brushwood. Moving south, the environment changes to sandy, uncultivated areas. In the south-eastern delta, there is an extent of salt waste, including Sirganda. There are salt deposits between the

Sir and Khori creeks. The riverine or katchho area stretches from Mirpur Bathoro to the Indus River's deltaic tehsils of Kharo Chan and Keti Bunder, with woods on both banks.

The topographical survey of the project land indicates that the area is primarily flat, with a gentle slope extending from north/northeast to south/southwest. The site's elevation ranges from 5m to 8.2m, with the land highly elevated on the roadside. Some parts of the project land hold a slightly higher elevation. Notably, contour lines with minor and major intervals of 1.00m and 0.20m, respectively, provide a detailed representation of the topographical variations across the site as shown in Exhibit 5.3.

5.6.2 Land Use and Visual Aspects

In terms of land use, Thatta district lands can be categorized into five (5) main types: woods, rough grazing lands, areas under human settlements, lands unavailable or unsuitable for agriculture, and forests (DDMA, 2017).

The predominant land use in the project vicinity is agricultural, with informal rural settlements featuring huts, several fish ponds, and a small number of orchards. In addition, the region is home to privately-owned farmhouses and a few industrial mills, mainly engaged in crop processing. The area has an extensive irrigation network feeding from the Link and Jaam Branch Canals and further distributing into small irrigation channels.

The Project vicinity was observed to have sporadic, sparse vegetation with a few trees used by the local herders for domestic animal grazing. The ground is barren in nature, with medium-density, silty sand and sandy silt deposits in shallow soils. There are a few nomadic communities, while some communities in the vicinity are known for their dairy farms. Individuals also keep cattle for personal consumption. The Project area is characterized by limited industrial activity with mostly flat topography. The surrounding area is primarily dominated by agricultural activities, without any major construction. The planned construction of a tyre manufacturing plant is anticipated to introduce highly visible structures, creating a significant contrast with the agricultural and farming landscape in the Project area.

a. General Land use

Most of the development in the area happened between 2006 - 2010, after the construction of coastal Highway which made area more accessible and easier for transportation of heavy machinery and raw material. Another rapid period of commercialization/ industrialization has been observed between the years 2006 to 2023. This also reflects in the change in land use as illustrated in Exhibit 5.4 and Exhibit 5.5. The percentage change in land use pre-2010 to 2023 is as follows:

Land Use	**2006**	**2023**
Agricultural Area	53%	52%
Residential Area	4%	8%

Surface water bodies	2%	2%
Commercial / Industrial	11%	14%
Barren/ Open Land	34%	23%

The land-use analysis indicates that open land in the area has been utilized for the development of housing societies, infrastructure, and commercial / industrial units. Lucrative businesses that have attracted the investors over the past years include development of commercial farmhouses, rice and flour process mills, seeds, fertilizers and pesticide shops and ware houses, poultry farms and raw manufacturing industries. Other profitable investments that has recently garnered traction in the region (post 2017) includes development of gated residential colonies and solar power plants including Gharo Satellite Town, China Town, Gharo Solar and Oursun Solar. The commercial/ industrial entities identified within the Project AoI during the site visits conducted for ESIA are indicated in Exhibit 5.6. While a few are in the planning phase as revealed during the stakeholder consultations. This has altered the land-use of the area from open plots/barren land to commercial/industrial entities. The only beneficial use of these barren lands were livestock grazing and easy access to other lands. Due to high salinity, these were not used for agricultural purposes.

Given this ongoing trend, many agricultural land owners have planned to shift their businesses from agriculture to commercial side as identified during stakeholder consultations. This shift is greatly driven by factors like loss of arable land due to high salinity levels and water shortage to grow water intensive crops such as rice. Furthermore, the ongoing extension project of Coastal Highway to connect Keti Bunder port to National Highway will further fasten up the pace of developments in the area due to increased accessibility and easy means of transportation.

b. Land Use on the Project Land

- *On-site Livelihood*: The site was purchased from the previous owner as a barren land with no prior construction or people living on the land, except for the Guard's household living in their huts. The consultations have revealed that the Guard has been appointed as a permanent staff with appropriate accommodation and living necessities provided.
- *Grazing Use:* Being a barren land with sparse vegetation and a pond, animal grazing was the commonly occurring activity identified on the project land. During consultations, the community did not raise any specific concerns regarding not being able to use the site area for this purpose, as there is sufficient accessible land available in the adjacent vicinity with ponds and sparse vegetation.
- *Accessibility to other lands*: Considering the open barren lands present adjacent to the site, communities have no concerns regarding movement or route accessibility.

5.6.3 Climate and Meteorology

Pakistan has an arid climate, with regional variation defined by its topography. The south of the country is generally dry and hot along the low-laying lands of the Indus River, and the temperature tends to get cooler in the mountainous northern regions (ADB, 2021). Based on the data from the Pakistan Meteorological Department (PMD), about 34.1% of the land is classified as hyper-arid, 28.8% as arid, 30.8% as semi-arid, 3.6% as sub-humid and 2.8% as humid to very humid (MoCC, 2018). The climatic zones of Pakistan are given in Exhibit 5.7 which shows that Project falls in Climatic Zone E which is mostly arid to hyper-arid. The province has a hot and dry climate, classified as a hot desert climate (BWh) according to the Köppen-Geiger climate classification system (Kottek et al., 2006), as depicted in Exhibit 5.8.

Data was collected through consultations with the Director General of Pakistan Meteorological Department (PMD) in Karachi, which revealed that Thatta district lacks proper meteorological coverage due to absence of any meteorological observing stations in the Gharo region. The current nearest operational meteorological observatory in Thatta district was installed in 2004 near Makli graveyard, close to Thatta city, approximately 31 km northeast of the project site. However, the radar technology employed at Karachi observatory has a coverage of around 450 km, which enables the department to capture precipitation data for a wider area including the Gharo region. It was indicated by PMD that there has not been any substantial change in the precipitation pattern or distribution in the project area.

In order to adequately capture the emerging changes in climate, there are plans to install up to 55 automatic weather stations (AWS) across Sindh, especially to cover areas where there are no meteorological observatories. The project will be funded by the World Bank Group (WBG), and is expected to be completed by end of 2025.

a. Temperature

From 1991 to 2020, the mean surface air temperature of Sindh was 27.26 °C, surpassing the country average of Pakistan, which stands at 21.38 °C. Sindh exhibits the highest average maximum surface air temperature in the country, reaching 34.78 °C, a trend underscored by the frequent occurrence of heatwaves in recent years (WBG & ADB, 2021). The mean temperature rise in Pakistan from 1985 to 2005 was 0.39 °C, exceeding the global value of 0.177 °C (MoCC, 2018). In Sindh, the maximum mean temperature attains 30 °C in June and July, while the minimum mean temperature falls to around 10 °C in January, based on data from 1991 to 2020 as shown in Exhibit 5.9.

Sindh is divided into three climatic zones: Siro, Wicholo and Lar. The three (3) zones are divided geographically as Siro being located in Upper Sindh, Wicholo located in Central Sindh and Lar is located in Lower Sindh (GoS, 2022a). Siro has the highest temperature compared to the other region as it is located along the thermal equator. Central Sindh is characterized by dry, hot days and warm nights, and the maximum temperatures ranges around 43 – 46 °C during the summers. The project site is located in Thatta which falls in

Lower Sindh, which has a damper and humid maritime climate. The average maximum temperature in Thatta is 33.8 °C, while the average minimum temperature is 21.9 °C (PDMA & SUPARCO, 2022).

Consultations conducted with the community and other institutional stakeholders indicated that there has not been any significant change observed in the temperature profile of the region, with summers typically being hot, humid and muggy, with strong coastal breeze often causing dusty conditions during the summer and monsoon seasons from April to September. Winters in recent years were observed to have become relatively colder.

b. Precipitation

Most of the country experiences minimal rainfall, with the exception of the northern region, where monthly rainfall during the monsoon season can exceed 200 mm (WBG & ADB, 2021). In comparison, Sindh receives relatively lower rainfall, measuring 158 mm, as opposed to the national average of 289.45 mm. Thatta, specifically, records an annual rainfall of 151.85 mm. The occurrence of El-Nino Southern Oscillation (ENSO) events significantly influences the amount of rainfall, with a general tendency for reduced precipitation (Mahmood et al., 2006).

The consultations with PMD further indicated that during the past few years, flooding has triggered by 50 mm to 60 mm of rain and it poses a significant risk, ranging from flash to riverine flooding. In contrast to the inputs received from PMD, local communities indicated that intensity and duration of precipitation in past five years has considerably increased, with the monsoon of 2022 being particularly devastating. It led to widespread flooding across the region, inundating agricultural lands, Gharo town and vast land around the Gharo Creek, as shown in the Exhibit 5.10. Flood waters receded after two to three weeks from Gharo town, while it took around two to three months to drain from the fields and plains around the creek area. Most community stakeholders interviewed stated that the monsoon of 2022 was the most intense since 1994. It was further stated during consultations that the re-construction and re-carpeting of the National Highway (N-5) has raised its level by up to 2 metres, causing the localities of Gharo town along it to be in a considerable depression. Consequently, rainwater floods the markets every time it rains heavily, which takes more than two weeks to drain.

Exhibit 5.11 illustrates that, over the period from 1991 to 2020, Thatta experienced its highest average precipitation in the months of July and August, ranging between 48 mm and 51 mm (WBG & ADB, 2021).

c. Wind Speed and Direction

Persistent winds are a year-round phenomenon in the coastal areas of Sindh, reaching peak velocities during the monsoon season, notably in July as shown in Exhibit 5.14. In the lower Sindh region, which encompasses the project area, south-western winds dominate in the summer, while north-eastern winds prevail in the winter (GEMS, 2017). During the southwest monsoons, wind speeds range from 46 km/h to 72 km/h, while in the winter

season, northeast winds typically reach speeds of 9 km/h to 18 km/h (SGS, 2013). Sindh boasts an average wind speed of 12.8 km/h, surpassing the national average for Pakistan, which stands at 8.7 km/h (*The Earth Tools*, 2024). The annual average wind speed for Sindh recorded from 1950 to 2022 is illustrated in Exhibit 5.12 while the seasonal variation over this period is depicted in Exhibit 5.14. The wind rose for Pakistan, the province of Sindh and the project area is given in Exhibit 5.13.

In 2023, Sindh recorded an average wind speed of 3.56 m/s, exceeding the national average for Pakistan (2.43 m/s). The windiest month was August, with the highest average wind speed reaching 5.37 m/s. Conversely, February was recorded as the calmest month, with the lowest average wind speed recorded at 2.62 m/s.

d. Humidity

In Sindh, the relative humidity typically fluctuates within the range of 40% to 60%. The coastal belt of Sindh, particularly in the lower part of the province where the study area is situated, significantly influences air humidity. April experiences notably low humidity levels, averaging at only 45%, indicating a relatively dry period. Conversely, August emerges as the most humid month, with an average relative humidity of 69%.

In Thatta, the most humid period occurs on average from July to September, while lower humidity levels are observed during December to February. Exhibit 5.15 presents the average monthly values of relative humidity in percentage over the period from 2001 to 2020 for Sindh.

5.6.4 Ambient Air Quality

Air emissions in Pakistan are predominantly attributed to energy and industrial processes. Carbon dioxide emissions stemming from energy-related activities are primarily produced by the industrial sector (32%), followed by the transport sector (28%), power sector (27%), and the building sector (11%) (Climate Transparency, 2020).

The site is the first project to be proposed under Sole Enterprise Special Economic Zone (SEPEZ). Currently, there is limited to no industrial activity in the region except for a few crop processing mills. Typical source of air pollution activities include collection and burning of trash in the open, and vehicular movement along the Gharo-Keti Bunder Highway, contributing to criteria air pollutants (NO_x, SO_x, CO etc.), dust emissions and particulate matter in the immediate vicinity of the site.

The prevailing wind direction in summer season is from the southwest, which changes direction towards the north-east during the winter season.

Overall air quality of the area depicted in the *Live Air Pollution Map* in Exhibit 5.16 is sourced from IQAir. It does not show significant impacts from anthropogenic activities and consistently remains in the *Moderate to Unhealthy range for sensitive groups* during winters (IQAir, 2024).

As observed during the field visits, the industrial activity in the region is limited, except for a few crop processing mills including Jeelani Rice Mill, Sheikh Altaf Flour Mill, Copper Processing Unit, an organic processing farm etc., as shown in Exhibit 5.5.

c. General Sources of Air Pollution

Typical sources of air polluting activities observed during stakeholder and community consultations include:

- Collection and burning of trash in the open.
- Vehicular movement along the Gharo-Keti Bunder Highway, contributing to criteria air pollutants (NO_x, SO_x, CO, ozone etc.), dust emissions and particulate matter in the immediate vicinity of the site.
- Rice husk from rice processing mills and agricultural residue have also been identified as the sources of pollution in late summer and autumn seasons (typically from August to November).
- Processing of locally grown and imported wheat, which is a source of pollution during the wheat harvest season (March to May).

d. Existing Air Quality

Ambient air quality monitoring was carried out at one upwind and one downwind sensitive receptor locations within 1-km radius of the site for 24 hours each, as shown in Exhibit 5.17. During the monitoring, the pollutants monitored included SO_2, NO_2, CO, O_3, PM_{10}, and $PM_{2.5}$. The rationale for selection of monitoring locations and observed weather conditions at the time of monitoring are given in Exhibit 5.18.

e. Results

The results of the ambient air quality monitoring activity are summarized in the Exhibit 5.19.

For the criteria air pollutants including SO_2, NO_2, CO and O_3, no exceedances against WHO Air Quality Guidelines or SEPA guidelines were observed at both locations, A1 and A2. This indicates that given the overall rural setting of the area and the lack of any significant commercial or industrial activity that could generate air pollution, the overall concentration of these pollutants was observed to be well within local and international regulatory limits. Another factor could also be the light precipitation that was observed the night before monitoring commenced, which could also have further improved the air quality of the area for the at the time of monitoring.

The maximum observed value of PM_{10} exceeded WHO Ambient Air Quality Guidelines at A1, while at A2, average observed value of PM_{10} also exceeded the WHO Ambient Air Quality Guidelines as well as SEPA Guidelines for Air. The PM_{10} exceedances can be attributed to presence of dust particles due to lose soils on agricultural lands, along with the

overall dry and hazy weather observed in the area around this time of the year. There is a likelihood that the concentration of particulate matter would have been noticeably higher if there was not any precipitation the day before monitoring was conducted. The traffic plying along the Gharo-Keti Bunder Highway could also be a source of particulate matter pollution at both points, although the impact or contribution in overall rural area may not be that significant due to absence of extensive secondary road network and vehicular movement. Therefore, the area can be considered less prone to anthropogenic sources of pollution. The maximum observed value of $PM_{2.5}$ was found exceeding the WHO ambient air quality guidelines as it was reported 62.33 µg/m^3 and 59.33 µg/m^3 A1 and A2 respectively. This could potentially be due to presence of dust from surrounding lands picked up by the breeze, along with some contribution from the traffic plying on Gharo-Keti Bunder Highway.

The Live Air Pollution Map which determines Air Quality Index (AQI) based on $PM_{2.5}$ concentrations in the atmosphere indicates that air quality is consistently in the *Moderate to Unhealthy range for sensitive groups* during the winter months of November to February. This is primarily due to the prevalent weather conditions influenced by the dry northeast breeze, which generally creates hazy conditions. Crop processing at the time of the monitoring was observed to be at a minimum, so anthropogenic contribution to this exceedance is expected to be significantly low.

5.6.5 Air Dispersion Modelling (ADM)

a. Introduction

Air Dispersion Modelling (ADM) exercise was carried out to determine the potential cumulative air quality impacts associated with the operations of the proposed tyre manufacturing plant. The aim of the modelling was to determine whether or not the emissions from the boiler on-site will result in exceedance of the World Health Organisation (WHO) Ambient Air Quality Guidelines, as mentioned in the Air Emissions and Ambient Air Quality section of IFC General EHS Guidelines document, and/or the Sindh Environmental Quality Standards (SEQS). The assessment was carried out using the air dispersion modelling software, AERMOD.

For the purpose of ADM, two (2) modelling scenarios have been considered:

- The *Normal Scenario* considers the plant's boiler operations on 70% lignite coal and 30% biomass;
- The *Extreme Scenario* considers the plant's boiler operating on 100% lignite coal.

All calculations are based on 6 years of WRF-Preprocessed Meteorological Data, AERMET/AERMOD (2018 to 2023), which was acquired from Lakes Environmental Consultants Inc.

b. Emission Characteristics for Normal and Extreme Scenarios

The following emission characteristics were provided by Armstrong ZE for ADM based on the *Normal* and *Extreme* scenarios. The results are discussed in the impact assessment section for the air quality impacts during the operation phase (Refer to Section 8.4.2).

Required Parameters	Values
Number of boilers to be operated and number of ours	1 boiler for 24 hours
Number of boiler stacks	1 per boiler
Stack Diameter	1.5 metres
Stack Height	30 metres
Stack gas Velocity	22 m/sec
Flue Gas Temperature	150 °C
Normal Scenario	
Fuel to be used in boiler(s)	70% lignite coal and 30% biomass (mainly rice husk)
Expected Emission Rate of Total Suspended Particulates (TSP)	≤ 0.5 g/sec
Expected Emission Rate of SO_2	6.25 g/sec
Expected Emission Rate of NO_2	3.75 g/sec
Expected Emission Rate of CO	0.9375 g/sec
Extreme Scenario	
Fuel to be used in boiler(s)	100% lignite coal
Expected Emission Rate of Total Suspended Particulates (TSP)	0.5 g/sec
Expected Emission Rate of SO_2	8.125 g/sec
Expected Emission Rate of NO_2	4.375 g/sec
Expected Emission Rate of CO	1.0 g/sec

5.6.6 Ambient Noise

As the project site is located along the main Gharo-Keti Bunder Highway, the main project route can be characterised by moderate to heavy traffic noise. However, the settlements are mostly situated away from the main highway so remain unaffected by traffic-related noise. The absence of paved roads to most settlements contributes to a relatively tranquil environment in these areas.

Noise impacts are anticipated to be considerable during the construction phase, particularly affecting communities along the project's northern boundary. Both the construction and operation phases may significantly influence the noise environment for nomadic dwellers in close proximity to the project, including a farmhouse located opposite the site on the other side of the Gharo-Keti Bunder Highway and nomadic dwellers along the project's northern

boundary. Ambient noise monitoring has been initiated on the project site on locations indicated in Exhibit 5.17.

a. Existing Ambient Noise Environment

Hourly spot noise readings were taken for 24 hours at each of the four (4) site corners of the Armstrong ZE site using the IFC Guidelines. The ambient noise monitoring was performed concurrently with ambient air monitoring exercise, while rationale for selection of noise monitoring sampling points is illustrated in Exhibit 5.20.

b. Results

The noise monitoring results and their comparison with IFC General EHS Guidelines is given in Exhibit 5.21, while the comparison of noise monitoring results in comparison with SEQS guidelines is given in Exhibit 5.22.

Exceedance in daytime and night-time ambient noise levels was observed against *IFC Residential, Institutional and Educational Standards* at N1 and N2, and all four locations (N1, N2, N3 and N4), respectively. Likewise, daytime and night-time exceedance in ambient noise levels was also observed against *SEQS Noise Level Guidelines for Residential and Silence Zone* at N1 and N2, and all four locations (N1, N2, N3 and N4), respectively.

The exceedance occurred against the more sensitive regulatory standards of IFC and SEQS pertaining to Residential, Educational and Silence Zone regulatory requirements; however, no exceedance was observed against Industrial and Commercial Guidelines of IFC and SEQS. The daytime and night-time regulatory standard exceedances likely occurred at N1 and N2 since the monitoring was performed along the main Highway, with both locations being susceptible to noise due to traffic movement on the Highway. No exceedances were observed in daytime at N3 and N4 due to their quieter locations off the Highway; however, night-time exceedances were recorded, likely due to occasional movement of bikes and other transport vehicles during the night hours by people commuting from the nearby communities who take the unpaved route instead of commuting directly via the Highway due to their location.

Exceedance against industrial and commercial regulatory standards of IFC and SEPA likely did not occur due to the overall rural outlook of the vicinity and sparse population, with very limited commercial and industrial activity. Only a few crop processing mills exist in the area, whose operations generally do not produce significant noise to exceed the regulatory limits.

5.6.7 Geology and Soil type

Geologically, Thatta district is composed of quarterly and tertiary volcanic and sedimentary rocks, comparable to the nature of the Indus Plain and Pakistan's eastern desert zone, which includes Cholistan, Nara, and Thar.

The soil of district is composed of fine-grained sediments with a high organic matter content and significant levels of arsenic. These are projected to integrate into aquifers via a variety of geochemical processes (Rubab et al., 2014). The soil in the region is classified as silty, clayey, moist and saline (DDMA, 2017). The region is part of the alluvial and deltaic plain of Lower Indus, characterized by alluvial deltaic sediments that house the aquifers in the area. The underlying rocks are primarily of marine origin, and extensively characterized by folding, faulting, and fissuring. They mainly consist of limestone and clay (ADB, 2004; G. S. Solangi et al., 2017). The soil on the project site is largely loamy and clayey, as it is characteristic of Sindh's coastal districts. The Geotechnical Soil Investigation Report of the project indicates that the subsoil of top 1 metre is made up of fill material, followed by medium-dense silty sand and sandy silt layers. Below this, there are dense to extremely dense, fine to coarse sand and sandy silt layers that extend to the investigated depth of 20 metres. Major subsurface deposits include brownish-grey, medium-dense sandy silt, greyish-brown medium-dense silty sand/ sandy silt, brown/ greyish-brown dense to very thick fine to coarse sand, and grey/ brown dense to very silty sand/sandy silt. The water table at the site varies between 1.38 metres and 1.62 metres.

5.6.8 Soil Quality Analysis

Six (06) bores were installed at an approximate depth of 5-6 mbgs for soil profiling and baseline, all of which were converted into groundwater monitoring wells.

c. Soil Profiling

The soil of vadose and aquifer zone is comprised of silt with sand due to the previous agricultural practices. All of the soil samples are undisturbed. The soil bore details of each installed bore are as follows:

- The bore log of SB-AZE-01 indicates that the soil type of vadose zone has low plasticity silt with sand while the aquifer zone starts from 1.8 mbgs which is comprised of silty sands only.
- The bore log SB-AZE-02 presents that the soil type in the vadose zone is comprised of low plasticity silt with sand and aquifer zone starts from 1.5 mbgs silty sand.
- The bore log SB-AZE-03 presents that the soil type is comprise of low plasticity silt with sand. The aquifer zone however, starts from 1.2 m bgs and is comprised of clayey silts.
- The bore log SB-AZE-04 presents that vadose zone is comprised of low plasticity silt with sand. The aquifer zone starts from 1.5 mbgs comprising of silty sands.
- The bore log SB-AZE-05 presents that vadose zone is comprised of low plasticity silt with sand. However, the aquifer zone starts from 0.9 mbgs and comprises of silty sands.
- The bore log SB-AZE-05 presents that vadose zone is comprised of low plasticity silt with sand whereas the aquifer zone starts from 1.2 mbgs and comprises of silty sands.

The schematic diagram of the bore logs is provided in the **Appendix G**.

5.6.9 Water Resources

a. Surface Water Hydrology

Thatta district contains a well stretched and diverse water network, comprising of numerous streams, freshwater lakes such as Keenjhar, Hadero, and Murdani, canal network and the River Indus (G. S. Solangi et al., 2017). Four talukas of the district (Thatta, Keti Bunder, Ghorabari, and Mirpur Sakro) include the areas where Indus River meets the Arabian Sea with the coastline spanning up to 270 km within the city.

Despite the availability of an extensive water drainage network, the province faces water shortages during the dry spell and often fails to fulfil the water requirement below Kotri Barrage. Due to lack of freshwater in downstream Kotri, sea water intrusion is a key phenomenon in the area.

The riverine area of Sindh is approximately 2.112 million acres that extends along both sides of the River Indus. It exhibits surface drainage patterns similar to areas with basin and range landforms in warm to hot arid regions. Irrigation in Sindh relies largely on the canal network that is diverting water from the river. Studies conducted specifically for district Thatta indicates gradual decrease in flow of the main tributaries of the River Indus, with minimum observed flow downstream at 0.29 MAF due to its location at the tail end of the River Indus. Consequently, district Thatta faces water scarcity, especially during dry periods between December and January when there is no upstream flow.

Macro-Environment

An inter-connected network of water bodies exist in the immediate macro-environment. These include Keenjhar Lake located 43 kilometers to the northeast and Hadero Lake at a distance of 28 kilometers in the same direction. Haleji Lake is situated 18 kilometers in northeast. Additionally, the Gharo creek traverses within a 3-kilometer radius of the site perimeter which ends up in the Arabian Sea located 43 km west from the site.

Micro-environment

An intricate network of irrigation channels is present in the project AoI to fulfil agricultural needs. These mainly include Khari Sir Canal, Phenri Canal, Jam Branch, and Chach Canal that facilitate the flow of water throughout the area. Phenri canal holds significance as it passes adjacent north of the site, augmenting the hydrological dynamics of the surrounding landscape. The canals Phenri and Kheeran are sourced from Hadero Lake while Jam branch is located further south is sourced from Keenjhar Lake. All these canals further bifurcate into small branches to irrigate agricultural lands. The surface water bodies/channels in the project AoI are illustrated in Exhibit 5.23.

1) Baseline Surface Water Usage and Quality

Site survey reveals that local residents use surface water only for domestic purposes, such as washing and cleaning.

The quality of surface water is a significant concern for drinking primarily due to high salinity, as the measured TDS in the identified surface water bodies ranges from 392 to 1,120 ppm. Seawater intrusion has aggravated the issue. Secondary data also suggests that the general quality of water available for drinking in District Thatta is of unsatisfactory quality and parameters of most of the water sources deviate from values prescribed in the Sindh Environmental Quality Standards (Drinking water quality assessment in Southern Sindh (Pakistan) June 2011). The analytical results for surface water samples are illustrated in Exhibit 5.24**.**

2) Municipal Water Availability

The community engagement in the different quadrants of the site has indicated that the water supply network of Water and Sanitation Agency (WASA) Hyderabad is sparsely available in the area. Municipal supply is only available in the north-western quadrant as shown in the Exhibit 5.25 with a consistency of 6 to 7 hours daily, while absent in all other cardinal directions.

People in northwest quadrant are generally involved in crab and fish farming due to the abundant seepage from the groundwater at approximately the level of 0.5 mbgs.

3) Surface water usage

The existing water channels are widely used for irrigation purposes, while many domestic uses; such as washing, bathing and cleaning have also been identified. It was identified during consultations with the local communities that they do not use surface water for drinking purposes due to concerns about water quality; however, it is consumed by domestic animals and other wildlife.

However, following concerns have been identified regarding the surface water quality in the project area and vicinity:

- Waterlogging on lands have been a common issue in the area due to shallow water table. To curtail excessive logging, multiple subsurface field drainage channels are also present in the area. The most commonly used water channel present in the close vicinity of the site is known as Sim Nullah, located 950m in the south.
- Seawater Intrusion - Regardless of the vast surface water network in the area, the local populace relies mainly on shallower groundwater to cater to their drinking water needs, while industrial units rely on tanker and hydrant water. It has also been stated by the community that during the drier season, i.e., winter season from December to February, when the canal is closed, their wells become sodic due to the discontinuation of the fresh

water recharge from canals. This indicates that the shallower groundwater is connected to the surface water.

4) ***Physicochemical and Biological quality profiling of Surface Water samples***

A total of four (04) surface water samples were taken at different locations after considering the site's discharge points and nearby fresh water channels that might get impacted from the site activities.

- Two (02) samples, SW-AZE-04 and SW-AZE-05, were taken from upstream and downstream areas of the link canal running adjacent to the site northern boundary.
- Two (02) samples have been collected from different locations i.e. one (01) from Sim Nullah (SW-AZE-01) which is identified as the potential discharge point for site's wastewater and other from the pond – a nearby receptor (SW-AZE-02) located 1.07 km south of the site.

Biological and chemical parameters analysed for baseline establishment were based on parameters prescribed in SEQS, 2016 and IFC General EHS Guidelines.

Physical Parameters: TDS, pH, D.O., Conductivity, and ORP

Chemical Parameters: Heavy metals, Total Petroleum Hydrocarbons and Pesticides

Biological Parameters: BOD, COD, fecal E. coli, Total Bacterial Count, and Total Coliforms

5) Physical Analysis

Salinity/TDS factor in the surface water samples ranges between 245 mg/l to 538 mg/l. However, a spike has been observed in the pond located 1,078 m south of the site has indicated 3,610 mg/l which is saline. The measured physical parameters in the surface water samples are presented in the Exhibit 5.26 for Field Water Quality and Usage Data for water bodies.

- pH ranges from 6.92 to 8.09, the highest pH has been measured in SW-AZE-01 i.e. from Sim Nullah.
- DO ranges from 2.7 to 5.4 mg/l, however, as per WHO standard, DO should range between 8-9 mg/l.

6) Chemical Analysis

- The laboratory analysis conducted for these surface water samples has only reported aluminium in the SW-AZE-01 and SW-AZE-02, which has exceeded the criteria defined by *USEPA Resident Tap water Regional Based Screening Levels (November 2023).*

7) ***Biological Analysis***

None of the sample reported any biological indicator above laboratory level of reporting.

b. Groundwater Hydrology

In Pakistan, groundwater is the major source of drinking water. The province of Sindh extends lower Indus Plain which is an aquifer well-known for its abundance of groundwater resources.

The southern region of Sindh, Pakistan, borders the Arabian Sea. The water of Sindh is not suitable for drinking purposes due to being highly susceptible to contamination, particularly by arsenic (Shahab et al., 2016). The quality of groundwater in low-lying, deltaic, and flood plain zones of Sindh is also significantly influenced by salinity due to sea-water intrusion as well as contamination of arsenic, fluoride, and microbial pollution. Despite this, people in these regions rely significantly on groundwater for drinking and irrigation due to low precipitation and limited flow of the Indus River.

The groundwater reserves in Thatta district are reported as contaminated due to seawater intrusion and presence of different trace metals. Most of the local inhabitants in the district extract groundwater by using hand pumps drilled into shallow aquifers at depths ranging from 5 metres to 12 metres. The people in the project area similarly supplement their water supplies by extracting groundwater from hand pumps. The groundwater quality was found to be variable (good to brackish). At some locations, tube wells are also installed to fulfil water needs for agricultural purposes (Ashraf et al., 2007). Municipal supply from WASA Hyderabad is also another important source of water in the wider region.

1) Baseline Groundwater Availability and Quality

An electrical resistivity survey was conducted at six locations to establish baseline groundwater quality, characterize the lithological nature of the aquifer(s), and determine its lateral extent and thickness. The survey aimed to provide valuable insights into the subsurface composition of the surveyed area, aiding in understanding the distribution of different lithological units and the presence of groundwater and its quality.

The survey utilized specialized equipment to measure apparent resistivity at each station, plotted against electrode spacing (AB/2). Qualitative interpretation was performed through electrical sounding imaging to identify distinct signatures, aiding in the characterization of layering. Computer models using an iterative Inverse modelling technique with IPI2Win were employed for further analysis.

Six profiles of the electrical resistivity survey were carried out at the site to ensure appropriate coverage. Four profiles were imaged along the site periphery, while two profiles were imaged diagonally to delineate the site effectively. The imaging was conducted at different depths:

- Two profiles were imaged at 200 m below ground surface (bgs), covering the western and eastern southern boundary over a horizontal stretch of 400 m.

- Two profiles were imaged at 300 m bgs, encompassing the northern and southern site boundaries over a stretch of 600 m.

- Two profiles were imaged diagonally from northeast to southwest and southeast to northwest, reaching depths of 400 m bgs over a stretch of 800 m.

The following findings have been elucidated from the electrical resistivity survey:

- The vertical lithological profiling reveals a predominantly uniform and laterally homogenous lithology within the surveyed area. The profile sections are provided Exhibit 5.27 and Exhibit 5.28.
- Apparent resistivity measurements were obtained for each profile conducted at six different locations. At Location VES-01, values ranged from 3.652 ohms-m to 209.244 ohms-m. At Location VES-02, resistivity values varied from 0.94 ohms-m to 31.87 ohms-m, while at Location VES-03, they ranged from 0.753 ohms-m to 28.61 ohms-m. Similarly, at Location VES-04, resistivity values spanned from 0.301 ohms-m to 233.691 ohms-m, and at Location VES-05, they ranged from 2.968 ohms-m to 112.58 ohms-m. At Location VES-06, resistivity values varied between 0.393 ohms-m to 18.86 ohm-m. The values encountered at each profile are provided in Exhibit 5.29**.**
- The electrical conductivity was calculated for each profile using Equation 1 based on the apparent resistivity measurements. The computed electrical conductivity values for each profile were determined to be 4 ds/m. These computed values were cross-referenced with a previous study conducted on groundwater quality in the Gharo Thatta Region in 2020, for validation purposes. The location wise electrical conductivity values are presented in Exhibit 5.29.

$$EC = \frac{1}{\rho} * 0.001 \longrightarrow \text{Eq 1.}$$

Where,

ρ= Apparent resistivity in ohms-m

EC= Electrical Conductivity in dS/m

- Total Dissolved Solids (TDS) were computed from the electrical conductivity measurements. Considering the coastal aquifer setting of the site, a conversion factor of 0.65 was applied to convert the electrical conductivity values to TDS. The highest TDS values were observed in the VES-02 profile, located at the eastern boundary of the site. The higher TDS levels across this profile are likely attributed to the proximity with the Sim Nullah, which runs along the eastern boundary of the site (temporarily closed). The peak TDS values are noted at depths ranging from 50 to 100 mbgs, with the highest recorded value of 34,483 mg/l observed in the profile located at the southern boundary of the site. The consolidated graph showing the peak TDS values versus depth across all profiles is provided in Exhibit 5.30.

- The observed decreased in TDS levels, particularly in the deeper sections of the aquifer beginning from 200 mbgs, suggests the presence of high-quality water. This variation indicates the likelihood of the existence of two or more aquifers within the project area. The stratification of TDS levels across different depths underscores the potential for distinct hydrogeological units within the subsurface. Lithological profiles encountered at each location further indicate the presence of the following aquifers:

Aquifer	*From (m)*	*To(m)*	*Thickness(m)*	*Lithology*
	0	2	2	Sandy Clay
1st	2	22	20	Fine sand
	22	36	14	Clay
2nd	36	66	30	Limestone
	66	115	49	Clay interbedded with Sand
3rd	115	120	5	Sand interbedded with Silt
	120	138	18	Claystone
4th	138	180	42	Limestone
	180	215	35	Clay minor Sand interbedded
	215	282	67	Limestone
	282	310	28	Clay
5th	310	400	90	Sand Interbedded with clay

Further investigation and characterization of these aquifer layers are essential to fully comprehend their properties and dynamics, which will be determined during pump testing. Refer to Exhibit 5.29 and Exhibit 5.31**.**

- The topography is generally flat in the project AoI, hence the subsurface lithology in the area is expected to be similar to the site lithology. The shallow aquifer that is being used by the community to cater to their water requirements is separated with thick clay layer of ~ 14 m from the deeper aquifer. There is no significant impact expected on the shallow aquifer as a result of groundwater extraction from the deeper reaches of the aquifer to fulfil the water requirements of the manufacturing plant during operation phase. A detailed subsurface profile depiction has been provided in Exhibit 5.32**.**
- Based on the lithological profile, the largest water bearing strata extends from ~130 to 280 m bgs in limestone overlain by clay interbedded with sand (~35 m thick). An estimation of the water storage in this stratum within the site boundaries of 50.25 acres is 36 million m^3. The annual groundwater requirement for site operation is estimated to be 55,000 m^3, which is 0.15% of water stored in this stratum within site boundaries. It is estimated that this small withdrawal volume will have no significant impact on the

aquifer in the targeted zone as recharge rates within the strata are likely to far exceed the withdrawals.

Based on the survey findings, the identified suitable locations for the test borehole are suggested to be in the profiles of VES-03 and VES-04 potentially from the 4th aquifer based on their adequate water bearing strata, which will be further confirmed during pump test. The test bore hole will be installed in a manner that it ensures the protection of the shallow aquifer(s). The well screen will be positioned within the interval corresponding to the depth of the deeper aquifer to allow water to enter the well, while ensuring that the shallow aquifers are not disturbed. The test bore further will be sealed with the appropriate annular sealant, typically bentonite clay slurry to prevent any vertical exchange of water or contaminants between the aquifers.

2) Groundwater Usage

A survey was conducted in the site vicinity in order to assess the groundwater quality in the project area. A total of sixteen (16) wells were identified including one (01) on-site and fifteen (15) off-site well within 3 km radius. The depth of all of the wells ranges from 4 m to 10 m and the age of the wells lies in between 2020 to 2023 which indicates that all are recently installed. It has also been revealed during the stakeholder engagement that there wells become saline after every 2 years as a result of which they change their bore location in order to abstract water from the shallow reaches which is less saline and drinkable due to continuously recharge from the catchment area and rainfall.

It was communicated by the stakeholders that the groundwater becomes saline when the flow in canal is stopped from upstream and also when the area experiences lesser precipitation from the usual monsoon season. The recorded values of the physical parameters measured in the groundwater abstraction wells are presented in Exhibit 5.33.

Out of sixteen (16) wells identified, five (05) samples were selected including one (01) on-site and four (04) off-site wells for the laboratory analysis.

Chemical: None of the sampled wells reported any impact above the laboratory level of reporting, except for aluminum in one (01) off-site well (OW-AZE-03) located in a gypsy camp at 281 meters northwest of the site, at a trace concentration of 0.7 mg/L, exceeding the Dutch Intervention value. This indicates that it is due to natural occurrence. Additionally, the Armstrong ZE has planned to install R.O. plant for community.

The trace concentration of aluminum exceeding Dutch intervention value was reported in the on-site hand-pump (DW-AZE-01). Given the impact detection, the site management has taken the hand-pump out of use (previously being used on-site to cater drinking water requirement). Now the site utilizes bottled water to fulfil their drinking water needs during construction phase.

Biological: None of the sample reported any biological indicator above laboratory level of reporting.

3) Baseline Groundwater Quality

All six (06) installed soil bores were converted into permanent groundwater monitoring wells. The locations are presented in Exhibit 5.34. Total six (06) samples from on-site monitoring wells were sent to the PRD laboratory for the analysis of the Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), fecal *E. coli* (biological markers), heavy metals and Total Petroleum Hydrocarbons (TPH) as shown in Exhibit 5.35. None of the sampled reported any impact except for cyanide exceeding SEQS 2016 and Dutch Target Value (2009) for groundwater. The summary of the exceeding detections is as follows:

Well ID	*Cyanide concentration (mg/l)*	*Well ID*	*Cyanide concentration (mg/l)*
MW-AZE-01	0.4611	**MW-AZE-04**	0.3019
MW-AZE-02	N.D.	**MW-AZE-05**	0.304
MW-AZE-03	0.261	**MW-AZE-06**	0.251

4) Depth to Groundwater and Flow Contours

The average depth to water table was gauged at 1.97 mbgs ranging between 1.50 to 2.47 m. The static water level gauged in each well is presented in Exhibit 5.36. The groundwater flow contours fanning out from the site central portion and converging in east, southeast, southwest and northwest as given in Exhibit 5.37.

5) Hydrological properties of the Aquifer

The hydrological properties of aquifer are as follows:

Vadose Zone	Silty sands
Aquifer Soil Type	Silty clay
Hydraulic Gradient (m/m)	0.00016
Hydraulic Conductivity (K) (m/sec)	$1.38x10^{-04}$ to $2.69x10^{-04}$
Groundwater Direction	The overall groundwater direction has been inferred towards the southwest.
Effective Porosity (θ)*	0.2
Discharge Velocity (m/yr.)	$6.96x10^{-1}$ to 1.36
Seepage Velocity (V = K*i/θ) (m/yr.)	3.48 to 6.79
Total dissolved solids (TDS) concentrations	Total dissolved solids (TDS) concentrations indicate groundwater quality to be good (TDS ranges between 389.5 mg/l to 1,580 mg/l) in the sampled on-site and off-site abstraction wells.

**** = Geotechdata.info, Soil porosity, November 18, 2013***

6) Tidal Fluctuation

The continuous data logging activity was performed for 24 hours between February 1, 2024, and February 2, 2024, to gauge the tidal effect on groundwater level. From the graph shown in Exhibit 5.38, it can be observed that there is a rise and fall corresponding to the tidal cycle, and its consequent effect on groundwater level. A delay of 8 to 9 hours has been observed between tidal water level rise vs. the static water level rise. This indicates the potential sea water intrusion into the groundwater. Refer Exhibit 5.38.

7) Physicochemical Quality Profiling of Creek Water Samples

A total of six (06) samples were collected from the stretch of approximately 2.5km at locations indicated in Exhibit 5.39. The strategy was devised to take each sample from the starting and end point and afterwards at every half a kilometer. The measured parameters analyzed include TDS, conductivity, ORP, DO and pH and the results are summarized in Exhibit 5.40**.**

- The TDS ranges from 2,210 to 3,155 mg/l, the highest value has been recorded at the closest location from the sea i.e. Location 05, which is located ~2.5 km northwest from the site. This indicates that the seawater has been intruded to the groundwater up till 46 km from the sea.
- The pH values at all locations ranges between 7.15 and 8.27, the highest value of 8.27 has been observed in the sample taken at *Location-00*, which indicates water is slightly alkaline where municipal drain discharges into the creek.

5.6.10 Natural Hazards

a. Earthquakes

Sindh province contains four major active faults which include Surjani fault, Jhimpir fault, Pab fault and Runn of Kutch fault. These fault networks have triggered historically large earthquakes in locations such as Kohistan, Pab Range and talukas of Jhimpir and Thatta (Bhatti et al., 2010) ranging from 5 to 7.6 on the Richter scale.

Since 1970, Thatta district has experienced eight earthquakes with magnitudes ranging from above 3.0 to 5.0. The strongest earthquake in Thatta occurred in December 1985, with a magnitude of 5.0. The most substantial quake near Gharo in the past decade had a magnitude of 4.7, occurring in September 2023, 44 km from Gharo. According to the Volcano Discovery Agency, the most recent seismic was recorded to have a magnitude of 3.8 on October 16, 2023, at a depth of 10 km, 35 km east of Gharo and 50 km southeast of Mirpur Sakro, (AllQuakes, 2024). Thatta District is situated away from the fault line, making it less susceptible to significant earthquakes.

As per the zoning done by Pakistan Engineering Council in Building Code of Pakistan, the Thatta district is categorized under Seismic Zone-2A as shown in Exhibit 5.41 (IISEE, n.d.; Siddique & Schwarz, 2014) which corresponds to a design earthquake featuring a peak horizontal acceleration of 0.15g for an earthquake magnitude of 6.5 on Richter Scale (Prasad, 2020).

b. Flood Risk

Flooding has been reported as the most frequent and damaging natural hazard in the district. In recent years, the district has experienced unusual distribution of rainfall, which may be attributed to a rapidly changing climate. Heavy rainfall tends to occur in the form of erratic, heavy showers and/or cloudbursts, particularly during the monsoon season, which often leads to flash floods and loss of life and property (DDMA, 2017). Monsoons in

northern part of Pakistan surged downstream into Sindh and Balochistan in 2010, which caused substantial damage to agricultural lands in Thatta (Britannica, 2023). The region was also affected during the widespread floods of July and August 2022 when torrential rainfall and flash floods resulted in considerable damage to infrastructure, crops, livelihoods, and physical displacement in Thatta (SRSO, 2022).

c. Tropical Storms and Cyclones

Coastal belt of Pakistan is prone to cyclones and associated storm surges during the pre-monsoon (May and June) and post-monsoon (September to November) seasons. In Sindh, three (3) coastal districts including Karachi, Thatta and Badin are highly vulnerable to cyclone hazards. Some of the major tropical cyclones to have struck the coastal areas of Pakistan occurred in May 1902, June 1926, June 1964, November 1993, June 1998, May 1999, June 2007 and 2011 and June 2014.

In May 1999, Cyclone 2A hit the coastal belt including Thatta as a strong Category 3 equivalent storm, killing 6,200 people in the region (Dawn, 2023). The cyclones of 2010 (Phet) and 2011 (Keila) also occurred during the recent years, of which Phet on June 6, 2010 caused significant damage in district Thatta. The Sindh-Makran coastline received torrential rainfall, measuring up to 376 mm within 36 hours in some areas (Dawn, 2010).

Cyclone Nanauk in June 2014 caused intermittent rainfall with gusty winds in coastal areas of Sujawal and Thatta, although it did not directly affect the Pakistani coastline. It damaged the protective embankment of Keti Bunder in Thatta, as a result of which more than 30 villages were flooded (Geo News, 2014). On September 30, 2021, Cyclone Shaheen, which originated from the remnants of Cyclone Gulab, had peripheral effects on Thatta in the form of high winds and intermittent rainfall.

Although the frequency of cyclonic storms to affect district Thatta is generally low and infrequent, yet they have the potential to cause considerable damage when they occur. Hence, the possible occurrence of a future cyclone with severe consequences, although quite rare, cannot be ruled out (NDMA, 2007).

5.7 Ecological Baseline

This section presents the ecological baseline for the Project, and was prepared using the international guidance on impact assessments for biodiversity, including IFC PS 6, voluntary guidelines on biodiversity-inclusive impact assessment[18].

[18] Impact assessment: Voluntary guidelines on biodiversity-inclusive impact assessment. UNEP/CBD/COP/DEC/VIII/28. https://www.cbd.int/decision/cop?id=11042

5.7.1 Ecology

The proposed Project is located in Thatta district, which is located at a coastal belt of Pakistan and a part of the Indus Delta, one of the world's richest ecoregions. The Indus ecoregion contains a variety of habitat types, including coastal, freshwater, and brackish wetlands, riverine forests, a vast desert, and irrigated plains. This area is extremely important ecologically and economically to the country as a whole, especially for local residents and is home to a vast diversity of flora and fauna. (WWF-Pakistan, 2007).

5.7.2 Protected Areas

The Protected Areas closest to the Project site/area are Haleji Wildlife Sanctuary and Haleji Lake located at a distance of ~19 km in the northeast of the site. The Protected Areas that are located within 50 km radius of the Project are as follows:

National Parks	**Approximate Distance from Project Area (km)**
Wildlife Sanctuary	
Haleji Wildlife Sanctuary	19
Hadero Wildlfie Sanctuary	28
Ramsar Convention Wetland Sites	
Haleji Lake	19
Indus Delta	37
Kinjhar Lake	50

Based on the aforementioned distances, there are no legally protected and/or internationally recognized Protected Areas located within the 10 km of the Project radius.

5.7.3 Habitat Type within Project EAoI

As per IFC PS 6, "*Natural habitats are defined as areas with viable groups of mostly native plant and/or animal species, or areas where human activities have not fundamentally affected the primary ecological functions and species composition*" while "*Modified Habitats are regions that may contain a considerable number of non-native plant and/or animal species, or where human actions have drastically altered an area's fundamental ecological functions and species composition*". According to this definition, there is no naturally occurring habitat within and around the boundaries of the Project Area. The habitat within and around the Project Area consists primarily of modified habitats. The relative percentage of each habitat type encompassing land uses are tabulated below:

Habitat Type	***Percentage Land Use as per 2023***
Agricultural Area	52%
Residential Area	8%
Surface water bodies	2%
Commercial / Industrial	14%

Barren/ Open Land	23%

Land use analysis is detailed in **Section 5.6.2** of this report.

5.7.4 Methodology for Baseline Assessment

Biodiversity within and around the Project site/area was identified using desktop-based research and undertaking field surveys. Data collection was undertaken during winter season (one sampling season).

The methodology adopted for baseline survey include a simplified way of assessment given due consideration to the time frame, seasonal representation, and factoring the climate change scenarios. The study area was set using the Project area as the core and adding a 3 km buffer to this to allow for a demonstrative assessment of the biodiversity of the receiving environment. The project was broadly categorized in circular strata /radius of 3 km, and tagged as area of primary concern or Area of Influence (AoI) illustrated in Exhibit 5.42**.** This has been done considering the consistency in the physical and biological concomitants.

The floristic list was compiled on ocular observation; the compiled data was subject to IUCN Red List filter and verification from secondary records. Each plant species was scrutinized for conservation sensitivities. The survey locations are indicated in Exhibit 5.43**.** The IUCN Red List of Ecosystem risk categories are: ***Not Evaluated (NE), Data Deficient (DD), Least Concern (LC), Near Threatened (NT), Endangered (EN), and Vulnerable (VU).***

Similar strategy was adopted for faunal study; it was mainly based on searching palate traces and foot of herpetic fauna, whereas avifauna survey is supported by binoculars / field glasses. Vantage point observations as identified in Exhibit 5.44, require an extended sampling duration, typically spanning a minimum of three (3) months. This timeframe is specifically designated for conducting population assessments and monitoring the influx of migratory birds, as well as identifying locations where migratory bird calls are usually observed. Therefore, a qualitative assessment was conducted to evaluate the gathered data comprehensively.

5.7.5 Flora and Vegetation

The field survey for flora was conducted on 15th and 18th of February 2024. A total of 114 distinct plant species are documented, with over half categorized as ornamental and cultivars. Notably, only 39 plant species were identified and classified as wild and none of them were found significant under IUCN Red List of species.

Exhibit 5.45 provides a comprehensive list of floral species identified during field surveys, and Exhibit 5.46 illustrates generic and phenological composition of the floral species, identified within the survey area, respectively. These indicate that the Project site predominantly comprised of shrubs, primarily halophytes. This prevalence could be attributable to the waterlogged land with numerous depressions. These depressions intermittently retain water and often remain dry, creating favorable conditions for the

proliferation of halophytic shrubs. The majority of the flora documented in the surrounding areas are cultivated by farmers or landowners, while two (2) of them are recognized as alien species. *None of the species identified within the study area possess / warrant conservation significance.*

5.7.6 Fauna

The field survey for fauna was conducted on 16th and 20th of February 2024. The faunal assemblage of the study area include a number of avifauna, mammals, and reptiles. A total of 47 avifauna species were identified during the survey listed in Exhibit 5.47**.** The birds observed within the study area are primarily the resident birds. Exhibit 5.51 illustrates an indicative route of birds that forms primarily due to the presence of water bodies from the Haleji Lake (~19 km) northeast to the mangroves (~10 km) in the south of the Project

The list of mammals and reptiles as provided in Exhibit 5.48 and Exhibit 5.49**,** respectively, is primarily based on literature review and expert knowledge of the broader area, as majority of the mammals and reptiles species were not encountered during the survey, possibly due to nocturnal nature of mammals and hibernation patterns of reptiles during winter season.

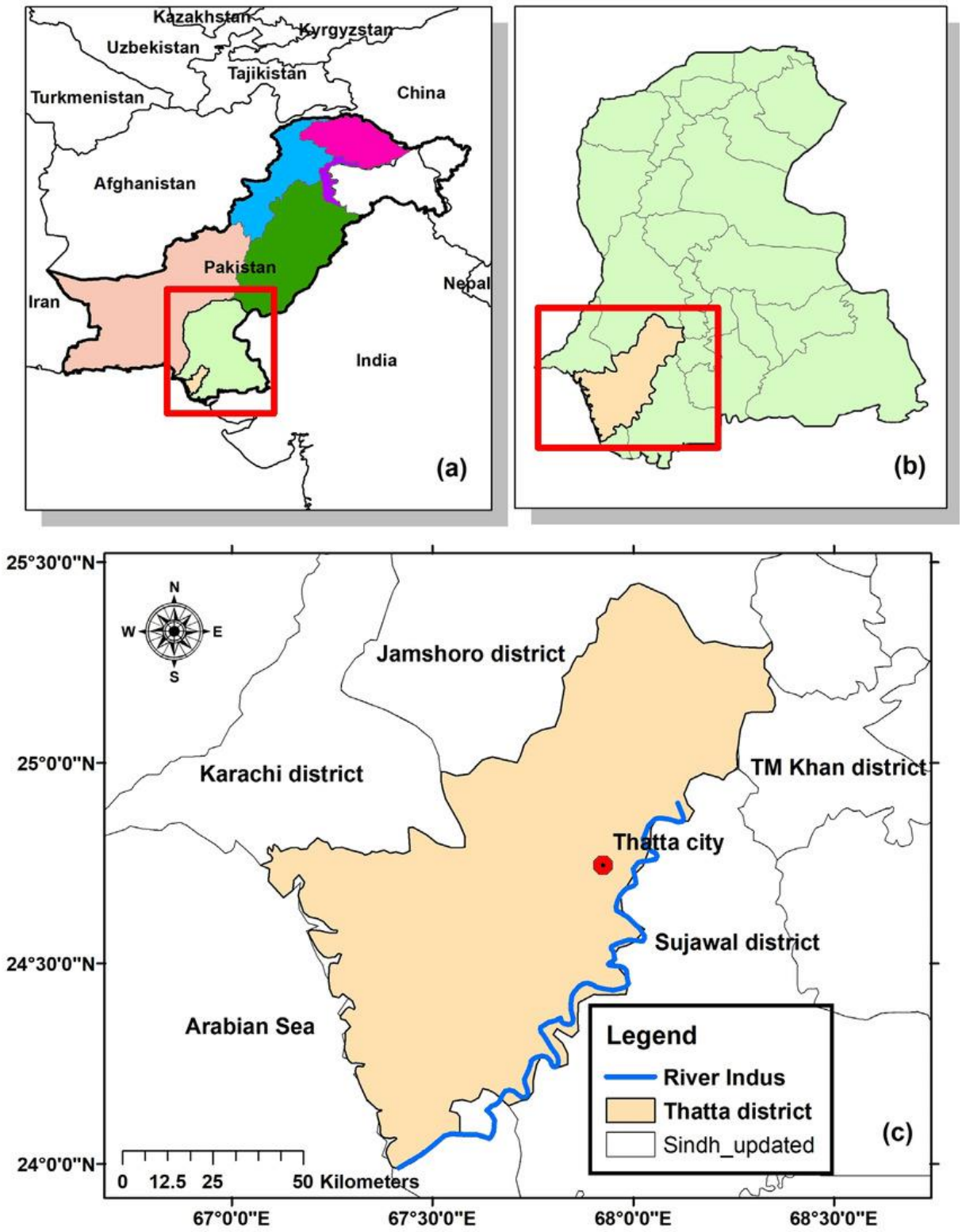
5.7.7 Critical Habitat Assessment Summary

As per the IFC PS 6, Critical Habitats are areas with high biodiversity value, including (i) habitat of significant importance to Critically Endangered and/or Endangered Species; (ii) habitat of significant importance to endemic and/or restricted-range species; (iii) habitat supporting globally significant concentrations of migratory species and /or congregation species; (iv) highly threatened and/or unique ecosystem; and/or (v) areas associated with key evolutionary processes (IFC PS6).

Only one (1) avifauna species i.e. Indian River Tern (*Sterna aurantia*), is identified as Vulnerable (VU) under IUCN Red List. However, Indian River Tern is one of the resident bird species of the area and is found in abundance within the broader area, and particularly in the Gharo creek, which is ~9.93 km northwest of the site (out of Project EAOI/Project buffer area). The closest habitat likely to meet the criteria for critical habitat is Haleji Lake, situated ~19 km northeast of the site, thereby unlikely to be affected by activities at the site.

Based on the findings of both desktop research and infield surveys, no critical habitat has been identified within the project study area.

Exhibit 5.1. Administrative Boundary of District Thatta



Source: (G. Solangi et al., 2019)

Exhibit 5.2. General Topography of District Thatta

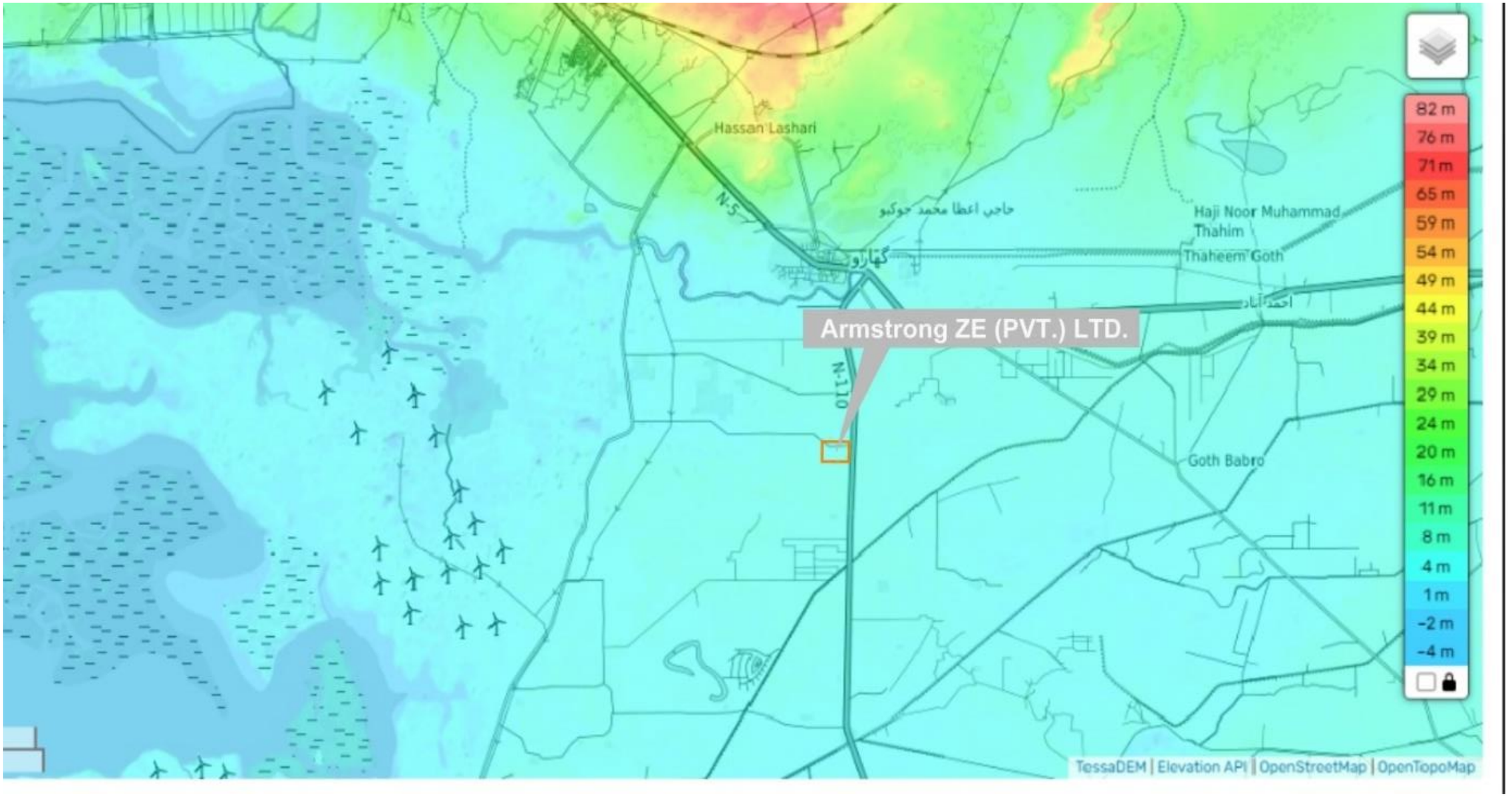
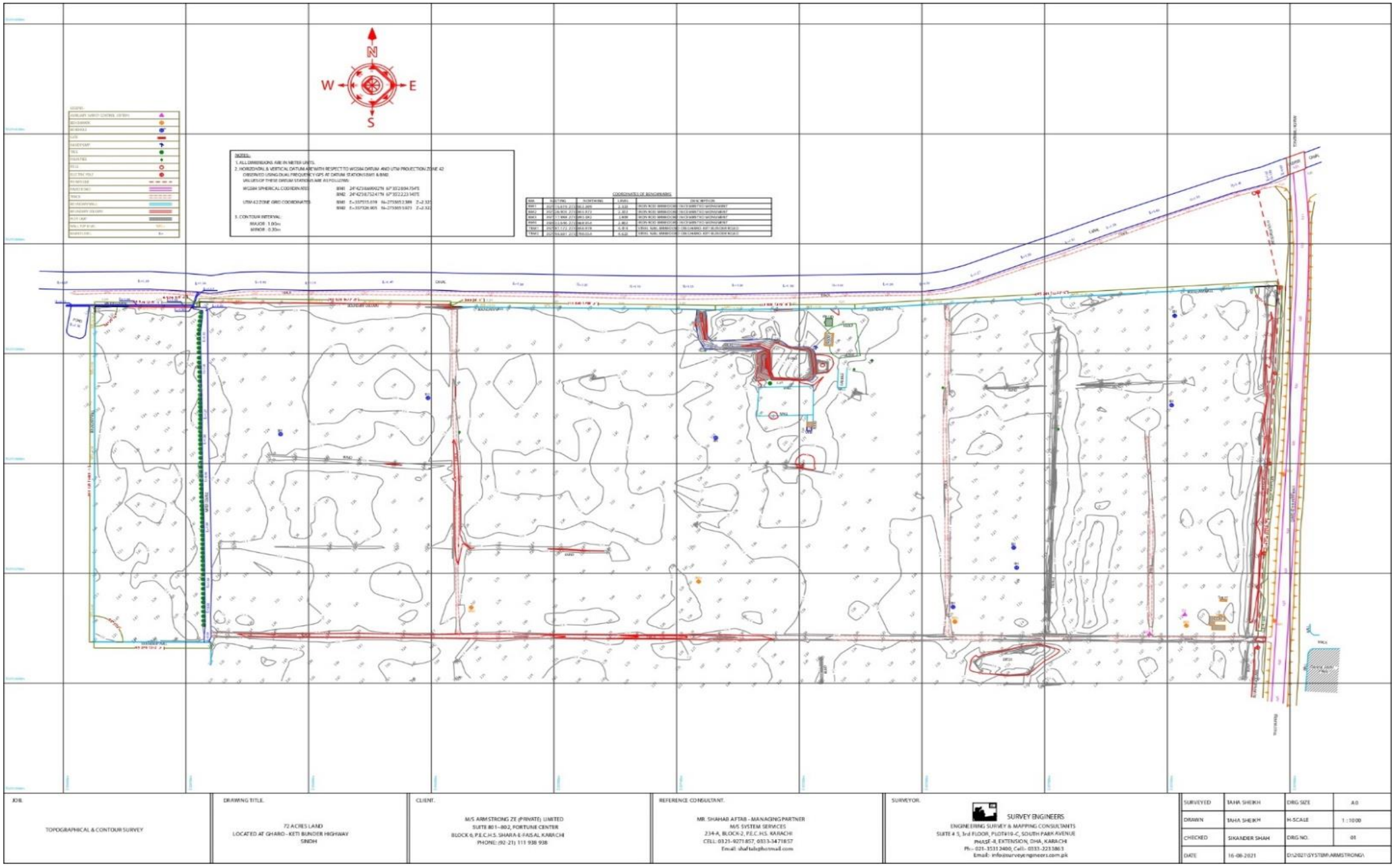


Exhibit 5.3. Topographic Profile of the Project Site



Source: Topography Survey of Armstrong ZE

Exhibit 5.4. Land Use in the Project AoI in 2006

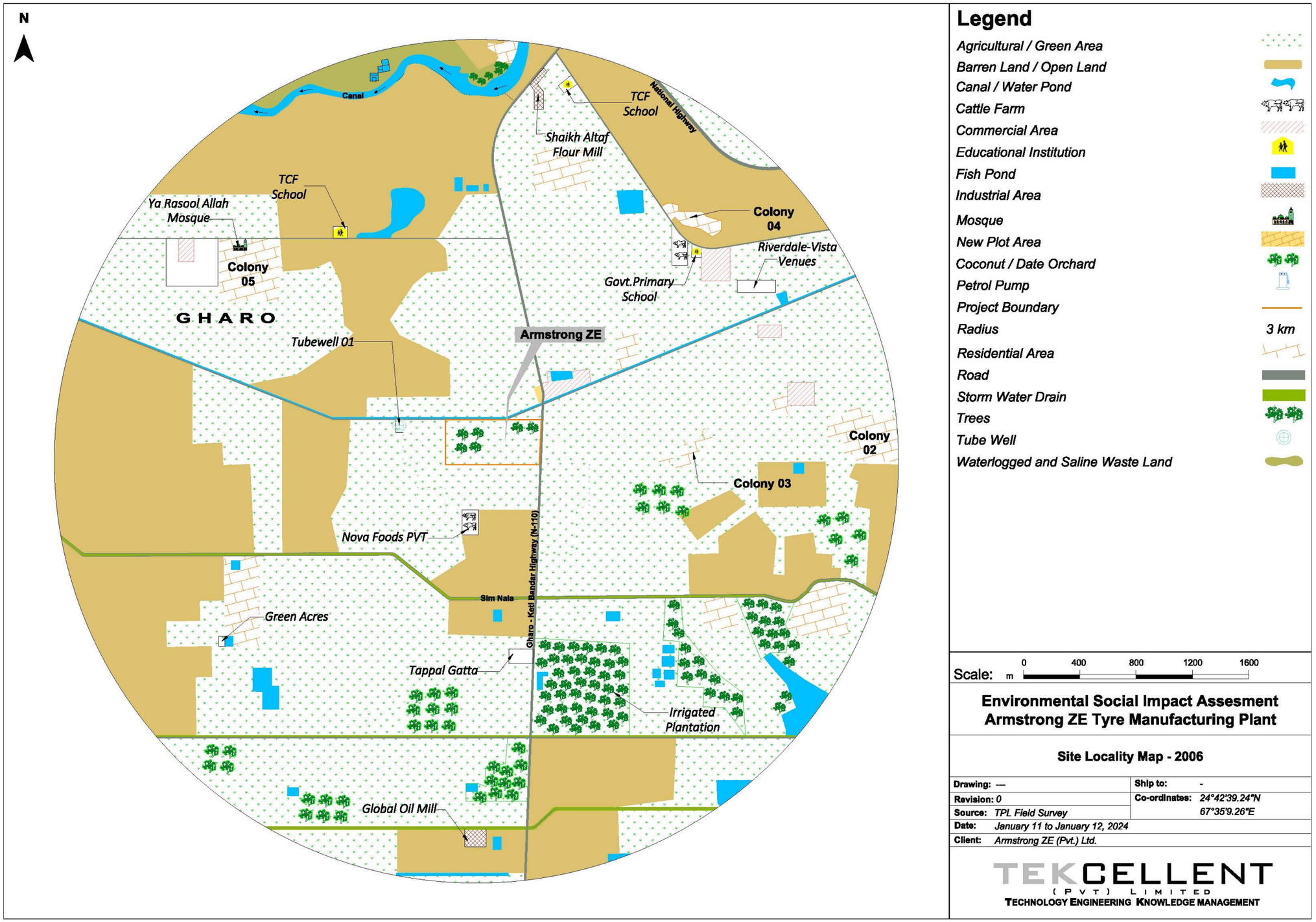
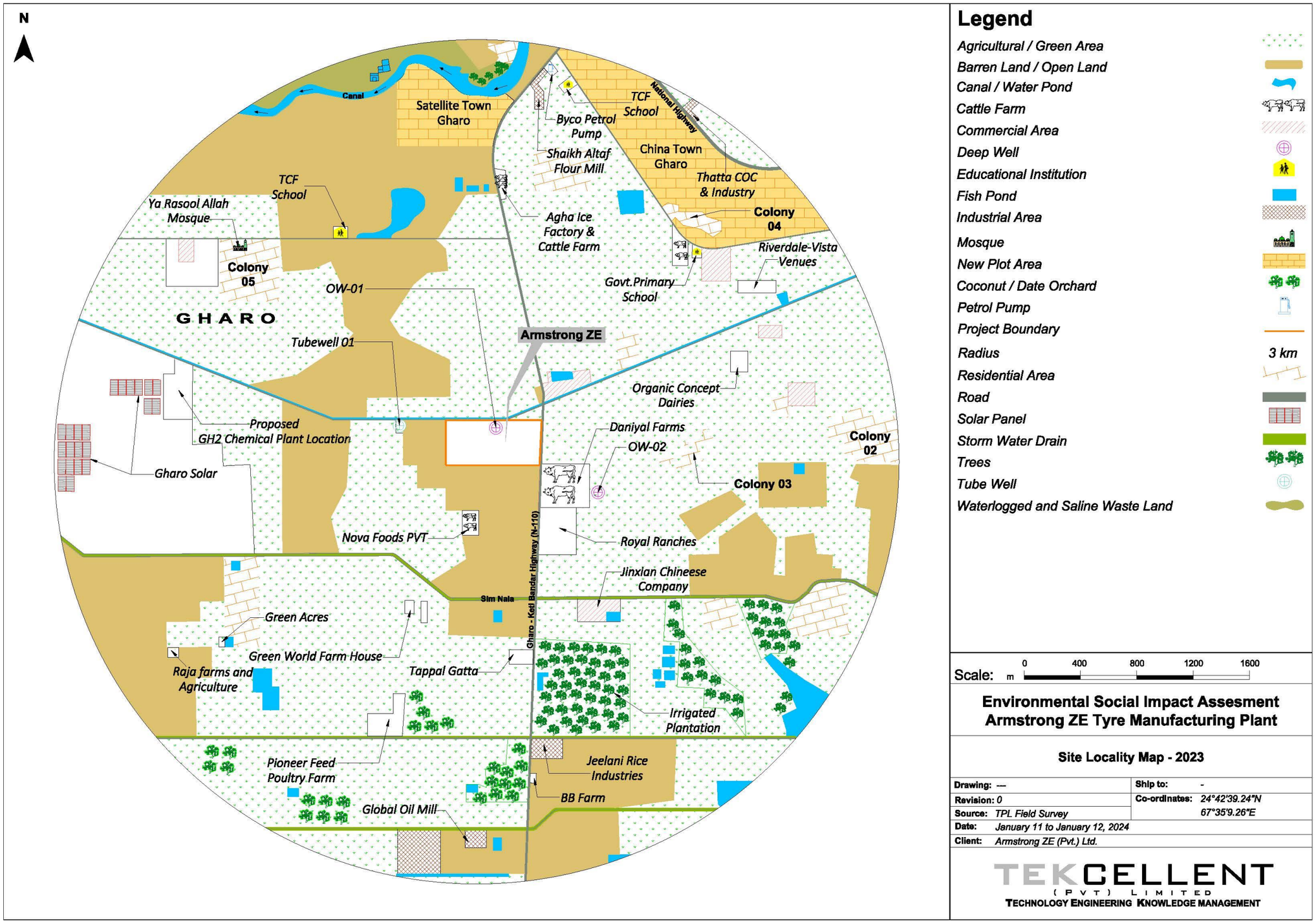


Exhibit 5.5. Land Use in the Project AoI in 2023



Legend

- Agricultural / Green Area
- Barren Land / Open Land
- Canal / Water Pond
- Cattle Farm
- Commercial Area
- Deep Well
- Educational Institution
- Fish Pond
- Industrial Area
- Mosque
- New Plot Area
- Coconut / Date Orchard
- Petrol Pump
- Project Boundary
- Radius — 3 km
- Residential Area
- Road
- Solar Panel
- Storm Water Drain
- Trees
- Tube Well
- Waterlogged and Saline Waste Land

Scale: m 0 400 800 1200 1600

Environmental Social Impact Assesment
Armstrong ZE Tyre Manufacturing Plant

Site Locality Map - 2023

Drawing: ---	**Ship to:** -
Revision: 0	**Co-ordinates:** 24°42'39.24"N 67°35'9.26"E
Source: TPL Field Survey	
Date: January 11 to January 12, 2024	
Client: Armstrong ZE (Pvt.) Ltd.	

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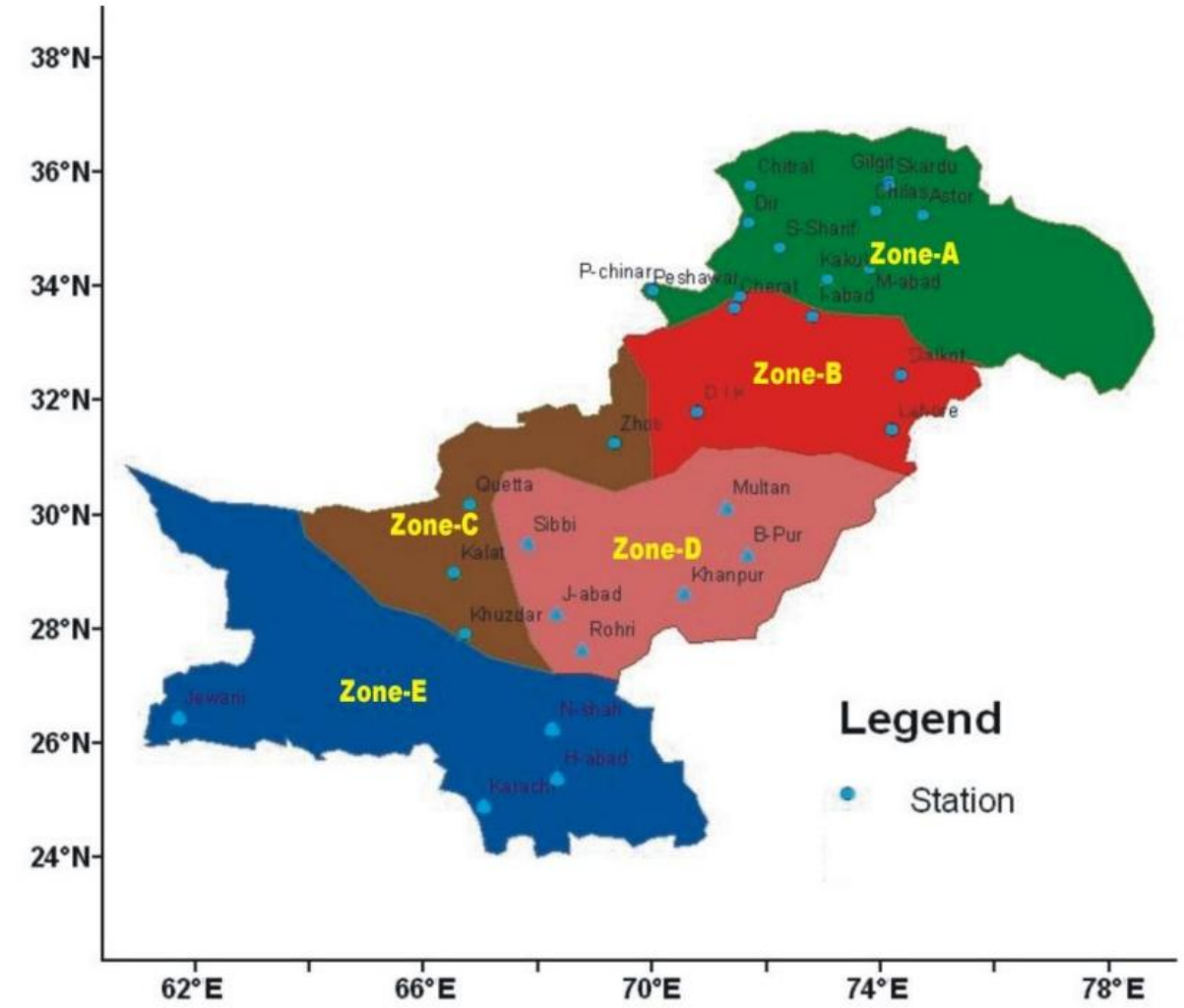
Exhibit 5.6. Commercial/ Industrial Entities Identified within Project AoI

Commercial/Industrial Entities in the area	*Type*	*Direction*	*Distance*	*Start of Construction*	*Operations*	*Previous use*
Daniyal Farms	Farmhouse	East	300m	2013	N/A	Green Area
Global Oil Mill	Factory	South	2.30 km	between 2006 to 2010	2010	Barren land
Tappal Gatta	Factory	South	1.22km	2006	2010	Agricultural land since 2004
Jeelani Rice Mill	Factory	South	1.63km	2011	2016	Barren land with sparse vegetation
Pioneer Feed poultry farm	Poultry farm	South	1.88km	2012	2014	Agricultural land
Green World Farmhouse	Farmhouse	Southwest	0.72km	between 2006 to 2010	2010	Agricultural land
Raja farms and Agriculture	Farmhouse	Southwest	2.4km	2018	2021	Barren land since 2004
Green Acres	Local Farming	Southwest	1.70km	between 2006 to 2010	2010	Agricultural Land
Royal Ranches	Farmhouse	Southeast	662m	2010	2011	Barren land since 2004
Jinxian Chinese Company	Factory	Southeast	0.80km	2010	2017	Barren land since2004
Satellite Town Gharo	Residential Colony	North	1.95km	2019	2021	Barren land since 2004
Shaikh Altaf Flour Mill Gharo	Factory	North	2.40km	between 2006 to 2010	2010	Barren land since 2004
Agha Ice Factory and Cattle Farm	Local Farming	North	1.62km	2014	2016	Barren Land
Organic concept dairies	Local Farming	Northeast	1.39km	2018	2019	barren land since 2004
Thatta Chamber of Commerce and Industry	Government Institute	Northeast	2.37km	2019	2020	Barren land since 2004
Government Boys Primary School	Educational Institute	Northeast	1.79km	Since 2004	N/A	School since 2004
Byco Station raj Filling	Fuel Station	Northeast	2.48km	2019	2021	Barren land since 2004
The Citizen Foundation	Educational Institute	Northwest	1.57km	2006	2010	Green Land
Gharo Solar Power Plant	Solar plant	West	1.84km	2019	2020	Barren Land
Our Sun Solar Power Plant	Solar plant	West	4.26km	2018	2019	Barren Land
Global Poultry Farm	Local Farming	West	0.72km	2006	between 2006 - 2010	Barren Land
China Town	Residential Colony	West	2.12km	2019	2020	Barren Land

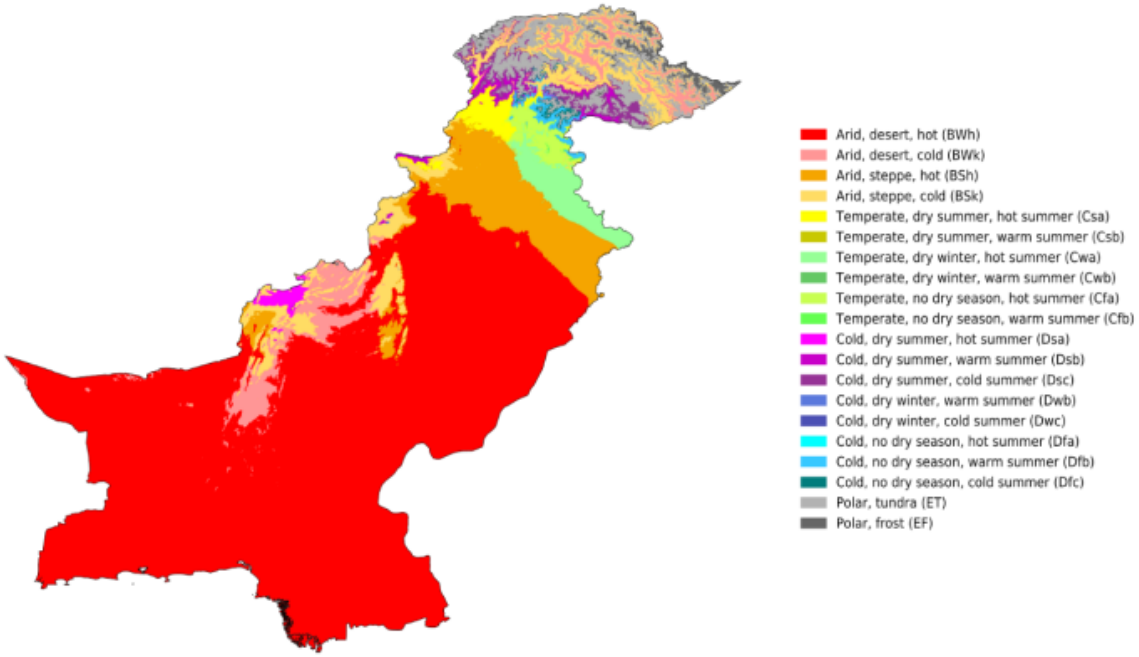
Exhibit 5.7. Climatic Zone of Pakistan



Source: (Khalid et al., 2012)- Pakistan Journal of Meteorology

Exhibit 5.8. Koppen Geiger Classification for Pakistan and Sindh

(a) Pakistan



Source: Beck et al.: Present and future Köppen-Geiger climate classification maps at 1-km resolution, Scientific Data 5:180214, doi:10.1038/sdata.2018.214 (2018)

(b) Sindh

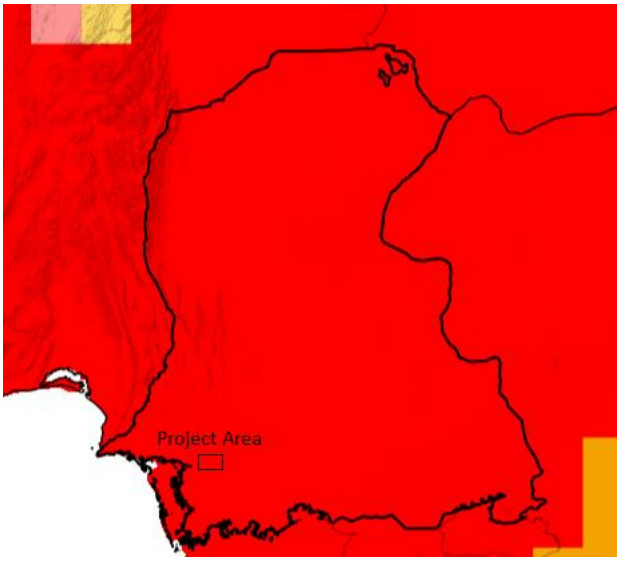
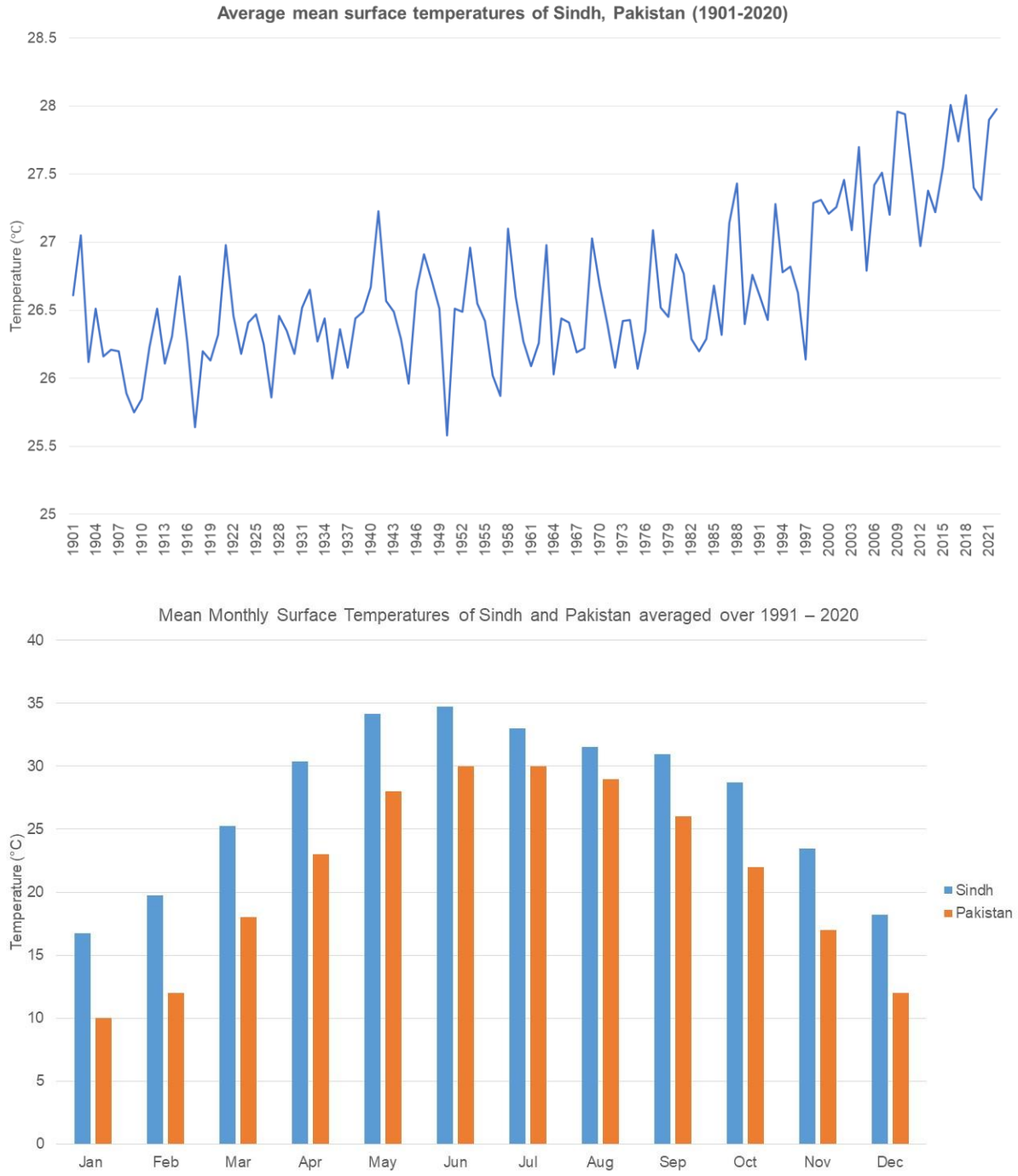
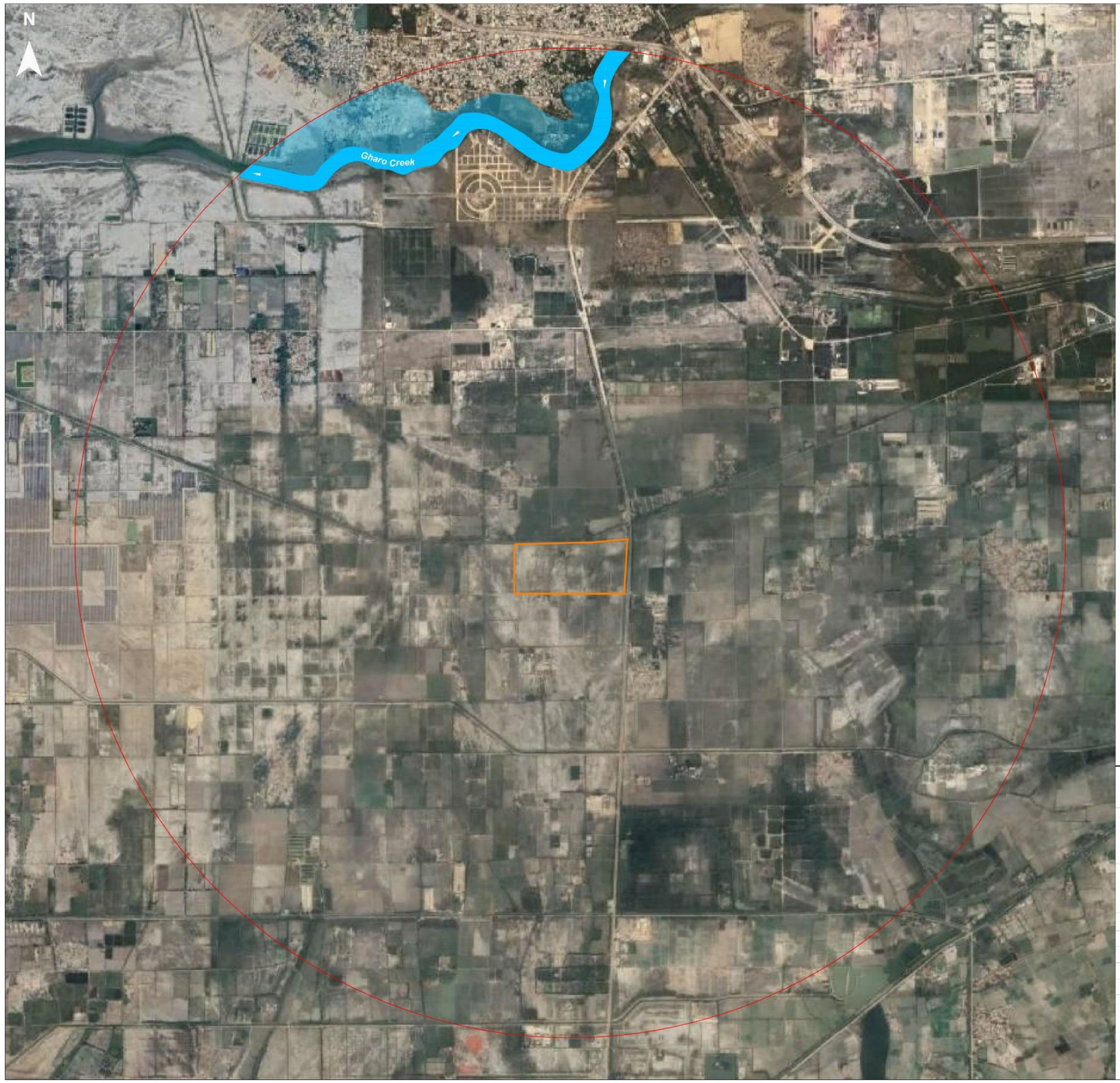


Exhibit 5.9. Annual Mean and Monthly Variation of Surface Air Temperature in Sindh, Pakistan



Source: WB Climate Change Knowledge Portal

Exhibit 5.10.Flood plain area along Gharo Creek



Legend

Project Boundary

Area Prone to Floods

Radius 3 km

Scale: m 0 400 800 1200 1600

Environmental Social Impact Assesment
Armstrong ZE Tyre Manufacturing Plant

Creek Flood Plain Area

Drawing: -
Revision: *0*
Source: *TPL Field Survey*
Date: *February 23, 2024*
Client: *Armstrong ZE (Pvt.) Ltd.*

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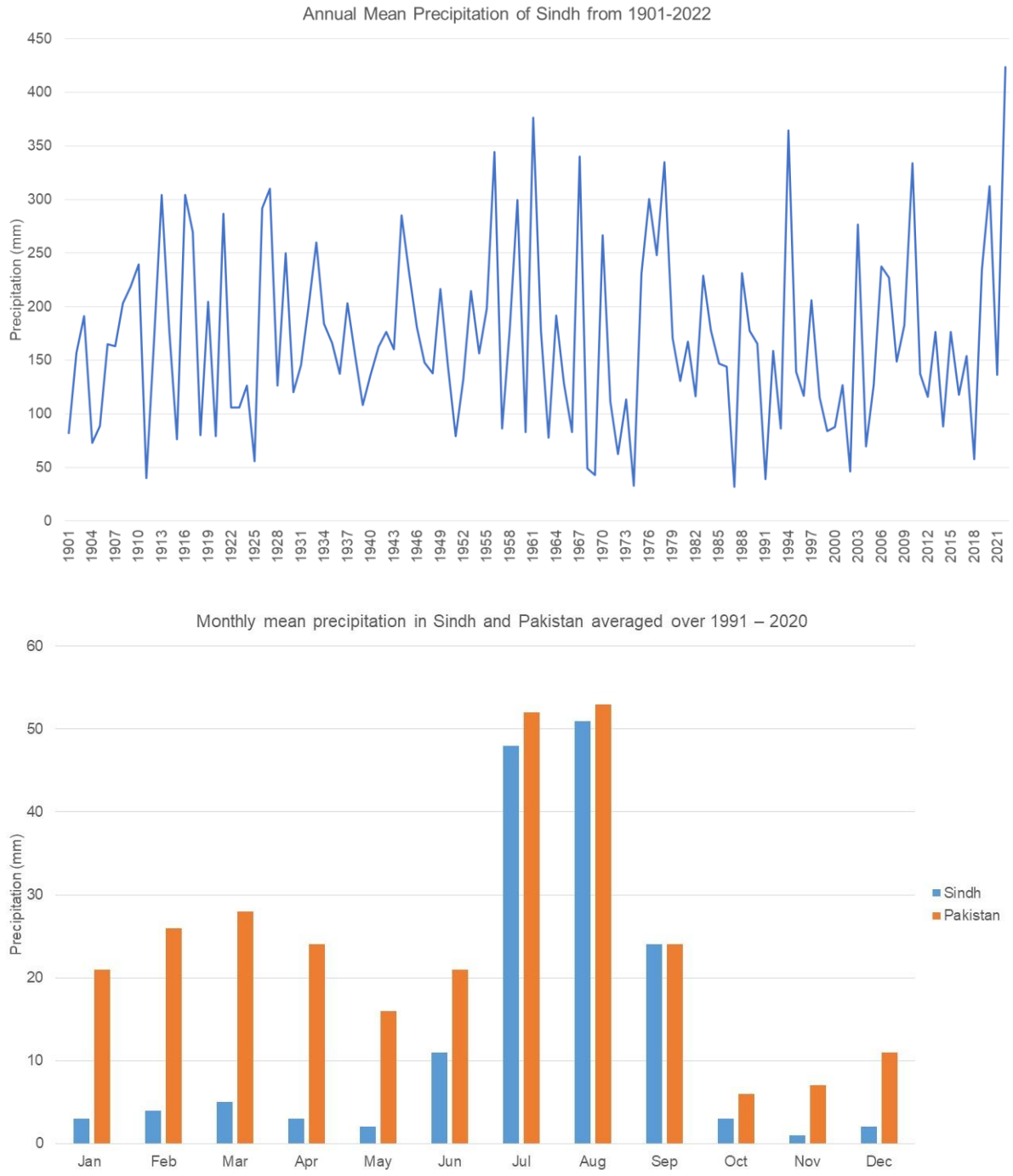
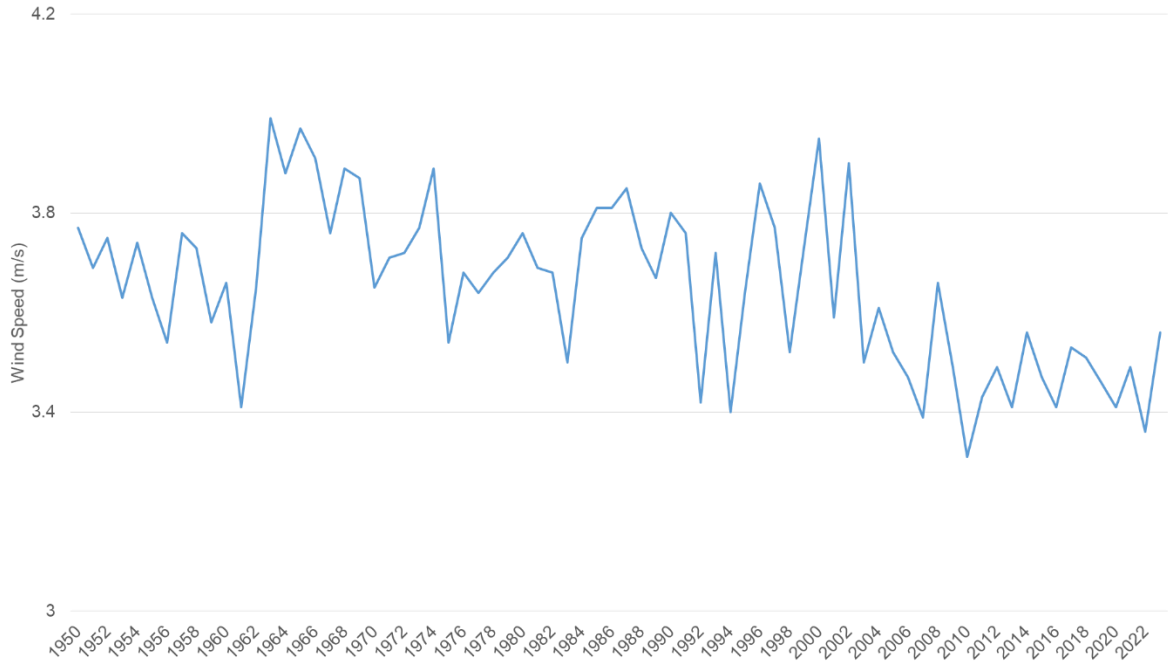
Exhibit 5.11. Annual Mean and Monthly Variation of Precipitation in Sindh, Pakistan



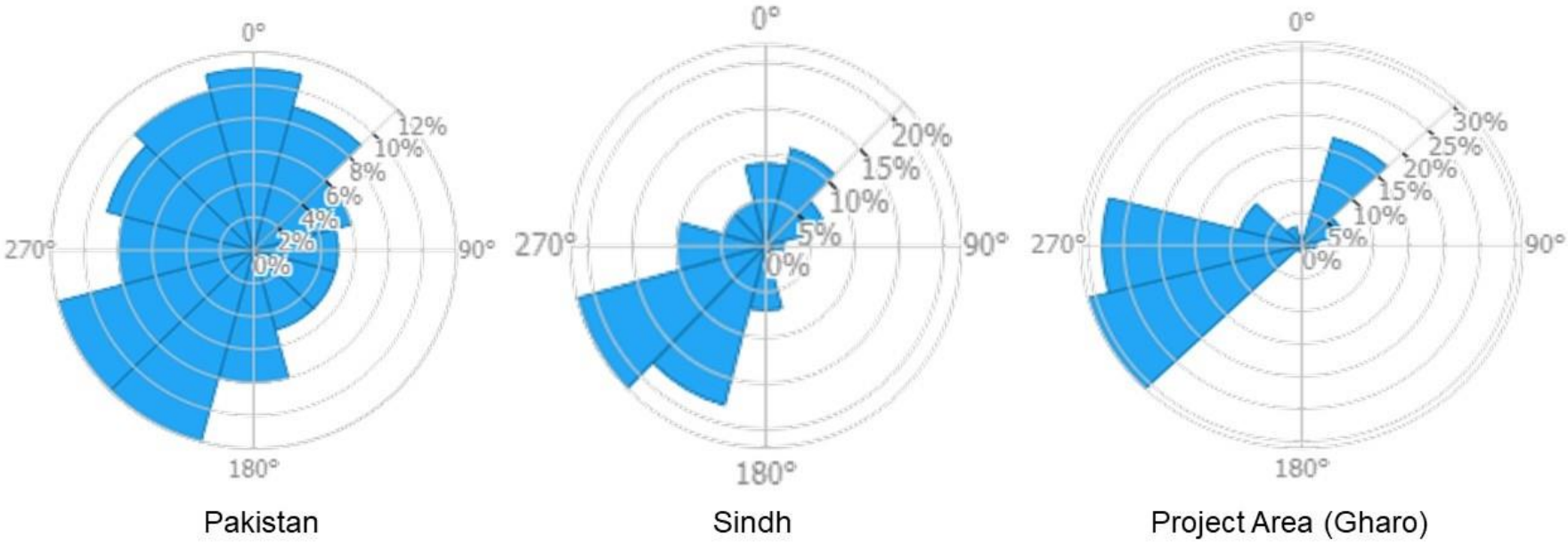
Source: WB Climate Change Knowledge Portal

Exhibit 5.12. Annual Mean Wind Speed recorded in Sindh over 1950 to 2022



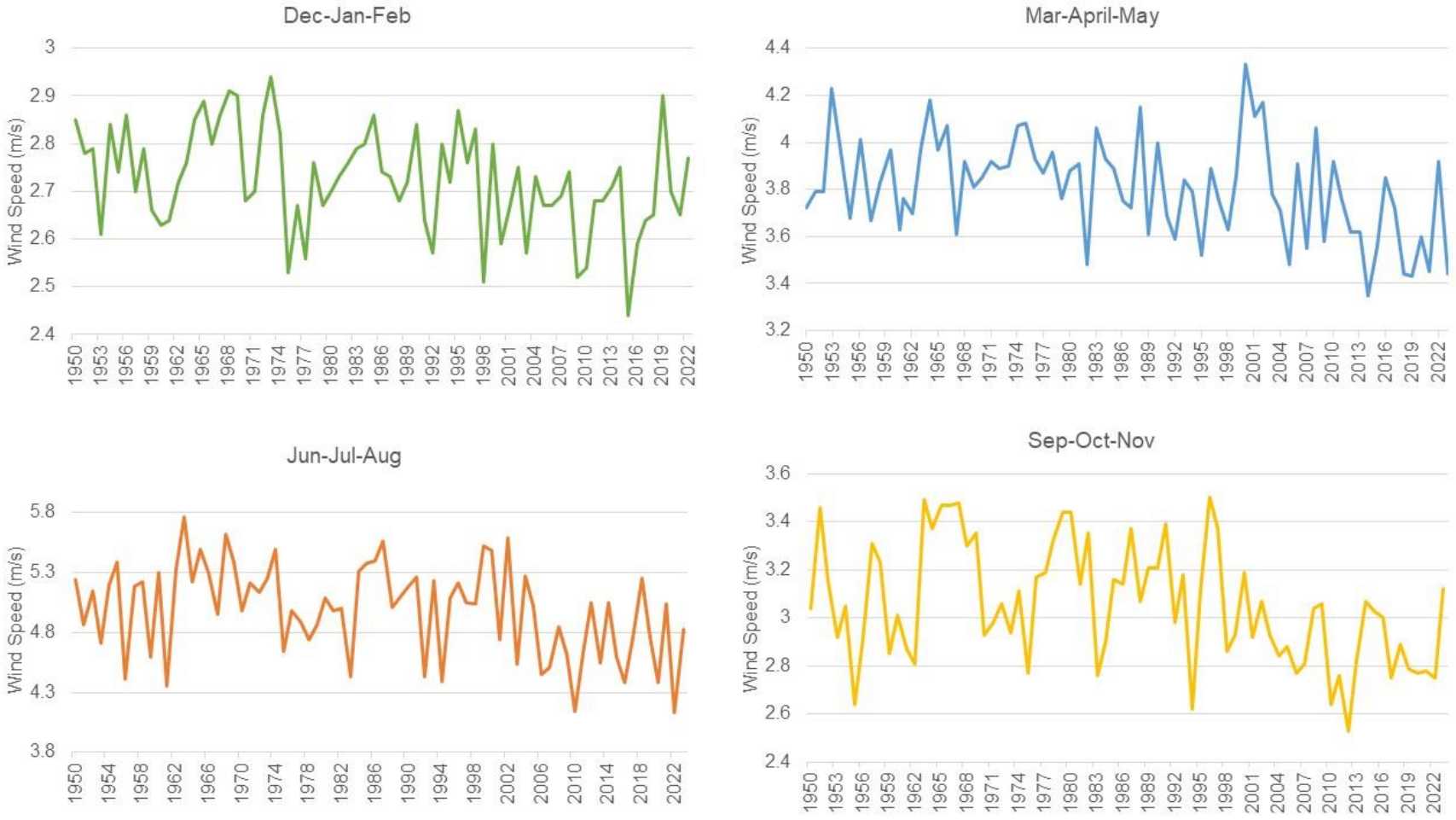
Source: Teal Earth Tool

Exhibit 5.13. Wind Rose of Pakistan, Sindh and Project Area



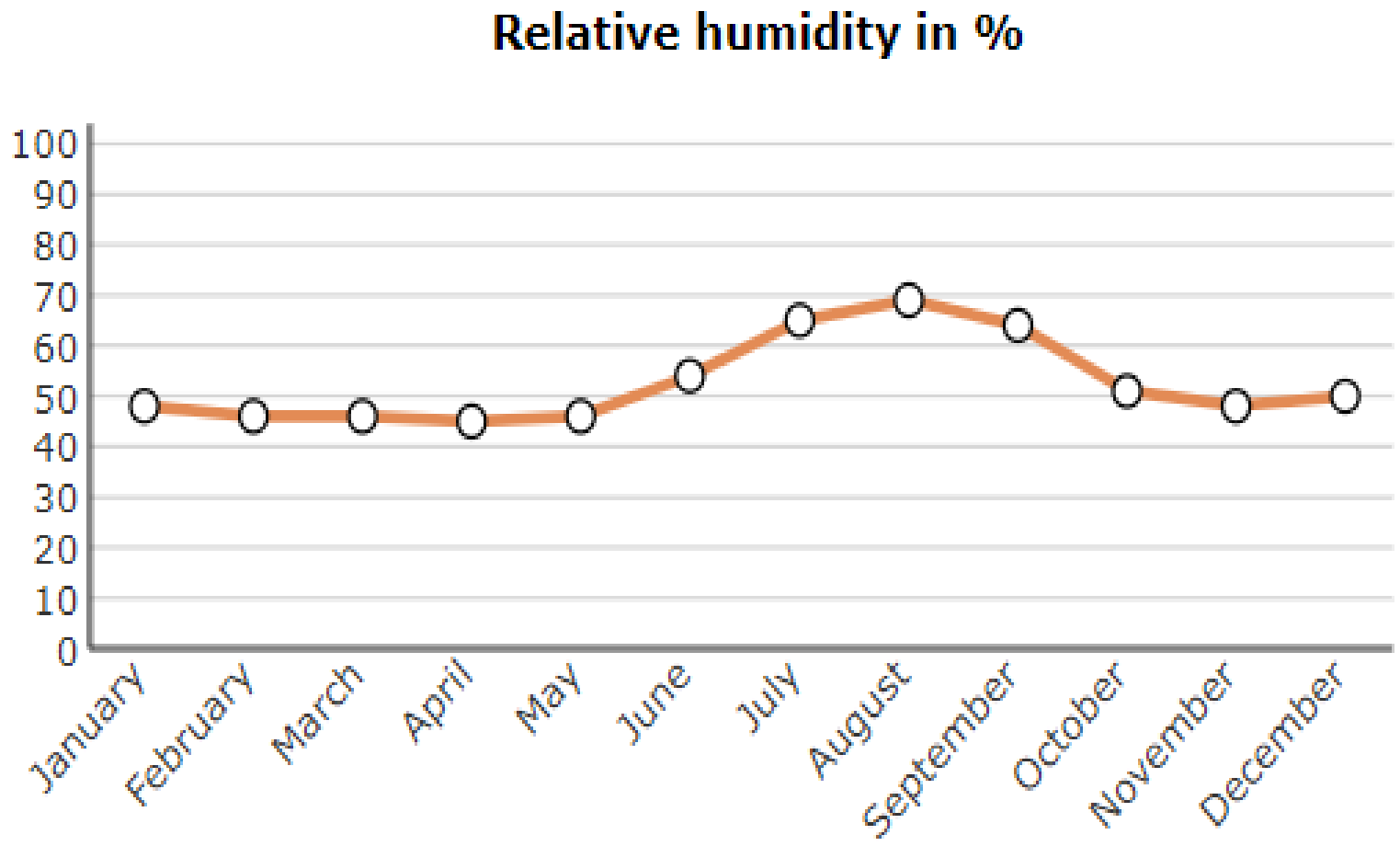
Source: Global Wind Atlas

Exhibit 5.14. Average Annual Seasonal Variation in Wind Speed Recorded in Sindh from 1950 to 2022



Source: Teal Earth Tool

Exhibit 5.15. Average Monthly Values of Relative Humidity recorded over last 20 years in Sindh, Pakistan



Source: WorldData.info

Exhibit 5.16. Air Pollution Map of Project Area at the time of field visit

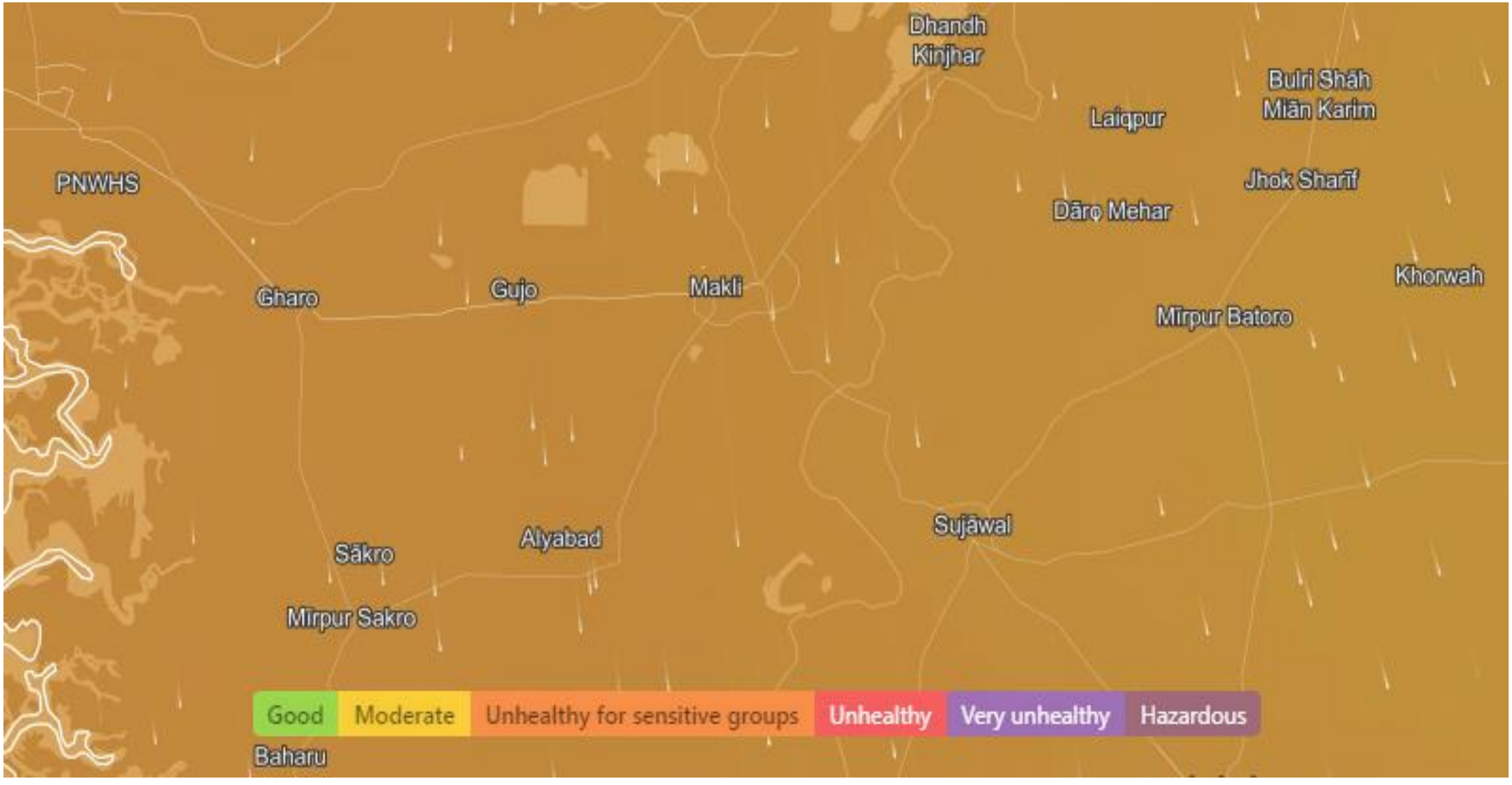


Exhibit 5.17. Locations for Ambient Air and Noise Monitoring

Legend

- Ambient Air Monitoring Location
- Canal / Water Pond
- Noise Measurement Locations
- Radius 1.5 km
- Road
- Storm Water Drain

Scale: m 0 200 400 600 800

Environmental Social Impact Assesment
Armstrong ZE Tyre Manufacturing Plant

Ambient Air and Noise Monitoring Locations

Drawing:	—
Revision:	0
Source:	TPL Field Survey
Date:	January 11 to January 12, 2024
Client:	Armstrong ZE (Pvt.) Ltd.

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Exhibit 5.18. Rationale for Selection of Monitoring locations and Weather Conditions at the time of Air Quality Monitoring

Sample ID	*Coordinates*	*Location*	*Rationale for Selection (based on IFC Guidelines)*	*Date & Time of Monitoring*	*Observed Conditions*
A1	24°42'39.42"N 67°35'35.92"E	In an open field in front of Daniyal Farms, 126 m east of the site	The selected point is present in close vicinity of the site. The emissions from the proposed plant will impact the air quality in this area and may lead to deposition of dust and particulate matter on the agricultural fields in the surroundings. Therefore, it is essential to establish baseline for existing air quality in the area, primarily because no data related to air quality exists in the area. It is to be noted that based on the dominant wind direction during the winter season (from the northeast), the area is *upwind* of the project site while based on the dominant summer wind direction (from the west/southwest), the location is *downwind* of the project site.	January 31, 2024 to February 01, 2024 (13:00 hours to 12:00 hours)	Light rain showers were observed the night before the monitoring commenced (January 30, 2024). During the monitoring period, the weather was observed to be partly cloudy to mostly sunny with breezy conditions (15 km/h to 25 km/h) from the west during daytime. The night was mostly calm with little breeze and mostly clear conditions.
A2	24°42'6.37"N 67°35'1.85"E	On vacant land close to a poultry farm, 990 m south of the site	The location has been selected to establish existing ambient air quality in the southern quadrant of the site in the absence of any local air quality data. It is located close to the poultry farm and some other commercial farmhouses that may get impacted from emissions emanating from the proposed site operations. The location is *downwind* based on dominant winter wind direction and *upwind* based on the dominant summer wind direction.	February 01, 2024 to February 02, 2024 (14:00 hours to 13:00 hours)	Morning of February 02, 2024 was overcast and a brief spell of drizzle was observed around 08:30 hours, after which the weather cleared. The afternoon had a light breeze from the west.

Exhibit 5.19. Results of Ambient Air Quality Monitoring

Parameters	Concentrations Reported As	Location A1: 24°42'39.42"N, 67°35'35.92"E	Location A2: 24°42'6.37"N 67°35'1.85"E	WHO Ambient Air Quality Guidelines	SEPA Guidelines for Air	Conclusions
SO_2 (µg/m³)	**Minimum**	28.20	28.20	50 (*Interim target-2 for 24-hour averaging period*)	120 (*24-hours*)	No exceedances were observed against the WHO or SEPA guidelines. This indicates that given the overall rural setting of the area and the lack of any significant commercial or industrial activity that could generate pollutants, the overall concentration of these pollutants was observed to be well within local and international regulatory limits. Another factor could also be the light precipitation that was observed the night before monitoring commenced, which could also have further improved the air quality of the area for the time being.
	Maximum	30.60	31.90			
	Average	28.47	29.34			
NO_2 (µg/m³)	**Minimum**	28.04	27.60	40 (*guideline for 1-hour averaging period*)	80 (*24-hours*)	
	Maximum	28.73	28.60			
	Average	28.32	27.88			
CO (µg/m³)	**Minimum**	50	630	-	5000 (*8-hours*)	
	Maximum	910	1160			
	Average	300	1020			
O_3 (µg/m³)	**Minimum**	21.60	21.63	100 (*guideline for 8-hour daily maximum*)	130 (*1-hour*)	
	Maximum	24.00	23.83			
	Average	22.71	22.53			
PM_{10} (µg/m³)	**Minimum**	31.30	29.33	50 (*Interim target-2 for 24-hour averaging period*)	150 (*24-hours*)	**Location A1:** The maximum observed value for PM_{10} was 86.3 µg/m³ (*exceeding the WHO Ambient Air Quality Guidelines*) **Location A2:** The maximum observed value of PM_{10} was measured at 156 µg/m3 (*exceeding the WHO and SEPA Guidelines*), while the average PM_{10} concentration also *exceeded WHO Guidelines*, measured at 75.47 µg/m³. The PM_{10} exceedances can be attributed to presence of dust particles due to loose soils on agricultural lands, along with the overall dry and hazy weather observed in the area around this time of the year. *Had it not been for the precipitation event, the particulate matter concentrations would have been noticeably higher.* The traffic plying along the Gharo-Keti Bunder Highway could also be a source of particulate matter pollution at both points, although the impact or contribution in overall rural area may not be that significant due to absence of extensive secondary road network and vehicular movement. Therefore, the area can be considered less prone to anthropogenic sources of pollution.
	Maximum	86.30	156.00			
	Average	46.88	75.47			

Parameters	Concentrations Reported As	Location A1: 24°42'39.42"N, 67°35'35.92"E	Location A2: 24°42'6.37"N 67°35'1.85"E	WHO Ambient Air Quality Guidelines	SEPA Guidelines for Air	Conclusions
$PM_{2.5}$ (µg/m³)	**Minimum**	10.66	11.33	50 (*guideline for 24-hour averaging period*)	75 (*24-hours*)	$PM_{2.5}$ maximum observed value was found to *exceed the WHO ambient air quality guidelines* at 62.33 µg/m³ and 59.33 µg/m³ at both, A1 and A2. This could likely be due to presence of dust from surrounding lands picked up by the breeze, along with some contribution from the traffic plying on Gharo-Keti Bunder Highway. As depicted in the Live Air Pollution Map (see below), which determines Air Quality Index (AQI) based on $PM_{2.5}$ concentrations in the atmosphere, indicates air quality consistently in the *Moderate to Unhealthy range for sensitive groups* during the winter months of November to February. This is primarily due to the prevalent weather conditions influenced by the dry northeast breeze, which generally creates hazy conditions. Crop processing at the time of the monitoring was observed to be at a minimum, so anthropogenic contribution to this exceedance is expected to be significantly low.
	Maximum	62.33	59.33			
	Average	21.72	26.19			
KEY		Exceedance against WHO Ambient Air Quality Guidelines (*as mentioned in the Air Emissions and Ambient Air Quality section of IFC General EHS Guidelines document*)				
		Exceedance against SEQS				

Exhibit 5.20. Rationale for selection of monitoring locations and weather conditions at the time of Noise Monitoring

Sample ID	*Coordinates*	*Location*	*Rationale for Selection (based on IFC Guidelines)*	*Date & Time of Monitoring*	*Observed Conditions*
N1	24°42'48.69"N 67°35'31.83"E	Northern corner of the site, along Gharo-Keti Bunder Highway	N1 and N2 both are located close to the Gharo-Keti Bunder Highway. Both locations were deemed essential to adequately capture noise levels during the day and night caused primarily by moderate to heavy traffic plying along the highway throughout the day and night.	January 31, 2024 to February 01, 2024 (13:30 hours to 12:32 hours)	Light showers were observed on the night before the monitoring commenced observed. During the monitoring period, the weather was observed to be partly cloudy to mostly sunny with breezy conditions (15 km/h to 25 km/h) from the west during daytime. The night was mostly calm with little breeze and mostly clear conditions.
N2	24°42'38.31"N 67°35'31.26"E	Southern corner of site, along Gharo-Keti Bunder Highway		January 31, 2024 to February 01, 2024 (13:40 hours to 12:35 hours)	
N3	24°42'38.16"N 67°35'7.87"E	Off Gharo-Keti Bunder Highway, 656 m west of N2	N3 and N4 are located at quieter locations off the highway. Measurement of noise levels at both locations would provide a typical representation of the levels of noise the communities and commercial farmhouses present off the main Highway. The baseline ambient noise levels will help determine the extent of mitigation measures the site would have to ensure to keep the noise levels within international and local regulatory limits.	January 31, 2024 to February 01, 2024 (13:45 hours to 12:38 hours)	
N4	24°42'47.92"N 67°35'7.68"E	Off Gharo-Keti Bunder Highway, 680 m west of N1		January 31, 2024 to February 01, 2024 (13:48 hours to 12:40 hours)	

Exhibit 5.21. Noise Monitoring Results and their Comparison with IFC Guidelines

Monitoring Location ID	Coordinates	Monitoring Period	Leq_{day} (dB(A))	Leq_{night} (dB(A))
N1	24°42'48.69"N 67°35'31.83"E	January 31, 2024 to February 01, 2024	64.45	54.64
N2	24°42'38.31"N 67°35'31.26"E	January 31, 2024 to February 01, 2024	59.62	54.63
N3	24°42'38.16"N 67°35'7.87"E	January 31, 2024 to February 01, 2024	48.68	47.27
N4	24°42'47.92"N 67°35'7.68"E	January 31, 2024 to February 01, 2024	47.35	46.14
IFC Noise Level Guidelines for Residential; Institutional; Educational (Daytime 07:00 to 22:00 and Nighttime 22:00 to 07:00)			55	45
IFC Noise Level Guidelines for Industrial; Commercial (Daytime 07:00 to 22:00 and Nighttime 22:00 to 07:00)			70	70
KEY		Exceeding IFC Noise Level Guidelines for Residential; Institutional; Educational (Daytime & Nighttime)		
		IFC Noise Level Guidelines for Industrial; Commercial (Daytime and Nighttime)		

Exhibit 5.22. Noise Monitoring Results and their Comparison with SEQS Guidelines

Monitoring Location ID	Coordinates	Monitoring Period	Leq_{day} (dB(A))	Leq_{night} (dB(A))
N1	24°42'48.69"N 67°35'31.83"E	January 31, 2024 to February 01, 2024	60.54	55.61
N2	24°42'38.31"N 67°35'31.26"E	January 31, 2024 to February 01, 2024	58.80	55.65
N3	24°42'38.16"N 67°35'7.87"E	January 31, 2024 to February 01, 2024	48.54	47.38
N4	24°42'47.92"N 67°35'7.68"E	January 31, 2024 to February 01, 2024	47.26	46.10
SEQs Noise Level Guidelines for Residential (Daytime 06.00am to 10:00pm and Nighttime 10:00pm to 06:00am)			55	45
SEQs Noise Level Guidelines for Commercial (Daytime 06.00am to 10:00pm and Nighttime 10:00pm to 06:00am)			65	55
SEQs Noise Level Guidelines for Industrial (Daytime 06.00am to 10:00pm and Nighttime 10:00pm to 06:00am)			75	65
SEQs Noise Level Guidelines for Silence Zone (Daytime 06.00am to 10:00pm and Nighttime 10:00pm to 06:00am)			50	45
KEY		Exceeding SEQS Noise Level Guidelines for Silence Zone & Residential (Daytime & Nighttime)		
		Exceeding SEQS Noise Level Guidelines for Commercial and Industrial (Daytime & nighttime)		

Exhibit 5.23. Surface Water Bodies in the Area of Influence

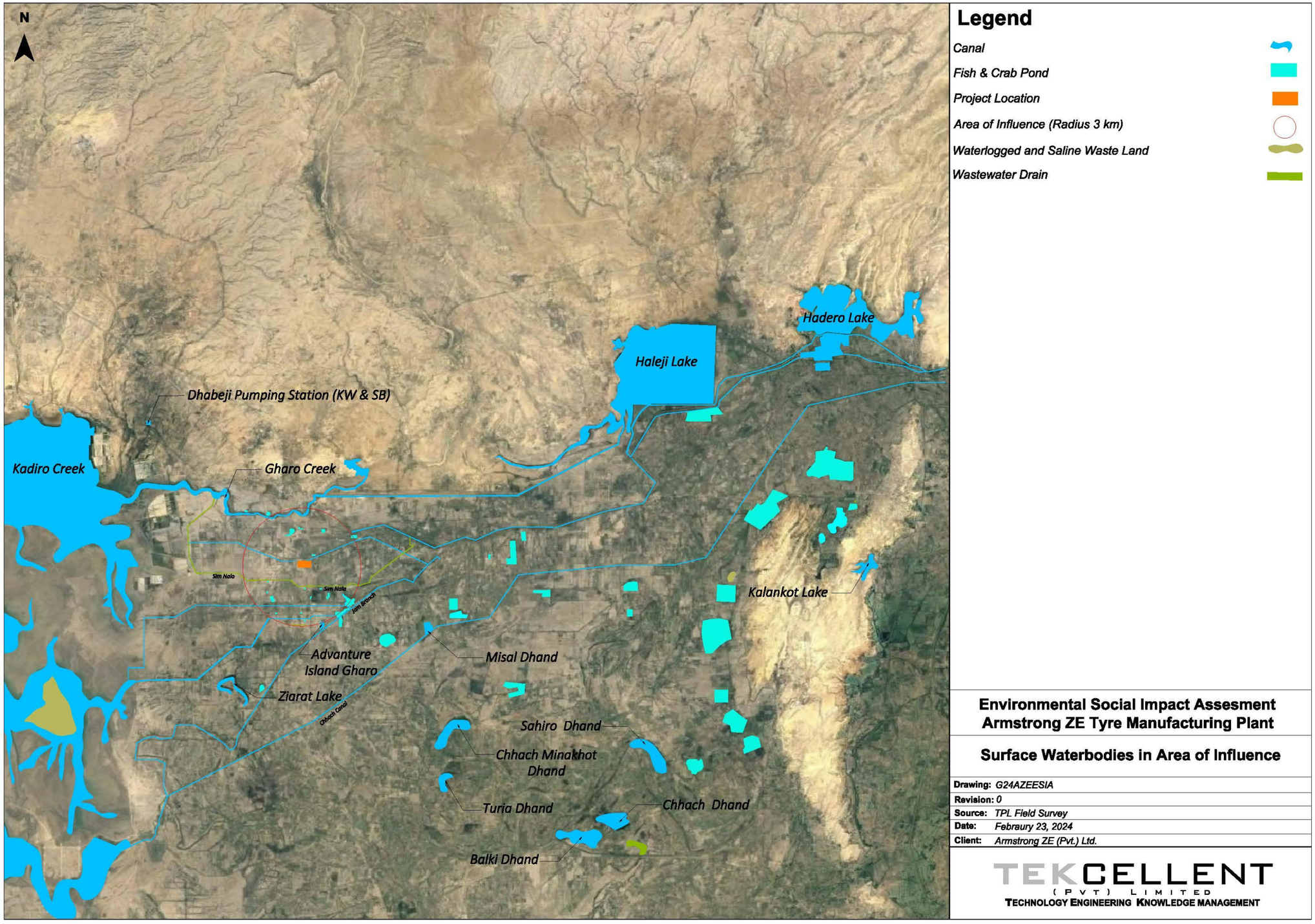
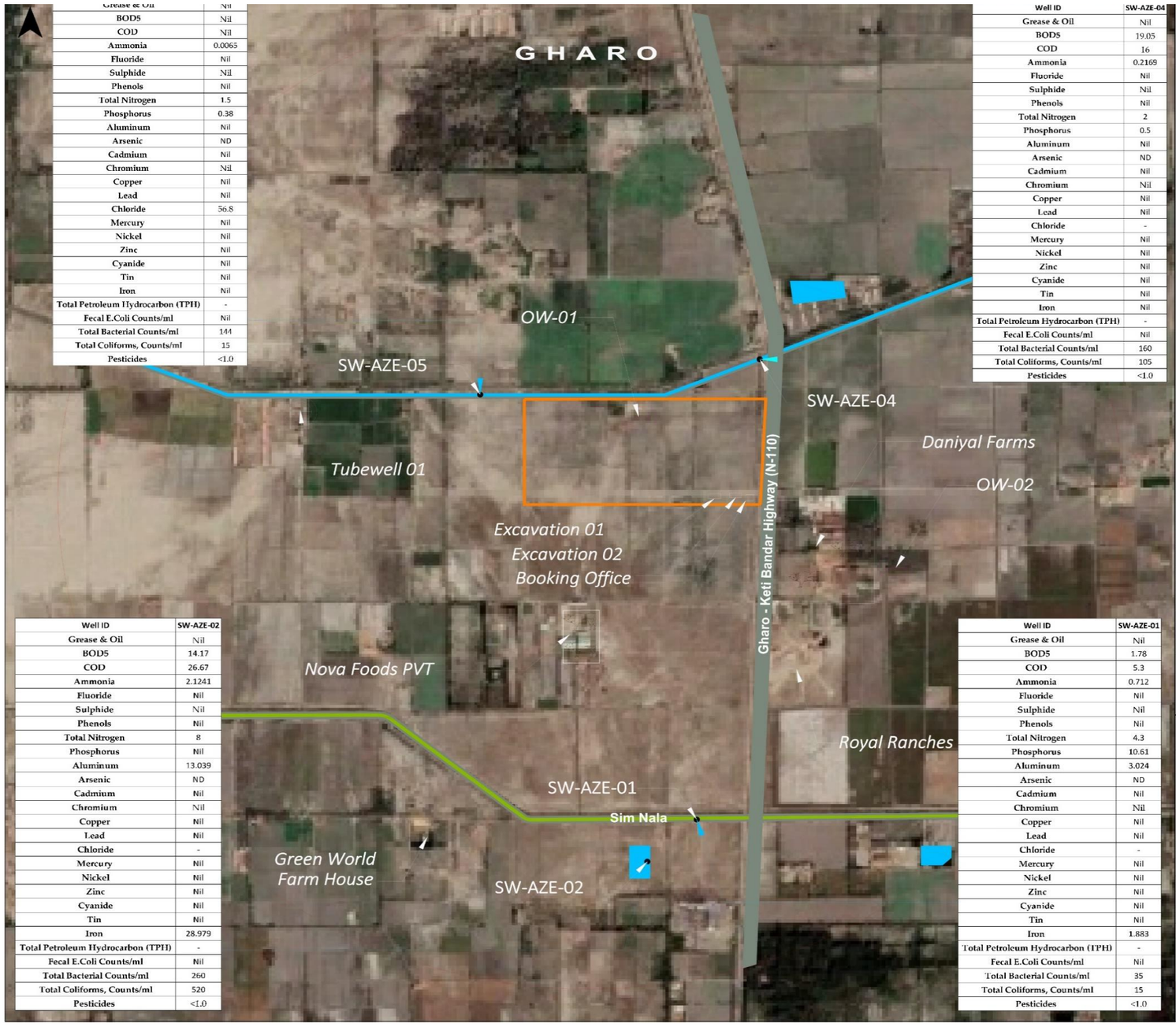


Exhibit 5.24. Laboratory Analytical Results for Surface Water Samples



Grease & Oil	Nil
BOD5	Nil
COD	Nil
Ammonia	0.0065
Fluoride	Nil
Sulphide	Nil
Phenols	Nil
Total Nitrogen	1.5
Phosphorus	0.38
Aluminum	Nil
Arsenic	ND
Cadmium	Nil
Chromium	Nil
Copper	Nil
Lead	Nil
Chloride	56.8
Mercury	Nil
Nickel	Nil
Zinc	Nil
Cyanide	Nil
Tin	Nil
Iron	Nil
Total Petroleum Hydrocarbon (TPH)	-
Fecal E.Coli Counts/ml	Nil
Total Bacterial Counts/ml	144
Total Coliforms, Counts/ml	15
Pesticides	<1.0

Well ID	SW-AZE-04
Grease & Oil	Nil
BOD5	19.05
COD	16
Ammonia	0.2169
Fluoride	Nil
Sulphide	Nil
Phenols	Nil
Total Nitrogen	2
Phosphorus	0.5
Aluminum	Nil
Arsenic	ND
Cadmium	Nil
Chromium	Nil
Copper	Nil
Lead	Nil
Chloride	-
Mercury	Nil
Nickel	Nil
Zinc	Nil
Cyanide	Nil
Tin	Nil
Iron	Nil
Total Petroleum Hydrocarbon (TPH)	-
Fecal E.Coli Counts/ml	Nil
Total Bacterial Counts/ml	160
Total Coliforms, Counts/ml	105
Pesticides	<1.0

Well ID	SW-AZE-02
Grease & Oil	Nil
BOD5	14.17
COD	26.67
Ammonia	2.1241
Fluoride	Nil
Sulphide	Nil
Phenols	Nil
Total Nitrogen	8
Phosphorus	Nil
Aluminum	13.039
Arsenic	ND
Cadmium	Nil
Chromium	Nil
Copper	Nil
Lead	Nil
Chloride	-
Mercury	Nil
Nickel	Nil
Zinc	Nil
Cyanide	Nil
Tin	Nil
Iron	28.979
Total Petroleum Hydrocarbon (TPH)	-
Fecal E.Coli Counts/ml	Nil
Total Bacterial Counts/ml	260
Total Coliforms, Counts/ml	520
Pesticides	<1.0

Well ID	SW-AZE-01
Grease & Oil	Nil
BOD5	1.78
COD	5.3
Ammonia	0.712
Fluoride	Nil
Sulphide	Nil
Phenols	Nil
Total Nitrogen	4.3
Phosphorus	10.61
Aluminum	3.024
Arsenic	ND
Cadmium	Nil
Chromium	Nil
Copper	Nil
Lead	Nil
Chloride	-
Mercury	Nil
Nickel	Nil
Zinc	Nil
Cyanide	Nil
Tin	Nil
Iron	1.883
Total Petroleum Hydrocarbon (TPH)	-
Fecal E.Coli Counts/ml	Nil
Total Bacterial Counts/ml	35
Total Coliforms, Counts/ml	15
Pesticides	<1.0

Canal / Water Pond
Cattle Farm
Deep Well
Fish Pond
Open Land
Project Boundary
Area of Influence (Radius 1.5 km)
Road
Tube Well
Storm Water Drain

Analytes	Unit	LOD	Sindh Environmental Quality Standard Values (2016)	WHO Guidelines for drinkig water	USEPA RBSL mg/l.	IFC Guideline Value *
Grease & Oil	mg/l	<2	≠10	-	-	10
BOD5	mg/l	<2	≠80	-	-	
COD	mg/l	<2	≠150	-	-	
Ammonia	mg/l	<1	≠40		-	10
Fluoride	mg/l	<1	≠1.5	1.5	-	20
Sulphide	mg/l	<0.5	≠1	-	-	1
Phenols	mg/l	<0.1	≠0.1	-	-	0.5
Total Nitrogen	mg/l	<2	-	-	-	35
Phosphorus	mg/l	<1	-	-	-	5
Aluminum	mg/l	<0.1	≤3.2	0.2	-	3
Arsenic	mg/l	<0.1	0	0.01	0.000052	0.1
Cadmium	mg/l	<0.1	0	0.003	-	0.1
Chromium	mg/l	<0.1	0	0.05	-	0.5
Copper	mg/l	<0.1	2	2	-	0.5
Lead	mg/l	<0.1	0.05	0.01	-	0.2
Chloride	mg/l	<1.0	<250	-	-	-
Mercury	mg/l	<0.01	0.001	0.006	-	0.01
Nickel	mg/l	<0.2	0.07	0.007	-	0.5
Zinc	mg/l	<0.2	5	-	-	2
Cyanide	mg/l	<0.1	≤0.05	0.05	-	1
Tin	mg/l	<0.2	-	-	-	2
Iron	mg/l	<0.2	-	-	-	3
Total Petroleum Hydrocarbon (TPH)	mg/l	0.5				
Fecal E.Coli Counts/ml	counts/ml	<100(MPN/100ml)		-		
Total Bacterial Counts/ml	counts/ml	<100(MPN/100ml)		-		
Total Coliforms, Counts/ml	counts/ml	<100(MPN/100ml)	-	-	-	-
Pesticides	mg/l	0.001	-	-	-	-

Exceeding Dutch Intervention or Indicative Values (2009)/Exceeding Sindh Environmental Quality Standards Values (2016)/ Exceeding WHO drinking water guidelines/Exceeding IF guideline values

Scale: 0 200 400 600 800 m

Environmental Social Impact Assesment
Armstrong ZE Tyre Manufacturing Plant

Surface Water Analytical Results

Drawing: *G24AZEESIA*
Revision: *0*
Source: *TPL Field Survey*
Date: *February 23, 2024*
Client: *Armstrong ZE (Pvt.) Ltd.*

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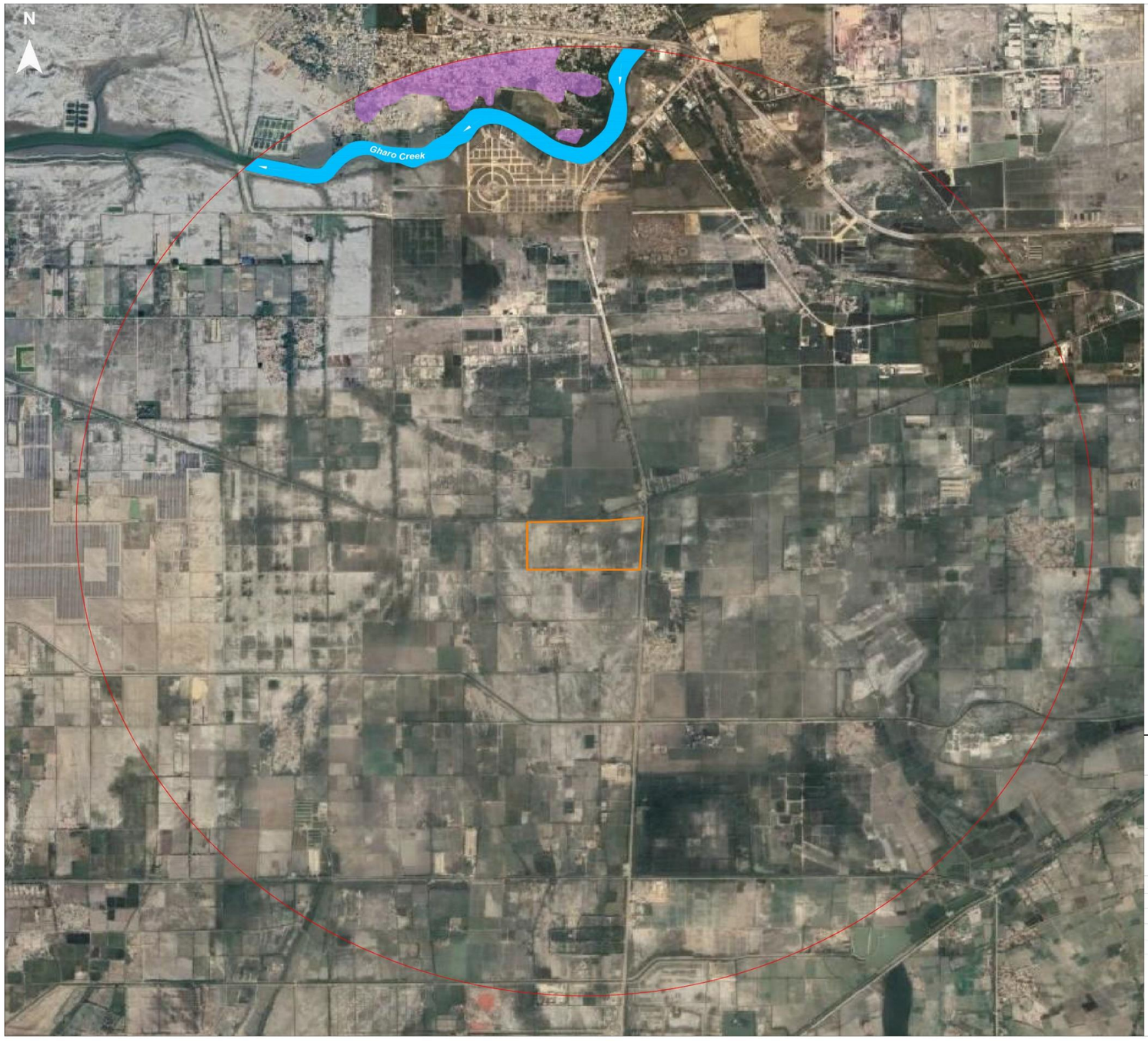
Exhibit 5.25. Extent of the Area where Municipal Water Supply is Available



Legend

Project Boundary	
Municipal Water Supply Area	
Radius	*3 km*

Scale: m 0 400 800 1200 1600

Environmental Social Impact Assesment
Armstrong ZE Tyre Manufacturing Plant

Municipal Water Supply Area

Drawing:	-
Revision:	*0*
Source:	*TPL Field Survey*
Date:	*February 23, 2024*
Client:	*Armstrong ZE (Pvt.) Ltd.*

TEKCELLENT (PVT) LIMITED
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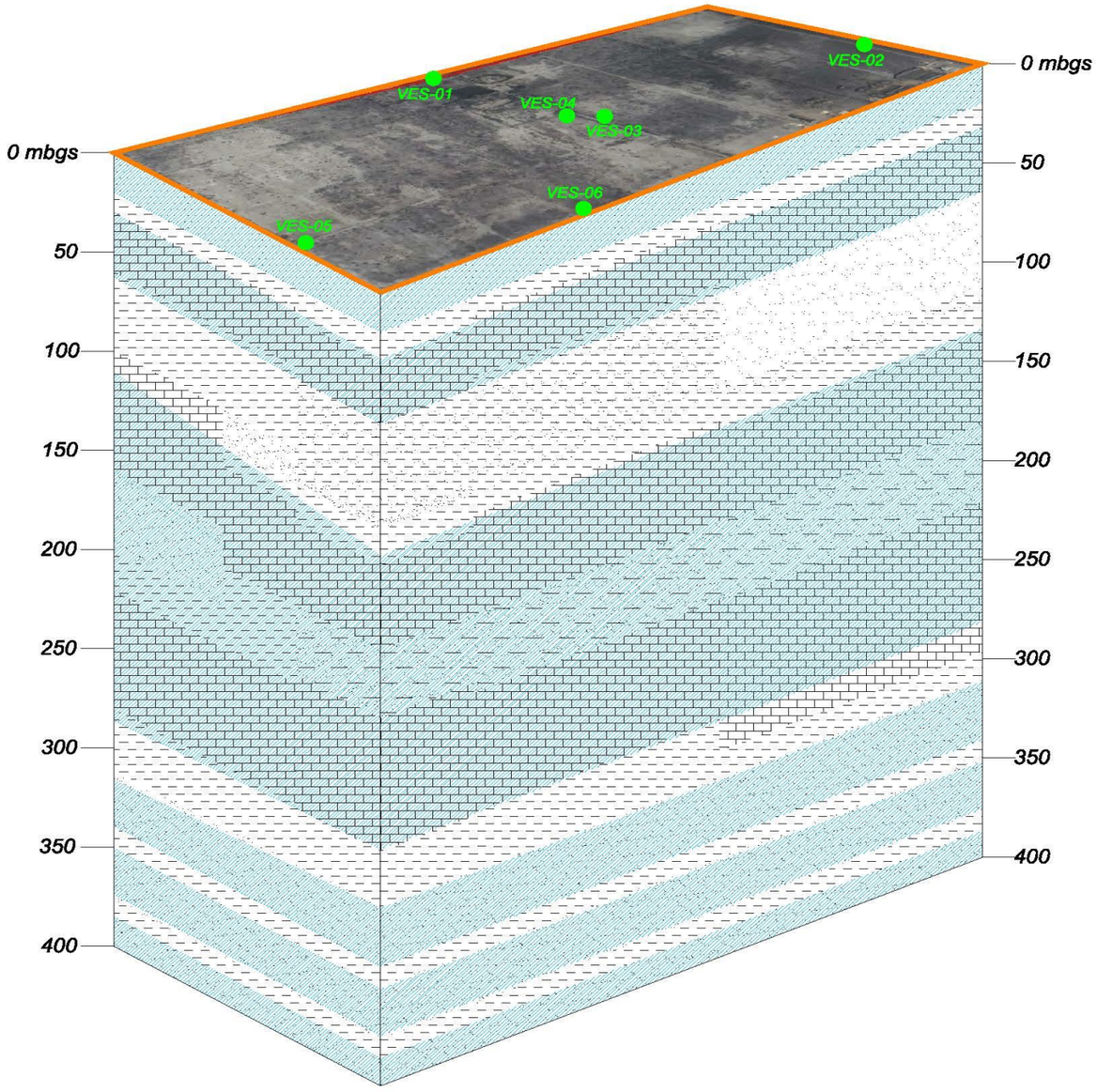
Exhibit 5.26. Field Water Quality and Usage Data for Surface Water Bodies

				Parameter Reading					*Physical Observations*[3]			
Date	*Sample ID*	*Type of Sample*	*Location*[1]	*pH*	*TDS (mg/L)*	*ORP (mV)*	*Conductivity (µs/cm)*	*DO (mg/L)*	*Odour*	*Taste*	*Turbidity*	*Usage/ Estimated Users* [2]
February 1, 2024	SW-AZE-01	Surface water	Sim Nullah, 958 m south of the site	8.09	510	174	1,020	3.0	None	-	-	Drainage/-
February 1, 2024	SW-AZE-02	Surface water	Pond, 1078 m south of the site	6.92	3610	173.9	7,320	5.2	None	Saline	-	No Usage
February 1, 2024	SW-03	Surface water	Canal, 549 m southwest of the site	7.85	538	205	1,077	2.7	-	-	-	Drinking, ablutions and washing/<10
February 1, 2024	SW-AZE-04	Surface water	Canal Upstream, 99 m northeast of the site	7.96	266.5	144.3	533	5.4	None	-	Clear	Washing and irrigation/-
February 1, 2024	SW-AZE-05	Surface water	Canal Downstream, 253 m northwest of the site	8.02	244.5	139.2	489	4.6	None	-	Clear	Washing, irrigation and Cattle farming/-

Notes:
1. Samples were taken from the nearest point.
2. Physical observations have been made directly by the TPL staff.

Exhibit 5.27. Geological Cross Section



Legend

Meters below ground surface	mbgs
Vertical Electrical Sounding	VES
Project Boundary	
Groundwater	

Lithology

- Sand
- Fine Sand
- Clay
- Limestone
- Clay Interbedded with sand
- Sands Silt mixtures

Environmental Social Impact Assesment
Armstrong ZE Tyre Manufacturing Plant

Geological Cross-section

Drawing:	G24AZEESIA
Revision:	0
Source:	TPL Field Survey
Date:	March 25, 2024
Client:	Armstrong ZE (Pvt.) Ltd.

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Exhibit 5.28. Details of Lithological Profiles Encountered at Each Location

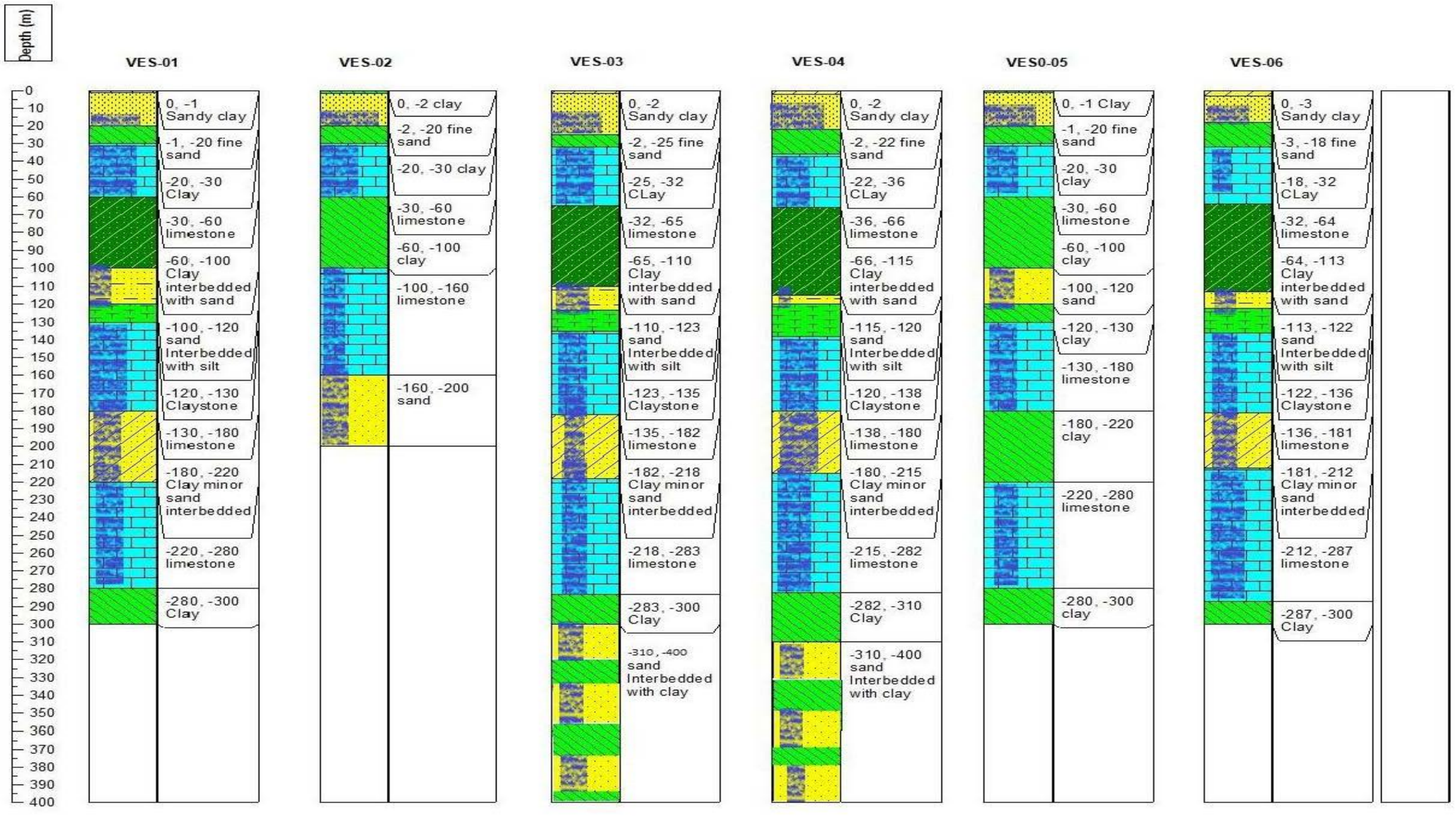
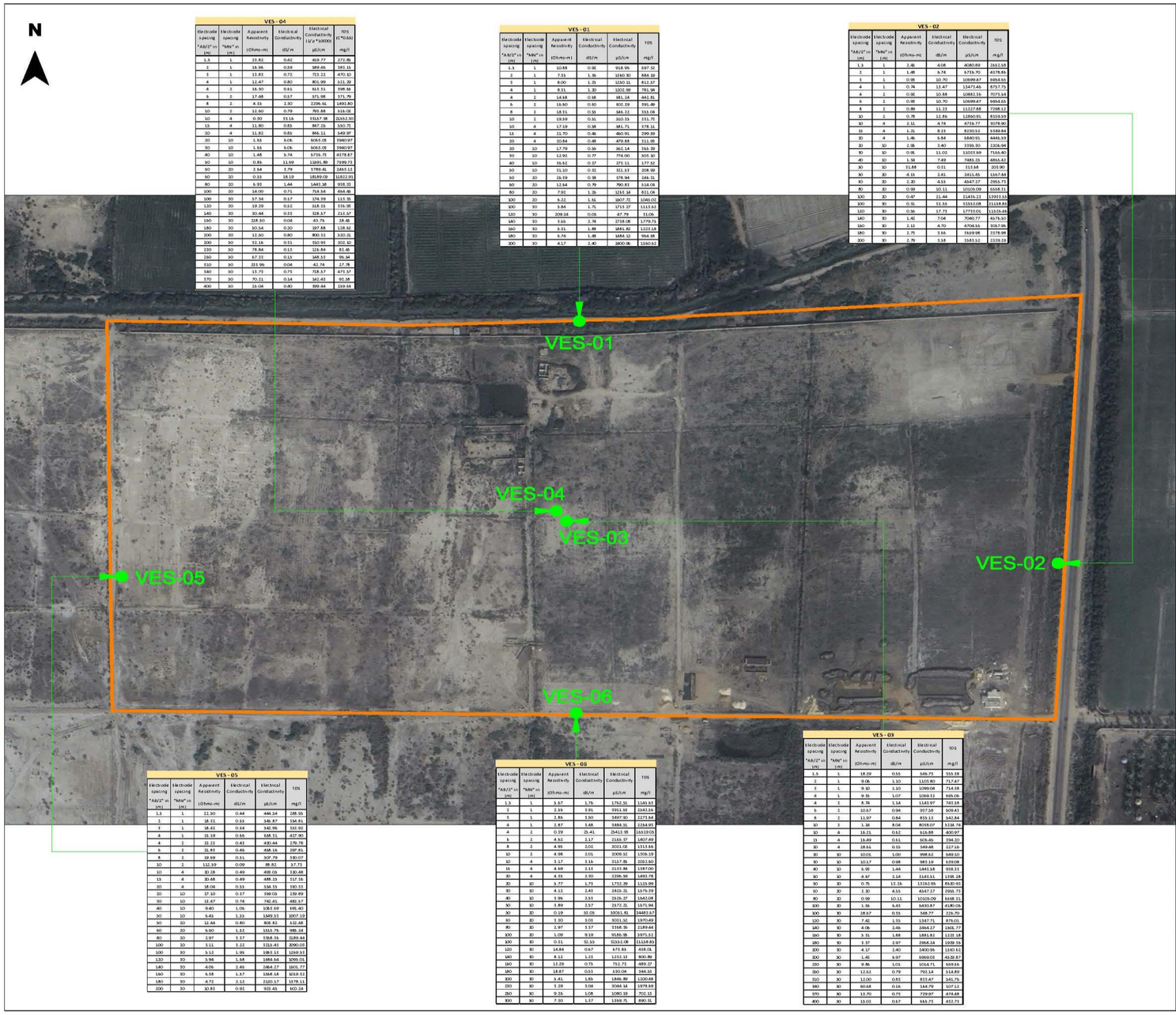


Exhibit 5.29. Electrical Resistivity Survey – Profile Details



VES - 04

Electrode spacing "AB/2" in (m)	Electrode spacing "MN" in (m)	Apparent Resistivity (Ohms-m)	Electrical Conductivity dS/m	Electrical Conductivity (1/ρ * 10000) µS/cm	TDS (C*0.65) mg/l
1.5	1	23.82	0.42	419.77	272.85
2	1	16.96	0.59	589.46	383.15
3	1	13.83	0.72	723.22	470.10
4	1	12.47	0.80	801.99	521.29
4	2	16.30	0.61	613.31	398.65
5	2	17.68	0.57	571.08	371.70
8	2	4.33	2.30	2296.61	1492.80
10	2	12.60	0.79	793.84	516.02
10	4	0.90	11.16	11157.38	15252.80
15	4	11.80	0.85	847.16	550.73
20	4	11.82	0.85	846.11	549.97
20	10	1.53	5.06	5065.08	3940.97
30	10	1.53	5.06	5065.08	3940.97
40	10	1.48	5.74	5736.75	4178.87
50	10	0.86	11.90	11891.80	7599.74
50	20	2.54	1.79	1789.81	1163.13
60	20	0.53	18.19	18189.08	11822.91
80	20	1.93	1.44	1441.36	936.71
100	20	14.00	0.71	714.58	464.48
100	30	17.54	0.57	574.79	373.71
120	30	19.29	0.52	518.53	336.95
140	30	10.44	0.95	958.57	623.07
160	30	28.50	0.35	350.96	228.12
180	30	30.54	0.33	327.48	212.86
200	30	12.50	0.80	800.01	520.01
200	40	32.16	0.31	310.95	202.12
230	30	78.84	0.13	126.84	82.45
260	30	67.11	0.15	148.99	96.84
310	30	221.96	0.04	45.04	29.28
340	30	13.73	0.73	728.17	473.32
370	30	70.21	0.14	142.41	92.56
400	30	23.04	0.43	433.94	282.06

VES - 01

Electrode spacing "AB/2" in (m)	Electrode spacing "MN" in (m)	Apparent Resistivity (Ohms-m)	Electrical Conductivity dS/m	Electrical Conductivity µS/cm	TDS mg/l
1.5	1	10.88	0.92	918.96	597.32
2	1	7.35	1.36	1360.90	884.58
3	1	8.00	1.25	1250.31	812.67
4	1	8.31	1.20	1203.99	782.59
4	2	14.58	0.68	685.54	445.61
5	2	15.60	0.60	602.39	391.49
8	2	18.11	0.55	545.22	354.39
10	2	19.99	0.50	500.05	325.03
10	4	17.19	0.58	581.71	378.11
15	4	21.70	0.46	460.91	299.59
20	4	20.84	0.48	479.88	311.92
20	10	17.79	0.56	562.14	365.39
30	10	12.92	0.77	774.00	503.10
40	10	16.62	0.57	571.11	371.32
50	10	11.10	0.81	811.13	208.99
50	20	16.19	0.58	578.94	244.31
60	20	12.84	0.79	790.83	514.08
80	20	7.92	1.26	1263.14	821.08
100	20	9.22	1.16	1807.72	1043.02
100	30	5.84	1.71	1715.27	1115.43
120	30	209.24	0.05	47.79	31.06
140	30	3.66	2.74	2738.08	1779.73
160	30	5.31	1.88	1841.82	1227.18
180	30	6.74	1.48	1484.12	964.68
200	30	4.17	2.40	2400.06	1560.62

VES - 02

Electrode spacing "AB/2" in (m)	Electrode spacing "MN" in (m)	Apparent Resistivity (Ohms-m)	Electrical Conductivity dS/m	Electrical Conductivity µS/cm	TDS mg/l
1.5	1	2.48	4.08	4080.89	2652.58
2	1	1.48	6.74	6735.70	4378.86
3	1	0.95	10.70	10699.67	6954.55
4	1	0.74	13.47	13471.41	8757.75
4	2	0.95	10.88	10882.16	7073.54
5	2	0.95	10.70	10699.67	6954.55
8	2	0.89	11.23	11227.83	7298.12
10	2	0.78	12.86	12860.91	8359.59
10	4	2.11	4.74	4715.77	3065.50
15	4	1.21	8.23	8230.52	5349.84
20	4	1.46	6.84	6840.91	4446.59
20	10	2.08	1.40	1399.30	2206.94
30	10	0.95	11.03	11037.89	7174.63
40	10	1.34	7.49	7483.23	4864.10
50	10	11.88	0.11	113.48	203.90
50	20	4.15	2.41	2411.45	1567.44
60	20	2.20	4.53	4547.27	2955.73
80	20	0.99	10.11	10109.09	6568.91
100	20	0.47	21.44	21436.22	13933.54
100	30	0.91	11.53	11533.08	11118.83
120	30	0.96	17.71	17715.01	11515.44
140	30	1.42	7.04	7040.77	4576.50
160	30	2.13	4.70	4704.55	3057.96
180	30	2.71	3.66	3659.98	2378.98
200	30	2.79	3.58	3583.53	2329.29

VES - 05

Electrode spacing "AB/2" in (m)	Electrode spacing "MN" in (m)	Apparent Resistivity (Ohms-m)	Electrical Conductivity dS/m	Electrical Conductivity µS/cm	TDS mg/l
1.5	1	22.50	0.44	444.34	288.95
2	1	18.32	0.55	545.87	354.81
3	1	18.43	0.54	542.96	352.92
4	1	15.19	0.66	658.31	427.90
4	2	22.23	0.45	450.44	292.78
5	2	21.83	0.46	458.15	297.81
8	2	18.69	0.53	507.79	330.07
10	2	132.59	0.08	88.82	57.73
10	4	20.28	0.49	493.08	320.48
15	4	20.48	0.49	488.23	317.35
20	4	18.04	0.55	554.33	360.31
20	10	27.10	0.37	369.05	239.89
30	10	18.47	0.74	741.41	481.37
40	10	9.40	1.06	1063.69	691.40
50	10	5.83	1.33	1349.53	1007.19
50	20	12.64	0.80	806.81	532.68
60	20	5.50	1.32	1313.76	986.24
80	20	2.97	1.57	1364.76	1249.44
100	20	3.11	2.22	2213.43	2090.03
100	30	5.12	1.95	1953.13	1269.33
120	30	3.94	1.58	1064.64	1095.01
140	30	4.06	2.46	2464.37	1601.77
160	30	5.18	1.37	1368.18	1019.92
180	30	6.72	2.12	2120.17	1378.11
200	30	10.81	0.91	933.43	606.24

VES - 06

Electrode spacing "AB/2" in (m)	Electrode spacing "MN" in (m)	Apparent Resistivity (Ohms-m)	Electrical Conductivity dS/m	Electrical Conductivity µS/cm	TDS mg/l
1.5	1	3.37	1.78	1782.31	1145.85
2	1	2.36	1.91	1911.46	1242.86
3	1	2.86	1.50	1497.90	1271.84
4	1	2.87	1.48	1484.31	2154.91
4	2	0.39	25.41	25411.98	16519.06
5	2	4.62	2.17	2165.37	1407.49
8	2	4.99	2.01	2011.08	1313.66
10	2	4.98	2.01	2009.32	1306.19
10	4	3.17	1.16	1157.85	2019.60
15	4	4.60	2.15	2151.98	1187.00
20	4	4.53	2.50	2496.30	1492.78
20	10	3.77	1.73	1732.39	1125.99
30	10	4.12	1.61	1611.31	1376.59
40	10	5.96	2.51	2526.27	1642.08
50	10	3.89	2.57	2572.21	1671.94
50	20	0.19	52.06	52051.81	34451.67
60	20	3.30	3.03	3031.52	1970.49
80	20	2.97	3.37	3368.36	2189.66
100	20	1.09	9.18	9185.98	5971.51
100	30	0.11	82.35	82353.08	81148.83
120	30	14.84	0.67	673.81	438.01
140	30	8.12	1.23	1232.13	800.89
160	30	13.29	0.75	752.73	489.27
180	30	18.87	0.53	530.04	344.52
200	30	9.45	1.85	1846.89	1200.48
190	30	5.29	3.04	3044.14	1978.69
260	30	9.26	1.08	1080.10	702.15
300	30	7.50	1.37	1369.75	890.35

VES - 03

Electrode spacing "AB/2" in (m)	Electrode spacing "MN" in (m)	Apparent Resistivity (Ohms-m)	Electrical Conductivity dS/m	Electrical Conductivity µS/cm	TDS mg/l
1.5	1	18.29	0.55	546.73	355.38
2	1	9.06	1.10	1103.80	717.47
3	1	9.30	1.10	1099.04	714.38
4	1	9.35	1.07	1068.12	694.28
4	2	8.76	1.14	1141.97	742.28
5	2	10.67	0.94	937.58	609.43
8	2	11.97	0.84	835.13	542.84
10	2	1.38	8.04	8038.07	5138.73
10	4	18.21	0.52	518.88	400.97
15	4	18.49	0.51	505.46	394.20
20	4	28.51	0.33	349.68	227.34
20	10	10.05	1.00	998.52	649.10
30	10	10.17	0.98	983.19	639.08
40	10	9.95	1.00	1003.99	652.59
50	10	4.87	2.14	2143.51	1198.28
50	20	0.75	13.26	13262.95	8620.92
60	20	2.32	4.33	4347.27	2955.73
80	20	0.99	10.11	10109.09	6568.91
100	20	1.16	8.63	8630.87	4180.06
100	30	28.57	0.35	348.77	226.70
120	30	7.42	1.35	1347.71	876.01
140	30	4.06	2.46	2464.37	1601.77
160	30	5.31	1.88	1841.82	1227.18
180	30	5.37	2.97	2968.14	1929.29
200	30	4.17	2.40	2400.06	1560.62
200	40	1.48	6.97	6969.05	4529.87
250	30	9.86	1.01	1014.71	659.56
260	30	12.62	0.79	792.14	514.89
310	30	12.00	0.83	833.47	541.75
340	30	60.68	0.16	164.79	107.12
370	30	13.70	0.73	729.97	474.48
400	30	13.02	0.67	863.73	432.73

Legend

Project Boundary

Vertical Electrical Sounding (VES)

Environmental Social Impact Assessment
Armstrong ZE Tyre Manufacturing Plant

Electrical Resistivity Survey
(Profile Details)

Drawing:	*G24AZEESIA*
Revision:	*0*
Source:	*TPL Field Survey*
Date:	*March 25, 2024*
Client:	*Armstrong ZE (PVT.) LTD.*

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Exhibit 5.30. Graph illustrating Depth Versus TDS values

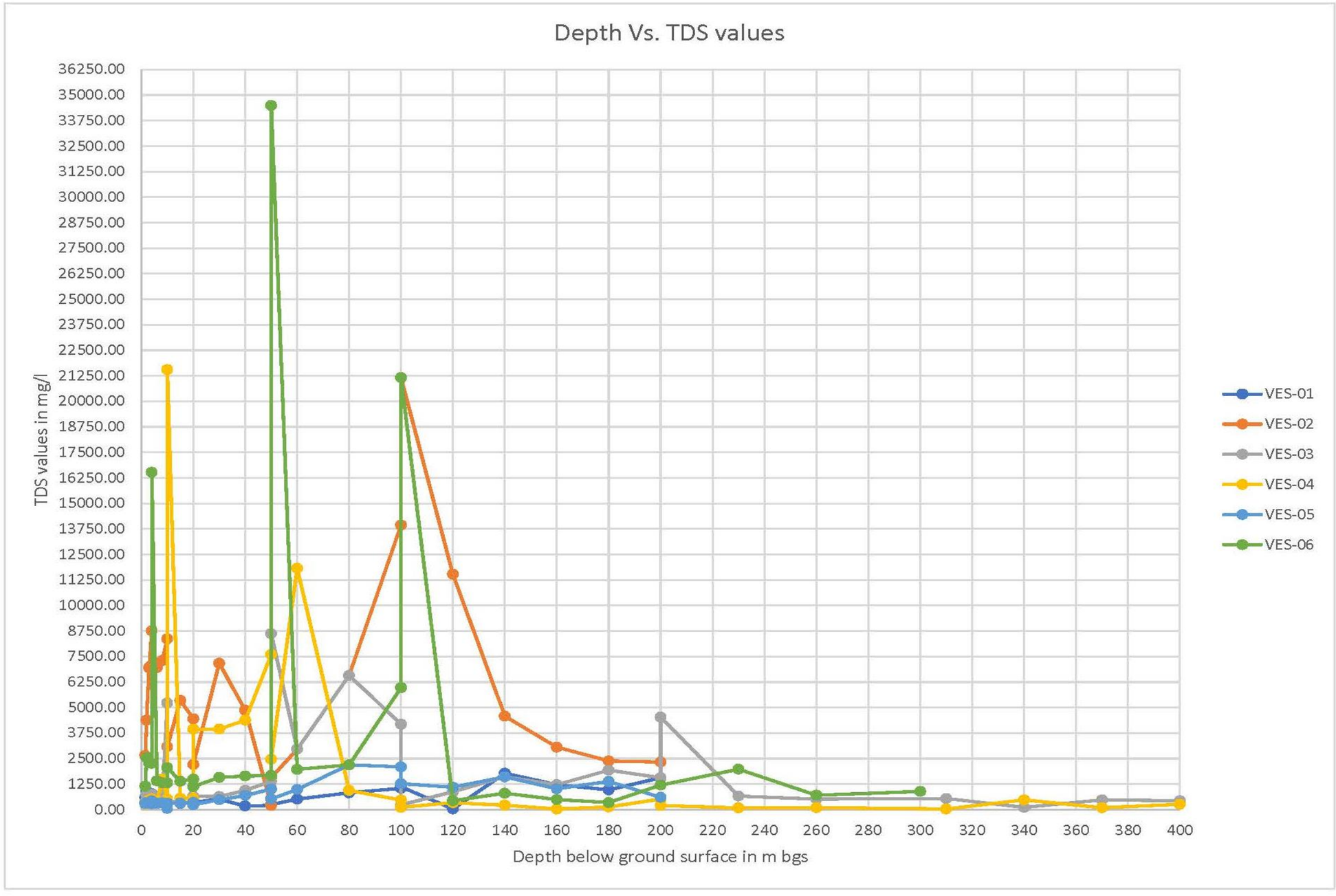


Exhibit 5.31. Electrical Resistivity Survey-Lithological Details

VES-04			
From (m)	To(m)	Thickness(m)	Lithology
0	2	2	Sandy clay
2	22	20	fine sand
22	36	14	Clay
36	66	30	limestone
66	115	49	Clay interbedded with sand
115	120	5	sand interbedded with silt
120	138	18	Claystone
138	180	42	limestone
180	215	35	Clay minor sand interbedded
215	282	67	limestone
282	310	28	Clay
310	400	90	sand interbedded with clay

VES -01			
From (m)	To (m)	Thickness (m)	Lithology
0	1	1	Sandy clay
1	20	19	fine sand
20	30	10	Clay
30	60	30	limestone
60	100	40	Clay interbedded with sand
100	120	20	Sand interbedded with silt
120	130	10	Claystone
130	180	50	limestone
180	220	40	Clay minor sand interbedded
220	280	60	limestone
280	300	20	Clay

VES -02			
From (m)	To (m)	Thickness (m)	Lithology
0	1.5	1.5	clay
1.5	20	18.5	fine sand
20	30	10	clay
30	60	30	limestone
60	100	40	clay
100	160	60	limestone
160	200	40	sand

VES-05			
From (m)	To(m)	Thickness(m)	Lithology
0	1	1	Sandy clay
1	20	19	fine sand
20	30	10	Clay
30	60	30	limestone
60	100	40	Clay interbedded with sand
100	120	20	sand interbedded with silt
120	130	10	Claystone
130	180	50	limestone
180	200	20	Clay minor sand interbedded

VES-06			
From (m)	To(m)	Thickness(m)	Lithology
0	3	3	Sandy clay
3	18	15	fine sand
18	32	14	CLay
32	64	32	limestone
64	113	49	Clay interbedded with sand
113	122	9	sand interbedded with silt
122	136	14	Claystone
136	181	45	limestone
181	212	31	Clay minor sand interbedded
212	287	75	limestone
287	300	13	Clay

VES-03			
From (m)	To(m)	Thickness(m)	Lithology
0	1.5	1.5	Sandy clay
1.5	25	23.5	fine sand
25	32	7	Clay
32	65	33	limestone
65	110	45	Clay interbedded with sand
110	123	13	sand interbedded with silt
123	135	12	Claystone
135	182	47	limestone
182	218	36	Clay minor sand interbedded
218	283	65	limestone
283	300	17	Clay
300	400	100	sand interbedded with clay

Legend

Project Boundary

Vertical Electrical Sounding (VES)

Note:
Table is providing Geoelectric layers with inferred lithologies at VES-01 to VES-06 of the Site location.

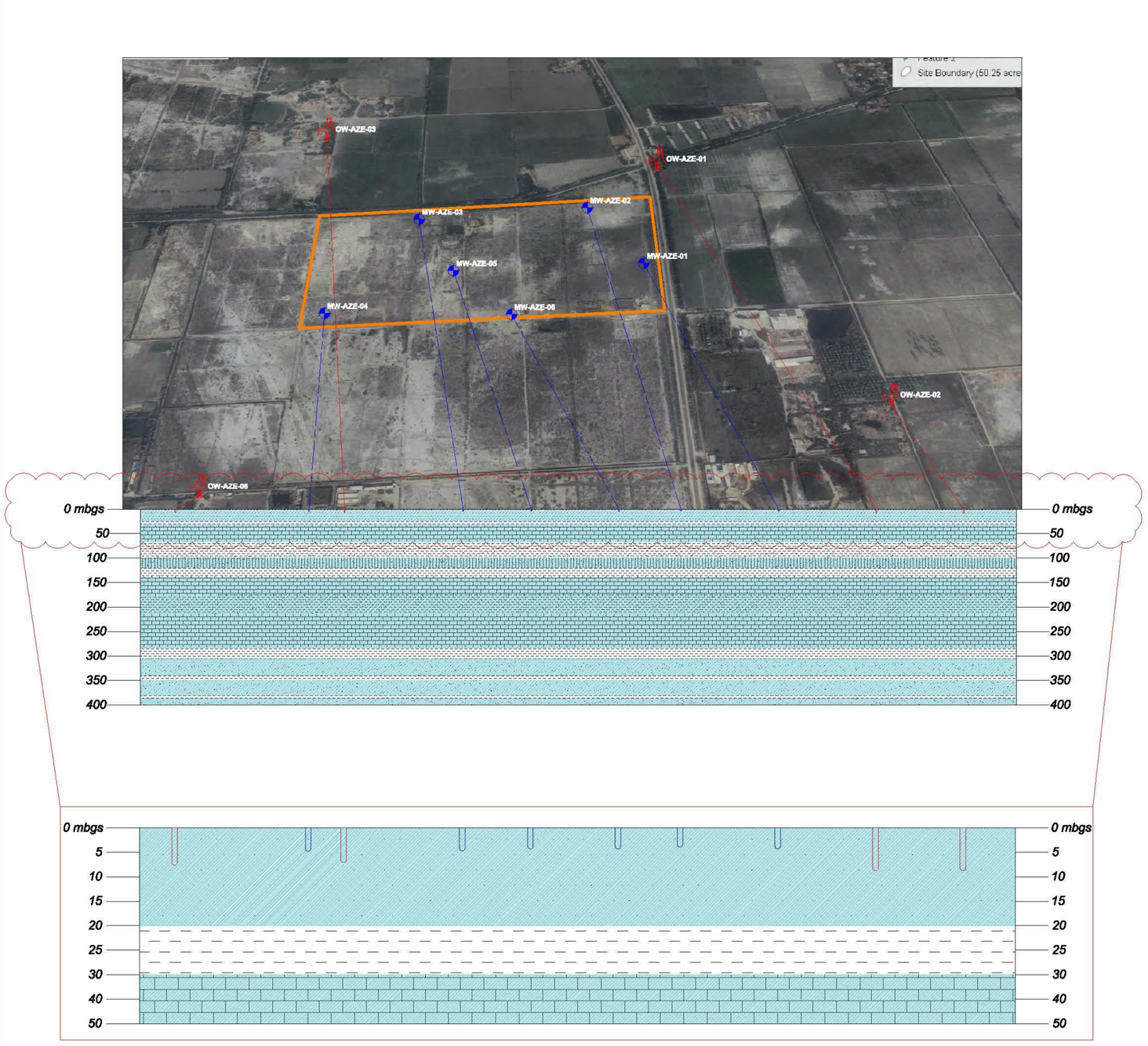
Environmental Social Impact Assessment
Armstrong ZE Tyre Manufacturing Plant

Electrical Resistivity Survey
(Lithology Details)

Drawing: *G24AZEESIA*
Revision: *0*
Source: *TPL Field Survey*
Date: *March 25, 2024*
Client: *Armstrong ZE (PVT.) LTD.*

TEKCELLENT (PVT) LIMITED
TECHNOLOGY ENGINEERING KNOWLEDGE MANAGEMENT

Exhibit 5.32. Subsurface Profile



Armstrong ZE Pvt. Ltd.	*AZE*
Meters below ground surface	*mbgs*
Monitoring Well	*MW*
Off-site Well	*OW*
Project Boundary	
Groundwater	

Lithology

- *Sand*
- *Fine Sand*
- *Clay*
- *Limestone*
- *Clay Interbedded with sand*
- *Sands Silt mixtures*

Environmental Social Impact Assesment
Armstrong ZE Tyre Manufacturing Plant

Subsurface Profile

Drawing:	*G24AZEESIA*
Revision:	*0*
Source:	*TPL Field Survey*
Date:	*March 25, 2024*
Client:	*Armstrong ZE (Pvt.) Ltd.*

TEKCELLENT (Pvt) Limited
Technology Engineering Knowledge Management

Exhibit 5.33. Field Water Quality and Usage Data for Abstraction Wells

Date	*Well ID*	*Type of Well*	*Date of Installation*	*Location*[1]	*Depth of Well*[2]	*Parameter Reading*					*Physical Observations*[3]			*Usage/Estd. Users* [2]
					(m)	*pH*	*TDS (mg/L)*	*ORP (mV)*	*Conductivity (µs/cm)*	*DO (mg/L)*	*Odour*	*Taste*	*Turbidity*	
February 1, 2024	DW-AZE-01	Hand Pump	2020	On-site well, towards northern boundary wall of the site	10.68	7.94	389.5	143.8	779	1.8	None	N.O.	Clear	Drinking, ablution and washing/5+
February 1, 2024	OW-AZE-01	Hand Pump	NP	Off-site well, near Samoo Hotel, 111 m northeast of the site	8.8	7.36	537.5	121.9	1,075	4.9	-	-	-	Drinking, ablution and washing/100+
February 1, 2024	OW-AZE-02	Hand Pump	NP	Off-site well, Gypsy Camp, 415 m southeast of the site	Unknown	7.37	972.5	119.7	1,945	4.4	-	-	-	Drinking, ablution and washing/>20
February 1, 2024	OW-AZE-03	Hand Pump	2020	Off-site well, Gypsy Camp, 281m northwest of the site	7.62	8.01	1250	149.1	2,500	2.1	-	-	-	Drinking, ablution and washing/50+
February 1, 2024	OW-04	Hand Pump	2019	Off-site well, Gypsy Camp, 400 m northwest of the site	7.62	7.64	1580	157.4	3,160	2.4	None	Slightly Salty	-	Drinking, ablutions and washing/10 -`15+
February 1, 2024	OW-05	Hand Pump	2018	Off-site well, 514 m northwest of the site	7.62	7.98	811.5	155.9	`1623	2.7	None	-	-	Drinking, ablutions and washing/150+
February 1, 2024	OW-AZE-06	Hand Pump	2023	Off-site well, 350 m southwest of the site	7.62	7.69	628	203.6	1,256	5.0	-	-	-	Drinking, ablutions and washing/10 - 15+
February 1, 2024	OW-07	Hand Pump	2023	Off-site well, 557 m southwest of the site	3.96	7.80	871.5	216.9	1,743	2.6	None	-	-	Drinking, ablutions and washing/-
February 1, 2024	OW-08	Hand Pump	NP	Off-site well, 847 m northwest of the site	Unknown	7.80	871.5	216.9	1,743	2.6	None	-	-	Drinking, ablutions and washing/>5
February 1, 2024	OW-09	Hand Pump	NP	Off-site well, 694 m northeast of the site	7.62	7.37	1725	1610	3,450	4.5	-	Slightly Salty	-	Drinking, ablution and washing/5+
February 1, 2024	OW-10	Hand Pump	NP	Off-site well, 499 m northeast of the site	7.62	7.44	798.5	165.2	1,597	2.9	-	-	-	Drinking, ablutions and washing/10+
February 1, 2024	OW-11	Hand Pump	NP	Off-site well, 242 m northeast of the site	Unknown	7.20	978.5	152.4	1,957	3.7	None	N.O.	Clear	Drinking, ablutions and washing/5+
February 1, 2024	OW-12	Hand Pump	NP	Off-site well, 607 m northeast of the site	Unknown	7.18	602.5	149.8	1,205	2.8	None	N.O.	Clear	Drinking, ablutions and washing/5+
February 1, 2024	OW-13	Hand Pump	NP	Off-site well, 1023 m southwest of the site	7.62	7.36	541.5	168.2	1,083	4.1	None	N.O.	Clear	Drinking, ablutions and washing/<5

Notes:

N.O. = Non-objectionable
NP = Not Provided
1. Wells were sampled from the nearest accessible tap/outlet of the well pump.
2. Extraction depth, estimated number of users and usage provided by the well users.
3. Physical observations have been made directly by the TPL staff.

Exhibit 5.34. Location of Monitoring Wells

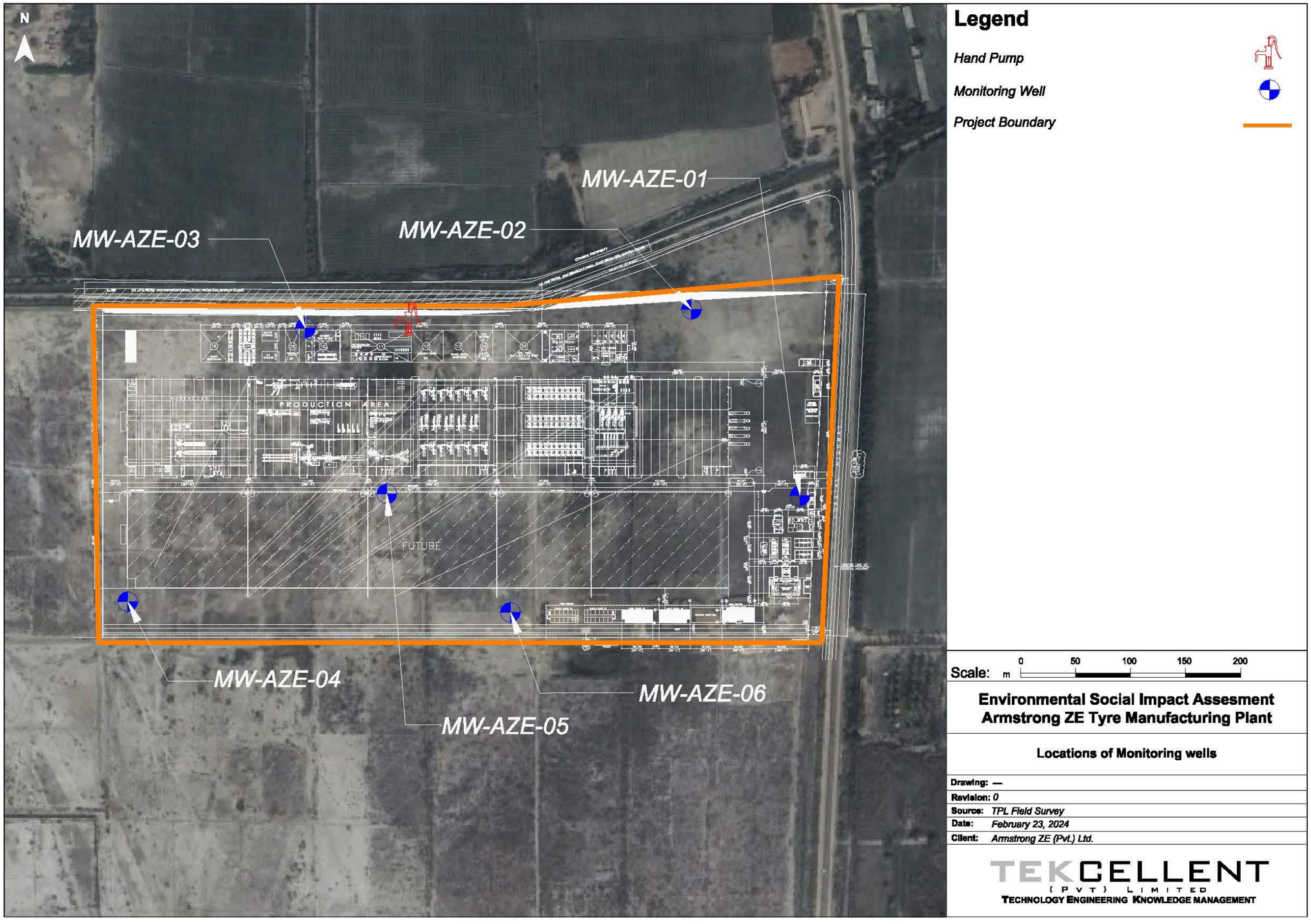
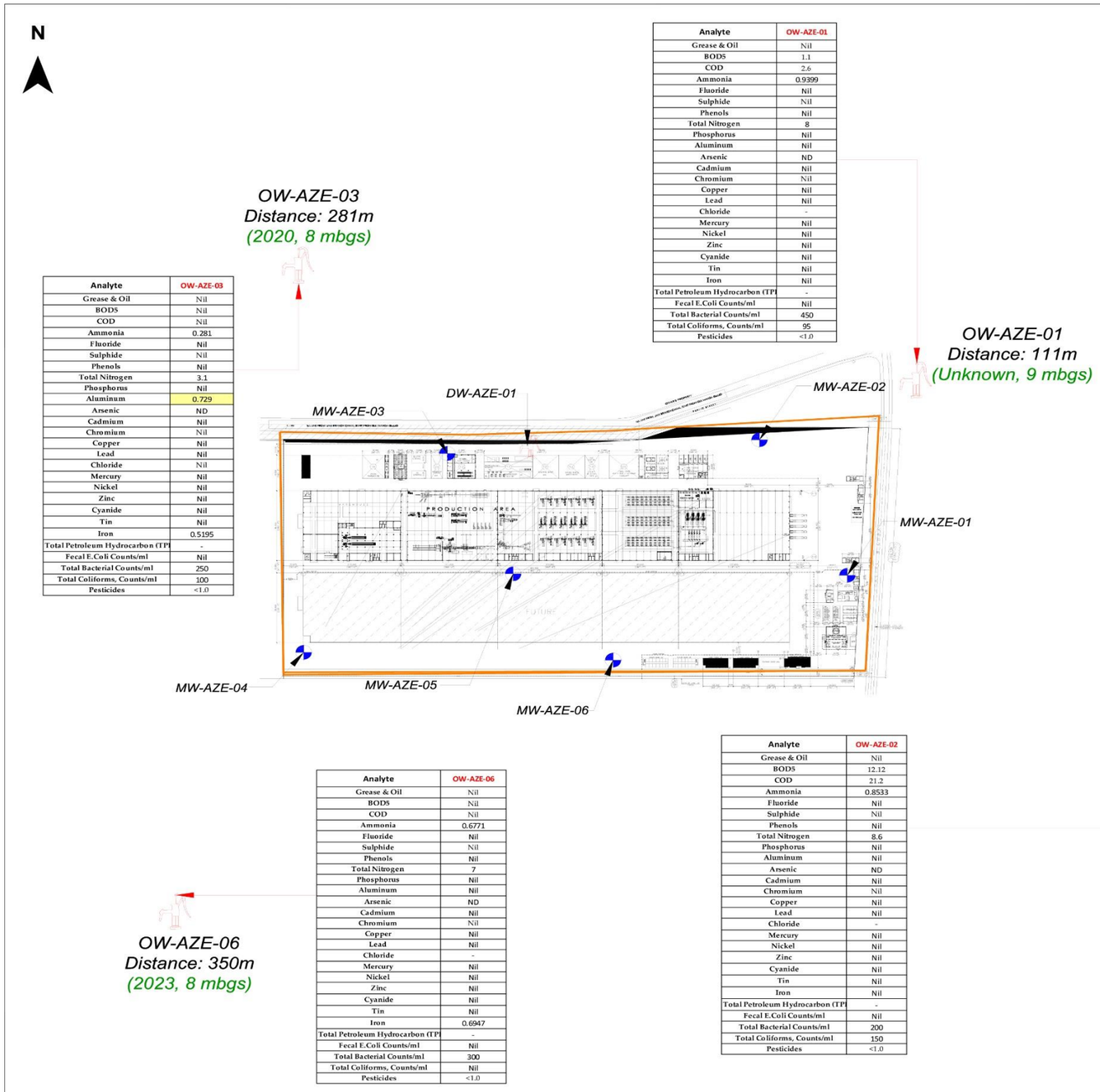


Exhibit 5.35. Results of Baseline Groundwater Quality



Analyte	OW-AZE-03
Grease & Oil	Nil
BOD5	Nil
COD	Nil
Ammonia	0.281
Fluoride	Nil
Sulphide	Nil
Phenols	Nil
Total Nitrogen	3.1
Phosphorus	Nil
Aluminum	0.729
Arsenic	ND
Cadmium	Nil
Chromium	Nil
Copper	Nil
Lead	Nil
Chloride	Nil
Mercury	Nil
Nickel	Nil
Zinc	Nil
Cyanide	Nil
Tin	Nil
Iron	0.5195
Total Petroleum Hydrocarbon (TPI	-
Fecal E.Coli Counts/ml	Nil
Total Bacterial Counts/ml	250
Total Coliforms, Counts/ml	100
Pesticides	<1.0

Analyte	OW-AZE-01
Grease & Oil	Nil
BOD5	1.1
COD	2.6
Ammonia	0.9399
Fluoride	Nil
Sulphide	Nil
Phenols	Nil
Total Nitrogen	8
Phosphorus	Nil
Aluminum	Nil
Arsenic	ND
Cadmium	Nil
Chromium	Nil
Copper	Nil
Lead	Nil
Chloride	-
Mercury	Nil
Nickel	Nil
Zinc	Nil
Cyanide	Nil
Tin	Nil
Iron	Nil
Total Petroleum Hydrocarbon (TPI	-
Fecal E.Coli Counts/ml	Nil
Total Bacterial Counts/ml	450
Total Coliforms, Counts/ml	95
Pesticides	<1.0

Analyte	OW-AZE-06
Grease & Oil	Nil
BOD5	Nil
COD	Nil
Ammonia	0.6771
Fluoride	Nil
Sulphide	Nil
Phenols	Nil
Total Nitrogen	7
Phosphorus	Nil
Aluminum	Nil
Arsenic	ND
Cadmium	Nil
Chromium	Nil
Copper	Nil
Lead	Nil
Chloride	-
Mercury	Nil
Nickel	Nil
Zinc	Nil
Cyanide	Nil
Tin	Nil
Iron	0.6947
Total Petroleum Hydrocarbon (TPI	-
Fecal E.Coli Counts/ml	Nil
Total Bacterial Counts/ml	300
Total Coliforms, Counts/ml	Nil
Pesticides	<1.0

Analyte	OW-AZE-02
Grease & Oil	Nil
BOD5	12.12
COD	21.2
Ammonia	0.8533
Fluoride	Nil
Sulphide	Nil
Phenols	Nil
Total Nitrogen	8.6
Phosphorus	Nil
Aluminum	Nil
Arsenic	ND
Cadmium	Nil
Chromium	Nil
Copper	Nil
Lead	Nil
Chloride	-
Mercury	Nil
Nickel	Nil
Zinc	Nil
Cyanide	Nil
Tin	Nil
Iron	Nil
Total Petroleum Hydrocarbon (TPI	-
Fecal E.Coli Counts/ml	Nil
Total Bacterial Counts/ml	200
Total Coliforms, Counts/ml	150
Pesticides	<1.0

Legend

Analytes	Unit	LOD	Sindh Environmental Quality Standard Values (2016)	WHO Guidelines for drinkig water	USEPA RBSL mg/l.	IFC Guideline Value *
Grease & Oil	mg/l	<2	≠10	-	-	10
BOD5	mg/l	<2	≠80	-	-	-
COD	mg/l	<2	≠150	-	-	-
Ammonia	mg/l	<1	≠40	-	-	10
Fluoride	mg/l	<1	≤1.5	1.5	-	20
Sulphide	mg/l	<0.5	≠1	-	-	1
Phenols	mg/l	<0.1	≠0.1	-	-	0.5
Total Nitrogen	mg/l	<2	-	-	-	15
Phosphorus	mg/l	<1	-	-	-	5
Aluminum	mg/l	<0.1	≤0.2	0.2	-	8
Arsenic	mg/l	<0.1	0	0.01	0.000053	0.1
Cadmium	mg/l	<0.1	0	0.003	-	0.1
Chromium	mg/l	<0.1	0	0.05	-	0.5
Copper	mg/l	<0.1	2	2	-	0.5
Lead	mg/l	<0.1	0.05	0.01	-	0.2
Chloride	mg/l	<1.0	<250	-	-	-
Mercury	mg/l	<0.01	0.002	0.006	-	0.01
Nickel	mg/l	<0.2	0.02	0.007	-	0.5
Zinc	mg/l	<0.2	5	-	-	2
Cyanide	mg/l	<0.1	≤0.05	0.05	-	1
Tin	mg/l	<0.2	-	-	-	2
Iron	mg/l	<0.2	-	-	-	3
Total Petroleum Hydrocarbon (TPH)	mg/l	0.5	-	-	-	-
Fecal E.Coli Counts/ml	counts/ml	<100(MPN/100ml)	-	-	-	-
Total Bacterial Counts/ml	counts/ml	<100(MPN/100ml)	-	-	-	-
Total Coliforms, Counts/ml	counts/ml	<100(MPN/100ml)	-	-	-	-
Pesticides	mg/l	0.001	-	-	-	-

Monitoring Well (2023)

Hand Pump

Exceeding Dutch Intervention or Indicative Values (2009)/Exceeding Sindh Environmental Quality Standards Values (2016)/ Exceeding WHO drinking water guidelines/Exceeding IF guideline values

Environmental Social Impact Assesment
Armstrong ZE Tyre Manufacturing Plant

Groundwater Analytical Results (Off-site wells)

Drawing: *G24AZEESIA*
Revision: *0*
Source: *TPL Field Survey*
Date: *Febraury 23, 2024*
Client: *Armstrong ZE (Pvt.) Ltd.*

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Exhibit 5.36. Well Gauging Details

Date	*Well ID*	*Top-of-Casing Elev. (m Datum)*	*Time*	*Depth to SWL (mToW)*	*Hydraulic Equivalent (m Datum)*	*Corrected Depth to SWL (mToW)*
January 19, 2024	MW-AZE-01	99.352	15:10	1.78	97.567	1.79
January 20, 2024	MW-AZE-02	99.263	15:40	1.50	97.763	1.500
January 18, 2024	MW-AZE-03	100.000	14:30	2.36	97.635	2.365
January 17, 2024	MW-AZE-04	100.006	13:55	2.47	97.536	2.470
January 18, 2024	MW-AZE-05	99.739	16:45	1.86	97.879	1.860
January 21, 2024	MW-AZE-06	99.824	16:15	2.000	97.824	2.000

Exhibit 5.37. Groundwater Flow Direction on the Project Site

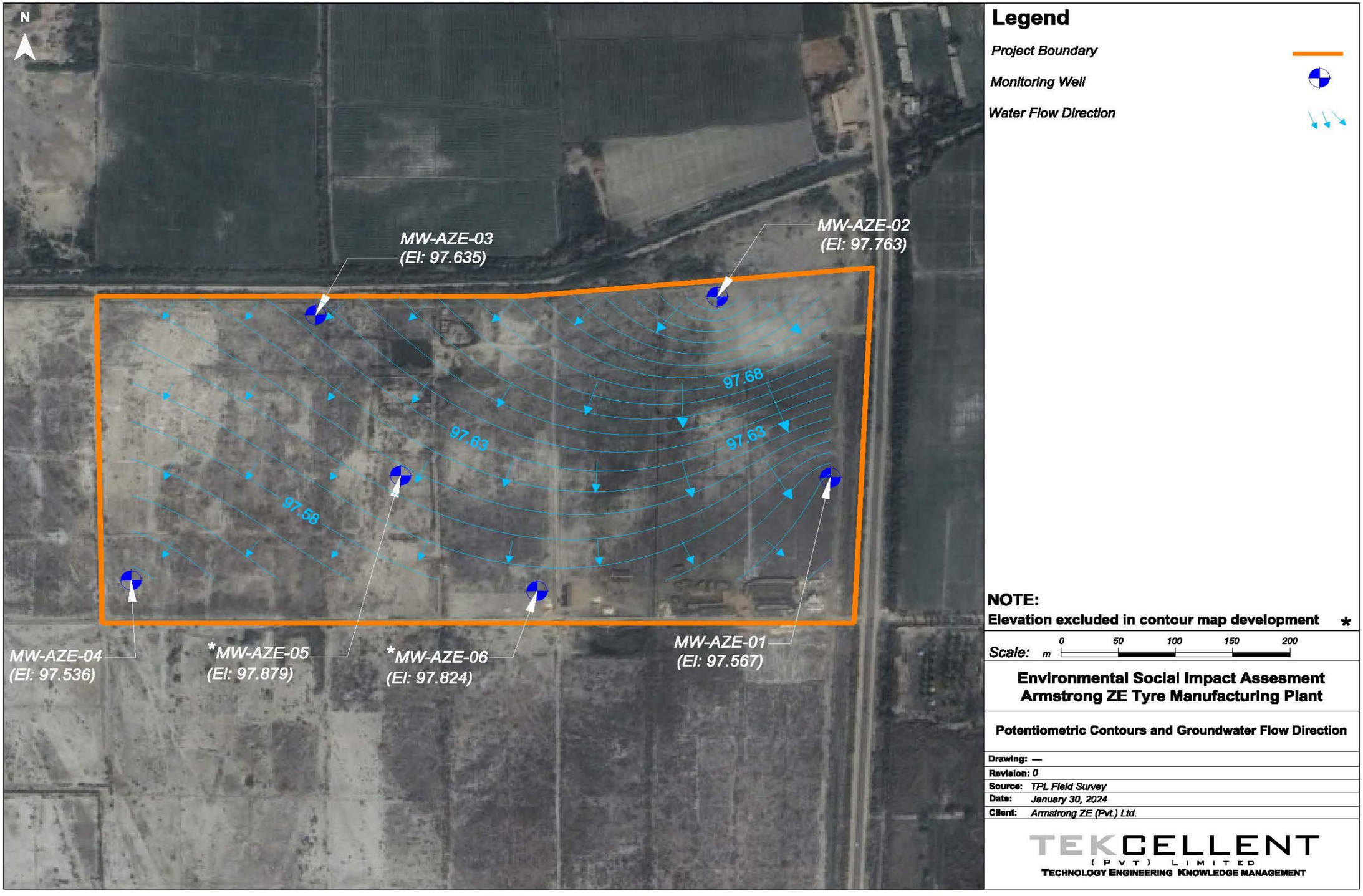


Exhibit 5.38. Influence of Tide Level on Static Water Level (SWL)

Exhibit 5.39. Creek Water Testing Locations

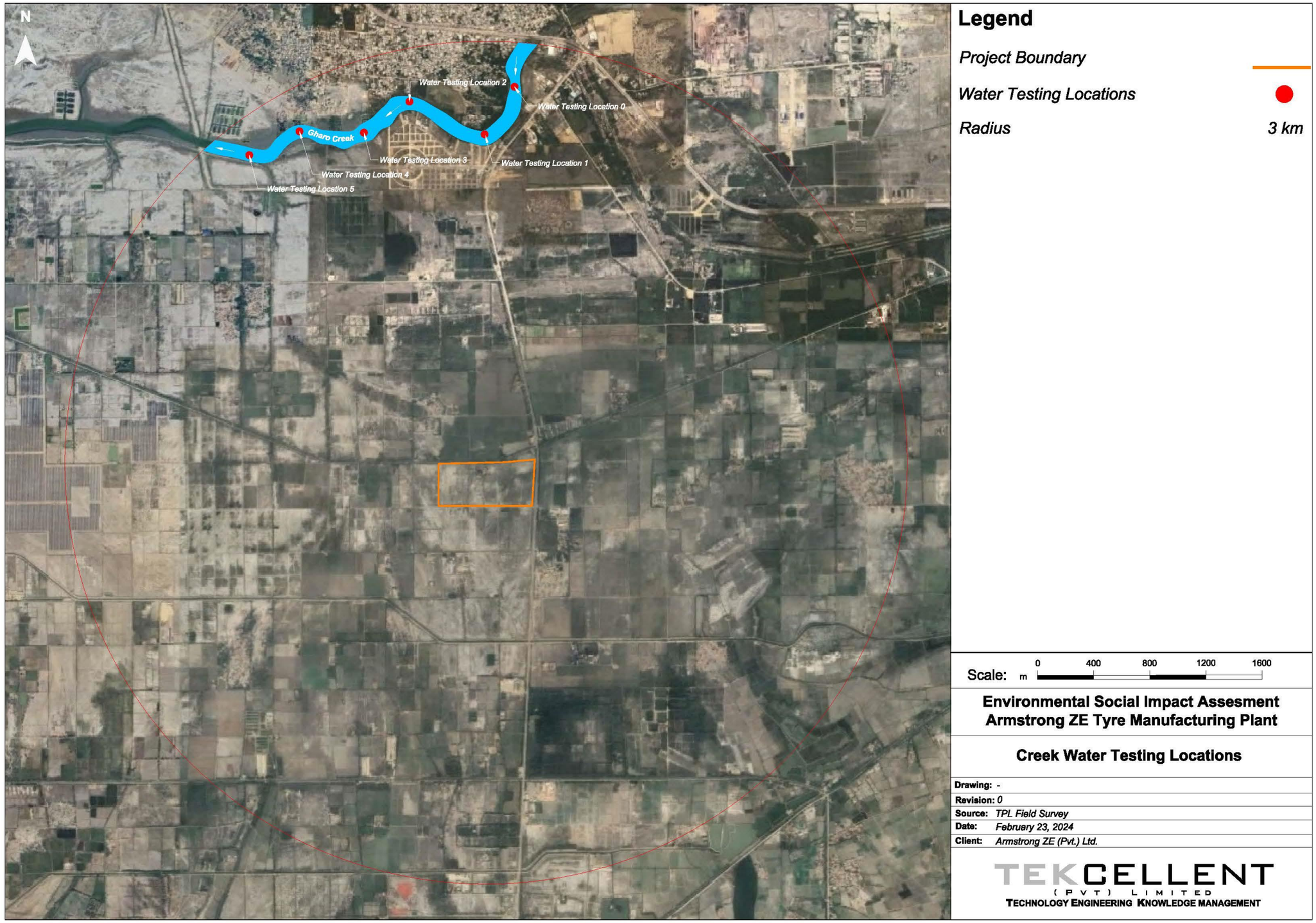
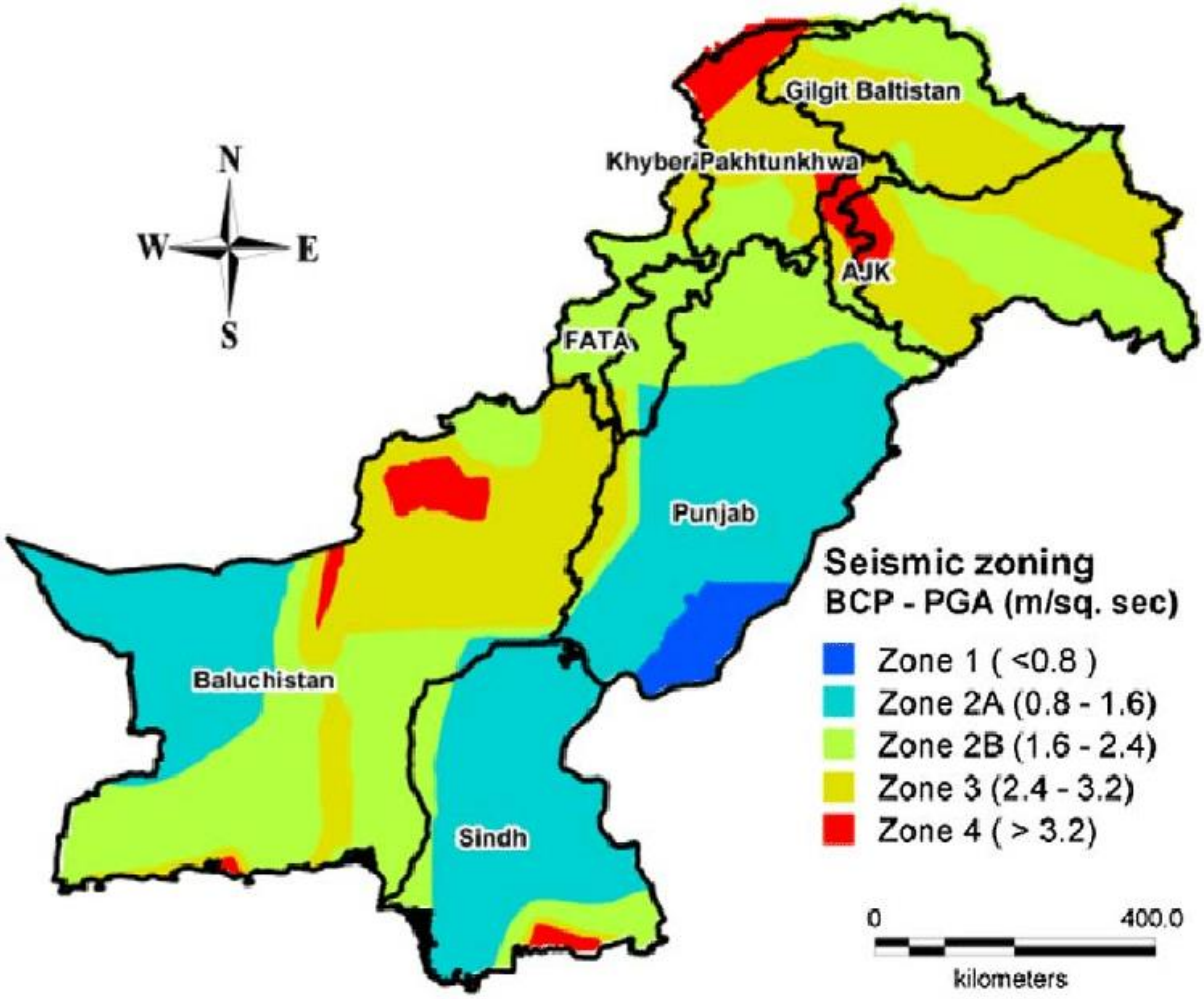


Exhibit 5.40. Water Quality of Samples Collected from Gharo Creek

Date	*Well ID*	*Location*[1]	*Parameter Reading*					*Physical Observations*[2]		
			pH	*TDS (mg/L)*	*ORP (mV)*	*Conductivity (µs/cm)*	*DO (mg/L)*	*Odour*	*Taste*	*Turbidity*
February 1, 2024	Location-00	Gharo Creek, 2655.07 m northeast of the site.	8.27	2,255	129.2	4510	2.2	None	Saline	Clear
February 1, 2024	Location-01	Gharo Creek, 2282.18 m north of the site.	7.15	2,210	110.9	4,420	1.8	None	Slightly Salty	Clear
February 1, 2024	Location-02	Gharo Creek, 2523.31 m northwest of the site.	7.90	2,530	89.6	5,060	1.7	None	Saline	Clear
February 1, 2024	Location-03	Gharo Creek, 2396.72 m northwest of the site.	7.63	2,840	86.3	5,680	1.9	None	Saline	Clear
February 1, 2024	Location-04	Gharo Creek, 2563.59 m northwest of the site.	7.15	2,880	110.8	5,760	2.1	None	Saline	Clear
February 1, 2024	Location-05	Gharo Creek, 2593.35 m northwest of the site.	8.01	3,155	118.9	6,310	2.2	None	Saline	Turbid

Notes:
N.O. = Non-objectionable
1. Samples were taken from the nearest point.
2. Physical observations have been made directly by the TPL staff.

Exhibit 5.41. Seismic Map of Pakistan



Source: BCP, 2007

Exhibit 5.42. Satellite Imagery showing AoI for Biophysical Baseline Survey

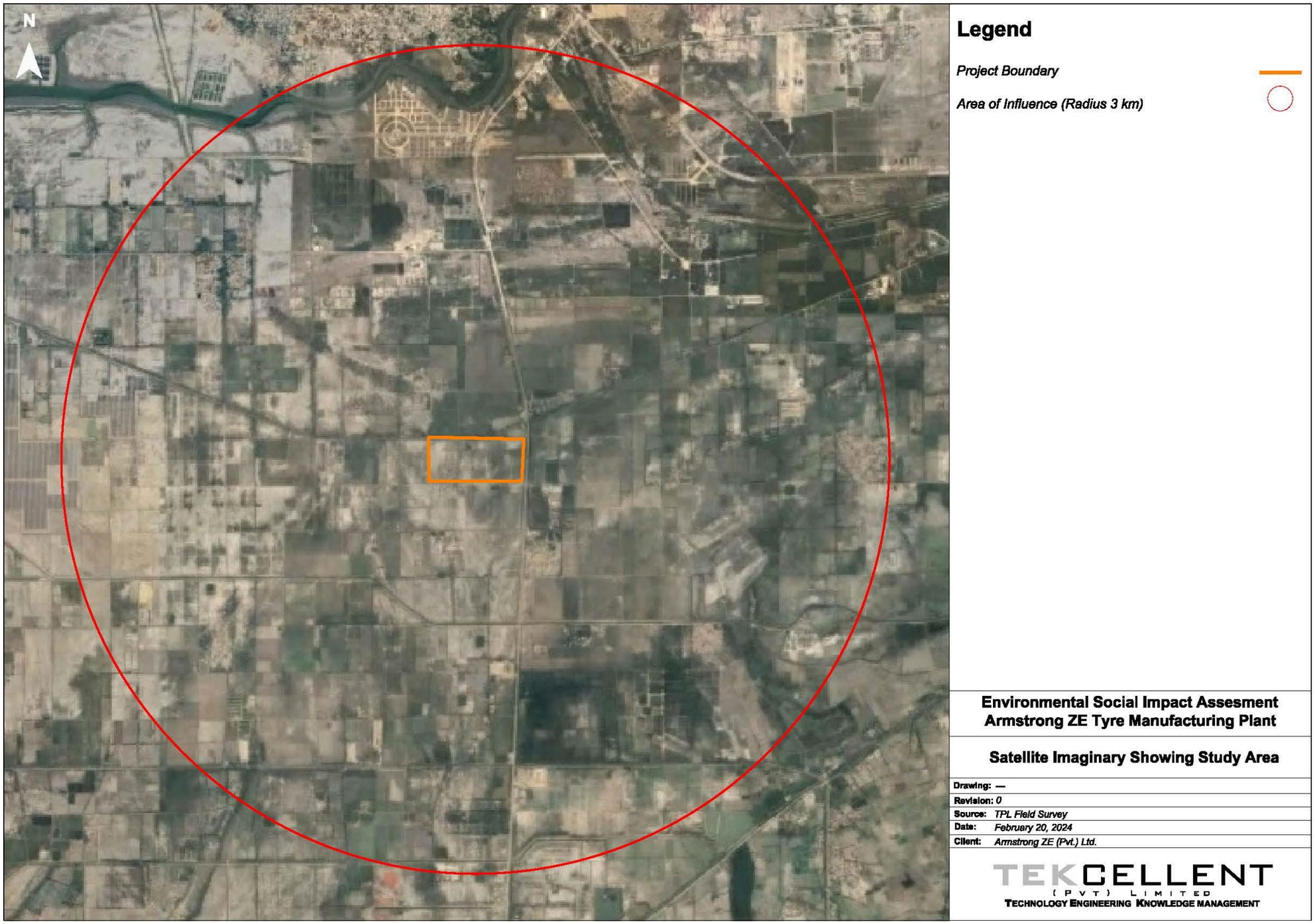


Exhibit 5.43. Survey Locations for Flora

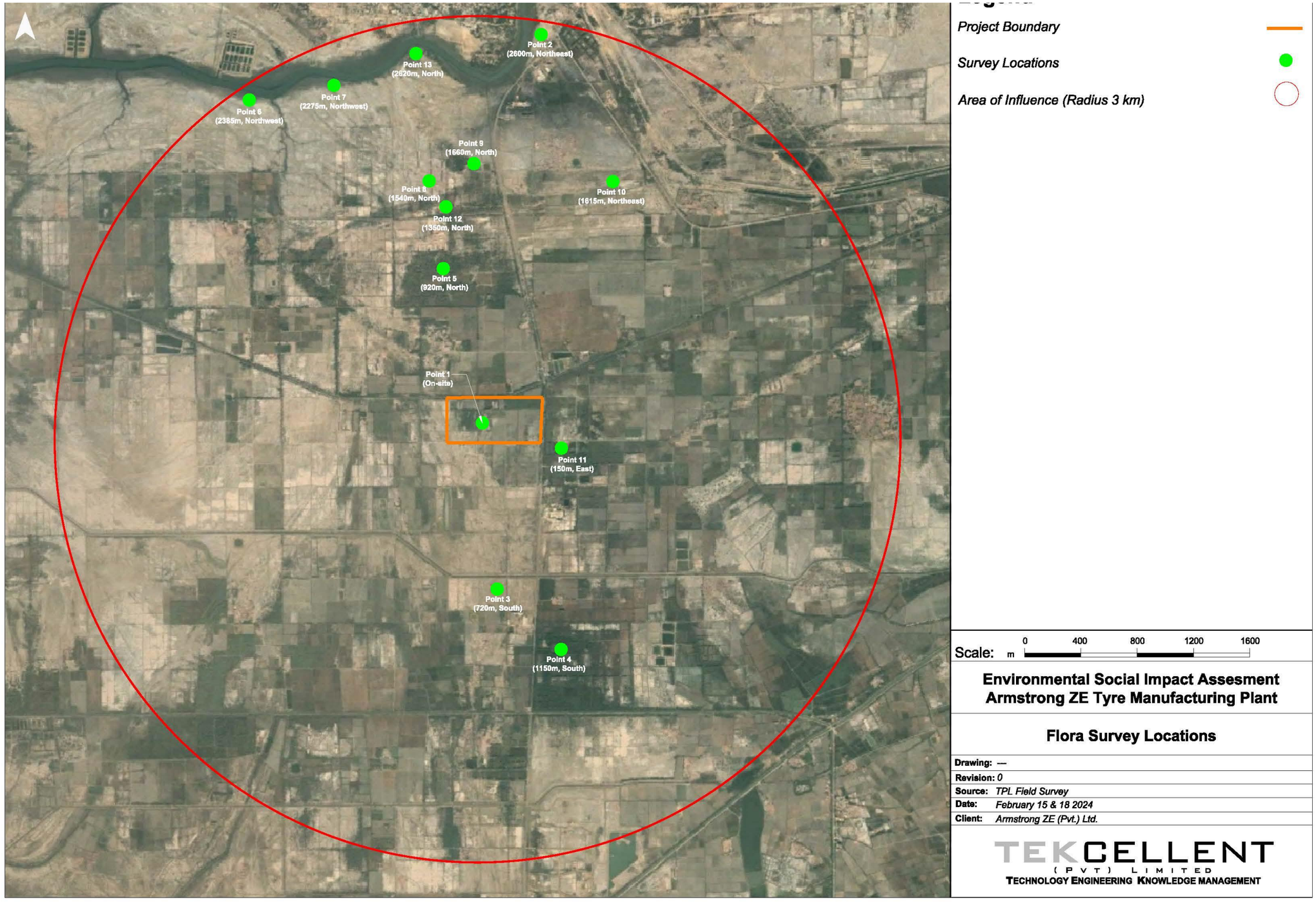
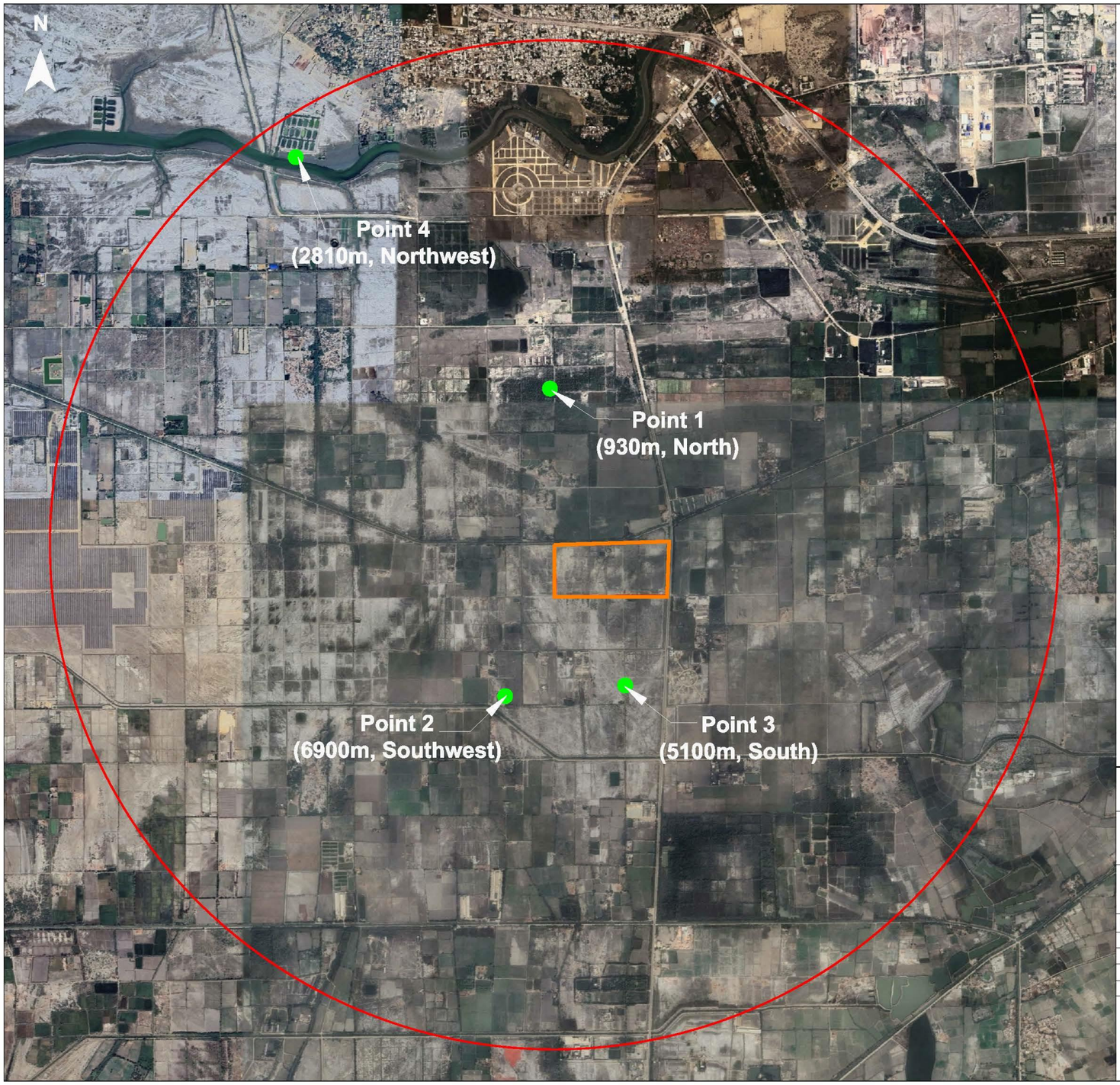


Exhibit 5.44. Survey Locations for Fauna



Legend

Project Boundary

Survey Locations

Area of Influence (Radius 3 km)

Scale: Km 0 250 500 750 1000 1250

Environmental Social Impact Assesment
Armstrong ZE Tyre Manufacturing Plant

Fauna Survey Locations

Drawing:	—
Revision:	*0*
Source:	*TPL Field Survey*
Date:	*February 15 & 18, 2024*
Client:	*Armstrong ZE (Pvt.) Ltd.*

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Exhibit 5.45. List of Floral Species Identified during the Surveys within 3 km AoI

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
1.	*Abutilon sp.*	Indian mallow	Malvaceae	NE	Shrub	Teresstrial	Perennial	
2.	*Acalypha wilkesiana*	Copperleaf, Jacob's coat	Euphorbiaceae	NE	Shrub	Ornamental	Perennial	
3.	*Adenium obesum*	Desert roset	Apocynaceae	LC	Shrub	Ornamental	Perennial	
4.	*Aerva javanica*	Booh	Amaranthacae	NE	Shrub	Xerophtic	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
5.	*Agave americana*	Century Plant	Asparagaceae	LC	Herb	Ornamental	Perennial	
6.	*Allamanda blanchetii*	Purple allamanda	Apocynaceae	NE	Shrub	Ornamental	Perennial	
7.	*Aloe vera*	Kuwar booti	Asphodelaceae	NE	Herb	Ornamental	Perennial	
8.	*Albizia lebbeck*	Siris/ sareh	Fabaceae	LC	Tree	Ornamental	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
9.	*Alhagi maurorum*	Kandero	Fabaceae	NE	Shrub	Xerophytic	Perennial	
10.	*Anagallis arvensis var. coerulea*	Billi Bootit	Primulaceae	NE	Herb	Weed	Perennial	
11.	*Araucaria cunninghamii*	Moreton Bay Pine	Araucariaceae	LC	Tree	Ornamental	Perennial	
12.	*Azadirachta indica*	Neem	Meliaceae	LC	Tree	Cultivated	Perennial	
13.	*Bacopa monnieri*	Waterhyssop	Plantaginaceae	LC	Herb	Aquatic	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
14.	*Bismarckia nobilis*	Bismarck Palm, Satra Palm	Arecaceae	LC	Tree	Ornamental	Pereniial	
15.	*Blepharis sindica*	Bhangari; Asad	Acanthaceae	NE	Herb	Xerophytic	Perennial	
16.	*Brassica campestris*	Mustard/ Saag	Brassicaceae	NE	Herb	Cultivated	Mostly annual	
17.	*Capsicum frutescens*	Mirchi/ Green Chilli/ Bird Pepper	Solanacae	NE	Herb	Agricultural	Perennial	
18.	*Calotropis procera*	Aak, Madar, Mundar	Apocynaceae	LC	Shrub	Xerophytic	Perennial	
19.	*Catharanthus roseus*	Periwinkle	Apocynaceae	NE	Shrub	Ornamental	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
20.	*Caroxylon imbricatum*	Saltwort	Amaranthaceae	NE	Shrub	Halophytic	Perennial	
21.	*Cereus repandus*	Peruvian apple cactus	Cactaceae	LC	Shrub	Ornamental	Perennial	
22.	*Chenopodium album*	Goosefoot	Amaranthaceae	NE	Herb	Weed	Perennial	
23.	*Chenopodium murale*	Nettle-Leaved Goosefoot	Amaranthaceae	NE	Herb	Weed	Perennial	
24.	*Chlorophytum comosum*	Spider plant	Asparagaceae	NE	Herb	Ornamental	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
25.	*Cocos nucifera*	Nariyel/ coconut	Arecaceae	NE	Tree	Cultivated	Perennial	
26.	*Conocarpus lancifolius*	Cono / Damas	Combretaceae	VU	Tree	Invasive	Perennial	
27.	*Cordia myxa*	Lesoro	Boraginaceae	LC	Tree	Cultivated	Perennial	
28.	*Corymbia citriodora*	Safeda/ Lemon Scented Tree	Myrtaceae	LC	Tree	Cultivated	perennial	
29.	*Cressa cretica*	Rudranti	Convolvulaceae	LC	Herb	Halophyte	Annual	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
30.	*Crinum asiaticum*	Poison Bulb, Giant Crinum Lily	Amaryllidaceae	NE	Herb	Ornamental	Perennial	
31.	*Croton bonplandianus*	Ban Tulsi	Euphorbiaceae	NE	Herb	Weed	Annual to perennial	
32.	*Cycas revoluta*	Sago Palm, King Sago Palm	Cycadaceae	LC	Tree	Ornamental	Perennial	
33.	*Delonix regia*	Gulmojhar	Caesalpinaceae	LC	Tree	Ornamental	Perennial	
34.	*Dieffenbachia seguine*	Dumbcane	Araceae	NE	Herb	Ornamental	perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
35.	*Dracaena marginata*	Madagascar Dragon Tree	Asparagaceae	NE	Herb	Ornamental	Perennial	
36.	*Dracaena trifasciata*	Mother-in-law's Tongue	Asparagaceae	NE	Herb	Ornamental	Perennial	
37.	*Dypsis lutescens*	Areca Palm	Aracaceae	NT	Tree	Ornamental	Perennial	
38.	*Echinops echinatus*	Indian Globe Thistle	Asteraceae	NE	Herb	Xerophytic	Annual	
39.	*Eclipta prostrata*	False Daisy / Ink Plant	Asteraceae	LC	Herb	Aquatic	Annual	

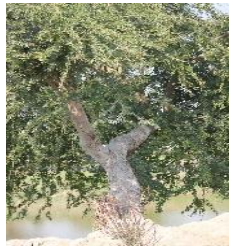
S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
40.	*Eichhornia crassipes*	Water Hyacinth/ Jal Khumbi	Pontederiaceae	NE	Herb	Aquatic	Perennial	
41.	*Euphorbia hirta*	Lal Dodhak	Euphorbiaceae	NE	Herb	Weed	Annual	
42.	*Euphorbia granulata*	Prostrate Spurge	Euphorbiaceae	NE	Herb	Weed	Annual	
43.	*Euphorbia milii*	Crown of Thorns	Euphorbiaceae	LC	Shrub	Ornamental	Perennial	
44.	*Euphorbia tithymaloides*	Devils Backbone	Euphorbiaceae	LC	Shrub	Ornamental	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
45.	*Fagonia indica*	Kandi	Zygophylaceae	NE	Herb	Xerophytic	Perennial	
46.	*Ficus benjamina*	Weeping Fig	Moraceae	LC	Tree	Ornamental	Perennial	
47.	*Ficus religiosa*	Sacred Fig	Moraceae	LC	Tree	Ornamental	Perennial	
48.	*Guilandina bonduc*	Katkaranj, Khayah-i-iblis	Caesalpinaceae	LC	Shrub	Weed	Perennial	
49.	*Hibiscus rosa-sinensis*	China Rose	Malvaceae	NE	Shrub	Ornamental	Perennial	
50.	*Hibiscus schizopetalus*	Coral Hibiscus	Malvaceae	NE	Shrub	Ornamental	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
51.	*Helianthus annuus*	Sunflower	Asteraceae	LC	Shrub	Agricultural	Annual	
52.	*Inula grantioides*	Cutch Inula	Asteraceae	NE	Herb	Xerophytic	Perennial	
53.	*Ipomoea aquatica*	Ganthian, Nari, Nali	Convolvulacae	LC	Herb/climber	Aquatic	Perennial	
54.	*Ipomoea carnea ssp. fistulosa*	Bush Morning Glory	Convolvulacae	NE	Shrub	Aquatic	Perennial	
55.	*Ixora coccinea*	Ixora	Rubiaceae	NE	Shrub	Ornamental	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
56.	*Jasminum sambac*	Arabian Jasmine	Oleaceae	NE	Shrub	Ornamental	Perennial	
57.	*Jatropha integerrima*	Peregrina or Spicy Jatropha	Euphorbiaceae	NE	Shrub	Ornamental	Annual	
58.	*Lagenaria siceraria*	Kadu/Lauki	Cucurbitaceae	NE	Climber	Agricultural	Annual	
59.	*Launaea intybacea*	Wild-Lettuce	Asteraceae	NE	Herb	Weed	Perennial	
60.	*Leucaena leucocephala*	Ipil Ipil	Caesalpinioideae	NE	Tree	Cultivated	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
61.	*Mangifera indica*	Mangro/Amb	Anacardiaceae	data deficient	Tree	Cultivated	Perennial	
62.	*Manilkara zapota*	Cheeko	Sapotaceae	LC	Tree	Cultivated	Perennial	
63.	*Medicago sativa*	Alfalfa	Fabaceae	LC	Herb	Weed	Perennial	
64.	*Melilotus indicus*	Ran-Methi	Papilionaceae	NE	Herb	Weed	Annual	
65.	*Morus nigra*	Shah Tut	Moraceae	NE	Tree	Cultivated	Perennial	
66.	*Nerium oleander*	Nerium	Apocynaceae	LC	Shrub	Ornamental	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
67.	*Ocimum basilium*	Niazbo	Lamiaceae	NE	Herb	Ornamental	Perennial	
68.	*Ocimum tenuiflorum*	Tulsi	Lamiaceae	NE	Herb	Ornamental	Perennial	
69.	*Opuntia ficus-indica*	Prickly Pear	Cactaceae	data defiecient	Shrub	Ornamental	Perennial	
70.	*Parkinsonia aculeata*	Horse Bean, Mexican Palo-Verde	Caesalpinaceae	LC	Tree	Ornamental	Perennial	
71.	*Pithecellobium dulce*	Jungle Jalebi	Fabaceae	LC	Tree	Cultivated	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
72.	*Portulaca grandiflora*	Rose Moss	Aizoaceae	NE	Herb	Ornamental	Annual	
73.	*Pongamia pinnata*	Indian Beech, Poonga Oil Tree	Fabaceae	LC	Tree	Cultivated	Perennial	
74.	*Prosopis juliflora*	Devi	Fabaceae	LC	Shrub	Xerophytic	Perennial	
75.	*Prosopis glandulosa*	Devi /Honey Mesquite	Fabaceae	LC	Tree	Xerophytic	Perennial	
76.	*Phoenix dactylifera*	Date Palm	Arecaceae	LC	Tree	Cultivated	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
77.	*Phyla nodiflora*	Turkey Tangle Fogfruit	Verbenaceae	LC	Herb	Aquatic	Perennial	
78.	*Plumeria obtusa*	White Champa	Apocynaceae	LC	Tree	Ornamental	Perennial	
79.	*Psidium guajava*	Guava/Amrood	Myrtaceae	LC	Tree	Cultivated	Perennial	
80.	*Ruellia brittoniana*	Mexican Petunia	Acanthaceae	NE	Herb	Ornamental	Perennial	
81.	*Solanum lycopersicum*	Tamatar/ Tomatoes	Solanaceae	NE	Herb	Cultivated	Perennial	
82.	*Solanum melongena*	Eggplant	Solanaceae	NE	Herb	Cultivated	Perennial	

S#	Scientific Name	Common Name / Local Name	Family Name	IUCN Status	Type	Habitat	Life-span	Photos
83.	*Salvadora persica*	Khabr	Salvadoraceae	LC	Shrub	Halophytic	Perennial	
84.	*Sida alii var. ovata*	Sida	Malvaceae	NE	Herb	Weed	Annual to perennial	
85.	*Solanum surattense*	Kundiari, Momoli, Mokri	Solanaceae	NE	Herb	Weed	Perennial	
86.	*Salvinia molesta*	Kariba Weed	Salviniaceae	NE	Herb	Aquatic	perennial or annual.	
87.	*Sonchus asper*	Prickly Sowthistle	Asteraceae	NE	Herb	Weed	Annual or Biennial	
88.	*Sonchus oleraceus*	Common Sowthistle	Asteraceae	NE	Herb	Weed	Annual	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
89.	*Sesbania sesban*	Jantar	Caesalpinaceae	LC	Shrub	Cultivated	Annual	
90.	*Spergularia marina*	Salt Sandspurry	Caryophyllaceae	LC	Herb	Weed	Annual	
91.	*Suaeda fruticosa*	Laani/ Laana	Chenopodiaceae	NE	Sub-shrub	Halophytic	Semi-perennial	
92.	*Suaeda vermiculata*	Seablite	Chenopodiaceae	NE	Shrub	Halophytic	Perennial	
93.	*Tagetes patula*	French Marigold	Asteraceae	NE	Shrub	Ornamental	Annual	

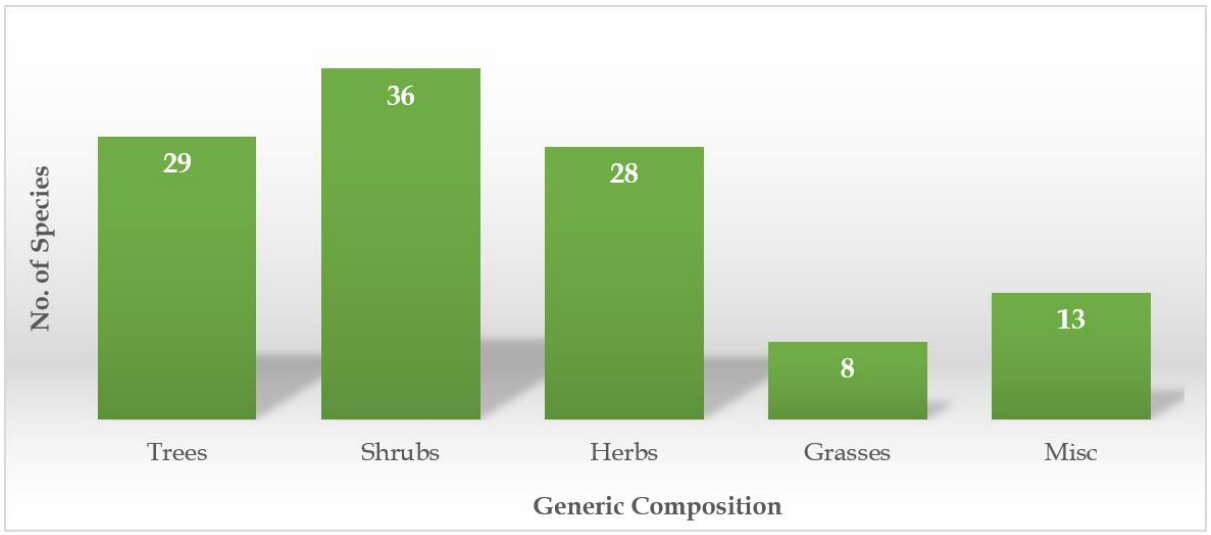
S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
94.	*Tamarindus indica*	Imli	Fabaceae	LC	Tree	Cultivated	Perennial	
95.	*Tamarix aphylla*	Athel Pine		LC	Tree	Halophytic	Perennial	
96.	*Tamarix indica*	Lai Dhadhi/Lao	Tamaricaceae	NE	Shrub	Halophytic	Perennial	
97.	*Tecticornia indica*	Glasswort	Amaranthaceae	NE	Shrub	Halophytic	Annual or Perennial	
98.	*Tecomaria capensis*	Cape Honey Suckle	Bignoniaceae	LC	Shrub	Ornamental	Perennial	
99.	*Terminalia catappa*	Badam/ Indian Almond	Combretaceae	LC	Tree	Cultivated	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
100.	*Tribulus terrestris*	Puncture Vine	Zygophyllaceae	LC	Herb	Xerophytic	Perennial	
101.	*Typha latifolia*	Cattail	Typhaceae	LC	Herb	Aquatic	Perennial	
102.	*Vachellia nilotica*	Babur/ Gum Arabic Tree	Fabaceae	LC	Tree	Xerophytic	Perennial	
103.	*Vachellia nilotica subsp. Indica*	Babur	Mimosaceae	NE	Tree	Xerophytic	Perennial	
104.	*Wodyetia bifurcata*	Foxtail Palm	Arecaceae	data deficient	Tree	Ornamental	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
105.	*Yucca aloifolia*	Aloe Yucca, Dagger Plant	Asparagaceae	Data Deficient	Shrub	Ornamental	Perennial	
106.	*Zygophyllum simplex*	Alethi, Putlani	Zygophyllaceae	NE	Herb	Halophytic	Perennial	
				Grasses				
107.	*Aeluropus lagopoides*	Mangrove Grass	Poaceae	NE	Grass	Halophytic	Perennila	
108.	*Chloris barbata*	Ganni, Jargi	Poaceae	NE	Grass	Mesophytic	Annual or Perennial	
109.	*Cynodon dactylon*	Dub, Khabbal	Poaceae	NE	Grass	Xerophytic	Perennial	
110.	*Cyperus rotundus*	nutgrass	Cyperaceae	LC	Grass	Mesophytic	Perennial	

S#	*Scientific Name*	*Common Name / Local Name*	*Family Name*	*IUCN Status*	*Type*	*Habitat*	*Life-span*	*Photos*
111.	*Dactyloctenium scindicum*	crowfoot grass	Poaceae	NE	Grass	Xerophytic	Perennial	
112.	*Desmostachya bipinnata*	Drubh/Halfa Grass	Poaceae	LC	Grass	Mesophytic	Perennial	
113.	*Phragmites australis*	Common Reed	Poaceae	LC	Grass	Aquatic	Perennial	
114.	*Triticum aestivum*	Common wheat	Poaceae	NE	Grass	Agricultural	Annual	

Exhibit 5.46. Generic and Phenological Composition of Identified Floral Species



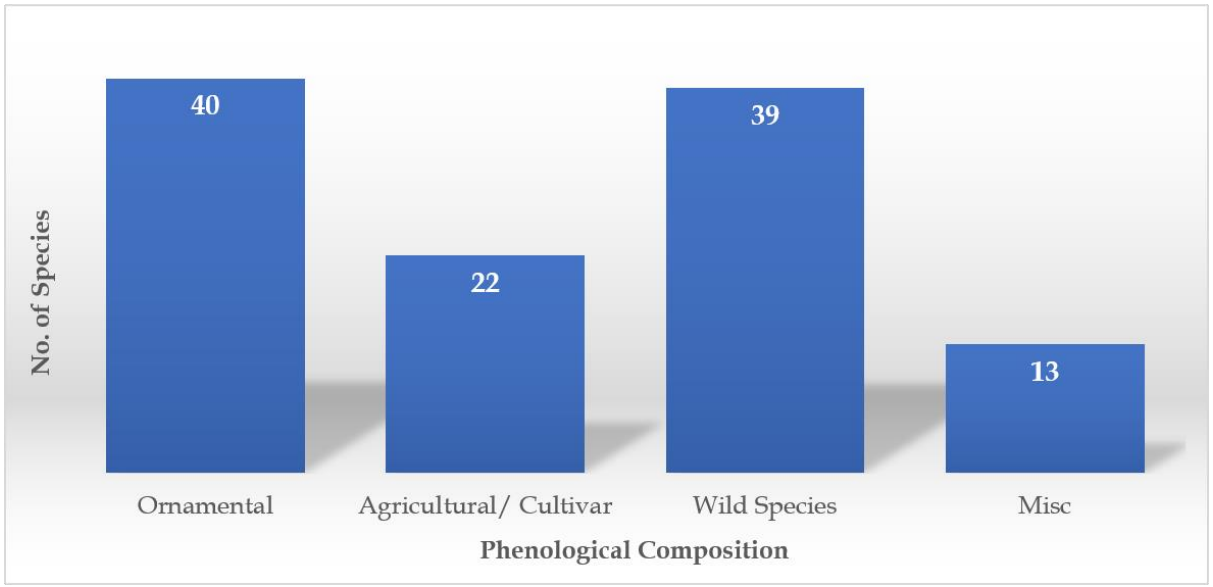
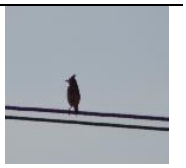
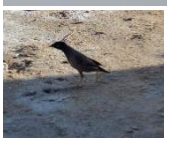
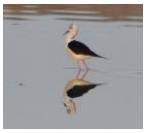
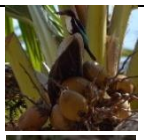
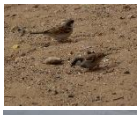
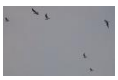
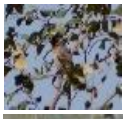


Exhibit 5.47. List of Avifauna Identified during Surveys within 3 km AoI

No.	Common Name	Scientific Name	Status		Occurrence				Conservation Status	Evidence
			Migratory	Resident	Common	Abundant	Less Common	Rare	IUCN Listing	Pictures
1.	Ashy Headed Finch Lark	*Eremopterix grisea*		x	x				LC	
2.	Bank Myna	*Acridotheres ginginianus*		x	x				LC	
3.	Bay Backed Shrike	*Lanius vittatus*		x	x				LC	
4.	Black Drongo/King Crow	*Dicrurus macrocercus*		x	x				LC	
5.	Black Kite	*Milvus migrans*		x	x				LC	
6.	Black Partridge	*Francolinus francolinus*		x			x		VU	Not encountered, but reported before in the area
7.	Black-Winged Stilt	*Himantopus himantopus*	x		x				LC	
8.	Blue Cheeked Bee-Eater	*Merops superciliosus*	x				x		LC	
9.	Blue Rock Pigeon	*Columba livia*		x		x			LC	
10.	Cattle Egret	*Bubulcus ibis*		x	x				LC	
11.	Collared Dove	*Streptopelia decaocto*		x	x				LC	

No.	Common Name	Scientific Name	Status		Occurrence				Conservation Status	Evidence
			Migratory	Resident	Common	Abundant	Less Common	Rare	IUCN Listing	Pictures
12.	Common/Blue Kingfisher	*Alcedo atthis*		x	x				LC	
13.	Common Babbler	*Turdoides caudatus*		x		x			LC	
14.	Crested Lark	*Galerida cristata*		x		x			LC	
15.	Crow Pheasant	*Centropus sinensis*		x	x				LC	
16.	Grey Partridge	*Francolinus pondicerianus*		x	x				LC	Not encountered, but reported before in the area
17.	House Crow	*Corvus splendens*		x	x				LC	
18.	House Sparrow	*Passer domesticus*		x		X			LC	
19.	House Swift	*Apus affinis*		x	x				LC	
20.	Indian River Tern	*Sterna aurantia*		x	x				VU	
21.	Indian Robin	*Saxicoloides fulicata*		x	x				LC	
22.	Indian Roller	*Coracias benghalensis*		x	x				LC	
23.	Indian Tree-Pie	*Dendrocitta vagabunda*		x	x				LC	

No.	*Common Name*	*Scientific Name*	*Status*		*Occurrence*				*Conservation Status*	*Evidence*
			Migratory	*Resident*	*Common*	*Abundant*	*Less Common*	*Rare*	*IUCN Listing*	*Pictures*
24.	Indian/Common Moorhen	*Gallinula chloropus*	x		x				LC	
25.	Indian/Common Myna	*Acridotheres tristis*		x	x				LC	
26.	Jungle Babbler	*Turdoides striatus*		x			x		LC	
27.	Little Egret	*Egretta garzetta*		x	x				LC	
28.	Little Green Bee-Eater	*Merops orientalis*		x		X			LC	
29.	Little Owl	*Athene noctua*		x			x		LC	Not encountered, but reported before in the area
30.	Little Tern	*Sterna albifrons*	x				x		LC	
31.	Paddy Bird/Indian Pond Heron	*Ardeola grayii*		x	x				LC	
32.	Pied Bushchat	*Saxicola caprata*		x	x				LC	
33.	Wagtail	*Motacilla*		x	x				LC	
34.	Pied Kingfisher	*Ceryle rudis*		x	x				LC	
35.	Red-Vented Bulbul	*Pycnonotus cafer*		x	x				LC	
36.	Red-Wattled Lapwing	*Hoplopterus indicus*		x	x				LC	

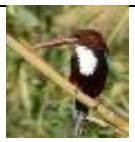
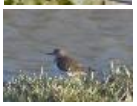
No.	*Common Name*	*Scientific Name*	*Status*		*Occurrence*				*Conservatio -n Status*	*Evidence*
			Migratory	*Resident*	*Common*	*Abundant*	*Less Common*	*Rare*	*IUCN Listing*	*Pictures*
37.	White-Breasted Kingfisher	*Halcyon smyrnensis*		x	x				LC	
38.	White-Cheeked Bulbul	*Pycnonotus leucogenys*		x	x				LC	
39.	Greater Cormorant	*Phalacrocorax carbo*	x			X			LC	
40.	Sea Gull	*Larinae*	x			X			LC	
41.	Plain Prinia	*Prinia inornata*		x	x	X			LC	
42.	Lesser Sand Plover	*Charadrius mongolus*	x		x	X			LC	
43.	Common Snipe	*Gallinago gallinago*	x	x		X			LC	
44.	Brahminy Kite	*Haliastur indus*		x	x				LC	
45.	Bonelli's Eagle	*Aquila fasciata*	x			X			LC	
46.	Marsh Harrier	*Circus aeruginosus*	x				x		LC	

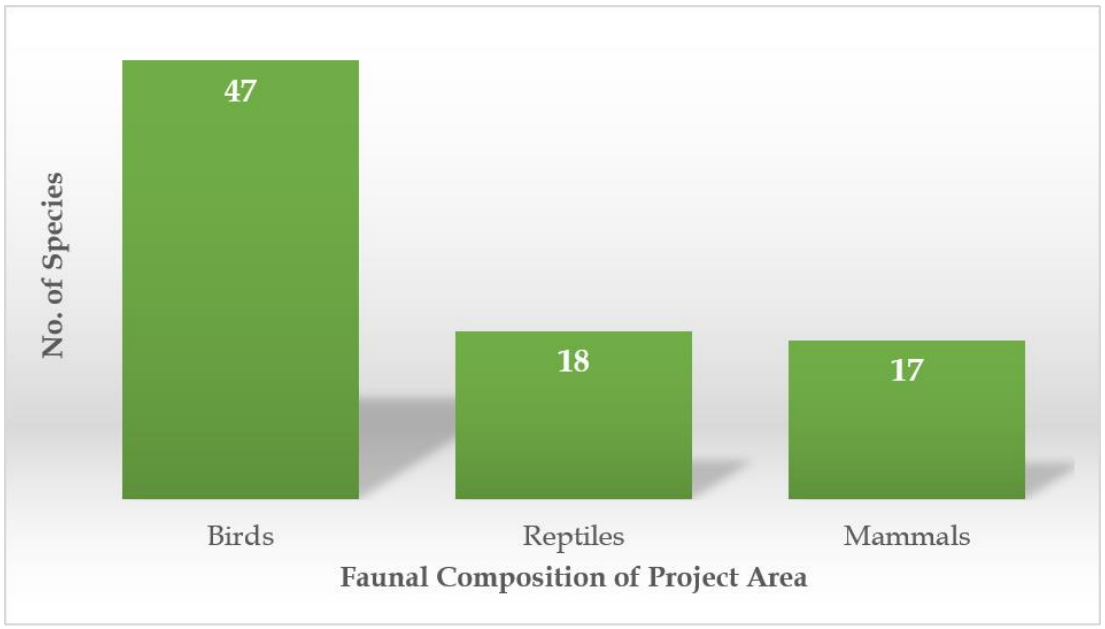
Exhibit 5.48. List of Mammals based on literature review of the Gharo region

No.	Common Name	Scientific Name	Occurrence				Listing		
			Common	Abundant	Less Common	Rare	WPO/Act	IUCN Red List	CITES Appendix
1.	Asiatic jackal	*Canis aureus*	x					LC	III
2.	Balochistan gerbil	*Gerbillus nanus*	x					LC	
3.	Desert cat	*Felis silverstris*			x			LC	III
4.	Desert hare	*Lepus tibetanus*			x			LC	
5.	Five stripped palm squirrel	*Funambulus pennantii*	x					VU	
6.	Egyptian Fruit Bat	*Rousettus egyptiacus arabicus*			x			LC	
7.	House mouse	*Mus musculus*	x					LC	
8.	Indian/Bengal fox	*Vulpes bengalensis*			x			LC	
9.	Indian bush rat	*Golunda ellioti*	x					LC	
10.	Indian desert jird	*Meriones hurrianae*	x					LC	
11.	Indian gerbil	*Tatera indica*		x				LC	
12.	Indian grey mongoose	*Herpestes edwardsi*	x					LC	III
13.	Indian porcupine	*Hystrix indica*	x					LC	
14.	Indian wild boar	*Sus scrofa*	x					LC	
15.	Little Indian field mouse	*Mus booduga*	x					LC	
16.	Long eared desert hedgehog	*Hemiechinus collaris*	x					LC	
17.	Small Indian mongoose	*Herpestes javanicus*	x				x	LC	III

Exhibit 5.49. List of Reptiles based on literature review of the Gharo region

No.	Common Name	Scientific Name	Occurrence			Listing
			Common	Less Common	Rare	IUCN Red List
1.	Brahminy blind snake	*Typhlops braminus*		x		LC
2.	Brilliant agama	*Trapelus agilus isolepis*	x			LC
3.	Checkered keelback	*Xenochrophis piscator piscator*		x		LC
4.	Indian Cobra	*Naja naja*		x		LC
5.	Common ground agama	*Trapelus ruderata baluchiana*		x		LC
6.	Desert monitor lizard	*Varanus griseus koniecznyi*		x		EN
7.	Dhaman/Rat snake	*Ptyas mucosus*	x			NT
8.	Garden lizard	*Calotes versicolor*	x			LC
9.	Glossy bellied racer	*Coluber vetromaculatus*	x			LC
10.	Indian monitor lizard	*Varanus bengalensis*	x			EN
11.	Indian sand boa	*Eryx johnii johnii*		x		NT
12.	Pakistan ribbon snake	*Psammophis leithii*		x		LC
13.	Royal diadem snake	*Spalerosophis diadema diadema*		x		DD
14.	Saw scaled viper	*Echis carinatus pyramidum*	x			LC
15.	Spotted Indian House Gecko	*Hemidactylus brookii brookii*	x			LC
16.	Yellow bellied house gecko	*Hemidactylus flaviviridis*	x			LC
17.	Indian flap shell turtle	*Lissemys punctate*		x		VU
18.	Common garden skink	*Lampropholis guichenoti*	x			LC

Exhibit 5.50. Composition of Identified Faunal Species



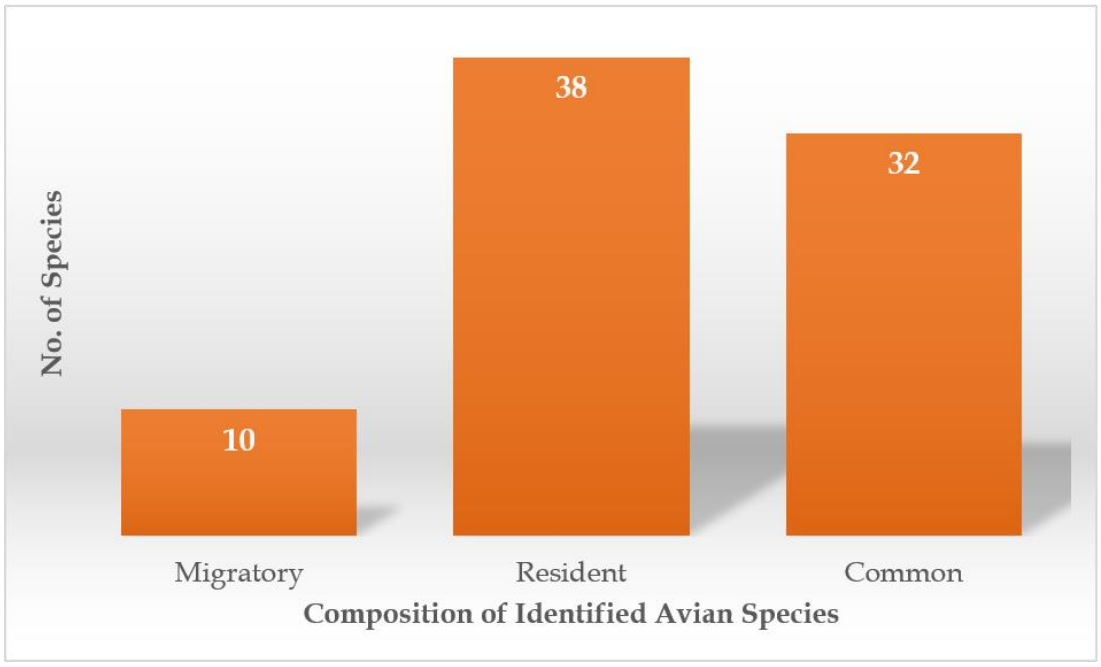
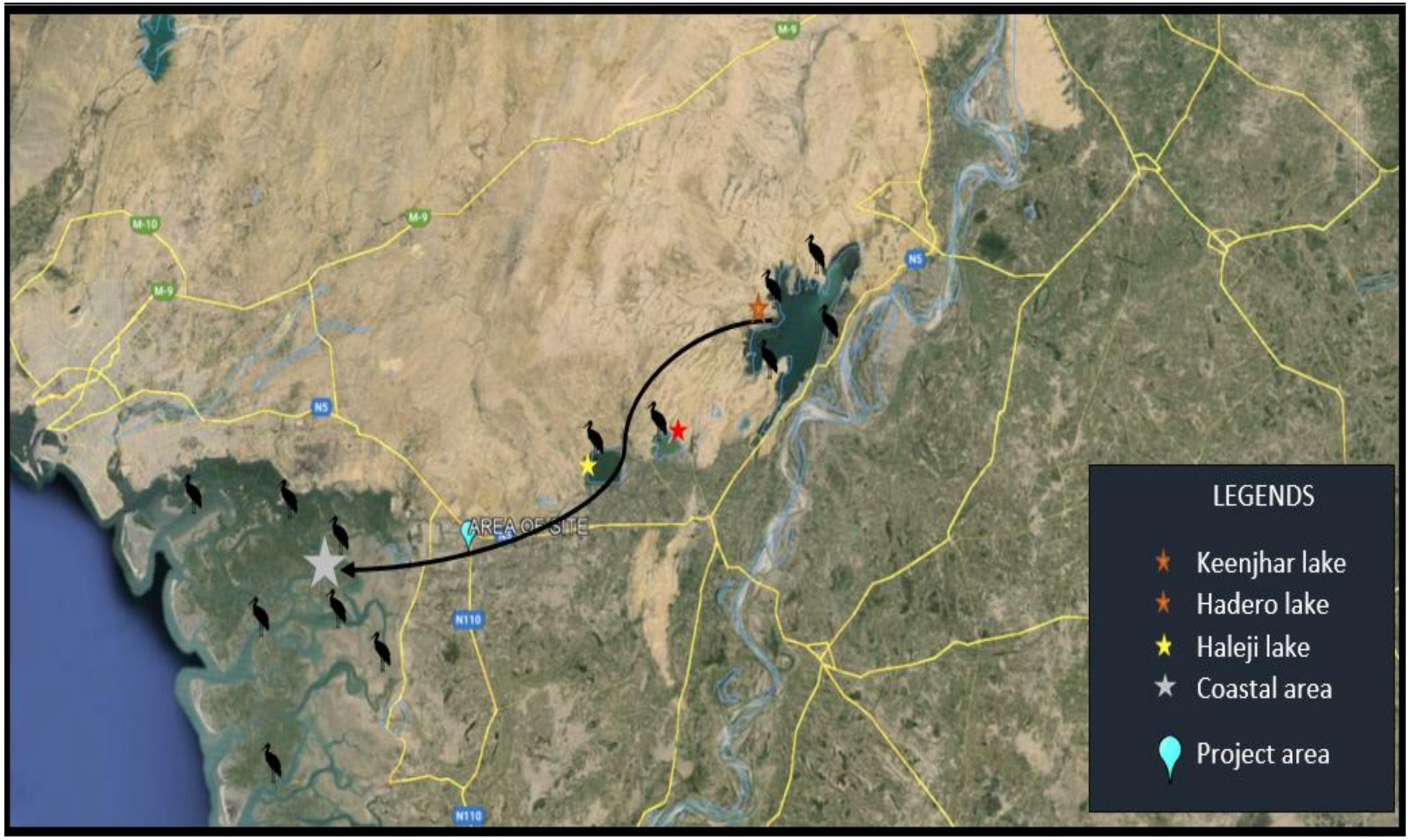


Exhibit 5.51. Indicative Route of Migratory Birds during Winter season



6. Social and Socio-Economic Baseline

6.1 Social Area of Influence (SAoI)

6.1.1 Primary SAoI

The areas of influence for direct social and socio-economic impacts include the households and communities that will be affected by the project footprint due to:

- Project location within the project footprint.
- Project location within the area(s) of influence for environmental resources, such as air or water quality, noise and vibration, visual and landscape etc.
- Impacts on livelihood resources that will be affected by the Project.
- Ecosystem services that will be impacted by the Project.

Based on the nature of the social dynamics and presence of communities in the project area, a primary AoI of 3-kilometer has been taken for this study to assess the impacts on the social and socio-economic environment.

6.1.2 Secondary SAoI

The areas of influence also consider populations that will experience indirect or induced impacts that may not be within the direct control of the project, such as:

- Economic opportunities associated with employment and economic spend.
- Interaction with the workforce.
- Use of services by workforce.
- In-migration of workers from other areas.

Project management has indicated that local community will be given priority in terms of employment, however, it's imperative for Armstrong ZE to ensure that contractors also adhere to it.

Moreover, the area of indirect social influence also include the socio-institutional space arising from the relationship of the project with political/territorial units where the project takes place within a region.

Extensive fieldworks were conducted to identify and map the stakeholders that have to be consulted. The identification and mapping was done after the scoping activity. Based on the fieldworks conducted from February 11, 2024 to March 1, 2024, the secondary areas of influence was identified to include the institutional stakeholders such as Hyderabad Electric Supply Corporation (HESCO) in Mirpur Sakro, Sindh Wildlife Department in Karachi,

Sindh Environmental Protection Agency (SEPA) in Karachi, Pakistan Meteorological Department (PMD) and Department of Antiquities and Archeology.

6.2 Demographic Profile

District Thatta has a total population of 982,138 individuals according to the census of 2017 (PBS, 2017a). Further in 2023, the population was found to increase at a rate of 1.65% and reported to be 1,083,191 with 206,281 households. The district has a population density of 127 persons per square kilometres. The average size of household as reported by Population and Housing Census 2023 is 5.25 (PBS, 2023). Complete results of Census 2023 are however not available so far.

The population of Tehsil Mirpur Sakro is 341,689 with 64,741 households, of which 86.2% population live in rural areas, while 13.7% is in urban areas. There are 52% male and 48% females with population density per square kilometres is 115.51. The average household size in the tehsil is 5.31 (PBS, 2017d).

Local communities have been identified through site visits during the scoping and analysis of the area using satellite imagery to identify settlements. All the settlements that were identified were selected for consultation to understand the local dynamics of the area and offer equal opportunity to each of them to voice their opinions and concerns related to the project. Prior to the site visits, survey forms were developed to collect data for baseline information and the Background Information Document was finalized with Armstrong ZE in the local language to provide information about the project. A total of around 50 people were consulted from all settlements identified in the project's AoI. Around 80% of the surveyed households belong to the project area by descent while 20% have migrated from other areas including Sanghar and Badin due to the availability of working opportunities. The migrant communities are basically nomadic who transiently establish residence where resources are available and relocate when alternative opportunity arises. One settlement of Mallah community with three households with a total population of 18 individuals including men, women and children was identified residing 10 m outside the project boundary wall on government owned land. Their kacha homes are made of straw, wood and thatched roofs. The nomads have been served an eviction notice by the government to vacate the land. They were consulted during the ESIA consultations, and did not express any concerns with regard to the project. There was almost an equal ratio of male and female population and except for Kohli communities, both men and women work as labour in agricultural areas to earn livelihood. An overview of the settlements identified within 3 km vicinity of the project area is captured in Exhibit 6.1 and their locations on the satellite imagery is indicated in Exhibit 6.2.

6.3 Linguistics

Sindhi is the most prominent language in the district with 62% people speaking Sindhi. It is followed by Urdu (18.20%), Pashto (5.5%), Punjabi (5.3%), Balochi (2%), Seraiki (2.2%),

Hindko (1.6%) and others (3.6%) (PBS, 2017c). The situation is similar in the immediate project area with majority Sindhi-speaking population.

6.4 Religion and Ethnic Profile

As per the 2017 census, 90.3% people in Sindh province follow Islam with Hindus comprising of only 7% of the population. In contrast, rural areas have a larger population of Hindus constituting 5% of the total population of the province. Other minority religious groups include Christians (0.85%), Ahmadiyas (0.05%) and others (1.77%) (PBS, 2017b). The population in the project's AoI comprised of Muslims and Hindu community.

Majority of the population are of Sindhi descent and most of the population in Thatta district belong to the Sunni sect, further classified into sub-sects such as Sayed, Samma, Jokhio, Palejo, Baloch, Rind, Khaskheli, Khawaja, Memon, Mallah, Mirbahar, Jat, Lashari, Jamali castes. The castes present in the project AoI included Mallah, Bukhero, Kohli, Samoo and Jokhio. Small settlements of two Baloch groups were also identified.

6.5 Social Infrastructure

The social setup in the project area exhibits a strong biradri (kinship) system, which defines the inter- and intra-community hierarchy, gender dynamics and allegiance, and also plays an important role in conflict resolution at the local level. Every social group has its own Sardar or Mukhia (Tribal leader), who represents the entire community. Most of the disputes among the community members are resolved at the community/ village level by the Sardar. The marriages are held within castes and there is no concept of inter-cast marriages so they live in close kinship. Typical Sindhi culture is followed which is also evident through their Autaq (gathering) system.

Women besides their household chores, are also involved in earning livelihood by working in fields or by rearing livestock. Those who are involved in fields or other labour based jobs often earn on daily wages. Women are also involved in stitching and embroidery and making handicrafts but they do it for their own household use only or sell it to other women in neighbouring settlements.

6.6 Economic Profile

Out of the area under cultivation for major crops, District Thatta contributes to 155,194 hectares with rice and sugarcane being major crops cultivated in the district. Canals and tube wells are the mode of irrigation in the district where 90% of agricultural land is irrigated by Canals while 10% by tube wells.

Total area under forest cover in Sindh is 28,073 hectares out of which the forest cover in Thatta is 12,053 hectares (10.3%). The district has 5% of the total livestock headcount of the province including cattle, goats, buffaloes, sheep and poultry. Fishing is also one of key sources of livelihood and 6.5% of the fish catch of the province is from Thatta. The district

also has 17 manufacturing units with average daily employment is 4,968. The district has a road network of 1,345 km.

The project itself is the first industrial facility in the immediate vicinity, however, there are various commercial entities in the site vicinity including farmhouses, food processing establishments, fishing ponds etc. Agriculture and livestock rearing are the key occupations identified in the project area. However, most of the settlements belong to low income groups and the ownership of agricultural land lie with landlords living in Karachi and other cities of Punjab. The local community is engaged in working on fields against daily wages or a percentage of yield.

6.6.1 Poverty

Multi-Dimensional Poverty Index (MDPI) measures the number of people/households that are 'multi-dimensionally' poor. Essentially, it means the number of people (or HHs) deprived in at least one-third of the weighted indicators along with the weighted average number of deprivations poor people experience at the same time. The weighted indicators are along the dimensions of education, health, and living Standards in District Thatta, the MPI value is 0.60. Reportedly, a significant 69.0% of household members in District Thatta are in severe poverty (GoS, 2022b).

6.7 Housing

In District Thatta, 88.4% of population owns houses while 11.7% do not own their houses (4.4% rented). According to MICS 2018-19, the average number of persons per room in Thatta is 4.9. Only 39.8% of households in Thatta have *Pacca* roofing while only 38.1% have *Pacca* walls (GoS, 2022b). By definition, kuccha houses are typically need-based or temporary structures made of clay, soil, mud, grass, bamboo, thatc, cloth rags or similar materials. Pucca houses in contract are proper concrete structures made of iron, bricks, cement, and steel.

The housing structures in the project AoI are mostly *kuccha* houses that are semi-permanent and comprise of walls generally made of locally available mud and thatched roofs. The housing structures made of brick and mud were found in Settlement 6 only where some people have tried to improve their housing after the floods of 2022.

6.8 Utilities

Access to basic facilities like clean drinking water, toilets and sanitation services provide a holistic supply-side service provision coverage in a district. In District Thatta, 82.0% of households have improved sources of drinking water while 24.4% of households have access to improved sanitation services. The prevalence of open defecation in Thatta is 58.4% (GoS, 2022b).

During the site visits, it was found that local population use groundwater for drinking which is drawn through hand pumps. Moreover, as they are mostly nomadic in nature with

informal housing structures and no access to toilets or sanitation facilities, they practice open defecation.

6.9 Health Facilities

The health facilities available in Thatta are as follows that have the capacity to serve 28,923 indoor while 1,111,130 outdoor patients.

Type of facility	Number	Capacity (No. of Beds)
Government, Departmental, Private and Local Bodies Hospitals	8	300
Basic Health Units (BHUs)	22	44
Rural Health Centres (RHCs)	6	80
Dispensaries	91	10
Mother & Child Health Centers (MCHCs)	6	4
Maternity Home	1	

In terms of ante-natal care coverage, 64.7% of women (15-49 years) are attended at least once by skilled health personnel and 74.7% of women reported having health checks following birth at home or facility. The prevalence of premature births is 5.4% in the district (GoS, 2022b).

Settlements in the project area do not have any healthcare services; therefore, health conditions were poor in the area. Generally, villagers access Gharo for treatment of major and minor diseases. The cost of healthcare in the project area is exorbitant due to the associated transportation charges, consultation fees and availability of medicines.

Generally prevailing diseases in the project area includes diabetes, hepatitis, diarrhoea, fever, flu and cough etc.

6.10 Educational Facilities

District of Thatta has a total of 1,607 public schools of which there are 552 schools for boys, 182 schools for girls, and 873 mixed schools. The total enrolment include 64.8% boys and 35.2% girls. There are 1,727 male teachers and 663 female teachers in the schools in Thatta. At district level, there are 908 functional schools in Thatta while 699 schools are dysfunctional, non-functional, non-viable or closed. Male literacy rate (15-49 years) in Thatta is 26.5% compared to 59.0% in Sindh while the female literacy rate is 14.3% compared to 40.9% in Sindh (GoS, 2022b).

During the field visits, no public school in the project's AoI was found. However, some people have taken initiative of home schooling their children by gathering children from different households and hiring a teacher for them. There is one primary school run by The Citizens Foundation (TCF) in the vicinity of project area, however, enrolment ration from

project area is low. Overall, literacy rate in the project area is not very encouraging with only 15% men and 5% women can read and write.

6.11 Ecosystem Services

European Environment Agency (EEA) defines Ecosystem services as the direct and indirect contributions of ecosystems to human wellbeing. They classify ecosystem system services into four categories which are as follows:

- Provisioning services include products obtained from ecosystem such as food, fresh water, wood, fiber, and medicines.
- Regulating services include benefits obtained from the regulation of ecosystem processes such as climate regulation, natural hazard regulation, water purification and waste management.
- Supporting services highlight the importance of ecosystems to provide habitat for migratory species such as wildlife sanctuaries.
- Cultural services include nonmaterial benefits that people obtain from ecosystems such as spiritual enrichment, intellectual development, recreation and aesthetic values.

Ecosystem services identified within the project AoI as shown in Exhibit 5.5 include:

- Agricultural land that provide food and livelihood (provisioning service).
- Shrubs serve as food for livestock (provisioning service).
- Local vegetation provides fuel wood to local communities for cooking and heating (provisioning service).
- Canals in the project AoI provide water for irrigation (provisioning service).
- Canal and stream network in the project area helps in maintaining the Indus Delta near Gharo Creek (regulating service).

During the ESIA, it was identified that the project itself do not result in impact on any provisioning or regulating services, however, pollution emanating from tyre factory many degrade the quality of services. Specific impacts have been identified and mitigation measures have been proposed in Chapter 8.

6.12 Traffic Infrastructure

6.12.1 Road Network

a. Gharo-Keti Bunder Road

The segment of the Gharo-Keti Bunder Road adjacent to the proposed development was selected as the traffic survey site. The project site is located at 24°42'43.08"N, 67°35'18.99"E along the Gharo- Keti Bunder Highway (N110), approximately 3 km South of Gharo town, Taluka Mirpur Sakro, District Thatta, in the Sindh province of Pakistan). This highway serves as the primary road connecting the project site to Karachi and other significant

regions. Gharo's high industrial growth potential and the fact that Gharo-Keti Bunder Road is the only major road connecting the region to Karachi and Up Country via the Karachi-Thatta Highway make it critical.

b. Gharo Intersection

Gharo Intersection (or Gharo Golaee) connects the Karachi-Thatta Highway with Gharo-Keti Bunder Road, serving as a crucial access point for regional traffic. Based on expected travel patterns, a significant portion of traffic from the development is anticipated to move towards Karachi and Up Country. This traffic will likely utilize Gharo Intersection, making it critical for analysis.

c. Coastal Highway

The Sindh Coastal Highway is a road that links Karachi with coastal towns in Sindh. It begins at N5, between Dhabeji and Gharo, and finishes close to Keti Bunder. The highway was created to help farming, bring new life to the fishing industry in the delta area, and make it easier to transport clean drinking water to the people living in coastal villages.

d. Existing Traffic Data

Analyzing historical traffic counts conducted at the Gharo Intersection in 2018 and 2021 revealed a 2.85% annual growth rate in traffic volume for the region.

A new traffic count survey was conducted on the Gharo-Keti Bunder Road on Tuesday, February 20th, 2024, spanning 24 hours. The Average Daily Traffic (ADT) factor was calculated using the historical traffic count data for the Gharo Intersection and the knowledge that Tuesdays typically experience higher traffic volumes compared to the weekly average. This analysis indicated an ADT factor of 0.95, which was then multiplied by the fresh traffic count data to obtain the Average Daily Traffic for the study area's road network. The detailed report of traffic assessment is provided as an appendix to this ESIA report.

Traffic was classified into vehicle categories:

1. Motorcycle / Scooters
2. Car/Jeep/Taxi
3. Rickshaw / Qingqi
4. Passenger Van / Pickups
5. Mini Bus / Mazda/ Coaster
6. Large Bus
7. 2-Axle / 3-Axle
8. 4-Axle/5-Axle/6-Axle
9. Tractor Trailer

Gharo Keti-Bunder Road

The Gharo-Keti Bunder Road serves as the primary access point for the proposed Armstrong ZE Tyre Manufacturing Facility. Therefore, it is crucial to evaluate its performance under various traffic scenarios using Level of Service (LOS) analysis. LOS is a qualitative measure of traffic flow conditions, typically assessed based on factors like speed, travel time, freedom to maneuver, and driver comfort.

The LOS analysis results for the Gharo-Keti Bunder Road indicate satisfactory performance under all three scenarios, with consistent LOS of "A" (excellent) throughout the peak hour period. This implies free-flowing traffic conditions with minimal delays for all traffic movements, regardless of the development's impact.

Gharo Intersection

The Gharo Intersection serves as a pivotal junction within the study area, connecting the proposed Armstrong ZE Tyre Manufacturing Facility with Karachi, Thatta, and surrounding regions via the Karachi-Thatta Highway (N5). This intersection currently handles significant traffic demand between Karachi, Thatta, and Southern Sindh.

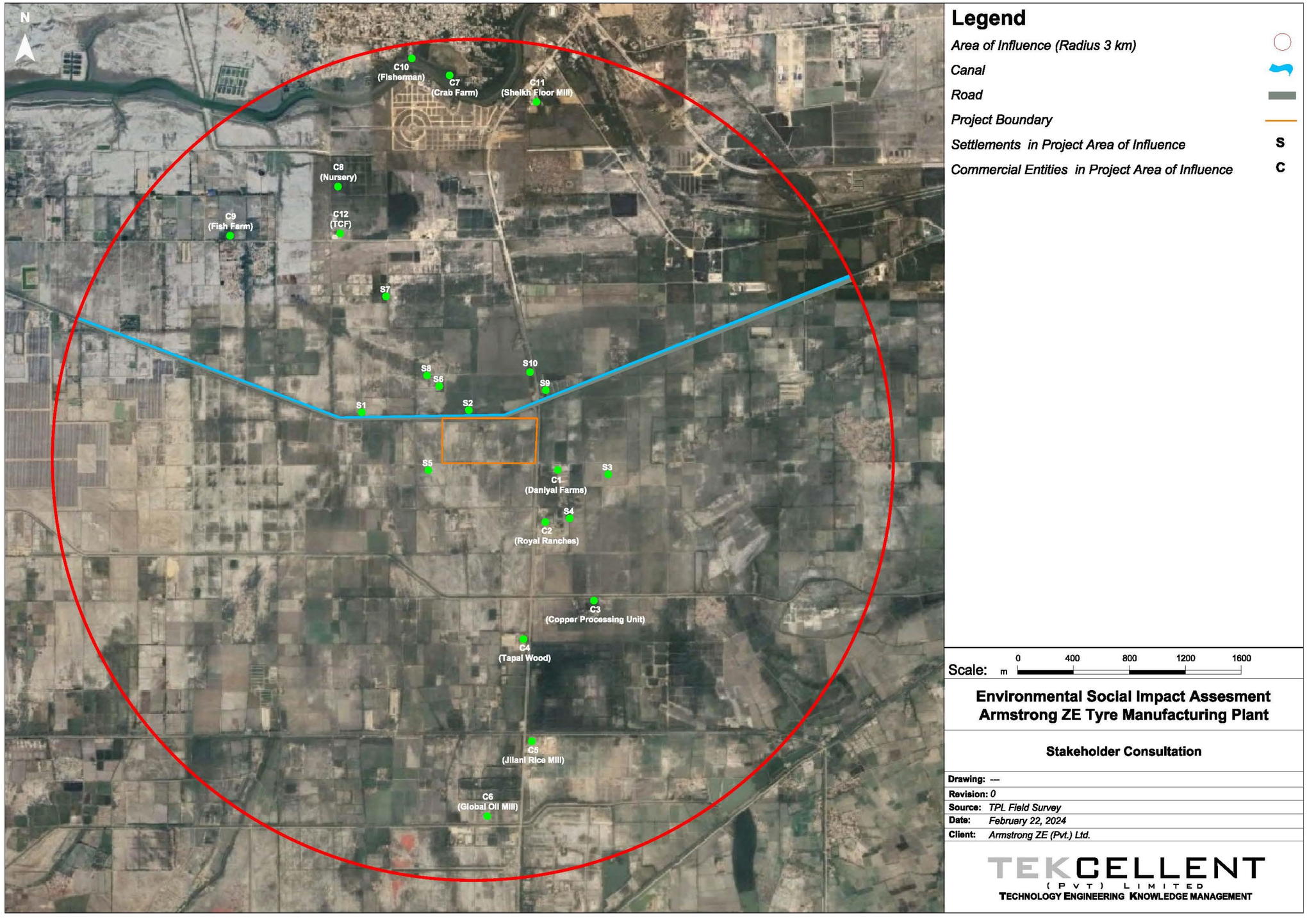
6.13 Indigenous People and Cultural Heritage

During the site visit conducted for the scoping activity, a preliminary screening for potential Indigenous People (IP) and Cultural Heritage (CH) was carried out in project's AoI for social environment. There is no indication that communities settled within project AoI classify as such. No heritage sites are observed in the project area as well. The Directorate General of Antiquities & Archaeology, Government of Sindh was consulted in the ESIA for further verification and he indicated that no significant antiquities or artefacts have been identified within or near the project site to date.

Exhibit 6.1. Settlements identified within Project AoI

Settlement	Cast	Latitude	Longitude	Distance from the Project	Population	Number of Household	Key Occupations
S1	Mallah	24°42'47.96"N	67°34'52.62"E	420 m	22	3	Labour on Agricultural Fields
S2	Mallah	24°42'48.12"N	67°35'16.88"E	Adjacent	18	3	Fishing, Labour
S3	Kohli	24°42'35.09"N	67°35'56.32"E	715 m	30	6	Labour
S4	Kohli	24°42'30.49"N	67°35'43.40"E	435 m	130+	20+	Labour on Agricultural Fields
S5	Bukhero & Mallah	24°42'38.58"N	67°35'5.52"E	60 m	100+	20	Agriculture
S6	Hashim Bukhero	24°43'2.28"N	67°35'6.30"E	950 m	250-300	50	Agriculture and Labour
S7	Kohli	24°43'25.14"N	67°34'57.12"E	1205 m	42-50	7	Labour
S8	Lashari Baloch	24°43'4.38"N	67°35'5.64"E	528 m	16	4	Livestock rearing
S9	Bhambro	24°43'6.60"N	67°35'29.34"E	583 m	37	6	Labour on Agricultural Fields
S10	Umrani Baloch	24°43'7.62"N	67°35'27.60"E	612 m	35	6	Livestock rearing
S11	Samoo & Jokhio	24°42'38.74"N	67°36'4.46"E	950 m	1000+	100+	Labour on Agricultural Fields/ Livestock rearing

Exhibit 6.2. Stakeholders Identified and Consulted during the Stakeholder Engagement Process



7. Stakeholder Engagement

7.1 Introduction

Stakeholders are defined as individuals or groups who: (a) are directly or indirectly affected by a project (Project Affected Persons); and (b) may have interests in a project and/or ability to influence its outcome, either positively or negatively (other interested parties).

Stakeholder engagement refers to a process of sharing information and knowledge, seeking to understand and respond to the concerns of stakeholders, and building constructive and responsive relationships that are important for successful management of a project's environmental and social risks, as well as the sustainability of a Project's outcomes.

This section comprises of description of consultation process that will be carried out with the various project stakeholders during the ESIA. In the scoping activity, stakeholder identification and mapping has been carried out and consultation activities have been initiated. The outcomes of stakeholder engagement conducted to establish social baseline in the project's AOI and consultation with institutional and other stakeholders is provided as an appendix to this ESIA report.

7.2 Objectives of Stakeholder Engagement

The objectives of stakeholder engagement include identification and analysis of stakeholder groups, their interest and influence on the project along with issues/ impacts they could encounter during any project phase and their concerns related to the project. Stakeholder engagement enables the project proponent to:

- Establish a systemic approach that supports the proponent to build and maintain a constructive relationship with all the stakeholders.
- Assess the level of interest and influence of various stakeholder groups.
- Addressing the concerns of the stakeholders and enabling their views to be considered in project design for improving overall environmental and social sustainability of the project.
- Provide a means for effective and inclusive engagement with Project Affected Persons (PAPs) and other interested parties throughout the Project life cycle on issues that could potentially affect them.
- Ensure appropriate and timely disclosure of environmental and social risks and impacts of the project to relevant stakeholders in an understandable, accessible, and appropriate manner and format.
- Provide the stakeholders with an accessible and inclusive mean to raise grievances and enable the project to resolve and manage such grievances.

- Ensure inclusion of all vulnerable, excluded and marginalized groups in stakeholder engagement during all project phases.
- Provide a mechanism for documenting and reporting all of the activities as part of stakeholder engagement.

7.3 Identification and Analysis

The stakeholder analysis reveals the nature and magnitude of the stakeholders' interests in and influence on a project. The first step for the analysis is to identify the stakeholders, who are essentially not limited to those affected by the project. They also include those who can affect or influence the project.

During the present study, the relevant stakeholders are identified on the basis of their ability to influence the project or their vulnerability to be negatively impacted from it. This approach ensured that no relevant groups would be excluded from the consultations during ESIA process, and appropriate engagement strategies will be developed for each stakeholder in Environmental and Social Management Plan. Identified primary, secondary and tertiary stakeholders are listed in Exhibit 7.1.

The stakeholder analysis aims to distinguish between the actual effects of the project on different stakeholders, and those stake stakeholders' perceptions about the project and its effects. The stakeholders can be best analysed by comparing their interest against the influence they wield. Exhibit 7.2 conceptually presents the interplay of stakeholders' interest and their influence. Exhibit 7.3 illustrates the stakeholder mapping based on the stakeholders identified in Exhibit 7.1 and stakeholder interaction illustrated in Exhibit 7.2.

The stakeholder identification process encompassed a comprehensive engagement strategy involving a diverse range of stakeholders, including regulatory bodies, local communities, commercial entities, and environmental organizations, among others. Consultations with local communities revealed valuable insights into the socio-economic dynamics, cultural heritage, and community needs, which are crucial for ensuring project alignment with local priorities and fostering community support. Insights from commercial stakeholders provided essential perspectives on economic opportunities, industrial activities, and potential impacts on local businesses, enabling the project team to assess potential synergies and mitigate adverse effects. Regulatory consultations with bodies such as SEPA, alongside engagements with utility providers like HESCO and SSGC, shed light on compliance requirements, essential services provision, and infrastructure considerations, facilitating regulatory adherence and efficient project planning. Engagement with environmental organizations like WWF and IUCN underscored the importance of environmental conservation and biodiversity management, guiding efforts to integrate sustainability principles into project design and implementation. Through these multi-stakeholder consultations, a comprehensive understanding of regulatory, environmental, social, economic, and community-related aspects was achieved, laying the foundation for inclusive decision-making, effective risk management, and sustainable project outcomes.

7.4 Participation Framework

The summary of consultations carried out during the ESIA study are described in the following section and detailed logs are provided in the appendix of the report. The findings have been taken into consideration which developing the stakeholder engagement framework as a component of ESMF and it would ensure participation of the all project stakeholders during the project lifecycle.

7.5 Summary of Consultations

7.5.1 Consultation with Local Communities

The consultation with local communities revealed various socio-economic aspects and concerns related to the proposed tyre factory project. Here's a summary of the key findings:

a. Social Baseline Information

- Housing structures predominantly comprised semi-permanent kuccha houses, with some settlements having brick houses.
- Dominant castes included *Mallah*, *Kohli*, *Samoo*, and *Bukero*, with others such as Baloch groups and *Bhambro* also present.
- Groundwater was the primary source of drinking water, and electricity, gas, and transportation facilities were lacking.
- Most communities depended on agriculture and livestock for livelihood, with low literacy rates and limited access to healthcare and education facilities.
- Religious and cultural practices varied across communities, with a predominantly male-dominant culture.

b. Feedback Regarding the Project

- Various settlements expressed concerns about livelihood opportunities, pollution, and health impacts.
- Some communities emphasized the importance of local employment opportunities and raised concerns about potential environmental pollution from the factory.
- Others highlighted the need for basic amenities like electricity, healthcare, and education facilities in the area.
- The consultation also revealed the community's expectations regarding mitigation measures and employment preferences for locals.

c. FGD Insights

A focused group discussion was held with a group of people from various settlements in the project AoI at Samoo Tea Hotel which is located along the road opposite to the project site. The key findings of FGD included:

- Drainage issues, lack of healthcare facilities, and inadequate educational institutions were common concerns raised during the focus group discussion.
- Participants highlighted challenges related to water drainage, healthcare access, and education infrastructure in the area.
- The absence of proper healthcare facilities posed risks, especially during emergencies like maternity cases and snake bites.

Overall, the consultation underscored the importance of addressing community concerns related to livelihood, pollution, and access to basic amenities in the proposed project area. It also emphasized the need for sustainable development initiatives that consider the socio-economic well-being of local communities.

7.5.2 Consultation with Commercial Entities in the Project AoI

a. Daniyal Farm

- It was previously a farmhouse owned by Chaudhry Iqbal involved in seed business.
- Dust allergies during rice harvest season and flooding issues were noted during the 2022 rainy season.
- Economic activities have increased in the region, and rice husk contributes to air pollution.
- The area faces water availability issues and saline bore water.
- Commercial activities include farmhouses and controlled incubation for poultry.

b. Gharo Satellite Town

- The town was constructed in 2021 on previously vacant land, primarily purchased from a private party.
- Societies face challenges due to lack of healthcare facilities and flooding issues after road construction.
- Educational institutions are planned, but lack of a productive environment leads youngsters to move to larger cities.
- Community cooperation is observed, with property purchasers mostly from Karachi.

c. Gharo Solar

- The project site was previously a barren land, now a 50MW solar plant is operational with positive community response.
- Future expansion expected, with CSR initiatives including hand pumps and food distribution.
- Water runoff managed through a filter plant and evaporation pond.

d. Copper Processing Area

- Their raw material is sourced from Balochistan, with locals employed for labour work.
- Electricity supplied by HESCO, waste disposal through burning, and a septic pond for black water.

e. Jeelani Rice Mills

- The mill was established in 2010 on barren land, waste management includes burning and disposal to Cattle Colony.
- Electricity supplied by HESCO, bore installed for water extraction, and local labor employed.

f. TCF School, Gharo

- The school was established in 2006, facing challenges of electricity and drinking water shortage.
- TCF Schools have subsidized fee structure, mostly enrolled students are from Gharo, with limited local enrolment.

g. Global Oil Mills

- The mill is not operational due to load shedding, lack of water resources, and gas supply.
- The owners are same for Tapal factory's whose closure rumoured due to pollution concerns.

h. Shiekh Altaf Flour Mills

- The mill was operational since a long time, waste disposal through soak pits, and daily wheat production of 40 muands.
- Electricity supplied by HESCO, no gas connection, and minimal traffic issues.

i. Fishermen at Fishing Point

- Abundant piped water supply from Gharo Municipal Administration, inadequate healthcare and schooling services.
- Industrial development viewed favourably for the regional economy, with seasonal migratory birds contributing to local market sales.

j. Malik Amin, Fish Farm Owner

- Business flourishing, facing challenges due to farmhouses affecting crop growth.
- Water availability improved, reduced water shortage months, and increasing poultry business.

k. Nursery Worker

- Nursery existing for 25 years, positive outlook towards industrial growth, and no major accidents observed on the main road.

l. Caretaker at Crab Farm

- Crab farm operational for 20-25 years, faces flooding issues and lack of utilities like gas and electricity.
- Crabs mainly exported to China, water fetched from Gharo city, and bore water saline.

7.5.3 Consultations with Institutional Stakeholders

a. Sindh Environmental Protection Agency (SEPA)

- SEPA mentioned that they must receive monthly environmental monitoring reports from Armstrong ZE, failure to this compliance may impact the issuance of the NOC for operation phase.
- The deputy director highlighted the necessity for Armstrong ZE to appoint an IMC and start submitting reports as per NOC conditions.
- The development and implementation of a CSR plan by Armstrong ZE to benefit the local population was also emphasized.

b. Pakistan Meteorological Department (PMD)

- They mentioned that they provided historical weather data for Thatta district.
- It was highlighted that the frequency and intensity of cyclones, noting the impact of global warming.
- Future threats including sea level rise, tropical cyclones, and increased thunderstorms was also discussed.

c. Department of Antiquities and Archaeology

- It was communicated during consultation that no significant antiquities or artefacts have been identified near the project site.
- Legal restrictions on construction near archaeological sites and the need for thorough investigation if artefacts are discovered were also discussed.

d. Hyderabad Electric Supply Company (HESCO)

- Project area falls under HESCO's jurisdiction.
- Detailed the process for acquiring connections and the need for feasibility studies and right of ways were communicated however the capacity constraint was also indicated.

e. Sui Southern Gas Company (SSGC)

- The process for acquiring gas connections, including feasibility studies and expenses borne by the applicant were identified.
- The need to explore alternative fuels due to the depletion of Sui gas reserves was also discussed.

f. Sindh Irrigation and Drainage Authority (SIDA)

- The drainage system in the region and the need for approval for wastewater discharge were discussed.
- The importance of obtaining an NOC for any discharge activities was emphasized.

g. Thatta Administration

- The Additional Deputy Commissioner was requested regarding assistance with land use queries but lacked specific knowledge about the area.

h. Pakistan Red Crescent

- The emergency response officer highlighted vulnerability to flooding and salinity due to aging drainage infrastructure.
- He also emphasized the importance of elevated construction and health and safety training for workers.

i. International Union for Conservation of Nature (IUCN)

- IUCN offered assistance with biodiversity conservation and CSR initiatives, pending a due diligence process.

These consultations provided valuable insights into environmental, cultural, infrastructural, and social considerations for the proposed tyre factory. Adhering to the recommendations and requirements outlined by various stakeholders will be crucial for ensuring sustainable development and regulatory compliance.

Exhibit 7.1. Identified Stakeholder Groups for Armstrong ZE Project

Stakeholder Groups	*Primary Stakeholders*	*Secondary Stakeholders*	*Tertiary Stakeholders*
Community	• Staff and labourers • Local community with project AoI • Agricultural area landlords adjacent to site	• Road side shops, hotels and commercial entities with AoI	
Neighbouring entities	• Royal Ranches Farmhouse • Daniyal Poultry Farm • Greenwood farmhouse • Chawla Farm • Fishing Ponds	• Organic Concept Dairies • Mosques, Imam Bargah and Shrines within AoI	
Institutional Stakeholders	• Project Investors	• Community based Institutions • IUCN • World Wildlife Fund (WWF)-Pakistan	
Government Bodies/ Regulatory Authorities	• District Administration • Taluka Municipal Administration • Sindh Environmental Protection Agency (SEPA) • Environment, Climate Change and Coastal Development	• Board of Revenue, Sindh • Pakistan Meteorological Department • Directorate General of Antiquities and Archaeology • Sindh Forest Department • HESCO	• Provincial Disaster Management Authority (PDMA) • Pakistan Red Crescent Society

Stakeholder Groups	*Primary Stakeholders*	*Secondary Stakeholders*	*Tertiary Stakeholders*
	Department, Government of Sindh • Sindh Wildlife Department • Sindh Irrigation Department	• SSGC	
External Groups	• Recreational facilities with AoI • Gharo Satellite Town	• Media • NGOs / Civil Society Groups	• Political Groups

Exhibit 7.2. Stakeholder Mapping based on level of influence and Concern

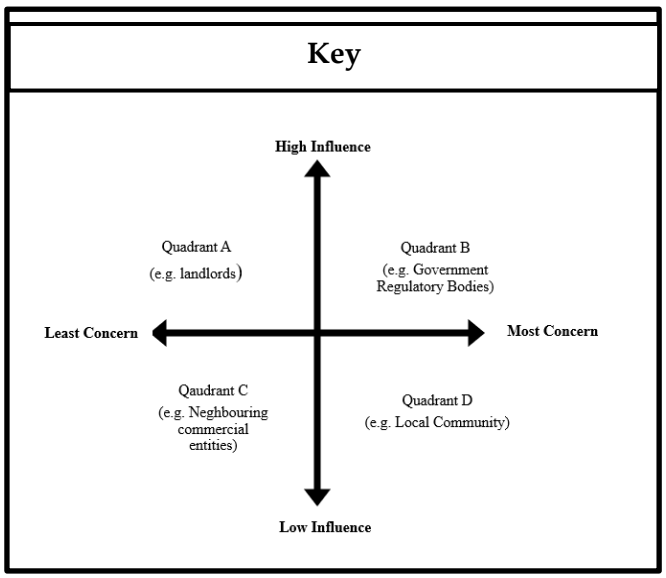


Exhibit 7.3. Stakeholder Mapping for Armstrong ZE based on Level of Influence and Concern

		Concern	
		High	Low
Influence	High	Sindh Environmental Protection Agency (SEPA) District Administration Taluka Municipal Administration Environment, Climate Change and Coastal Development Department, Government of Sindh Sindh Irrigation Department Investors and Lenders	Department of Antiquities District Administration Sindh Forest Department Sindh Wildlife Department Pakistan Meteorological Department IUCN Pakistan-World Wildlife Fund SSGC, HESCO PDMA
	Low	Local community Staff and labourers Royal Ranches Farmhouse Daniyal Poultry Farm Greenwood farmhouse Chawla Farm Fishing Ponds Shehzad Cattle Farm EPC and O&M Contractor	NGOs and Civil Society Groups Community based organizations Political parties Recreational facilities with AoI Gharo Satellite Town Mosques, Imam Bargah and Shrines Media

8. Environmental and Social Impact Assessment

8.1 Introduction

This section identifies and assesses the potential changes in the environment, ecological and social scenario that could arise from the Armstrong ZE project. The analysis discussed below assesses the manner in which the project will interact with elements of the physical, biological, cultural and human environment to produce impacts to resources/receptors.

The assessment has been organized according to environmental, ecological and social receptors with a discussion of potential impacts across the project lifecycle, including construction, operation and decommissioning.

The specific purpose of this section is to:

- Identify and assess the range of potential impacts and extent of their severity.
- Explain the ways in which the project might affect environment, ecology, and socioeconomic resources.
- Propose viable mitigation measures for the identified impacts.

The impact assessment section has been organized across identified environmental and social receptors that were scoped as sensitive for the project. The discussion for each receptor has been organized as per the various stages of the project lifecycle including construction, operation and decommissioning in order to understand the risks and impacts associated with each of these individual stages.

8.2 Impact Assessment Methodology

The impact assessment method adopted during ESIA study is indicated in Exhibit 8.1**.**

8.2.1 Identification of Environmental and Social Aspects

Environmental or social aspect is an element of organization's activities, products and services that can interact with the environment and society leading to a positive or negative impacts. Environmental and social aspects were identified for each activity that would be undertaken during the Project lifecycle. The activity-impact interaction matrix for the Project is provided in Exhibit 8.2**.**

8.2.2 Prediction of Impacts

Impacts prediction was carried out with an objective to determine what is likely to happen to the physical, biological and social environment as a consequence of the project and its associated activities. It involves following steps:

a. Impact Characterization

Each impact was characterized on basis of nature of impact or impact type, geo-extent, duration, reversibility, and frequency or likelihood of impact.

- On basis of nature or type, impact could be direct and indirect. The impact nature basically indicates the relationship of impact to the project in terms of cause and effect.
    - A direct impact results from direct interaction between a project activity and the receptor.
    - An indirect impact that follow on from the direct interactions between the Project and its environment as a result of subsequent interactions within the environment.
- The geo-extent refers to the "reach" of the impact which may be confined to a small area around the project footprint or projected for several kilometres, etc. It could be local, regional, international.
- Duration is the time period over which a resource/ receptor is affected. It could range from temporary to permanent and short-term to long term.
- Reversibility refers to the extent to which the environmental changes caused by a project can be mitigated, restored, or returned to their original state after the project is completed or terminated. It could be reversible, partially reversible or irreversible.
- The likelihood or frequency indicates the probability of occurrence of an event and it is designated using a qualitative scale, as described below:
    - Not possible: The event that may occur in a 1000 years.
    - Possible but unlikely: The event that is unlikely to occur once in 10-100 years.
    - Possible: The event is likely to occur at once in 1-10 years.
    - Likely: The event that occurs frequently i.e., once or twice a year.
    - Almost certain: it refers to the recurring events, more than twice per year.

b. Evaluation of Impacts

Besides characterizing the magnitude of impact, the other principal impact evaluation step is defining the consequence of the impacted resource/receptor. There are a range of factors that are taken into account when defining the sensitivity of the resource or receptor, which may be physical, biological, social or cultural. Other factors like legal protection, government policy, stakeholders' perspectives and economic value are also taken into consideration for defining the impact sensitivity on all receptors.

In the context of Environmental Impact Assessment (EIA), consequence refers to the magnitude and significance of the potential environmental, social, or economic effects resulting from a proposed project or activity. Magnitude is typically a function of impact characteristics defined above. It essentially describes the intensity of the change that was predicted to occur in the resource/receptor as a result of the impact. The magnitude could

be designated as positive, negative, or neutral. Based on the above factors, the significance of an impact for all resources/receptors is designated as low, medium, and high.

8.2.3 Mitigation and Enhancement

The impact assessment process is intended to reduce the negative impacts and enhance the benefits of an intended activity by identifying potential impacts and benefits and the ways of dealing with them. Planned mitigation measures are described and additional mitigation measures/controls are recommended where impacts are considered unacceptable. Recommended post-project monitoring needs are identified and included in the separate environmental and social management plans.

In this assessment, the mitigation hierarchy for planned events is as follows:

- Avoid or reduce at source: Avoiding or reducing at source is essentially designing the project so that a feature causing an impact is designed out or altered
- Abate at site: This involves adding something to the basic design to abate the impact.
- Abate at receptor: If an impact cannot be abated on site then measures can be implemented off site.
- Repair or remedy: Some impacts involve unavoidable damage to a resource. Repair involves restoration and reinstatement type measures;
- Compensate in kind/ compensate through other means: Where mitigation approaches are not possible or fully effective, then compensation for loss or damage might be appropriate.

8.2.4 Residual Impacts

In some cases, it may only be possible to reduce the impact to a certain degree. These impacts are therefore residual in the sense that they remain after mitigation measures have been designed into the intended activity. In this assessment, residual impacts have been identified and their significance has been evaluated.

8.3 Impacts during the Construction Phase

8.3.1 Climate Change

a. Potential impacts

- Extreme heat could disrupt and / or delay construction works.
- Reduced efficiency of equipment / engines due to higher ambient temperatures.
- Severe precipitation events reducing surface water quality, affecting clean water availability for workers and surrounding community.
- Risk of injuries due to both surface and flowing water.
- Inaccessible or unsafe working conditions in Site offices for staff.

- Days of extreme and prolonged heat periods could cause cracks and potholes in the road surface.
- Potential spread of waterborne disease as a result of standing water (e.g.: cholera etc.).
- Prolonged and more frequent dry periods result in dust generation (dust storms) for Site and local communities.

The unmitigated impacts of climate change on the receptors is characterized below.

Nature	Direct
Duration	Short term
Geo-Extent	Local
Reversibility	Mostly reversible
Likelihood	Likely
Magnitude	Negative
Impact Significance	Moderate to High based on the intensity of any extreme climate events

b. Mitigation Measures

Following mitigation measures will be adopted to reduce the potential impacts:

- Flexible construction scheduling to avoid extreme heat periods
- Providing shaded areas and hydration facilities for workers
- Regular maintenance and servicing of equipment for optimal performance
- Use of heat-resistant materials for construction equipment and machinery
- Implementing sediment and erosion control measures to prevent runoff into surface water sources
- Providing appropriate training for working safely in wet conditions
- Implementing proper drainage systems to redirect water away from work areas
- Installing cooling systems such as fans or air conditioning in site offices
- Ensuring proper ventilation to reduce indoor heat build-up
- Regular inspection and maintenance of roads to repair cracks and potholes
- Implementing mosquito control measures to prevent the spread of waterborne diseases
- Providing sanitation facilities and promoting hygiene practices among workers
- Implementing dust control measures such as watering exposed surfaces
- Using windbreaks or barriers to reduce the spread of dust to local communities
- Implementing energy-efficient practices such as using energy-efficient lighting and equipment

- Regularly updating the surrounding community on construction activities and potential impacts
- Establishing communication channels for community members to report concerns or issues
- The Project's Climate Change Management Framework presented in the Climate Change Risk Assessment (CCRA) study, as appended with the ESIA, to be referred for holistic management of climate change impacts during construction and operation phases of the Project.

c. Residual Impacts

By adopting the proposed mitigation measures, the anticipated residual impact is expected to be low.

8.3.2 Changes in Land use

a. Potential Impacts

There was no settlement identified to exist on the project land through the historic imagery, neither was it used for any agricultural activity, therefore no physical or economic displacement is anticipated. However, some herders were found to pass through the project land for grazing their animals, however, as the project boundary is limited to 50 acres, and a wider area is available, they did not raise any concern regarding any impact on their livelihood. However, the change in land use is likely to have the following potential impacts due to the project construction.

- The project is located in close proximity of wind corridor, thus the removal of vegetation on the land for land clearance is anticipated to reduce soil stability resulting in erosion.
- Despite presence of only scanty vegetation with no significant economic value, it still provides habitat for various small animals, insects, and microorganisms which will be altered due to the project.

The unmitigated impacts of proposed activities on land use are characterized below.

Nature	Direct and Indirect
Duration	Short to medium-term
Geo-Extent	Local
Reversibility	Mostly reversible
Likelihood	Likely
Magnitude	Negative
Impact Significance	Moderate

b. Mitigation Measures

- Avoid clearing the vegetation from the areas that will not be used by the project

- Implement plans to restore vegetation in areas where it has been disturbed or removed. This may involve replanting native species, seeding, or natural regeneration.
- Establish buffer zones between industrial and agricultural areas to minimize direct and indirect impacts on agricultural lands.
- Consider engaging with relevant stakeholders to implement rotational grazing practices to reduce pressure on existing grazing lands and ponds.

c. Residual Impacts

By adopting the proposed mitigation measures, the anticipated residual impact is expected to be low.

8.3.3 Soil Erosion and Degradation

a. Potential Impacts

- Construction activities associated with the plant, such as excavation and earthmoving, can lead to soil compaction, erosion, and loss of natural vegetation cover, resulting in soil degradation.
- Chemical spills or leaks during the handling and storage of raw materials, chemicals, or waste products can contaminate the soil, leading to reduced soil quality and fertility.
- Soil disturbance can disrupt microbial communities and soil structure, affecting nutrient cycling processes and overall soil health.
- Heavy machinery and equipment used during construction and operation can cause soil compaction and disturbance, potentially altering soil properties and affecting soil organisms.
- Reduced soil stability and altered drainage characteristics, with potential to affect groundwater recharge rates and natural surface water drainage channels outside watercourses.
- Increased sediments and suspended particles outside watercourses.

The unmitigated impacts of proposed activities on soil degradation and erosion are characterized below.

Nature	Direct
Duration	Short-term
Geo-Extent	Local
Reversibility	Irreversible
Likelihood	Possible
Magnitude	Negative
Impact Significance	Low

b. Mitigation Measures

- The soil erosion will be controlled by using sediment barriers at strategic locations within the construction site to capture the sediment laden run-off, to prevent sediment from entering nearby water bodies.
- Cement and lime stabilization will be done during construction phase in order to ensure the soil stability and structure.
- For spill prevention and containment measures, secondary containment systems will be installed during construction phase.

c. Residual Impacts

With proper implementation of mitigation measures, the residual impact is anticipated to be "low".

8.3.4 Air Quality

a. Potential Impacts

The potential impacts during construction phase would include:

- Particulate matter pollution (*PM_{10} and $PM_{2.5}$*) and dust generation from land clearing and site levelling activities, vehicular movement over unpaved surfaces and vehicle exhaust emissions; and
- Air emissions from transportation of construction, equipment and materials (*NO_x, SO_2 and particulate matter*)
- The abovementioned dust-raising activities can potentially effect the human and ecological receptors sensitive to dust and particulate matter, and the project workforce has the potential to be exposed to occupational health and safety (OHS) air quality emissions risks.

The unmitigated impacts of proposed activities on the air quality are characterized below.

Nature	Direct
Duration	Short-term
Geo-Extent	Local and/or regional
Reversibility	Reversible
Likelihood	Likely
Magnitude	Negative
Impact Significance	High

b. Mitigation Measures

The following measures will be implemented by the proponent:

- Use of water sprinkling on unpaved tracks where vehicular movement or other construction activities are likely to raise dust;

- Limit site run-off (of water and mud) to prevent material egress to other areas that can create dust emissions when dried;
- Speed limits of all project-related vehicles will be restricted to not more than 30 km/h, especially on unpaved surfaces and work areas, along with implementation of awareness trainings for the drivers;
- Off-roading will be minimised closer to the community areas to limit dust pollution; and
- Tree-plantation in exposed areas to stabilise surfaces.

c. Residual Impacts

Based on the mitigation measures to be adopted by the proponent for the construction activities at the site, the residual impacts are considered to be low.

8.3.5 Noise and Vibration

a. Potential Impacts

Potential impacts would include:

- Loud noise and vibration impacting human health; and
- Noise and nuisance due to increased traffic load of equipment and vehicles bringing in construction material.

The unmitigated impacts of proposed activities on noise and vibration are characterized below.

Nature	Direct
Duration	Short-term
Geo-Extent	Local and/or regional
Reversibility	Reversible
Likelihood	Likely
Magnitude	Negative
Impact Significance	Low to Medium

b. Mitigation Measures

The following measures will be implemented by the proponent:

- Low-noise equipment will be procured to minimise overall construction-related noise levels;
- Daily inspection and timely maintenance of construction machinery and vehicles will be carried out to ensure their proper working;
- Limit usage of construction-machinery usage to daylight hours only to maintain the peace and calm of the vicinity at night; and
- Provision of appropriate personal protective equipment (PPEs) to workers so they are not exposed to increased levels of noise during construction.

c. Residual Impacts

Based on the mitigation measures proposed for the expected construction activities at the site, the residual impacts are considered to be "low".

8.3.6 Biodiversity

The Project area surrounded by agricultural fields falls under the category of the modified habitat based on the baseline study carried out. The modified habitat predominantly comprises of agricultural area and residential, commercial areas, and man-made forest (see ***Section 5.6.2)***.

Given the project land comprised of limited vegetation cover and absence of ecologically sensitive species (see ***Section 5.7*** of this report), the likelihood of impacts on biodiversity in construction phase is mild and does not require mitigation measures as such, unless there is any change in project design that poses significant impacts.

Moreover, the vegetation composition on-site consists mainly of scanty shrubs. None of the species identified/recorded on-site and within the study area during baseline surveys possess/warrants conservation significance, indicating that the site may not currently support species that are particularly vulnerable to changes in their environment. This implies that the area lacks critical habitat features or environmental conditions necessary for these species to thrive.

8.3.7 Waste Management

a. Potential Impacts

During the construction phase, expected type of waste to be generated along with its classification and sensitivity would include the following:

POTENTIAL SOLID WASTE	CLASSIFICATION	SENSITIVITY
Excavation waste (topsoil, rocks, debris)	Non-Hazardous	Low
Wooden waste / timber	Non-Hazardous	Low
Mixed scrap metals (iron, steel, copper)	Non-Hazardous	Low
Concrete	Non-Hazardous	Low
Concrete washout (slurry)	Non-Hazardous	Low
Plastics and packaging material, paper/cardboard, glass	Non-Hazardous	Low
Dormitory and canteen waste	Non-Hazardous	Low
Asphalt and Bitumen waste (drums)	Hazardous	Medium
E-waste (used batteries, used wires, cables, fluorescent tubes)	Hazardous	Medium
Used paint cans/drums	Hazardous	Medium

Used oil or waste oil, oily rugs and oil filters	Hazardous	Medium
Contaminated soils from spillages,	Hazardous	Medium

General construction waste is characterized by low sensitivity due to the short-term nature of activities and the availability of recycling options for non-hazardous waste disposal.

Moreover, potential liquid wastes would include:

POTENTIAL LIQUID WASTE	CLASSIFICATION	SENSITIVITY
Sanitary waste	Non-Hazardous	Low
Accidental fuel and oil or lubricants spills	Hazardous	Medium

The anticipated generation of hazardous waste entails a moderate level of impact. The potential impacts during construction phase:

- Inadequate handling, transfer, and disposal of both hazardous and non-hazardous waste will lead to uncontrolled release into land, groundwater, and air, thereby causing pollution to the receiving environment and may cause entanglement issues to the avifauna and fauna in the site vicinity, if solid waste discarded outside the facility.
- Inadequate handling and storage of hazardous waste will lead to health hazards to workers.

The unmitigated impacts of proposed activities on waste management are characterized below.

Nature	Direct
Duration	Short-term
Geo-Extent	Local
Reversibility	Reversible
Likelihood	Possible
Magnitude	Negative
Impact Significance	Medium

b. Mitigation Measures

General mitigation measures for managing all types of waste include:

- *Appointment of HSSE Personnel and Trainings*: Due to the presence of multiple contractors on-site and given the exigencies in construction phase, the responsibility of managing construction waste needs to be assigned to a relevant HSSE personnel who can implement the waste management guidelines as provided in the Waste Management Plans developed for the construction phase ESMS and trains the workers on them.
- The construction waste management guidelines are provided as part of Waste Management Framework as ***Appendix D*** in ESMF. Armstrong ZE and contracts will develop, implement, monitor and update Waste Management Plan (WMP) as per the guidelines provided in Waste Management Framework.

- Construction related waste management aspects need to be incorporated in the contractors' contracts, including prohibition on the use of certain materials, such as asbestos, PCB containing materials, lead based paints, etc.

Specific mitigation measures for the waste expected to be generated during construction phase as identified above include the following.

- *Excavation waste (topsoil, rocks, debris):* Reclaim on-site for backfill materials excavated or removed from the site (such as soil or debris). Grade fill for future development – Excavated materials, including topsoil and debris, shall be redistributed and compacted to create level ground surfaces, providing a stable foundation for future construction and development
- *Wooden waste / timber* Wooden waste, such as sawdust and wood shavings, will be reused and/or will be sold in the local market. Wood waste can be combined with cement to produce a wood-cement composite mixture to be used as a building material.
- *Mixed scrap metals (iron, steel, copper)* Scrap materials should be segregated according to their type and moved to the recycling facility or scrap yard. Scrap materials can undergo processes such as melting and purification, which enable them to be further processed or reused in new products without compromising quality.
- *Concrete:* Concrete waste will be used for backfill purposes.
- *Concrete washout (slurry):* Concrete washout should be reused by crushing the hardened concrete and reusing it as aggregate in new concrete mixes. Concrete washout water should also be recycled and reused in concrete mixes.
- *Plastics and packaging material, paper/cardboard, glass:* Packaging material will be sold to local market for recycling, repurposing, or reuse.
- *Dormitory and canteen waste*: Dormitory and canteen waste will be collected by SEPA approved waste management contractor for recycling/composting for safe disposal. Waste segregation shall be implemented at source for efficient waste management.
- *Asphalt and Bitumen waste (drums)* Asphalt and bitumen waste (drums) should be disposed of through recycling processes, such as crushing and repurposing for road construction or asphalt production, or through proper containment facilities equipped to handle hazardous materials.
- *E-waste (used batteries, used wires, cables, fluorescent tubes)* E-waste can be sold to SEPA approved contractors/other local facilities equipped to handle e-waste adequately for repairing and refurbishing purposes.
- *Used paint cans/drums:* Used paint cans/drums will be collected and recycled (where feasible) by SEPA approved waste management contractors.
- *Used oil or waste oil, oily rugs and oil filters*: Used oil should be send to SEPA and Oil and Gas Regulatory Authority (OGRA) approved oil blending plants or waste management facilities for recycling, energy recovery, and safe disposal.
- *Contaminated soils from spillages* The contaminated soil will be collected by SEPA approved waste management contractor and will be designated to a disposal facility for treatment or containment.

- *Sanitary waste*: Construct septic tanks with adequate lining and implement guidelines provided in a waste management framework as part of ESMF
- *Accidental spills of fuel/ oil/ lubricants:* Promptly contain the spill using barriers to prevent further spread. Use absorbent materials (such as pads or pillows) to soak up and spill kits the spilled oil. Properly dispose of the saturated absorbents in designated hazardous waste containers. Consider using bioremediation products or techniques that enhance microbial activity and accelerate oil breakdown.

c. Residual Impacts

With proper implementation of mitigation measures, the residual impact is anticipated to be "low".

8.3.8 Occupational Health and Safety

a. Potential Impacts

The potential impacts to occupational health and safety of workers and employees hired by Armstrong ZE, their contractors or sub-contractors during the construction phase of the project would include:

- Construction sites often involve physical hazards such as falls from heights, slips and trips, being struck by moving objects or machinery, and ergonomic hazards from manual handling of materials. These hazards can lead to injuries such as fractures, strains, and sprains.
- Exposure to chemicals, adhesives, paints, solvents, insulation materials during construction can lead to skin irritation, respiratory problems, and long-term health effects such as cancer or organ damage if proper safety precautions are not followed.
- Fatal and non-fatal injuries and incidents can occur during transportation of construction equipment and materials, land clearance, construction of land- based infrastructure and supporting facilities, and material storage, handling, and use onsite.
- Construction sites may also harbour biological agents such as mould, bacteria, and pests, causing biological hazard. Workers exposed to such hazards may develop respiratory problems, allergies, or infections.
- Working outdoors in hot environments, especially during periods of extreme heat, can lead to heat-related illnesses such as heat exhaustion and heat stroke. Prolonged exposure to high temperatures without adequate hydration and rest breaks can pose serious health risks to workers.
- Electrocution, burns, and fatality from construction equipment contacting high voltage power transmission line.
- Prolonged exposure to high levels of noise from construction machinery, power tools and equipment can lead to auditory problems if proper hearing protection is not used.

- Fire caused by construction equipment contacting high voltage power transmission line
- Use of Child Labour

The unmitigated impacts of proposed activities on Occupational health and safety are characterized below.

Nature	Direct
Duration	Short-term
Geo-Extent	Local
Reversibility	Reversible
Likelihood	Possible
Magnitude	Negative
Impact Significance	Medium

b. Mitigation Measures

The project will develop and implement a comprehensive site specific occupational health and safety plan and emergency preparedness and response plans based on the frameworks provided under Environmental and Social Management Framework (ESMF) to ensure mitigating the identified impacts. These mitigation measures include:

- Conduct comprehensive risk assessments to identify potential hazards and implement appropriate control measures.
- Provide adequate training, supervision, and personal protective equipment (PPE) to workers to ensure their safety on site.
- Implement engineering controls, such as guardrails, fall protection systems, and ventilation systems, to minimize exposure to hazards.
- Establish protocols for handling hazardous materials safely, including proper storage, handling, and disposal procedures.
- Monitor environmental conditions such as temperature, humidity, noise levels, and air quality to prevent heat stress and other health risks.
- Encourage open communication and reporting of health and safety concerns among workers and management.
- Promote a culture of safety awareness and encourage workers to actively participate in safety initiatives and programs.
- Comply with relevant occupational health and safety regulations and standards to ensure legal compliance and accountability.

c. Residual Impacts

By adopting these mitigation measures effectively, the residual impacts is anticipated to be low.

8.3.9 Community Health and Safety

a. Potential Impacts

The potential impacts to communities in the project's area of influence during the construction phase of the project would include:

- Degradation of air quality in the project area due to generation of dust, emissions from machinery, and exhaust fumes from construction activities that can exacerbate respiratory conditions and cause discomfort for nearby residents.
- If construction activities continue at night time, excessive noise can disrupt the peace and quiet of nearby communities, leading to annoyance, stress, and potential health effects such as sleep disturbances and hearing loss.
- Increased traffic associated with construction activities will increase traffic volume and can increase the likelihood of accidents and injuries for both construction workers and local residents.
- The influx of construction workers into a remote area may strain local healthcare resources and infrastructure. Inadequate access to healthcare services and emergency response capabilities may increase health and safety risks for both workers and local residents.
- Influx of nomadic communities and informal settlers into the project area opportunistically in pursuit of improved resources and livelihoods.

The unmitigated impacts of proposed activities on community health and safety are characterized below.

Nature	Direct
Duration	Short-term
Geo-Extent	Local
Reversibility	Reversible
Likelihood	Possible
Magnitude	Negative
Impact Significance	Medium

b. Mitigation Measures

The project management will adopt following measures to mitigate the identified impacts:

- Implement measures to minimize dust, noise, and other environmental impacts through the use of dust suppression techniques, noise barriers, and scheduling construction activities during less sensitive times.
- Develop a traffic management plan to minimize disruptions and ensure the safe flow of traffic during construction.

- Engage with local communities to address concerns, provide information about the project, and involve residents in decision-making processes.
- Provide training and support for local healthcare providers to address the needs of both construction workers and community members.
- Establish mechanisms for effective communication and feedback between the project developers, construction workers, and the local community to address concerns and mitigate potential impacts in a timely manner.
- Strategize and incorporate measures in community health and safety plan to be developed under ESMS for management of influx of other communities/ nomadic settlers near the project to manage their expectations and anticipated pressure on the project to facilitate them.

c. Residual Impacts

By implementing these mitigation measures, the residual impact on community health and safety is anticipated to be low.

8.4 Impacts during the Operation Phase

8.4.1 Climate Change Impacts

a. Potential Impacts

The potential impacts contributing to climate change during the operation phase of the Project mainly arise from GHG emissions from proposed Project's activities. These are expected to be emitted from the usage of coal in the boiler, usage of diesel in the gensets, usage of utility gas, and usage of purchased electricity for the manufacturing operations within the facility. Biogenic CO_2 emissions are also expected from the use of biomass (rice husk) in the boiler. The GHG emissions estimation and GHG alternative assessment has been conducted in the Climate Change Risk Assessment (CCRA), appended with the ESIA report.

The unmitigated impacts of proposed activities on climate change are characterized below.

Nature	Indirect
Duration	Medium-term to Long-term
Geo-Extent	*Climate change is global phenomenon*
Reversibility	Irreversible to Partially Reversible
Likelihood	Likely
Magnitude	Negative
Impact Significance	Medium

b. Mitigation Measures

The following mitigation measures have been proposed:

- Conduct regular energy audits to identify areas of energy wastage, and consider measures to optimize energy consumption.
- Integrate advanced control systems, lean manufacturing principles, and energy efficient technologies to minimize energy usage.
- Explore the integration of renewable energy to offset energy demand from traditional fossil fuel sources. Install on-site renewable energy generation systems such as solar panels or wind turbines, and consider power-purchase agreements with renewable energy providers.
- Utilize higher composition of biomass as an alternative source of energy. This will reduce emissions from the use of coal, whereas increase the biogenic emissions.
- In terms of material management, use alternative materials with lower embedded carbon content in Tyre production, such as bio-based or recycled rubber.
- Collaborate with suppliers to source raw materials from sustainable and low-carbon sources to reduce the carbon footprint of the supply chain. Consider indigenous, plant-based, renewable alternatives for rubber. This will further optimize transportation logistics and reduce emissions associated with the transportation of raw materials.
- Prioritize sustainability and consider innovative technologies and practices, in mitigating climate change and drive the adoption of sustainable practices in their supply chain, fostering a more environmentally responsible industry.
- The Project's Climate Change Management Framework presented in the Climate Change Risk Assessment (CCRA) study, as appended with the ESIA, to be referred for holistic management of climate change impacts during construction and operation phases of the Project.

8.4.2 Air Quality

The potential impacts on air quality during operations of the plant will arise mainly from the operations of the boiler, and to a limited extent, from the backup diesel gensets that will be operational in case of power outage. There are engineering controls provisioned in the design, such as wet scrubbers, which will significantly reduce the emissions from the boiler. The boiler equipment with the engineering controls and resulting expected emissions are under finalization by the technical consultant. However, the residual emissions and the geographical extent of the plume and contamination levels at the location of receptors have been assessed through the Air Dispersion Modelling (ADM) activity.

a. Analysis of ADM Results

The ADM exercise has led to the following results during the operation phase of the proposed tyre manufacturing plant:

Parameters	Air Dispersion Modelling (ADM) Scenarios	ADM Results	WHO Ambient Air Quality Guidelines	SEQS Guidelines for Air

Sulfur dioxide (SO_2) ($\mu g/m^3$)	**Normal**	47.44	50 (*Interim target-2 for 24-hour averaging period*)	120 (*24-hours*)
	Extreme	51.44		
Nitrogen dioxide (NO_2) ($\mu g/m^3$)	**Normal**	39.22	40 (*guideline for 1-hour averaging period*)	80 (*24-hours*)
	Extreme	41.07		
Carbon monoxide (CO) ($\mu g/m^3$)	**Normal**	664.2	-	5000 (*8-hours*)
	Extreme	664.4		
Total Suspended Particulates (TSP) ($\mu g/m^3$)	**Normal/ Extreme**	86.61	-	360 (*Annual*) 500 (*24-hours*)
KEY		Exceedance against WHO Ambient Air Quality Guidelines (*as mentioned in the Air Emissions and Ambient Air Quality section of IFC General EHS Guidelines document*)		
		Exceedance against Sindh Environmental Quality Standards (SEQS)		

The results indicate only marginal exceedances against WHO Ambient Air Quality Guidelines for sulphur dioxide and nitrogen dioxide under extreme modelling scenario, while no exceedance were observed against the SEQS.

It is to be noted that the proposed tyre manufacturing plant is located in a generally flat area where there are no structures or natural obstructions to disrupt the wind flow or the dispersion of pollutants to cause downwash of pollutants. Therefore, impacts due to the plant's operations are unlikely to cause any significant deterioration of the area's air quality. The minor exceedances against the WHO Ambient Air Quality Guidelines can be catered through more stringent mitigation measures proposed in this section to keep the concentrations within the prescribed limits.

The detailed ADM report containing the methodology, output maps and conclusion of the ADM activity is provided as ***Attachment G.***

b. Potential Impacts

The potential impacts on the air quality and other associated impacts, due to the residual emissions, are provided below:

- Potential risks to human health associated with exposure to residual air pollutants, odours and fugitive emissions of the plant, which may impact the vulnerable populations among the nearby local communities including children, the elderly and people with pre-existing health conditions;

- Residual particulate emissions will still remain, which can lead to increased settling of dust and soot on close community farmlands; and
- Residual emissions could lead to increased formation of haze at times of low winds in the area, which could impede visibility and affect travel among the locals.

c. Mitigation Measures

Based on the identified potential impacts, the mitigation measures that will be adopted include the following:

- Upgrade emission control technologies in the plant to reduce the release of SO_2 and NO_2 into the atmosphere through installation of even more efficient scrubbers
- Based on the future feasibility, the ratio of biomass in the boiler will be increased, which will curtail the emissions further
- Regular maintenance and inspection of the boiler and wet scrubbers to avoid any disruption in their effective operation;
- Prevent accumulation of solids in the wet scrubber;
- Develop a comprehensive monitoring and reporting plan to ensure that the plant operates within acceptable emission limits, in compliance with the regulatory guidelines; and
- Enhancing employees' trainings and awareness

d. Residual Impact

Based on the mitigation measures to be adopted, the residual impacts are considered to be "low".

8.4.3 Noise and Vibration

a. Potential Impacts

The potential impacts associated with noise and vibrations are listed below:

- Loud noise emanating from operations of the plant machinery; and
- Noise emanating from the operations of the backup diesel generators when needed.

The unmitigated impacts of proposed activities on noise and vibration are characterized below.

Nature	Direct
Duration	Long-term
Geo-Extent	Local

Reversibility	Partially reversible
Likelihood	Likely
Magnitude	Negative
Impact Significance	Medium to high

b. Mitigation Measures

The following measures will be implemented by the proponent:

- Installing effective sound barriers and acoustic enclosures to limit noise levels in the vicinity;
- Sound insulation measures to maintain sound levels to as low as reasonably practicable and within regulatory standards; and
- Backup generators be placed in sound-proof canopies to limit the noise levels in the vicinity.

c. Residual Impacts

Based on the mitigation measures to be adopted at the site, the residual impacts are considered to be "low".

8.4.4 Water Resources, Quality and Availability

a. Potential Impacts

The potential impacts to water resources, their quality or availability to the existing receptors during the operation phase of the project would include:

- Accidental spills or leakages of waste is likely to cause reanimation of sub-surface contamination; stockpiling and disposal of excavated material.
- Altered hydraulic gradient with potential to create preferential pathways for contaminants in groundwater.
- Surface water and groundwater contamination from accidental spillage and/or leakage of fuel and/or lubricants from construction equipment and machineries.
- Changes in groundwater table through planned or unplanned discharges during from land clearing, site levelling, and construction activities.
- Storm-water runoff from the plant site, containing pollutants such as sediment, oils, and chemicals, can infiltrate into the groundwater, carrying contaminants along with it.

The unmitigated impacts of proposed activities on water quality and availability are characterized below.

Nature	Direct
Duration	Long term
Geo-Extent	Regional

Reversibility	Irreversible
Likelihood	Possible but unlikely
Magnitude	Negative
Impact Significance	Low-Medium

b. Mitigation Measures

- The initial 5-minute surface run-off from the facility during the rains will be directed to the effluent treatment plant in order to prevent any contamination.
- Implement slope management techniques and employ landscaping methods to create natural slopes, ensuring efficient water drainage within the small storm water drainage channels.
- A controlled discharge system from the storage points to prevent sudden water release will be implemented.
- Construct basins to temporarily store excess rainwater from the project, later on, discharge it into Canal or other water bodies. This will manage the seawater intrusion into groundwater by providing a continuous water source for infiltration, especially during periods when the canal is closed from upstream. This approach ensures groundwater replenishment, reduces reliance on extraction, and promotes long-term water resource sustainability.

c. Residual Impacts

The residual impacts after adopting of mitigation measures is anticipated to be "low".

8.4.5 Groundwater

a. Potential Impacts

The potential impacts to groundwater, their quality or availability to the existing receptors during the operation phase of the project would include:

- The operation of a manufacturing tyre plant typically requires significant water usage for cooling, cleaning, and other processes. Increased water extraction from groundwater sources can lead to groundwater depletion and lowering of the water table.
- Improper storage, handling, or disposal of hazardous chemicals and waste products can lead to the contamination of groundwater through leaching or direct spills. Chemicals such as solvents, lubricants, and heavy metals used in tyre manufacturing can pose significant risks to groundwater quality.

The unmitigated impacts of proposed activities on groundwater quality and availability are characterized below.

Nature	Direct
Duration	Long term
Geo-Extent	Local

Reversibility	Irreversible
Likelihood	Possible
Magnitude	Negative
Impact Significance	Medium

b. Mitigation Measures

- Given that the project area has a coastal aquifer, the site has planned on extracting groundwater from deeper levels i.e. from the 4th aquifer as established in Section 5.6.8.(b(1)) rather than utilizing groundwater from shallow aquifer. This approach is chosen to ensure sustainable water usage and to prevent adverse effects on the local hydrology and to the competing users of shallow aquifer(s).
- A spill prevention control system and forecourt drains will be installed in the hazardous substances storage area to prevent groundwater contamination resulting from leaching and direct spills.
- Groundwater monitoring, as outlined in the Environment and Social Management Framework, will be conducted at specified frequencies as part of the groundwater monitoring plan.

c. Residual Impacts

The residual impacts after adopting of mitigation measures is anticipated to be "low".

8.4.6 Biodiversity

a. Potential Impacts

During operations, potential impacts on the flora and fauna in the vicinity are as follows:

- Inadequate solid waste management practices, such as the disposal of scorched rubber, packaging material, plastic waste, or other materials outside the facility, pose a risk of entanglement to both fauna and avifauna;

- The discharge of waste from the plant operations, if left unmitigated or without adequate controls, can lead to changes in air, soil, and water quality. Moreover, the accidental release of solid and liquid waste into the receiving environment, including materials like scorched rubber, packaging materials, solvents, chemicals, spills, and micro-plastics, can have far-reaching indirect impacts on biodiversity. For instance:

    - The introduction of harmful chemicals and pollutants into the soil can disrupt nutrient cycling processes, alter soil pH levels, and impede the growth and reproduction of plant species;

    - Air pollutants can harm respiratory systems of organisms, including birds within the Project vicinity, leading to weakened immune responses, and even population declines.

- Operations, transportation, and associated facilities, such as generators, can cause noise pollution. If left unmitigated or without appropriate controls, the noise will have the potential to disrupt wildlife behavior, such as their communication instincts.

  The unmitigated impacts of proposed activities are characterized below.

Nature	Direct
Duration	Long-term
Geo-Extent	Local
Reversibility	Irreversible
Likelihood	Likely
Magnitude	Negative
Impact Significance	Medium

b. Mitigation Measures

In order to maintain the ecological balance within the surrounding environment and to avoid potential impacts on local biodiversity, following actions will be implemented:

- Strict solid waste management protocols within the facility to prevent open disposal of materials;
- Erection of barriers or fences around the facility to prevent wildlife access to potentially hazardous waste materials;
- Conduct of regular inspections and clean-up activities to remove any waste that may pose entanglement risks to fauna and avifauna;
- Spill prevention and response plans to minimize the risk of accidental releases into the receiving environment;
- Employees and workers awareness programs on the importance of responsible waste management practices and provide training on spill response procedures;
- Air and water monitoring as provided in air and water monitoring plan as part of Environmental and Social Management Framework (ESMF);
- Installation of sound barriers or acoustic insulation around the noisy operations and equipment to minimize the propagation of noise beyond the facility boundaries;
- Where feasible, implementation of operational controls, such as schedule noisy activities during periods of low wildlife activity (e.g. avoid noise at nighttime), to reduce disturbance in particular to birds within the vicinity;
- Regular noise monitoring to assess compliance with regulatory limits and identify opportunities for further noise reduction measures;

- Utilization of quieter equipment and machinery where feasible to minimize overall noise emissions.

c. Residual Impacts

By adopting the aforementioned mitigation measures, the residual impact is expected to be "low".

8.4.7 Use of Hazardous Substances

a. Potential Impacts

The potential impacts from use of hazardous substances could include:

- The release of VOCs and other pollutants from tyre manufacturing processes can contribute to air pollution in the surrounding area. This can result in adverse health effects for nearby communities, including respiratory problems and exacerbation of existing conditions such as asthma.
- Hazardous substances from tyre manufacturing can leach into groundwater or be discharged into nearby water bodies, leading to contamination of drinking water sources and aquatic ecosystems. This pollution can harm aquatic life and pose risks to human health through the consumption of contaminated water or fish.
- Workers in tyre manufacturing plants may be exposed to hazardous substances through inhalation, skin contact, or ingestion. Exposure to chemicals such as benzene, toluene, and styrene can lead to a range of health problems, including respiratory issues, skin irritation, neurological effects, and increased risk of cancer.
- Spills or improper disposal of hazardous substances can result in soil contamination around the manufacturing plant. This contamination may persist for long periods and can affect soil fertility, plant growth, and overall ecosystem health.
- Some hazardous substances used in tyre manufacturing, such as flammable solvents and dust particles, can pose fire and explosion hazards if not properly handled and stored.

The unmitigated impacts of proposed activities are characterized below.

Nature	Direct
Duration	Long-term
Geo-Extent	Local
Reversibility	Partially reversible
Likelihood	Likely
Magnitude	Negative
Impact Significance	High

b. Mitigation Measures

To manage hazardous substances effectively, the project will adhere to the recommendations outlined in the IFC General EHS Guidelines, Edition April 30th, 2007,

specifically focusing on Hazardous Material Management. The overall objective of hazardous materials management is to avoid or, when avoidance is not feasible, minimize uncontrolled releases of hazardous materials or accidents (including explosion and fire) during their production, handling, storage and use. This objective can be achieved by:

- Establishing hazardous materials management priorities based on hazard analysis of risky operations identified through Social and Environmental Assessment;
- Where practicable, avoiding or minimizing the use of hazardous materials. For example, non-hazardous materials have been found to substitute asbestos in building materials, PCBs in electrical equipment, persistent organic pollutants (POPs) in pesticides formulations, and ozone depleting substances in refrigeration systems;
- Preventing uncontrolled releases of hazardous materials to the environment or uncontrolled reactions that might result in fire or explosion;
- Using engineering controls (containment, automatic alarms, and shut-off systems) commensurate with the nature of hazard;
- Implementing management controls (procedures, inspections, communications, training, and drills) to address residual risks that have not been prevented or controlled through engineering measures.

c. Residual Impacts

By adopting the proposed mitigation measures, the residual impact is expected to be medium to low.

8.4.8 Waste Management

a. Potential Impacts

During operations, the expected waste streams resulting from project activities along with the tentative sensitivity ranking are outlined below on the basis of preliminary assessment. These would include following types of solid waste:

SOLID WASTE	POTENTIAL SOURCES	CLASSIFICATION	SENSITIVITY
Scrap material	Shaping and finishing operations	Non - Hazardous	Low
Scorched rubber	Mixing, milling, calendaring, and extruding	Hazardous	Medium
Packaging	Raw material and finished products	Non - Hazardous	Low
Coal ash and boiler slag	Coal combustion in boilers	Hazardous	High
Particulate matter	Bag filters in compounding areas, banbury, and grinders	Hazardous	High

Sludge	Effluent Treatment Plant (ETP)	Hazardous	High
Rejected / Used RO membrane filters	Effluent Treatment Plant (ETP)	Hazardous	High
Used oil or waste oil	Maintenance activities	Hazardous	Medium
Waste Electrical and Electronic Equipment (WEEE)	Maintenance activities	Hazardous	Medium
Contaminated soil	Accidental spillages	Hazardous	Medium

The liquid wastes generated would include:

LIQUID WASTE	POTENTIAL SOURCES	CLASSIFICATION	SENSITIVITY
Suspended solids	Vulcanizing	Non-Hazardous	Medium
High TDS reject water	RO plant	Potentially Hazardous	Medium
Oil and grease	Centrifuges	Hazardous	Medium
Trace metals	Cleaning of fresh latex receiving ponds	Potentially Hazardous	Medium
Additives and solvents	Effluent arising from dipped latex rubber products	Hazardous	Medium
Hot water	Heating and cooling activities	Potentially Hazardous	Medium
Accidental spillages	Storage and handling	Hazardous	Medium

The potential gaseous emissions would include:

GASEOUS EMISSIONS	POTENTIAL SOURCES	CLASSIFICATION	SENSITIVITY
Fugitive dust emissions	Pre-weighing of additives where chemicals kept in open storage in compounding area	Toxic	Medium
	Loading of chemicals into internal mixer	Toxic	Medium
Particulate emissions	Surface grinding activities	Toxic	Medium
VOCs emissions	Use of solvents in various capacities during the entire manufacturing process. Extensive Vulcanization - to	Toxic	Medium

	impart the desired properties to the rubber		
Sulphur dioxide (SO_2)	Rubber Curing	Toxic	Medium

Potential impacts during operational phase are:

- Inadequate handling, transfer, and disposal of both hazardous and non-hazardous waste will lead to uncontrolled release to land, groundwater, and air, causing pollution to the receiving environment.
- Improper handling and storage of hazardous waste will cause potential health hazards to workers.

The unmitigated impacts of proposed activities on waste management are characterized below.

Nature	Direct
Duration	Long-term
Geo-Extent	Local
Reversibility	Reversible
Likelihood	Possible
Magnitude	Negative
Impact Significance	High

b. Mitigation Measures

Armstrong ZE shall uphold Extended Producer Responsibility (EPR), which constitutes a fundamental pillar of waste management strategy for the entire lifecycle of its products. This entails acknowledging the plant's responsibility for the entire lifecycle of its products, from design to end-of-life management, initiating with management at source. To fulfill the Project's zero-waste commitment, the following measures are provided to commence waste management at source:

- The wastes to be generated during operations shall be classified, characterized and quantified, segregated, and stored adequately prior to their disposal, treatment and management options.
- Develop, implement, monitor, and update site specific *Waste Management Plan* (WMP) for operation phase as per the guidelines provided in Waste Management Framework in ***Appendix D*** under Environmental and Social Management Framework (ESMF). The WMP will follow the waste management hierarchy, which will include handling, storage, transportation, management, and disposal of hazardous and non-hazardous wastes.
- For the waste generated in manageable quantities, containment at source approach will be implemented. As in wherever practicable and safe to do, proactive containment and treatment at source option will be prioritized.

- Obtain necessary permits and licenses for hazardous substances as and when required.

Specific mitigation measures for potential waste types identified above are provided below keeping in consideration the local context and best available technology not entailing excessive costs (BATNEEC). These measures are selected based on IFC EHS Guidelines for Metals, Rubber, and Plastic Products Manufacturing.

SOLID WASTE	WASTE-SPECIFIC MITIGATION MEASURES, POLLUTION PREVENTION AND CONTROL TECHNIQUES
Scrap material/ Scorched rubber/ Packaging waste	Recycle - Scrap from thermoplastic polymers can be reground and mixed with virgin materials. Cured and off-specification rubber waste should be either recycled at the facility or reused (through shredding) to make other products; Uncured rubber, as well as slightly cured waste rubber, can be recycled to Banbury mixers; If reuse or recycling is not possible, the waste rubber (including scrap polymer parts that have been excessively heated) can be disposed of according to industrial waste management recommendations in the General EHS Guidelines for management and disposal of industrial waste.
Coal ash and boiler slag	Cement Kilns/Structural Fill
Particulate matter	The synthetic nature of filter bags makes it difficult to biodegrade, adding to pollution concerns (typically in local context). The ideal scenario involves collecting, melting, drawing, and reusing these bags, however, the current technological limitations hinder this approach. Therefore, at present, the preferred/viable method for managing used bag filters is through controlled incineration (i.e. with embedded controls), for complete combustion, under high-temperature.
Sludge	The Sludge generated from ETP and Septic Tanks will be collected and disposed of by EPA approved third-party waste contractor in an environmentally safe manner as per IFC General EHS guidelines on Water and Sanitation for Sludge treatment and incineration as safe disposal option. The agricultural use of sludge, by direct application, as well as landfilling of sludge require stringent control in place, which are not typically practiced in local context, Therefore, sludge incineration shall be considered, which shall be performed in Sindh EPA approved designated waste incinerators with embedded controls for air emissions. The sludge can also be incinerated in cement kilns after pre-drying, as they have a high calorific values and complete

combustion in clinker due to high temperature (i.e. ≥1300° C) and sufficient retention time in clinker.[19] Refer to **Section 2.3.3.b (ii).**

Rejected / Used RO membrane filters	Damaged or exhausted membranes are typically generated from water treatment systems. It will be disposed of by Sindh EPA approved third-party waste contractor for an environmentally sound disposal.
Used oil or waste oil	Used oil will be re-refined into lubricants, processed into fuel oils, used as raw materials for the refining and petrochemical industries.[20] Therefore, recycle used through Oil and Gas Regulatory Authority (OGRA) approved oil blending plant.
Waste Electrical and Electronic Equipment (WEEE)	Recycle or return to original supplier
Contaminated soil	Use of containment at source

WASTEWATER	**WASTE-SPECIFIC MITIGATION MEASURES, POLLUTION PREVENTION AND CONTROL TECHNIQUES**
Suspended solids High TDS Reject water Oil and grease Trace metals Additives and Solvents	Wastewater should be trapped in a rubber trap, to let rubber float to the top for recycling / reuse. Wastewater should then be conveyed to treatment plant. WWTP should also consider the following, along with other components: 1. Solid settling for suspended solids 2. Oil removal system.
Hot water	If released in surface waters, will disturb the natural ecosystem. Closed-loop water cooling or heating systems should also be considered.

[19] UNEP - Technical Guidelines on the Environmentally Sound Co-Processing of Hazardous Waste in Cement Kilns. UNEP/CHW.10/6/Add/3/Rev.1.

[20] US EPA guidelines on Managing, Reusing, and Recycling Used Oil | https://www.epa.gov/recycle/managing-reusing-and-recycling-used-oil#:~:text=Recycling%20used%20oil%20keeps%20it,base%20stock%20from%20crude%20oil.

Accidental spillages	Use of solvents should be carefully managed to prevent spill and fugitive emissions. Guidance on storage and handling of solvents will be provided in Hazardous Material Management Plan.
POTENTIAL GASEOUS EMISSIONS	**WASTE-SPECIFIC MITIGATION MEASURES, POLLUTION PREVENTION AND CONTROL TECHNIQUES**
Fugitive dust emissions	Use chemicals in small, pre-weighed, sealed bags for direct addition to the internal mixer to limit dust generation. Control emissions from mixer by using bag filters.
Particulate emissions	Use of primary cyclone and a secondary bag filter or two-stage electrostatic precipitator to control dust and fine rubber particles generated by surface grinding activities.

Coal Ash:

- The actual composition of coal ash depends on the type of coal being used. As per the IFC guidelines ash residues are not typically classified as hazardous waste due to their inert nature. However, where ash residues are expected to contain potentially significant levels of heavy metals lead (Pb), arsenic (As), mercury (Hg), and chromium (Cr) in varying concentration (based on coal being used), radioactivity or other potentially hazardous materials, *they should be tested at the start of plant operations to verify their classification as hazardous or non-hazardous*[21].
- Additionally, guidelines on the management of hazardous and non-hazardous wastes are provided in the Waste Management Framework, as ***Appendix D*** under ESMF.
- Develop a coal ash handling and management procedure, which should include monitoring of coal ash yard (such as, storage conditions, quantification of coal ash stored and disposed, and procedure for potential leachate or run-off).
- Along with the adequate liners, design considerations for the coal ash storage yard shall also include the installation of suitable covers to avoid any contact with air and/or rodents, birds, etc.

[21] IFC - World Bank Group EHS Guidelines on Thermal Power Plants. Pg. 11-12. Dated: December 19, 2008. https://www.ifc.org/content/dam/ifc/doc/2000/2008-thermal-power-ehs-guidelines-en.pdf.
Note: In Pakistan, there is no such binding document that has classified fly ash as hazardous or non-hazardous waste.

- Carry out groundwater monitoring for heavy metals, such as lead, arsenic, mercury, etc. (as metals are constituents of concern in the coal combustion wastes) along the coal ash yard boundaries to verify the leachate/seepage does not impact down gradient groundwater.
- Conduct regular inspection/monitoring and maintenance of coal ash storage yard in accordance with internally recognized standards.[22, 23]

c. Residual Impacts

With proper implementation of mitigation measures, the residual impact is anticipated to be "low".

8.4.9 Occupational Health and Safety

a. Potential Impacts

The potential impacts to occupational health and safety during the operation phase would include:

- Employees and workers exposure to indoor air pollutants.
- Employees and workers exposure to hazardous materials (such as coal, sulphur, and fuel handling).
- Employees and workers exposure to hazardous wastes.
- Fire hazard.
- Any disease outbreak in the project area impacting the health or workers.

The unmitigated impacts of proposed activities on occupational health and safety are characterized below.

Nature	Direct and Indirect
Duration	Long-term
Geo-Extent	Local
Reversibility	Partially irreversible.
Likelihood	Likely
Magnitude	Negative
Impact Significance	High

[22] See, for example, U.S. Department of Labor, Mine Safety and Health Administration regulations at 30 CFR §§ 77.214 - 77.216.

[23] Additional detailed guidance applicable to the prevention and control of impacts to soil and water resources from non-hazardous and hazardous solid waste disposal is presented in the World Bank Group EHS Guidelines for Waste Management Facilities.

b. Mitigation Measures

The project will develop and implement a comprehensive site specific occupational health and safety plan and emergency preparedness and response plan under its Environmental and Social Management System (ESMS) to ensure mitigating the identified impacts.

c. Residual Impacts

By adopting the proposed mitigation measures, the residual impact is anticipated to be "low".

8.4.10 Community Health and Safety

a. Potential Impacts

The potential impacts include:

- Disease breakout in the community due to migrant workers
- Fire and/or explosion caused by failure any equipment or fuel spillage, etc.
- Stack emissions from chimney during the manufacturing operation
- Accidental spillage or leakage of fuel, chemicals, or lubricants may cause direct or direct impacts to local communities' health.
- The presence of the vehicles and equipment may cause impacts to transport and traffic via exclusion from navigation routes during construction.
- Use of local access roads can impact local traffic and increase risk of accidents / collisions. The Traffic Impact Assessment also indicated that the proposed development will have a modest impact on the surrounding traffic network, particularly during the peak hour. However, the projected traffic volumes are not expected to exceed the capacity of the existing roadways.

The unmitigated impacts of proposed activities on community health and safety are characterized below.

Nature	Direct and Indirect
Duration	Long-term
Geo-Extent	Local
Reversibility	Partially irreversible.
Likelihood	Likely
Magnitude	Negative
Impact Significance	High

b. Mitigation Measures

The proposed mitigation measures include:

- The project drivers will be trained for defensive driving skills

- Vehicular speeds near/within communities will be kept low to minimize safety hazards.
- Firefighting equipment will be made available at the site and camps; fire extinguishers will be provided in the project vehicles. The camp staff will be provided firefighting training.
- All safety precautions will be taken to transport, handle and store hazardous substances, such as fuel.
- Liaison with the community will be maintained.

c. Residual Impacts

By adopting the proposed mitigation measures, the residual impact is anticipated to be "negligible".

8.5 Climate Change Risk Assessment of Project

The assessment considered the likely climate hazards around the project location and their potential impacts. Climate hazards were identified through a review of the historical climate data, past climate-related events and future projections. Hazards such as high temperatures and flash flooding have affected the region in the past, and these effects are projected to increase in the future. These climate hazards can impact critical components of the project, such as buildings and infrastructure, utilities, manpower and operations. The climate-related vulnerabilities of the tyre sector were also referred to assess the typical challenges to the sector. Considering the impacts of the climate hazards and the adaptive capacity, the vulnerabilities of the project were established. In view of likely climate hazards and their impacts and the project vulnerabilities, the physical risks were categorized as high, moderate and low.

Transition risks were identified by assessing current policies and practices and future possibilities and the associated risks of transitioning to a low-carbon economy. It took the legal and institutional frameworks relevant to climate change into consideration. Transition risks were assessed from the legal and policy perspective, technological and market considerations, and reputation risks to the project.

The expected Greenhouse Gases (GHG) emissions of the project were estimated in line with the GHG Protocol Corporate Standard. Annual Scope 1 emissions were estimated to be 17,554 tons CO_2e, while Scope 2 emissions were 13,382 tons CO_2e. Alternatives to reduce the emissions include integrating renewable energy, conducting regular energy audits, increasing biomass as fuel for the boiler, and other measures.

The Climate Change Management Framework for the project addressed both Physical and Transition Risks by proposing suitable Adaptation and Mitigation measures, to address the project's vulnerabilities. Measures to increase the overall adaptive capacity of the project and proponent have been proposed. To address the major physical risks to the project, proposed

adaptation measures for extreme heat and temperature events include adequate insulation and heat proofing in the project design, sufficient shading and provision of water to workers during construction and operation phases, and in the events of extreme precipitation and floods establishing of alternate routes that can be used during blockages due to flood water are among the proposed adaptation measures. To address the transition risks, mitigation measures include diversifying energy sources towards alternative energy sources, and conducting regular energy audits to identify areas of energy wastage.

The above sections pertaining to climate change risk assessment and management of the project have been detailed separately in the Climate Change Risk Assessment Report of the project provided in **Appendix E**.

8.6 Climate Change Impacts on Environment and Social Receptors

Recurrent extreme weather events in the past decade, such as floods, droughts, cyclones, and heatwaves, have taken a toll on life, property, and economic growth. The 2010 and 2022 super flood in Sindh alone caused widespread devastation, resulting in numerous casualties and substantial economic damage. The severe heatwave in 2015, primarily affecting Sindh Province, led to over 1,200 heat-related deaths. The detailed climatic projections of the area and climatic parameters that led to the Impacts of climate hazards onto the environment and social hazards are provided in **Appendix F**.

8.7 Traffic Impact Assessment

The Gharo Intersection currently operates as an unsignalized intersection with four approaches (Keti Bunder, Karachi, Thatta, and Armstrong ZE). However, the Keti Bunder approach experiences encroachment from on-street parking and commercial stalls, effectively reducing the number of usable lanes to one in each direction. This analysis considers the intersection's full capacity of two lanes per approach (2+2) for a more comprehensive evaluation, while acknowledging the current limitations.

- No-Built Scenario: Under the No-Built Scenario, the Gharo Intersection operates at LOS "C" during the peak hour, indicating that it is already approaching capacity and experiencing moderate delays.
- Impact of Development: The addition of traffic generated by the Armstrong ZE development in Phase 1 (2026) has a minimal impact on the LOS, with the intersection remaining at LOS "C" and experiencing an average delay increase of only 2.5 seconds per vehicle.
- Background Traffic Growth: However, the projected background traffic growth of 2.85% per year in the Gharo region is expected to significantly increase traffic demand at the intersection by 2029 (Phase 2). This independent growth, unrelated to the development, is anticipated to cause the LOS to deteriorate to "D," resulting in average delays of around 31.7 seconds per vehicle.

- Gharo-Keti Bunder Road: It is noteworthy that the LOS analysis for the Gharo-Keti Bunder Road, which serves as the primary access to the development, remains at "A" (excellent) throughout all scenarios. This indicates that the road itself has sufficient capacity to handle the anticipated traffic volumes associated with the development.

The traffic impact assessment (TIA) in the project AoI has been conducted. The study analyzed existing traffic patterns, estimated trip generation from the facility, and projected future traffic volumes for both phases of operation.

8.7.1 Trip Generation Study

The trip generation study successfully estimated potential traffic generated by the proposed tyre manufacturing plant in both phases (normal operating capacity and expanded production).

a. Key findings:

- Heavy vehicle traffic: Daily, AM peak hour, and PM peak hour trips were estimated based on ITE Trip Generation Manual data.
- Private vehicle traffic: Estimates were derived through an analytical approach considering person trips, travel distances, mode split, directional distribution, and industry practices.
- Phase 2: Anticipates a 30% increase in private vehicle demand compared to Phase 1.

8.7.2 Traffic Surveys

The traffic survey successfully collected data on existing traffic patterns in the vicinity of the proposed tyre manufacturing plant. This data, specifically the peak hour traffic volume on Gharo-Keti Bunder Road identified as 12:00 PM to 1:00 PM, will be used as the baseline for future traffic projections.

The findings of the traffic survey include:

- 24-hour traffic count data for Gharo-Keti Bunder Road.
- Peak hour traffic count data for the identified peak hour on Gharo-Keti Bunder Road and Gharo Intersection.
- Modal composition of traffic on the road, with the majority being motorcycles and passenger cars.

Level of Service (LOS) Analysis

Gharo Intersection currently operates at moderate capacity (LOS "C") and is projected to deteriorate further (LOS "D") in 2029 due to background traffic growth, independent of the development.

8.7.3 Traffic Impact Assessment (TIA) on Local Communities

The Traffic Impact Assessment (TIA) findings suggest that the proposed development will not cause major traffic impact on the community the initial phase (2024-2026) plant will be operated at normal capacity and from 2029 onwards it will be operated at 100% capacity It looks like there will be a bit more traffic, but nothing that the existing roads can't handle the peak hour traffic is observed at 12:00 – 13:00 So it's usually busy during this time. The roads should still function pretty well. However, the TIA also indicates that while there will be some increase in traffic volumes (30% each phase) it's projected to remain within the capacity of the existing roadways. This indicates a modest impact on the community's traffic infrastructure. Residents can expect only marginal changes in congestion levels and travel times, with the overall functionality of the roadways expected to be maintained. The Level of Service (LOS) analysis findings for the Gharo-Keti Bandar Road indicate excellent performance across all three scenarios, consistently maintaining a LOS rating of "A" during peak hours. This suggests that traffic flows smoothly with minimal delays for all movements, regardless of the development's influence. This can be attributed to the projected Peak Hour Traffic generated by the study development, estimated to be around 76 vehicles per hour by 2029. This translates to an average arrival time of approximately 47 seconds per vehicle, ensuring ample critical gaps for manoeuvring without disrupting the flow of through traffic and with minimal impact on the community.

8.8 Cumulative Impact Assessment

Based on the definition provided in Good Practice Handbook on Cumulative Assessment, *"Cumulative impacts are those that result from the successive, incremental, and/or combined effects of an action, project, or activity when added to other existing, planned, and/ or reasonably anticipated future ones"*(IFC, 2013). These can be different and synergistic in nature, often larger in magnitude, long-lasting, great in significance and greater in spatial extent as compared to individual impacts of a project. Considering fact that this is the first industrial project of this scale within the project AoI and no similar project is planned in the immediate future, it is advised to conduct a cumulative impact assessment when the development activities in the project area increase in the future.

Exhibit 8.1. Impact Assessment Process adopted for ESIA

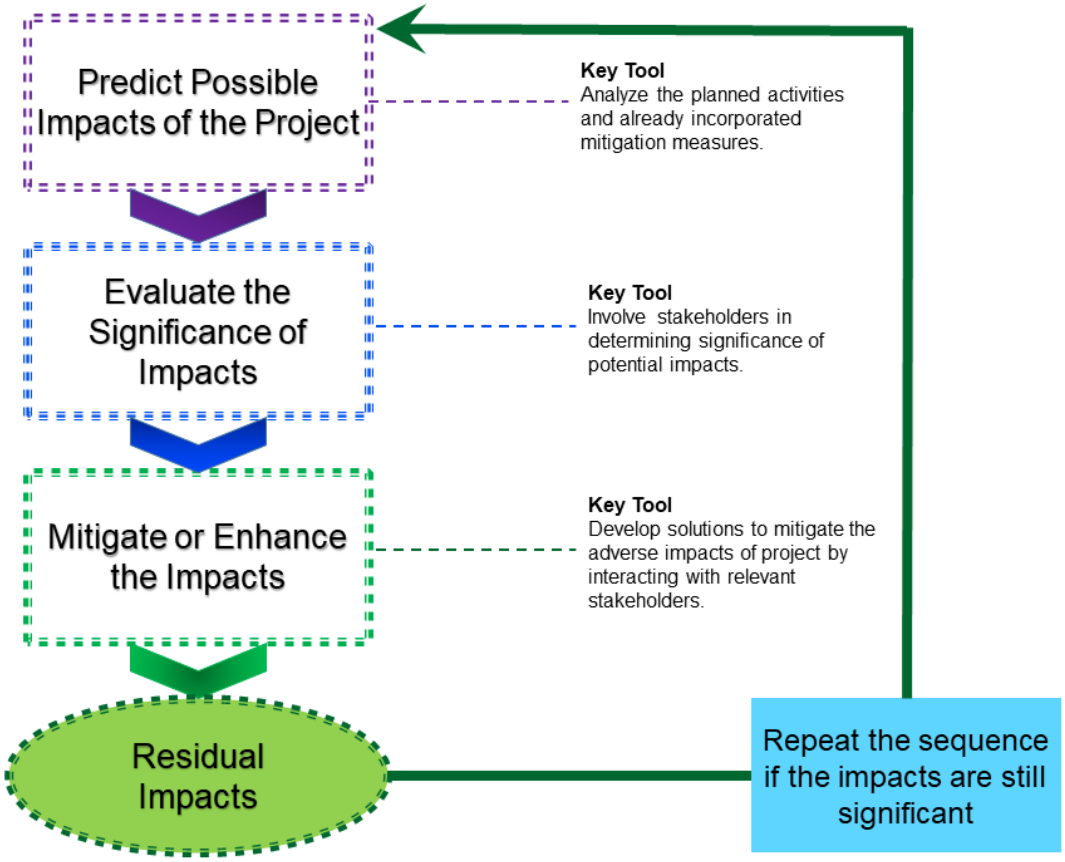


Exhibit 8.2. Activity-Impact Interaction Matrix for Armstrong ZE

Project Phases and Activity	*Climate*	*Soil Erosion and Degradation*	*Air Quality*	*Noise and Vibration*	*Soil and Groundwater*	*Water resources, quality & availability*	*Biodiversity*	*Light, visual and aesthetics*	*Occupational health & safety*	*Community health & safety*	*Archaeology, culture and heritage*	*Infrastructure and Economy*	*Gender and Social*
Construction phase activities													
Site clearance (excavation, piling, filling etc.)		✓	✓	✓	✓	✓	✓		✓	✓			
Construction of labour accommodation and bachelor's hostel		✓	✓	✓	✓	✓	✓		✓	✓			
Construction of project components (Manufacturing facility and offices, roads, parking areas, storage areas, soak pits, coal yard, warehouses, effluent treatment plant, waste storage areas)		✓	✓	✓	✓	✓	✓		✓	✓			✓
Installation of water, electricity, gas and drainage systems		✓	✓	✓	✓	✓	✓		✓	✓			✓
Installation of tyre manufacturing area		✓	✓	✓	✓	✓	✓		✓	✓			
Operation Phase Activities													
Routine manufacturing operations			✓	✓		✓			✓	✓			

Project Phases and Activity	*Climate*	*Soil Erosion and Degradation*	*Air Quality*	*Noise and Vibration*	*Soil and Groundwater*	*Water resources, quality & availability*	*Biodiversity*	*Light, visual and aesthetics*	*Occupational health & safety*	*Community health & safety*	*Archaeology, culture and heritage*	*Infrastructure and Economy*	*Gender and Social*
Maintenance of production machinery and equipment	✓	✓	✓	✓	✓	✓	✓		✓	✓			
Inspection and calibration of equipment		✓	✓		✓					✓			
Monitoring and optimization of manufacturing processes	✓	✓	✓	✓	✓	✓	✓		✓	✓			✓
Inspection and maintenance of utilities	✓	✓	✓	✓	✓	✓	✓		✓	✓			
Maintenance of infrastructure, buildings, and roads		✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Waste collection and storage													
Effluent treatment					✓	✓							
Environmental monitoring and compliance		✓	✓		✓	✓							

9. Environmental and Social Management Plan

9.1 Introduction

This chapter complements the comprehensive Environmental and Social Management Framework (ESMF) separately provided with the ESIA, to guide the implementation and monitoring of the mitigation measures to address the potential impacts of the Project.

9.2 Purpose and Scope

An ESMP typically provides the delivery mechanism to address the adverse environmental as well as social impacts of the proposed project during its execution, to enhance project benefits, and to introduce standards of good practice to be adopted for all project works.

The specific objectives of the ESMP are to:

- Define the responsibilities of the project proponents, contractors, and environmental monitors, and provide a means of effectively communicating environmental and social issues among them.
- Define the implementation mechanism for the mitigation measures identified during the present study.
- Define the monitoring mechanism and identify monitoring parameters in order to:
    - Ensure the complete implementation of all mitigation measures, and
    - Ensure the effectiveness of the mitigation measures.
    - Provide the mechanism for taking timely action in the face of unanticipated environmental or social situations.
    - Identify environmental as well as social training requirements at various levels.

All these objectives have been kept into consideration in developing the environmental and social management framework for the project. This framework provide the basis to the project for developing Environmental and Social Management Systems (ESMS) for both the construction and operation phases.

9.3 Components of ESMF

The Environmental and Social Management Framework addresses the following:

9.3.1 Stakeholder Engagement and Consultation

The stakeholder consultation is a continuous process and it is will be valid for all phases of lifecycle of the Project. The mechanism for stakeholder engagement is briefly described in Stakeholder Management Plan provided in the ESMF.

It briefly describes:

- Objectives and key values for stakeholder engagement
- Mechanism of communication
- Community participation
- Roles and responsibilities
- Monitoring and evaluation
- Framework for management of environmental and social issues.

9.3.2 Grievance Redressal Mechanism

The grievance redressal mechanism is provided in ESMF briefly. The purpose of this mechanism is to make a strategy for formalizing the way of acceptance, assessment and resolving the community feedback or complaints.

9.3.3 Construction Labour Management

This plan provides a framework for management of construction labour according to the applicable regulatory and other requirements. It is provided as an addendum to the above-mentioned Environmental and Social Management Framework (ESMF).

9.3.4 Emergency Preparedness and Response

The framework for developing specific emergency preparedness and response plan is also provided in ESMF.

9.3.5 Health and Safety Management

This management plan addresses occupational health and safety, community health and safety and traffic safety and control in project area during the project's lifecycle. The framework to develop this plan will be delivered as part of ESMF.

9.3.6 Waste Management

The framework for waste management is developed and provided as addendum to ESMF. The purpose of this plan is to provide framework for effectively managing the risk associated with the potential impacts including minimising waste generation.

9.3.7 Water Management

The framework for water management is developed and provided as addendum to ESMF.

10. Conclusion and Recommendations

10.1 Introduction

This chapter sheds light on conclusions of the study and suggest recommendations for the project to effectively manage environmental and social risks. The ESIA process undertook extensive risk and impact assessments, identifying and assessing a range of potential impact to physical, biological and social environment. Where significant impacts have been identified, appropriate mitigation measures have been provided in the ESIA. These mitigation measures will reduce the significance of these impacts to minor or negligible level. However, for some impacts, major to moderate residual impacts may persist even after application of mitigation measures. These impacts will be addressed by developing specific management plans for careful and consistent management.

10.2 Conclusion

Primary concerns associated with the project primarily revolve around air quality, waste, water usage and social concerns pertaining to the local communities. Construction activities may cause soil degradation, compaction, and contamination, while operational processes pose risks to groundwater quality and water resources due to chemical usage and increased water extraction.

The construction phase of the proposed tyre manufacturing plant may induce significant air quality impacts, particularly particulate matter pollution and dust generation, stemming from land levelling and transportation activities. These pose risks to human health, ecological receptors, and the project workforce's occupational health and safety. The unmitigated impacts are deemed of high significance, albeit with potential reversibility. To address these concerns, mitigation measures such as fencing high-risk areas, limiting run-off, reducing vehicle speeds, and using water sprinkling have been proposed. These aim to mitigate adverse air quality impacts during construction, ultimately reducing residual impacts to a low level. The potential impacts on air quality during operations of the plant will arise mainly from the operations of the boiler, and to a limited extent, from the backup diesel Gensets that will be operational in case of power outage. There are engineering controls provisioned in the design, such as wet scrubbers, which will significantly reduce the emissions from the boiler. The boiler equipment with the engineering controls and resulting expected emissions are under finalization by the technical consultant.

The ADM activity undertaken indicates only marginal exceedances against WHO Ambient Air Quality Guidelines for sulphur dioxide and nitrogen dioxide under extreme modelling scenario, while no exceedance were observed against the SEQS. It is to be noted that the proposed tyre manufacturing plant is located in a generally flat area where there are no structures or natural obstructions to disrupt the wind flow or the dispersion of pollutants to cause downwash of pollutants. Therefore, impacts due to the plant's operations are unlikely

to cause any significant deterioration of the area's air quality. The minor exceedances against the WHO Ambient Air Quality Guidelines can be catered through more stringent mitigation measures to keep the concentrations within the prescribed limits.

A detailed mitigation plan will be outlined in the Environmental and Social Management Framework (ESMF) to address residual impacts from air emissions during operations. Implementation of these measures will enable the plant to effectively mitigate air quality impacts, ensuring regulatory compliance and compliance with IFC Guidelines, and fostering sustainable environmental practices.

The proposed tyre manufacturing plant presents potential noise and vibration impacts during both construction and operational phases. Construction activities such as land clearing and transportation may cause short-term, reversible disturbances, while operational noise from machinery and generators could lead to long-term impacts of medium to high significance. To mitigate these effects, measures including sound insulation, provision of personal protective equipment, and restrictions on construction hours have been suggested for the construction phase. Similarly, during operations, installation of sound barriers and use of sound-proof canopies are recommended. Implementation of these measures is crucial to manage noise and vibration impacts effectively, ensuring compliance with regulations and minimizing disruptions to surrounding areas.

The ESIA underscores significant concerns regarding tyre manufacturing processes, highlighting risks of air and water pollution, soil contamination, and worker health hazards. To mitigate these risks, stringent measures are essential, including advanced pollution control technologies, robust waste management practices, and comprehensive worker safety protocols. Moreover, the leaching of hazardous substances from tyre manufacturing into groundwater or nearby water bodies poses threats to both aquatic ecosystems and human health through contaminated drinking water sources and fish consumption. Workers within tyre manufacturing plants face direct exposure to hazardous substances, risking various health issues such as respiratory problems, skin irritation, and increased cancer risk. In addition, spills or improper disposal of hazardous substances may result in soil contamination around the manufacturing plant, impacting soil fertility, plant growth, and overall ecosystem health. Furthermore, hazardous substances like flammable solvents and dust particles used in tyre manufacturing present fire and explosion hazards if not handled and stored properly.

It is to be noted that adherence to the pollution management protocols outlined in the Environmental and Social Management Framework (ESMF) are expected to curtail the projected impact on the area's natural and socioeconomic fabric to within permissible thresholds. Moreover, the project pledges compliance with all statutory requirements and standards enumerated in **Section 4** of this report.

Given that this is among the first industrial projects of this scale within the project area of influence, the need of cumulative impact assessment would be considered when the development activities in the project area increase in the future.

10.3 Recommendations

Based on the findings of this ESIA, it is recommended that:

- The ESMF should be made part of the contracts awarded by Armstrong ZE for the proposed project.
- In-house environmental and social management capacity should be developed in Armstrong ZE to manage environmental and social aspects of the project.
- Armstrong ZE should effectively implement its HSE Policy and Environmental & Social Policy, which would demonstrate the company's commitment towards sound environmental and social management practices throughout its operations.
- Armstrong ZE should adhere to the environmental legislation and regulations, throughout the project lifecycle.
- Armstrong ZE and its contractors should continually engage with local communities and prefer local labour for jobs appropriate to the skill level.

By integrating these recommendations into the ESMF, the tyre manufacturing plant would mitigate its environmental footprint and promote responsible practices, safeguarding both the surrounding environment and the interests of nearby communities.

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APPENDICES

APPENDIX A – PHOTOLOG

Description	Photograph
Photograph 01 *Project sign board with the site's pole-mounted transformer (PMT) visible in the foreground*	
Photograph 02 *Panoramic view of the site*	
Photograph 03 *Temporary office block at the entrance to the project site*	

Description	Photograph
Photograph 04 *View along the project's southern boundary*	
Photograph 05 *Ongoing construction for the Bachelor's Hostel behind the temporary office block*	
Photograph 06 *Construction work in progress for Labor's Accommodation*	

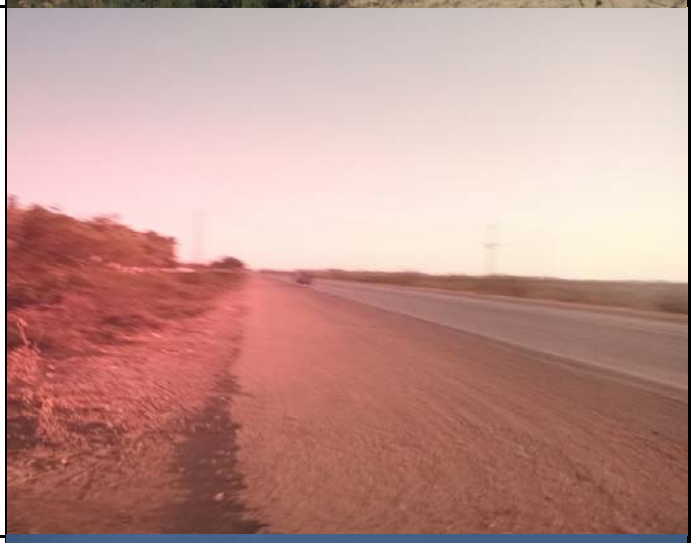
Description	Photograph
Photograph 07 *Foundation rocks brought from Manghopir Hills for foundation laying and other construction activities*	
Photograph 08 *Construction of boundary wall for the project area*	
Photograph 09 *A view of the batching plant along with the diesel generator*	

Description	Photograph
Photograph 10 *Temporary kitchen arrangement by Shamsi Builders on-site for food and tea arrangement for labour*	
Photograph 11 *Temporary accommodation provided to labour by Shamsi Builders*	
Photograph 12 *Scoping Day 01 - Soil boring in progress for installation of an abstraction well*	

Description	Photograph
Photograph 13 *Goats of local shepherds roaming on project land towards the northwest corner*	
Photograph 14 *Shepherd's cow grazing along the project's northern boundary*	
Photograph 15 *Scanty vegetation present on project land*	

Description	Photograph
Photograph 16 *General shrubbery vegetation on project land*	
Photograph 17 *On-site water pond and guard house towards the northern boundary of the project site*	
Photograph 18 *On-site hand pump adjacent to the water pond, used by the guard and his family*	

Description	Photograph
Photograph 19 *Phenri Canal along the site's northern boundary*	
Photograph 20 *Vacant land towards the site's northeast corner*	
Photograph 21 *Settlements along the project's northern boundary wall*	

Description	Photograph
Photograph 22 *Vacant land with natural vegetation of shurbs in the adjacent south of the project land*	
Photograph 23 *Gharo-Keti Bander Road (N-110) in the project's adjacent east, also serving as the only access road to the project*	
Photograph 24 *Vacant land with scattered vegetation in the project's adjacent west*	

Description	Photograph
Photograph 25 *Sim Nullah located 970 m south of the project's southern boundary*	
Photograph 26 *Royal Ranches Farmhouse, 337 m southeast of the project's southern boundary*	
Photograph 27 *Packaging spot for locally grown vegetables*	

Description	Photograph
Photograph 28 *Nova Foods Private Limited, located 340 m south of the project's southern boundary*	
Photograph 29 *Agricultural land with coconut orchards present in the AoI*	
Photograph 30 *A fish pond present 1,070 m south of the project's southern boundary, across the Sim Nullah*	

Description	Photograph
Photograph 31 *Toolbox talk before commencement of installation of monitoring wells*	
Photograph 32 *Cable locating device positioned on the ground to locate underground cables before conducting soil boring activities*	
Photograph 33 *Decontaminating equipment before taking samples to avoid any contamination that may occur due to equipment.*	

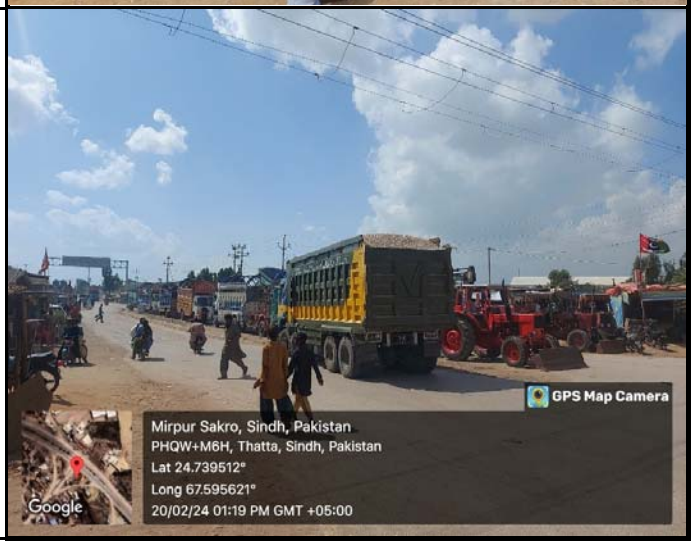
Description	Photograph
Photograph 34 *Equipment blank sampling*	
Photograph 35 *Soil boring in progress*	
Photograph 36 *Soil sample collection*	

Description	Photograph
Photograph 37 *Taking PID reading for soil samples*	
Photograph 38 *Cable tool operating*	
Photograph 39 *Casing pulling activity*	

Description	Photograph
Photograph 40 *Filter pack filling*	
Photograph 41 *Monitoring well gauging*	
Photograph 42 *Monitoring well purging*	

Description	Photograph
Photograph 43 *View of on-site water sampling*	
Photograph 44 *View of surface water sampling from Phenri Canal along the project's northern boundary*	
Photograph 45 *Sample collection of OW-AZE-01, 111 m northeast of the project site*	

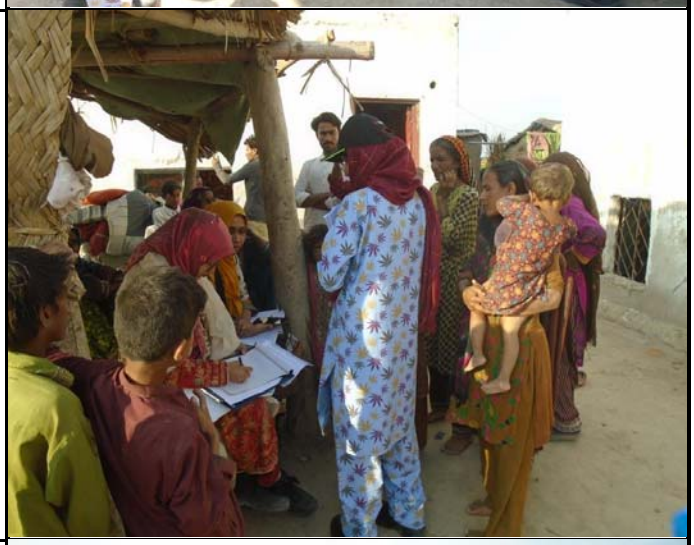
Description	Photograph
Photograph 46 *Consultation with Muhammad Yousuf along Coastal Highway*	
Photograph 47 *Consultation with manager of Daniyal farms*	
Photograph 48 *Consultation with Malik Ameen, a fish farm owner, at Goth Haji Lal Baig Awan, 1.74km northeast of the site*	

Description	Photograph
Photograph 49 *Ambient air monitoring*	
Photograph 50 *Noise monitoring*	
Photograph 51 *Gharo intersection survey for traffic impact study*	

Description	Photograph
Photograph 52 *Road inventory survey for Gharo-Keti Bander Road*	
Photograph 53 *Fauna Specie, Camelus, identified in surrounding area of the project*	
Photograph 54 *Floral Specie, Ipomoea Aquatica identified in surrounding area of the project*	

Description	Photograph
Photograph 55 *Consultation with local fishermen near Gharo Creek*	
Photograph 56 *Consultation with pesticide shop owners along Gharo Keti Bander Highway*	
Photograph 57 *Stakeholder consultation with Mah Dev, manager of Jeelani Rice Mills, located 1.6 km southeast of the project site*	

Description	Photograph
Photograph 58 *Stakeholder consultations with local settlers residing adjacent northeastern boundary of the project site*	
Photograph 59 *View of children coming from TCF School*	
Photograph 60 *Stakeholder consultation with Tea Stall Owner, located adjacent east of the site*	

Description	Photograph
Photograph 61 *Stakeholder consultation with Mr. Rizwan, translator in Chinese Copper Processing Plant, located 1 km southeast of the project site*	
Photograph 62 *Stakeholder consultation with community, residing 1.09 km east of the project*	
Photograph 63 *Consultation at Hamza Masjid, within the community, located east of the project site*	

Description	Photograph
Photograph 64 *Stakeholder consultation with Ms. Shumaila, Principal of TCF school, located 1.57 km northeast of the project*	
Photograph 65 *Stakeholder consultation with SEPA*	
Photograph 66 *Stakeholder consultation at SSGC office, Gharo*	

Description	Photograph
Photograph 67 *Stakeholder consultation with Sindh Forest department*	
Photograph 68 *Stakeholder consultation at HESCO Grid Station, Mirpur Sakro*	
Photograph 69 *Stakeholder consultation with Sindh Irrigation Department*	

Description	Photograph
Photograph 70 *Stakeholder Consultation at settlement 11*	
Photograph 71 *Stakeholder Consultation at settlement 2*	
Photograph 72 *Stakeholder consultations with local settler*	

Description	Photograph
Photograph 73 *Stakeholder consultations at settlement 3*	
Photograph 74 *Stakeholder consultations at settlement 4*	
Photograph 75 *Stakeholder consultations at settlement 10*	

APPENDIX B – BACKGROUND INFORMATION DOCUMENT (BID)

Background Information Document (BID)

Tyre Manufacturing Facility

Information Sharing Process for the Environmental and Social Impact Assessment (ESIA)

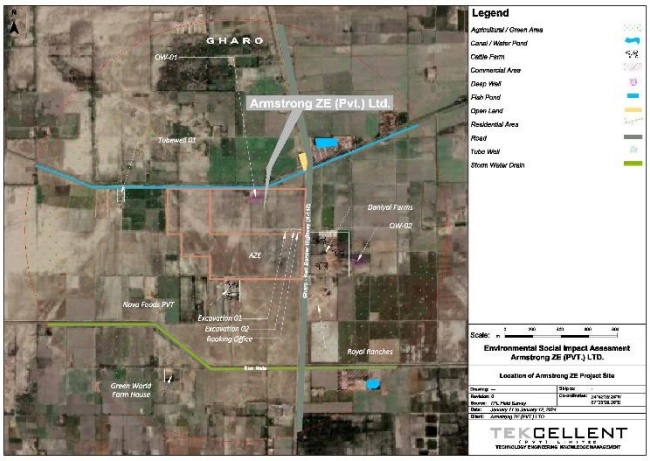
Purpose of the Document

The Purpose of this document is to explain the background and share the necessary information about the project to our stakeholders about the proposed project.

Background

On October 5th, 2018, the partners at Zafar Enterprises officially founded Armstrong ZE (Private) Limited, a privately held company duly registered with the Securities Exchange Commission Pakistan (SECP). The primary objective of this establishment is to initiate the development of a tire manufacturing plant in Gharo, Sindh, Pakistan, operating under the reputable Armstrong brand – well-recognized in international markets.

The Armstrong ZE tire manufacturing facility aims to meet the increasing demand for tires driven by the escalating automobile production and circulation across the country. Beyond addressing this demand, the facility also contributes to reducing import dependency, consequently conserving valuable foreign exchange and fostering the growth of the Pakistani economy.



Project Location

Spanning across 50.25 acres along the Gharo – Keti Bunder Highway, the plant's strategic location ensures easy accessibility via National Highway N-5. The project boundaries are illustrated in the figure.

The construction of the project is scheduled to commence in the year 2024, with completion expected by 2025. The Commercial Operation Date (COD) for the plant is projected to be in 2025.

Environmental and Social Impact Assessment (ESIA)

The project received an NOC against the EIA submitted to Sindh Environmental Protection Agency (SEPA) conducted by a consultancy in 2022. However, to comply with IFC requirements, Tekcellent Private Limited (TPL) is undertaking an ESIA study in order to determine the potential positive and negative impacts of the proposed project on both bio-physical and socio-economic environments, as a consequence of the construction of the industry. The ESIA will evaluate impacts from the project at large and propose mitigation measures for all the identified impacts to avoid or reduce negative impacts and enhance positive impacts. Where necessary, TPL will also make recommendations for further data collection and associated monitoring activities to be performed during different project phases. The project will be assessed for potential impacts related to land use change, climate and climate change, air quality, water quality and quantity, soil and groundwater, noise environment, visual aesthetics, waste management, biodiversity and sensitive habitats, existing infrastructure, social and socio-economic environment, societal changes, archaeology and cultural heritage and other aspects as deemed necessary.

Impact Mitigation

Specific mitigation measures for each aspect assessed will be identified in ESIA. However, the organization ensures that:

i. The site management will develop and implement Heath, Safety and Environment management plan to avoid any disturbance to neighbouring communities. Temporary arrangements for labour accommodation are made onsite to restrict unnecessary movement of labours outside the project premises. Labours will be provided with adequate training to ensure community safeguard. However, in case of any issues, concerns or grievances community can reach out to the HSE Manager (Contact no.: 0326-8001209) for this project.
ii. The site has committed to ensure zero wastewater generation. Therefore, there will be no discharge in the project AoI.
iii. Arrangements will be made to control air and noise pollution during construction and operation phases.
iv. A proper waste management plan will be developed and implemented. Solid waste burning or disposal will not be undertaken outside the facility or in the vicinity.
v. Local community will be given priority for unskilled labour and also for skilled employment if any individual meets the competency criteria.

Actions Desired for Corporate Social Responsibility

i. Provision of clean water to communities by installing a Reverse Osmosis (RO) plant.

ii. Facilitate small businesses to acquire products and services given that there is no significant difference in price and quality of procured products or services meets the criteria.

iii. Provide growth opportunities to local small enterprises.

APPENDIX C – STAKEHOLDER CONSULTATION FORM

Assessment Form

Part A: General Information *(to be filled in by interviewer itself)*

Name of interviewer:	**Date:**	**Time:** _____to_____
District:	**Village:**	
UC:	**Taluka:**	**Caste:**

Part B: Information of Beneficiary

Name:			**Age:** _____ **years**			**Gender:**	*M*	*F*			
Religion:_____			**Marital Status:**	*Single*	*Married*	**Education**					
No. of Family members:_____		Male		Female		Children					
Occupation: *(could be more than one)*	*Fishing*	*Livestock rearing*	*Farming*	*Poultry farming*	*Labor*	*Any other:*					
Do you earn whole year by this profession:		*Y*	*N*	*If no, then how many months:* _____							
Average income:_____ **PKR/month**	**Is this income sufficient to fulfill your daily needs?**					*Yes*	*No*				
Do you have any livestock?	*Y*	*N*	*Cow*		*Goat*		*Sheep*		*Camel*		*Other:*

Part C: General Village Profile

Average number of household in village:											
Average total population of village:											
Castes of people living in village:											
Number of Schools in Village:		**Primary**		**Middle**		**Secondary**					
Are the teachers available in school:	*Y*	*N*	**Average number of school going children**								
Average number of school going children		**Average Literacy Rate:**									
Source of electricity:											
Source of Drinking Water & household uses:											
Source of Fuel:											
Availability of Health Facilities (*dispensaries, basic/mobile health unit, maternity home if any*): **Key Illnesses:**											
In general, what are the road conditions in your area?											
What are the main forms of transportation? Are there any issues with local roads / transportation?											

Part D: Livelihood/ General Occupations of Villagers

a. What are the main sources of income– (a) for men and (b) for women? (Agriculture, commercial farming/livestock/handcrafts, daily wage worker, salaried people etc.)
b. What is the average daily wage earned for different types of work? Can you indicate the monthly minimum wage for workers in your community?
c. Minimum working age in your community
d. What natural resources do people rely on and where do they access them from? (E.g., collect NTFP products, fishing, grazing, firewood collection, hunting-selling)?
e. Agriculture (main crops): **What are the types of crops planted in the surrounding areas?** **What are the sowing and harvesting periods?** **Any usage of herbicides?** **What are the waste management practices (e.g. crop burning) typically undertaken at agricultural areas surrounding the project?**
f. Fishery: **How many months?** **Average monthly income?** **Fishing location?** **Type of net used?**
g. Livestock: **Personal (owned)?**
h. Labor:
i. Other:

Part E: Ethnic Profile

a. Who are the key ethnic groups in your area? Are there any ethnic minority groups?
b. Are there any issues of societal barriers based on ethnicity?

c. Are there existing conflicts between the different ethnicities?
d. Is there any territorial land owned by a particular ethnic group that is sensitive?

Part F: Cultural Profile

a. Dressing:
b. Status of Women
c. Customs
d. Areas of interest (mosques, shrines, recreational or archaeological site)
e. Marriages
f. Festivals

Part G: Views related to Project

How far you reside to project location				
Within 500 m	*500m-1km*	*1-5 km*	*>5 km*	*Along access roads*
How would you expect that project will influence your lives				
Beneficial	*Harmful*	*In both ways*	*In no way*	
Will the project affect any of the following aspects of your life				
Natural environment	*Water resources*	*Livelihood*	*Culture & customs*	*Privacy*	*Any other*
What benefits you expect to get from the project:				
Do you have any sort of concerns related to project:				
General comments/views related to project:				

Questions for Focused Group Discussion with Community

Dominant wind direction based on seasons?

How familiar are you with air quality issues in the area, if any?

Main concerns regarding air pollution in the community?

Have you noticed any changes in air quality in this area over the past years? To what extent has it improved or deteriorated? To what extent is it affecting the health and well-being of the locals?

Any particular seasons when air pollution/dust worsens or improves?

Any health issues witnessed due to poor air quality?

Any specific odours or smells frequently noticed in air?

What are common sanitary practices in the area.

What activities or sources of pollution do you believe contribute most to poor air quality in the area?

Any concerns with regard to air pollution in case of industries being set up in the area in future?

How would you describe the typical noise levels in the area during the day and night?

Any specific sources of noise that bother you the most (traffic, construction activity, plant operations etc.)

Any disturbances you expect would occur in your daily activities or sleep due to noise?

Any concerns regarding potential increase in noise levels from the proposed project?

Are there any quiet areas or times of day that you value and would like to protect from noise disturbances?

Common waste generation sources and disposal mechanisms in project area?

Type of Crops grown in different seasons/ Diseases and other vulnerability to crops

How do you deal with the salinity issues? What do you do when your groundwater well turns saline?

Potential causes of visual obstruction in your opinion

Commonly observed traffic patterns and rush hours on the highway.

Common mode of transportation.

Any foreseen issues related to increased traffic.

What are your thoughts and concerns about the proposed project and its potential impacts on air quality and noise levels in the area?

How do you think the project might affect your health, livelihoods, or quality of life?

Are there any cultural or social activities in the community that could be impacted by changes in air quality or noise levels?

What measures do you think should be taken to minimize any negative effects of the project on the environment and community well-being?

Are there any traditional knowledge or practices related to air quality and noise management that should be considered in the project's planning and implementation?

Assessment Form

(For government officials/institutional/NGOs)

Part A: General Information *(to be filled in by interviewer itself)*

Name of interviewer:	**Date:**	**Time:** _____to_____
UC:	**Taluka:**	
District:	**State:**	

Part B: General Information of Person Interviewed:

Name:			**Gender**	M F	**Contact**:
Affiliation:				**Designation:**	
How would you define yourself as an organization? Please select appropriate and specify the category					
	Government		National *(ministry, public agency)*		Local
			Regional/Provincial		Other *(please specify)*
	Regulatory Authority		Economic		Environmental
			Other *(please specify)*		
	Civil society		Member based organization		NGO
			Community based organization		Other *(please specify)*
	Media		***Contractor/ Sub-contractor***		***Other*** *(please specify)*

Questions specific to different stakeholders:

Stakeholders relevant to Land Use

What was the previous use of the land?

When was the land purchased/ Industry established?

Future Planned Uses of the Site

General developments planned in the area

Future Road Construction plans in the area / or any plans by the company/ other CSR activities

Sindh Environmental Protection Agency (SEPA)

How do you analyse project in its scope?

General process undertaken at Sindh EPA for approval of EIA studies.

Compliance related expectations from the project.

Department of Archaeology

Are there any known archaeological sites or cultural heritage sites / legally defined buffer area within 5 km radius of the proposed plant? If yes, what are their names, distance and direction from the site, their status / significance provincial, national or international and their rights under national law?

Are there historic archeological structures of significance in area such as buildings, cemetery?

Is there any location or area being under consideration to be declared as cultural heritage site?

Do you know any artefacts found during the construction activities in the specified 5-10 km radius of the project site?

Is there any procedure prescribed by the department of archeology, in case of any artefacts identified during construction?

Is there any significant cultural resources / local traditional practices identified/recognized by the Department of archeology within the project area?

Have any previous archaeological surveys or studies been conducted in the area? If so, what were the findings?

Are there any legal protections in place for the identified archaeological sites or cultural heritage in the area?

What are the potential risks to these archaeological sites posed by the construction and operation of the tire manufacturing plant?

How might the proposed plant impact the integrity and preservation of the archaeological sites in the area?

Are there any specific mitigation measures or preservation strategies that should be implemented to minimize the potential impacts on the archaeological sites?

Are there any specific regulations or guidelines that the proposed project must adhere to in order to protect archaeological sites and cultural heritage?

Are there any opportunities for collaboration between the project developers and the Department of Archaeology to ensure the protection and preservation of the archaeological sites?

What steps should be taken if any unexpected archaeological discoveries are made during the construction or operation of the plant?

Pakistan Meteorological Department

Frequency of tropical storms and associated rainfall/windstorm events since 2004. Has the frequency increased or decreased?

Average rainfall increasing or decreasing?

How frequently has the area experienced floods? Precipitation amounts generally recorded during flood events?

Trend in temperature averages?

Dominant wind direction and seasonal wind speed averages?

Cloud cover normally observed in all seasons and has it increased or decreased?

Frequency and trend of thunderstorm and hail storm events?

Extremes of heat and cold and what is the overall trend in extreme events respective of the area

Given significance of the Gharo special economic zone, any plans to install a meteorological observatory or an automatic weather station in the area? Since neither Thatta nor Karachi MOS can represent the climate of the Gharo region.

Frequency of localized rainfall events and its impact in the area?

Any method to monitor localized weather events that do not occur at the observatory but does affect other areas, in the absence of weather observatories?

Overall intensity of rainfall and whether or not intense rainfall events have increased or decreased over time? At what time of the year do they normally occur? How frequently does it lead to flooding events?

During wind storm events, what is generally the wind direction?

During days when "normal" weather prevails, what is the seasonal wind speed and direction?

Utility Supply

Gas usage and availability? Alternate source

Water used for drinking purposes and other? Alternatives? Issues related to water shortages.

Any recent survey done by any utility provider for supply provision.

Irrigation and Drainage Department/Town Municipal Authority/ Pakistan Red Crescent Society

What are the legal requirements project is expected to comply to?

What is your opinion on general climate related vulnerability of the area? Specifically in context of extreme rains and flood episodes.

Has the past flood episodes related in considerable damages within the project area? What was their nature and extent? How was affected population facilitated?

What are the disaster risk management practices in place? Are these tested periodically?

Is there any cleaning mechanism and frequency of canals and drains?

Other institutions (related questions were asked as apply to each department)
How do you analyze the project in its scope?

How do you foresee project to comply requirements of your department?

What would be probable impact of the project on the community? Please identify certain positive and negative impacts which you expect to occur?

Please suggest some mitigation measures for negative impacts you identified?

What financial/economical outcomes do you expect to find in outcome of the work?

How do you inspect the project details in terms of Health, Safety, Security and Environment (HSSE)?

To how much extent you find this project to fulfill CSR goals?

Specific to Pond Owners
Source of water for aquaculture (ponds) and where is it disposed?

Nutrients added and frequency

Fish harvesting period and any changes or impacts on fishes from activities/development going on in the neighbouring areas? Which is the main market where you supply fish?

Other Commercial Stakeholders
Background of their entities.

General sources of resource requirements and utilities.

Key challenges that they face while operating in the area.

APPENDIX D – STAKEHOLDER CONSULTATION MINUTES

STAKEHOLDER CONSULTATION MINUTES

1. Consultation with Local Communities

This section provides details of consultation undertaken with locals. The location of settlement, cast, population, number of households and key occupations are given in Exhibit 6.1. The consultations were aimed at (a) collecting baseline data from the locals to establish the social baseline in the project's AoI and (b) to disclose key information regarding the project to local communities using Background Information Document prepared in local language and address their opinions and concerns on it. The information gathered in terms of social baseline is provided in relevant sections of the report and mentioned here for all the settlements collectively. The feedback of community on the project is provided for each settlement.

1.1. Information on Social Baseline	
Housing Structure	The housing structures in majority settlements comprised of kuccha houses that are semi-permanent in nature and comprise of walls generally made of locally available mud, straw and thatched roofs. However, in settlement 6 (Goth Hashim Bukero) and settlement 11 (Samoo and Jokhio), there were some houses built with bricks. Those in Hashim Bukero were sponsored by the management of TCF.
Major Castes	Mallah, Kohli, Samoo and Bukero are the dominant castes in the project area. Other castes present in the area surveyed included Baloch groups and Bhambro.
Source of Drinking Water	Groundwater is usual source of water on the project land. Communities use hand pumps to extract from groundwater for their use.
Other Amenities	There is no electricity in the whole area surveyed. Roughly 10% of surveyed population have bought solar panels to use for lightening. There is no gas supply all communities use native locally available vegetation for use as fuel wood. Waste burning is common practice. There are no transportation facilities.
Income Sources	Only Bukero community has their own agricultural lands. Rest all the communities work on the lands of other landlords or rear

	livestock against a percentage. Mallah community also earns through fishing but it is not more than 5-6 months a year.
Literacy	The literacy rate in the area is very poor. Children only from Hashim Bukero community (settlement 6) go to TCF school due to its close proximity from their settlement while Jokhio and Samoo community (Settlement 11) have made a homeschooling arrangement that some of their children benefit from as there is no public school in the accessible vicinity.
Health Facilities	There are no health facilities in the immediate vicinity and people have to visit Gharo for this purpose. In case, specialized healthcare is required, they take patients to Thatta or Karachi. Cough and flu, cold and congestion, skin allergies and stomach illnesses are most common issues within the project area.
Religion	The Kohli community comprised of followers of Hinduism, rest all the communities follow Islam.
Culture	The culture is typically male-dominant, however, women usually take decisions regarding day-to-day functions of their houses. At the community level, decision making authority to resolve issues lies with their leader (sardar). They have strong kinship system and there is no concept of inter-cast marriages.
Women Role in Everyday Life	Except for Kohli community, all women work with the men in fields or for livestock rearing. Some also sell their local embroidered handicrafts and clothes but due to the lack of access to market, this trade is usually within communities only.
Key Social and Socio-Economic Issues	Lack of livelihood resources, poverty, unavailability of electricity and gas, healthcare facility, transportation facility, lack of education and motivation has emerged as key issues.
1.2. Feedback Regarding the Project	
Settlement 1 (Distance from site: 420m)	Key Personnel interviewed: Sharif Mallah, Ramzan Mallah, Umam Baloch Mallah and their wives. There were only 3 households in this settlement that have come from Sujawal and have been living here since 11 months. They work on the agricultural fields of Abu Bukero. They were neutral about the

	project as they mentioned, *"We rely on availability of livelihood. If we keep getting earning opportunities here. We will continue living here, if not, we will move in search of better opportunities".*
Settlement 2 (Distance from site: Adjacent)	Key Personnel interviewed: Meeru Mallah, Ali Mallah, Dilbar, Guddi (w/o Meeru). Their settlement lies adjacent to Armstrong ZE boundary however they did not raise any concerns regarding it. They mentioned that they earn their living through fishing and go to Ibrahim Hyderi Fishing Harbour which is starting point for their fishing journeys. Women contribute in livelihood by rearing livestock.
Settlement 3 (Distance from site: 715m)	There were 6 households in this settlements and key respondents were Kamji, Malho and Nara of Kohli community along with their spouses. They work on the land of Chaudhry Rasool, a Punjab based landowner. Due to their distance from the site, they mentioned they find the project neither beneficial nor detrimental to them as they don't believe it will affect them anyway.
Settlement 4 (Distance from site: 435m)	This comprised of 7 households of Kohli community. Of which 5 have been living here since years while 2 have recently moved here from Khipro. Heera Kholi was key respondent while womenfolk from this community gathered and participated in the consultation with him. Some of the men are employed at farmhouses in the vicinity as cleaning labour and earn around 600/day. Rest work as labour on the fields. Women of their community typically don't work. They have recently enrolled 5-6 children from their community into TCF school. Regarding the project they mentioned, our sole issue is earning opportunities. If it turns out to be a source of providing livelihood to us, we appreciate it. We have no concern with it otherwise.
Settlement 5 (Distance from site: 60m)	There were around 18-20 households that are located in this settlement comprising of Bukero and Mallah communities. Bukeros are basically land owners and have vast land parcels used for agriculture whereas Mallah work as labour on the fields. They mentioned that they have installed tube well to extract

	water from the canal. Their key concern regarding the project revolved around discharge of any type of effluents from the project that could contaminate their water bodies and discharge of emissions that can damage their crops and ambient air. While discussing BID with this community, they were informed of the desired mitigation measures. They mentioned that in case the project fails to implement these controls, they would opt for making complaints through legal platforms.
Settlement 6 (Distance from site: 950m)	This was the second most populated settlement in the AoI. There are approximately 40-50 households in this settlement. They are primarily land owners as well as labour who work on those lands. This goth is located at closest proximity to TCF school and therefore around 30-35 children from here study in school. The respondents also mentioned that there was a public primary school in the vicinity which is dysfunctional from last 3 years due to lack of appointment of teacher and allocation of resources by the government. Regarding the project, they did not raise any concern, however, they expect the locals to be given priority for labour based unskilled jobs at minimum.
Settlement 7 (Distance from site: 1205m)	This settlement comprised of Kohli community with around 7 households. Their key source of earning is labour on daily wages. They did not express any concern regarding the project.
Settlement 8 (Distance from site: 528m)	There are 4 households in this settlement and they have been using abandoned poultry farm structures for residential purpose. Women participated from this community primarily in the consultation and indicated that they have migrated here from Badin 1.5 year ago, due to lack of any livelihood opportunity. They basically follow nomadic lifestyle and their current livelihood is livestock rearing which belongs to some landlord of Karachi. They mentioned that they burn their solid waste to repel mosquitoes but it also causes breathing issues for them.
Settlement 9	There were 5 households in this settlement and key respondents included Nasreen from females and Moula Bux from males. This

(Distance from site: 583m)	settlement belonged to Bhambro community and they have been living in this area for more than 8 years. They earn livelihood by working in fields and get one-fourth of yield. Women also work as labour at daily wage of 300/day and the average household income is around 10,000-15,000 PKR/day. They mentioned cough and flu prevail as common illness and expressed their concern that if tyre industry emits its pollution in the area, it will affect the health of locals in a more adverse manner. Moreover, they expect the job opportunities to be extended to locals instead of bringing in migrant labour.
Settlement 10 (Distance from site: 612m)	This settlement belongs to Umrani Baloch and had 6 households. The key respondents were Shehr Bano, Aneela, Sabir-un-Nisa and Yar Muhammad. They earn their living by livestock rearing. Their major concerns from the project were pollution discharge in form of emission and effluents. They mentioned if the project discharges its wastewater outside the facility, it will affect the area and may lead to increase in illnesses making it unacceptable. Besides this, they also expect the project to be a source of livelihood for locals.
Settlement 11 (Distance from site: 950m)	This was the largest settlement in terms of size and population. There are 100+ households of Samoo and Jokhio communities. They generally work as labour in fields and some also earn by crab farming, however, this is not a year-long occupation. They are not involved in livestock rearing for livelihood purposes, however, some households have some goats and cows for their personal use. They indicated that they use fuel wood but the supply is continually decreasing. Skin and respiratory allergies are common in the area and they raised the same concern that if the project pollutes the air, it would certainly lead to an increase in illnesses for the communities. Moreover, they mentioned that although they believe they should be given priority for jobs, they are not very hopeful because as projects start, they always bring labour from outside and don't hire any local labour.

FGD at Samoo Hotel	An FGD was held with 12-15 local residents of the area at Samoo Hotel which is located along the Gharo- Keti Bunder Highway opposite to the site. The common occupation of the gathered audience was labour working on agriculture lands or running small shops. Regarding the overall conditions, group mentioned that usually vegetables are grown in this region besides cotton. Earlier, rice were grown too but driven by the unavailability of water in the area, rice cultivation have been affected. More farmers have therefore shifted to crops with less water requirement. Participants also mentioned that drainage is another common issue in the area that occurs after rains when the area gets inundated with at least 2-3 feet water depending on the topography and distance to the creek. This also occurred in 2022 and one of the main reasons for it is lack of maintenance of Sim Nullah. The existing drainage network is very old and has almost lost the capacity. Due to presence of water table at a shallow depth, water takes couple of days to drain completely especially in the creek area. Regarding healthcare infrastructure, people mentioned that there is no health facilities available in the area. The nearest available facility at Gharo- Keti Bunder intersection is sufficient for first aid and preliminary treatment only. They generally go to Ali Akbar Memorial Clinic in Thatta. The absence of any proper healthcare facility nearby also lead to casualties and death when there is a need for emergency treatments primarily for maternity cases and snake bites. Malaria, Skin Allergy, stomach diseases are most common after rainy season due to consumption of contaminated water. Moreover, there is no proper educational institute available in the area. People who can afford to travel long distance and bear fuel expenses can send their children to TCF school. The primary school is roughly around 1.5km from the project site while the

	secondary school is 3 to 4 km away from the area. There are no public schools available.

2. Consultation with Commercial Entities in the Project AoI

Commercial entities were identified in the project AoI as given in Exhibit 5.6 and consultation were undertaken with available focal persons. The details are as follows:

Asif Iqbal Arain/ Regional Manager/ Daniyal Farms	Date: February 15, 2024 Owner name was stated to be Chaudhry Iqbal who is involved in seed business. Farmhouse is used for private purposes and is not open to general public or for rental purposes. He mentioned that economic activities have increased for locals and the industrialisation is termed something good for the region. The farmhouse exists since 2013, while prior site land usage is not known. Previously, also a farm house. Land is not considered suitable for cultivation due to water availability issues and salinity. During rice harvest season, dust allergies are a common occurrence, especially during August to November period. Rice husk is a common issue for air pollution. Once a month, PPH van visits the area. Chaudhry owns 378 acres of land in the area. Flooding issues exist in the area water came inside during 2022 rainy season. Takes 3-4 months to get completely drained. Bore water saline: They have installed a filter plant to improve the water quality. No water connection available. Farmhouses for commercial purposes is a famous commercial business in the area. Poultry business is reducing to increased price of chicken. People are moving towards controlled incubation. PPH provides free OPD. Traffic issues not so much. Mall Piri is organized every Monday in Sakro where commodities are sold at cheaper rates."
Ms. Shumaila / Admin Manger/ Gharo Satellite Town	Date: February 15, 2024 According to Ms. Shumaila, the land was stated to be vacant prior to the construction of the town, and was purchased from a private party. Construction of the town was completed in 2021.

	Community is cooperative and more than 85% of property purchasers belong to Karachi. The town gets uninterrupted power supply from K-Electric. Currently, water supply is sourced from water tankers (from Dhabeji). Societies are banned from giving gas connection due to lack of supply, however, connections are available. Primary and secondary schools and college are in plan which will be open for outsiders as per the source. She was of the view that the overall youngsters of Dhabeji, Thatta and Gharo are well-educated but do not stay in town due to lack of productive environment, so they move to larger cities. Health care is in poor state. No tertiary care medical services are available in close vicinity. No flooding issues prior to road construction were encountered, but NHA raised the level of highway by 6-7 feet during reconstruction, which caused the surrounding town to be in depression, which has artificially made it prone to flooding. Road construction: A bypass is under construction near Keti Bunder which will be connected to N110 to make passage for oil tankers commute. This will increase the flow of traffic on the road. No community conflicts reported as such. N110 to be converted into dual carriageway.
Waseem Akhter/ Admin Manager/ Gharo Solar	Date: February 16, 2024 He mentioned that the project land was previously a barren land. Future extension up to 15MW is expected on the adjacent land parcel. There have been 18 labourers employed from the community for washing of panels. Banu Mukhtar was their construction contractor and OMS being contractor for operation phase. Overall, community response was positive during the construction and inception phases. The neighbouring solar plant Oursun Solar has the same contractors. The water runoff from the site goes into Sim Nullah while Black

	water is taken by third part contractors. RO reject water is evaporated through an evaporation pond. Water tank is installed which is sourced from Link Canal/ Phenri canal used for drinking and domestic use onsite. A bore is also installed which is used for washing of solar panels. A lot of industries/similar nature projects are in planning development including Zenfa solar. Residential schemes in a wider radius are also in planning. Solid waste is segregated onsite which is picked up by the waste contractors (Hadia Baloch) local waste contractors. For CSR, they have installed hand pumps and distribute rashan, 2 to 3 times per year. GH2 is managed by the same owners, which will probably become operational in 2026. To acquire gas connection, they need NOC from Railway and irrigation departments which is a process underway. HESCO/WAPDA jurisdiction starts from Gharo Golai area.
Rizwan/ Translator/ Copper Processing Area	Date: February 16, 2024 He indicated that it was previously a barren land as per his knowledge. Raw material for processing is sourced from Baluchistan. Locals have been hired for labour work. He was not able to give any information about owners of facility. Electricity is supplied by HESCO while for gas, cylinders are used. A bore is installed to fulfil drinking. Tranport route through main N110. They burn the food and domestic waste. There is a septic pond for blackwater disposal.
Maha Dev/ Manager/ Jeelani Rice Mills	Date: February 16, 2024 The facility was established in 2010 and it was previously a barren land. The site owner lives in Karachi. Manager indicated that their waste includes rice husk and polish mainly which is used in other processes and sent to Karachi. Rice husk is used as a raw material in different process while rice polish is sent to Cattle Colony. The solid waste is burnt and rice sac is sold off to Gatta market in

	Karachi. The product (rice) is sent to facilities at Port Qasim where they are further processed. There is a septic tank for wastewater which is cleaned weekly by a worker from municipality. All the labour hired by facility is local. Electricity is supplied through HESCO while there is no gas connection. For water, bore is installed near Kheeran Nali for water extraction which is used for domestic use. The bore depth is 30ft and water quality is good. This canal doesn't get closed and supply water round the year as it lies in the midway, which gets connected to KT-1 and KT-2, supplying water to Karachi. Depth of canal is 5 to 7 feet. The third canal (Jam Branch) gets closed for 3 to 4 days for routine maintenance. Regarding the agricultural activity in the vicinity, he mentioned that cotton is most vulnerable as it gets infected easily by white fly.
Ms. Shumaila/ Principal/ TCF School, Gharo	Date: February 20, 2024 She leads the Samara campus and Akbar Campus of TCF School established in this area in 2006. Both campuses are of primary level. She has been serving as a Principal for last one year and before that, she was working as a teacher for the last 9 years. She mentioned that she herself comes from Dhabeji while most of the other staff also comes from Gharo town or Dhabeji. She indicted that school has subsidized fee structure where students are also given uniform and course for up to Rs. 100/-. She also mentioned that the local enrollment is very less, only children from settlements around Bukero community, Yousuf Khaskheli Goth and Phenri Nali are enrolled, rest all students are from Gharo. As a whole, there are 413 students enrolled in both campuses, the total capacity is of 420 students. She also mentioned that the students enrolled are generally punctual. While discussing about the project, she mentioned that the school itself is operating at full capacity and we have no room for expansion, but, if anyone want to assist us in terms of CSR, they should facilitate in terms of provision of electricity and drinking water as the school lack both

	the facilities. She mentioned that the parties interested in providing any benefit to school as part of CSR should contact their Head office located at Qayyumabad, Korangi, Karachi.
Nadeem Ahmed Memon/ Security Guard/ Global Oil Mills	Date: February 16, 2024 The owners of global oil mills are the same as of Tapal Wood/ Cardboard Factory. Due to frequent load shedding, lack of water resources, and gas supply, both factories are no longer operational over past few years. It has also been communicated by different community members that Tapal factory was closed on public pressure as it was used to generate pollution, but it could not be confirmed.
Shiekh Altaf Flour Mills (24°44'4.83"N 67°35'29.73"E)	Date: February 16, 2024 The mill has been in operations since a long time. They process local and imported wheat and in years of lesser production, they process wheat from government godowns. The by-products are sold for animal fodder. Soak pits are used for waste disposal. Power supply is sourced from HESCO, but daily load shedding of 4 hours is observed. No gas available. No backup generators installed. Waste is dumped and burned in open at times. Floods last occurred in 2022. Harvested wheat is moved in pickup trucks to Gharo city and Karachi, but hardly 2 to 3 pickups leave every day. Daily wheat production is 40 muands. The mobilisation of pickups on the highway does not lead to traffic snarl ups since the volume of pickups is very low.
Fishermen at Fishing point (24° 44′ 12.948″N 67° 34′ 59.28″E)	Date: February 15, 2024 The fishermen reported that they sold the fish to Karachi and Gharo town. In last 30 years, no significant variation in temperatures was observed, while in general, June to August witnessed more rainfall than other months. Piped water was provided by the Gharo Municipal Administration in abundance (2 pm to 8 pm daily), with abundant supply available, which was also used for drinking. Piped gas from SSGC is available; however, the pressure was very low, especially in winter months.

	Therefore, they relied on fuel wood for cooking, while wealthier households also used LPG cylinders. The hospital and schooling services were reported to be largely inadequate. Industrial development in the area was considered favourable for the overall economy of the region. Main fish caught included *aari, tornado, neerala* etc. Seasonal migratory birds also visit the area, which were hunted by the locals and Arab hunters alike. These birds were stated to be sold in the local markets as well as in Karachi. Flooding was stated to be an issue in the area, and the 2022 monsoon caused widespread water logging in the area, which took 2 to 3 months to drain out. Overall precipitation has increased in recent years in terms of intensity and amount.
Malik Amin/ Fish farm owner (24° 43′ 30.33″N 67° 34′ 11.688″E)	Date: February 15, 2024 Name of village was stated to be Goth Haji La Beg Awan. HESCO is electricity supplier in the area since 1994 and currently there is load shedding of up to 4 hours daily. Fish farms are present in the area since 1960s. Crops grown in the area include rice, fruits, animal fodder, while currently, wheat, cotton and vegetables including ladyfinger, ridged gourd, bottle gourd and pumpkin are grown. The area was not affected by flooding; however, availability of water supply in the area has improved due to increase in rainfall in recent years. Reportedly, duration of water shortage months has reduced from 5-6 months in the past to just 2 months at present. Temperatures have not shown any significant change. June to August is very windy, causing dusty conditions at times. Commercialisation has increased in recent years, and Amin intends to go with the turning tide of business in the years to come. Business of poultry is also increasing in recent years. Water table is generally encountered at 3 metres, while bores are generally installed at depths ranging from 6 to 7.5 metres. He complained

	that due to construction of farm houses in the area winds and sunlight of the crops get blocked which effects their growth.
Worker at Nursery (24°43′41.34324″N 67°34′38.36568″E)	Date; February 16, 2024 The nursery has existed here since 25 years, and before that it was a barn for keeping animals. The weather is humid with strong winds in summer months. Temperatures have remained consistent in the long-run while precipitation frequency and intensity has increased in the recent years. The rainfall as intense as 2022 was last observed in 1994. Positive outlook towards industrial growth in the area. No such accidents observed on the main road. Traffic movement is consistent 24/7.
Hamza/ Caretaker/ Crab Farm (24° 44′ 6.94428″N 67° 35′ 10.02804″E)	Date: February 16, 2024 The crab farm was reported to be at least 20 to 25 years old and prior to that it was barren land. The area is prone to flooding and floods during heavy rains as well as high and low tides. No gas or electricity is available. Crabs from the farm are sold in Karachi but mainly exported to China. Wood used for cooking. Strong winds blow during the summer and sometimes in winters. Drinking water is fetched in cans from Gharo city. Water bores are present that are only used for ablutions and washing purposes as the groundwater is saline. Bore depth is generally 10 to 12 metres.

3. Consultations with Institutional Stakeholders

Different institutions were identified as the project stakeholders and were consulted during the ESIA activity. The minutes of consultations are as follows:

Mr. Mubarak – Assistant Director/ Mr. Imran Sabir – Director (EIA) – Sindh Environmental Protection Agency	Date: February 14, 2024 AD Mr. Mubarak briefed about the process of technical review undertaken by experts and advisory committee for any project whose EIA report is submitted to SEPA. He indicated that whenever a project report is received, it is evaluated followed by a public hearing notice. The comments from public are received and combined with the comments from expert committee and

	advisory committee reviews. Based on these comments, conditions of the NOC are postulated that the projects have to comply to. TPL team requested Mr. Mubarak to share those comments. Mr. Imran Sabir indicated that currently, an NOC is issued to development projects for construction phase only and they require to apply for an NOC for operations too once the construction is completed. However, issuance of the NOC for operation phase totally depends on project's compliance to conditions postulated in NOC for construction phase. During consultation with SEPA, they indicated that Armstrong ZE is required to submit monthly environmental monitoring report (as per NOC) and failure to do this will lead to non-issuance of NOC for operation. They mentioned that project must appointed an Independent Monitoring Consultant (IMC) now and start submitting reports as postulated in NOC as the construction has already been started. They also mentioned that Armstrong ZE should also develop and start implementing a CSR plan to facilitate local population.
Dr. Sardar Sarfarz/ Chief Meteorologist/ Pakistan Meteorological Department (PMD), Met Complex Karachi	Date: February 12, 2024 He mentioned that available data for Thatta district is from 2004. The station is located near the Makli graveyard in Thatta. Particularly, no weather monitoring stations are available in the Gharo region. However, information can be purchased from the department for Thatta district. The cyclone that hit the most in the Thatta region occurred in 1999. It was the second cyclone named as 02-A cyclone. That cyclone was the strongest one until 2007. It directly hit the Arabian Sea, causing major destruction to the Thatta Keti-Bandar region as well. The storm surge was 3.4 meters in 1999. After 2007, Cyclone Gonu, which went towards Oman, was stronger than the 1999 cyclone, but it did not directly hit the Thatta region. From 1945 to 2015, no significant increase in frequency of cyclones have been observed. The frequency is decreasing, but the intensity is increasing due to increased ocean

	temperature and global warming. The longest-lasting cyclone in the history of the Arabian Sea lasted 13 days; otherwise, the average cyclone lasts for 4-5 days. If the sea surface temperature reduces to 26°C up to a depth of 50 meters, it provides energy to the cyclone. No change is observed in the rainfall pattern; however, meteorological data will be acquired from the meteorological department when requested. 50-60mm of rain can cause flooding, which can be flash flooding or riverine flooding. Future threats in the Thatta region include sea level rise and tropical cyclones. Specifically, rainfall patterns can be observed through radar, as radar can record rainfall patterns at 450m. Thunderstorms are also increasing. According to the IPCC, for each 1°C increase in temperature, there is a 7% increase in moisture in the atmosphere. Sea surface temperature, vertical wind shear, and upper air wind are factors that can favour cyclones. The department has planned to install 50-55 automatic weather stations in Sindh, covering missing areas. The project is funded by the World Bank Group, and the plan to achieve this project is approximately 1 year.
Mr. Abdul Fatah Sheikh/ Director/ Department of Antiquities and Archaeology	Date: February 13, 2024 The director informed that the Gharo region has not been investigated and no such antiquities or artefacts of cultural heritage have been identified within 5km radius of the project. Normally, the archaeology team would conduct a survey of the site and dig trenches to discover artefacts of archaeological significance, but a formal letter and approvals are needed for such procedures that would take up to 6 months until the provision of report. He was of the view that in the case of shrines in the area, winter is the most prominent season when devotees or locals visit the shrine(s). The Antiquities Act of 1975 is applicable and holds legally binding. No construction is allowed within 200 feet of the archaeological site. If the archaeology team discovers any artefact

	during digging at or within 200 feet of the project, a stay order will be immediately issued and a thorough investigation initiated, until completion of investigation and issuance of NOC. No construction is allowed to proceed if the investigation finds the artefact of significance.
Mr. Ghulam Akbar / SSO-II/ HESCO (Mirpur Sakro Grid Office)	Date: February 20, 2024 He mentioned that the project area falls within the jurisdiction of HSECO, however, an application for connection from HESCO has to be made at Hyderabad office and they will provide necessary assistance in it. He further shared the names and numbers of respective personnel who can be contacted once any applicant want to apply for connection from HESCO.
Mr. Niaz Muhammad Khaskheli/ Billing Department / SSGC	Date: February 20, 2024 Mr. Khaskheli is working in SSGC for the last 5-6 years. During consultation regarding acquisition of connections for Armstrong ZE, he mentioned that any organization interested in seeking connection has to make a formal application to SSGC against which sales department conducts a feasibility study for line provision and the expenses have to be borne by the applicant. Following this study, a schedule of expenses is prepared along with identification of route and the applicant to acquire right of ways from relevant authorities where required. He mentioned that another application is made for connections once line is gasified and commissioned. The time period in the whole process depend on nearest point of gas availability. He further mentioned that 2 or 3 applicants in one area can also submit a collective application and bear the expenses equally. For this project, he mentioned they would likely require to apply for Right of Way (RoW) from National Highway Authority, however, this can only be firmed up after a feasibility study. He further mentioned that provision of line and connection doesn't ensure security of supply as reserves of Sui gas in Pakistan have already been exploited and there is a dire need to switch to alternative fuels. He also

	mentioned that even currently, imported RLNG is being supplied but government has to reduce all subsidies and consumers have to pay a higher cost as compared to the past.
Mr. Abdul Majeed Khaskheli / Assistant Engineer/ Sindh Irrigation and Drainage Authority	Date: February 28, 2024 He mentioned that Kharisian outfall drain falls into Gharo Creek and there are 145 small and big drains in the region that fall in their jurisdiction. The drains are cleaned once every 3 years but full blown cleaning doesn't occur anymore due to budgetary constraints. The gates of drains are closed twice every day during the high tide to prevent sea water to enter through them. The regulator of Sim Nallah is at the back side of Gharo city and is one of the most significant drains in the area that moves from Coastal highway and falls into the sea. The project has to acquire from NOC and indicate volume of wastewater to be discharged if it plans to discharge its treated wastewater, even for storm water. SIDA will take action on their application and prepare arrangements for inlet. He further mentioned that outfall drains are of 4 types: Main outfall drain that falls into the sea, Kharisi and Kherani are main drains of this area. Others are branch drain, sub-drain and link drain.
Mr. Kashif Ali Qureshi/ ADC-II/ Thatta	Date: February 28, 2024 He mentioned that he has joined this position quite recently in November, 2023 and is not much aware with the area. However, all the queries regarding land use and other aspects can be sent to him and he could try retrieving information from concerned personnel *(An email has been sent, however, no response have been received to date).*
Mr. Shehzad Sadiq/ Divisional Forest Officer/ Sindh Forest Department	Date: February 29, 2024 He mentioned that the project management should not lead to any disturbances of flora at any stage. He mentioned that if the client requires the department to provide explicit comments on the project, they can request for a field visit where a field officer from department would visit the area with the project team and

	could provide recommendations after considering the potential distribution of local ecology and quantum of effect.
Mr. Ghazi Salahuddin & Mr. Altaf Sheikh / WWF	Date: February 29, 2024 Mr. Ghazi and Mr. Sheikh mentioned that WWF is working in Gharo region primarily along the Mangrove belts. Regarding the potential impacts they foresee from the project, they would need to review the preliminary information about the project. *(The information has been sent by email but no response have been received to date).*
Mr. Zain ul Abideen (Emergency Response Officer) & Ms. Erum Ayaz (Climate Advocacy Officer) / Pakistan Red Crescent- Sindh Provincial Branch	Date: February 29, 2024 They mentioned that the project area is vulnerable to flooding due to elevation along the road. The run off is drained through the drains lying on the back side of Gharo Satellite Town ending in the creeks. These drains come from Right Bank Outfall Drain (RBOD). Most of the drains within the area are 60 to 100 years old and have already lost capacity due to lack of maintenance. Mr. Zain further mentioned that precipitation and flooding are the extreme cases, even during the daily tidal cycle, around 3-4 area along the creek is inundated. The gates of drainage channels are no longer sufficient to control overflow. This is continuously increasing the salinity levels of soil and therefore less absorption of water through the soil occurs. He further mentioned that due to the close proximity of wind corridor, it is necessary to control air emissions, otherwise they would affect a wider area damaging the crops and the human health. Mr. Zain also indicated that the site must be built with an elevation of 3-4 m otherwise it will also be inundated in future.
Dr. Syed Muhammad Ali/ Pakistan Red Crescent- Sindh Provincial Branch	Date: February 29, 2024 Dr. Syed mentioned that while such projects must ensure hiring local labour, they also need to develop and implement a comprehensive training plan to ensure that the health and safety aspects of employees and community can be managed. He said cross-contamination is usually one of the major issues leading to

	diseases. The workers must be trained on health and hygiene practices as it is very normal for them to wear each other's uniforms and open defecation is practiced in the area so they must be taught on its adverse impacts and how they can manage hygiene aspects. Moreover, training on behavior based safety, general health and safety, first aid, ergonomics and other issues deemed significant must be provided. Safety culture must be in place.
Vijay Kumar (Social Safeguard Specialist)/ Arshad Memon (Environmental Consultant)/ Sindh Irrigation Department	Date: February 29, 2024 It was discussed during the consultation that the risk of floods and inundation is high and therefore it leads to impacts on local community. They said that the canal is one of the sources of drinking water. It is important to strengthen the local community, therefore, locals must be given priority and the organization must focus on CSR. They further mentioned that ESG has to be incorporated.
Mr. Danish Rashdi/ Head of Karachi Programme/ IUCN	Date: March 1, 2024 (done online) IUCN has an office in Karachi by way of which it oversees projects in Sindh and Balochistan. In Sindh, Gharo falls under the KPO domain. IUCN has worked in the Gharo area in recent past, where it undertook a project for a renewable energy company, to do an Offset Plan. Currently, a scoping study and an offset plan for a wind power company is undertaken by IUCN in the area. Community awareness sessions are carried out by IUCN as part of the above offset project. IUCN can assist in biodiversity conservation and implementation of a biodiversity management plan that companies are generally asked to do. IUCN can also support nature based solutions. IUCN will first need to understand the project and will carry out a due diligence prior to any engagement.

APPENDIX E – CLIMATE CHANGE RISK ASSESSMENT

Climate Change Risk Assessment

Report

Armstrong ZE (Pvt.) Ltd.

R24AZECRA01PD

March 19, 2024

TEKCELLENT (PVT) LIMITED
TECHNOLOGY ENGINEERING KNOWLEDGE MANAGEMENT

Armstrong ZE

Climate Change Risk Assessment

Phase II – Detailed Assessment

Armstrong Tyre Manufacturing Plant

Gharo, Sindh

Report

TPL Reference: R24AZECRAV01PD

March 19, 2024

Tekcellent Private Limited
Karachi

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1 Introduction

1.1 Overview and Project Background

Armstrong ZE (Private.) Limited (hereinafter referred as "AZE") is a private company with the objective of establishing a tyre manufacturing facility to meet the growing demand for tyres throughout the country. The proposed tyre manufacturing plant is situated along the Gharo-Keti Bandar Highway (N-110), Gharo, Taluka Mirpur Sakro, District Thatta, in Sindh Province. The parent company, Zafar Enterprises, owns a total of 133 acres of land in the project area. Armstrong has acquired 50.25 acres of land from the Zafar Enterprises, of which 16 acres has been converted to Industrial/ Commercial land. An application was submitted to Sindh Master Plan Authority (SMPA), which was duly approved on June 6, 2023.

The development plan for the tyre manufacturing facility has been structured into three (3) phases: Phase I - Bachelors and Labour Accommodation, Phase II – Utility Buildings, and Phase III – Production Area and Infrastructure.

AZE is seeking project finance from International Finance Corporation (IFC) and therefore requires the project to comply with the applicable International Finance Corporation (IFC) Performance Standards (PS) and the World Bank Group (WBG) guidelines, as well as other international and local laws and regulations related to climate change and resilience.

Tekcellent Private Limited (hereinafter referred to as "TPL") was commissioned by AZE for undertaking Climate Change Risk Assessment (CCRA) in the project area. TPL planned the assessment in two (2) phases: Phase I consisted of Screening Stage, which identified the key climate hazards and risks relevant to the project. Phase I report was submitted to IFC and was duly approved. The Phase II involves a detailed assessment of risks, impacts and vulnerabilities, estimation of GHG emissions, assessment of transition risks, and identification of relevant mitigation and adaptation measures.

1.2 Objectives of Detailed Assessment

The detailed CCRA aims to identify the impacts of major climate hazards on the project and provide mitigation and adaptation measures to address the project vulnerabilities. This is fundamental for informing the prioritization of climate mitigation and adaptation measures for the project. The objectives of the assessment include:

- Identification and assessment of potential physical risks and vulnerabilities associated with climate change;
- Identification and assessment of the transition risks to the project;
- Estimation of GHGs and alternatives assessment for GHG reduction

- Recommendation for adaptation and mitigation measures under the climate change management framework for the project; and
- Provision of inputs to inform the project's alignment with Paris Agreement.

1.3 Report Structure and Organization

Section 1: Introduction
Overview, project background, objectives, screening assessment and document structure

Section 2: Legal and Institutional Framework for Climate Change
National Policy Overview, Intended Nationally Determined Contribution (NDCC), National Adaptation Plan (NAP), International Finance Corporation and Equator Principles

Section 3: Project Appreciation
Land use, topography, surface water network in the project vicinity and description of project operations

Section 4: Climate Change Risk Assessment (CCRA)
Approach & methodology, baseline climate overview, trends & projections, scenarios & pathways, timeframes and future trend projections of MET variables/ climate drivers, key concepts & definition of CCRA terminologies, climate hazard screening, climate change impacts, adaptive capacity and project vulnerabilities, physical risk assessment

Section 5: Transition Risk Assessment
Types of Transition Risks, methodology for risk assessment, risk summary, transition management

Section 6: GHG Estimation and Alternatives Assessment
Purpose and scope of GHG assessment, methodology, estimation of GHG emissions and limitations, alternatives for GHG reduction

Section 7: Climate Change Management
Opportunities for Adaptation, Mitigation and Transition, monitoring and evaluation, climate-related opportunities

Section 8: Alignment with Paris Agreement
BB1 (Mitigation) and BB2 (Adaptation and Resilience)

2 Legal and Institutional Framework for Climate Change

In developing countries such as Pakistan, the impact of climate change emerges as a significant obstacle to progress on environmental, social, and economic fronts, triggering voluntary and forced migration both within the country and across its borders. Pakistan is already witnessing the tangible consequences of global climate change, including more frequent droughts, heightened instances of flooding, unpredictable weather patterns, shifts in agricultural practices, diminished freshwater resources, and biodiversity loss. Effectively addressing climate change necessitates a dual approach: mitigation to curb its effects, and adaptation to cope with the changes.

2.1 National Policy Overview

National Climate Change Policy (NCCP)

The policy aims to address the possible challenges of climate change adaptation and mitigation. The NCCP, first published by the Government of Pakistan (GoP) under Ministry of Climate Change (MOCC) in 2012, and it updates after every five years in collaboration with United Nations Development Programme (UNDP) and relevant Federal/Provincial Departments. The policy was last updated in 2021, in which the components of Paris Agreement, United Nation (UN) Sustainable Development Goals (SDGs), and the Sendai Framework for Disaster Reduction were appended. Consequently, related appropriate measures to disaster preparedness, capacity building, institutional strengthening, technology transfer and international cooperation have also been incorporated. The NCCP defines high-level policy measures for each of the following areas:

- *Climate Change Adaptation*
  - Water Resource
  - Agriculture and Livestock
  - Human Health
  - Forestry
  - Biodiversity
  - Other Vulnerable Ecosystems
  - Disaster Preparedness
  - Socioeconomic Measures
- *Climate Change Mitigation*
  - Energy Generation

- Energy Efficiency and Energy Conservation
- Transport
- Urban Planning & Waste Management
- Industries
- Agriculture and Livestock
- Carbon Sequestration and Forestry

- *Capacity Building and Institutional Strengthening*
- *Awareness Raising*
- *International and Regional Cooperation*
- *Finance*
- *Technology Transfer*
- *Policy Implementation Mechanism*

Sindh Climate Change Policy

The Government of Sindh has also published policy in 2022, in line with the National policy 2022. The objective of the Sindh Climate Change policy is to ensure that the climate action is mainstreamed in the development of the planning, particularly the economically and socially vulnerable sectors of the economy and to steer Sindh towards economic growth and climate compatible development. The policy has suggested specific measures with key focus on mitigation, adaptation and capacity development processes for different sectors and sub-sectors like in agriculture, irrigation, forestry, industries, health, nutrition, education, energy, etc. The strategic objective outcomes of the policy are as follows;

- Adapt Pakistan Climate Change Act 2017 and National Climate Change Policy 2021 with items relevant to the Province of Sindh.
- Legislative review to harmonize existing legislation, policies and rules of line departments with Climate Change
- Sectoral operating procedures (design guidelines) for planning and management developed
- Operational guidelines for NGOs and CBOs and for government executed projects, working for Climate Change
- The provincial and municipal services duty bearers have necessary managerial and leadership skills for an integrated climate change adaptation and mitigation approaches

2.2 Intended Nationally Determined Contribution (INDC)

The NDCs provide a national vision for climate action. They are central components of the global effort to combat climate change, outlined in the Paris Agreement. NDCs encapsulate both mitigation and adaptation strategies aimed at addressing the challenges of a changing climate. On the mitigation front, countries articulate their commitments to reducing greenhouse gas emissions, often specifying targets for renewable energy adoption, energy efficiency improvements, and other measures designed to limit carbon footprints. Simultaneously, NDCs outline adaptation plans to enhance resilience against the impacts of climate change, encompassing sectors such as agriculture, water management, and infrastructure development.

Pakistan NDC's first communicated to the UNFCCC in 2016, and later updated in the 2021 represents the goal and the vision of Pakistan becoming a sustainable, low carbon, and climate-resilient country. Pakistan's NDC in 2016 projected a 300% growth in GHG emissions (with a 2015 baseline) for the period 2015-2030 and intended to reduce up to 20% of its 2030 projected GHG emissions. The updated NDC 2021 aligning with the requirements of the Paris Agreement, commits to reduce emissions by 50% by 2030, of which 15% of reductions are unconditional, and 35% are subject to international financial support.

The updated NDCs also provide non-GHG targets and include the initiatives taken by Pakistan for strengthening adaptation in various sectors. These targets are relevant to several sectors such as power, renewable energy, transportation, biodiversity, land use/degradation/restoration, investments etc. The updated NDCs also provide targets for 0.9% reduction in industrial emissions in 2030. The timeframe for implementation of these targets is 2021-2030.

2.3 National Adaptation Plan (NAP)

The Pakistan National Adaptation Plan (NAP) provides a framework for implementing adaptation, promoting inclusivity, and facilitating collaboration among different stakeholders, and serves as an effective tool for climate. The NAP aims to safeguard the wellbeing of present and future generations and to preserve the rich biodiversity, ecosystems, and cultural heritage that make Pakistan such a distinctive and vibrant nation. The NAP presents future projections related to climate change and its consequences, along with the national vision and goals related to various sectors. It also presents various adaptation initiatives that can be implemented across the sectors, and their objectives. Holistically, the NAP identifies the adaptation measures Pakistan needs to implement in order to reduce its vulnerability to the impacts of climate change, prevent further adverse effects, build climate resilience among communities, and promote sustainable development.

2.4 Pakistan Vision 2025

The UN SDGSs 2030 Agenda stands as a blueprint for advancing people, planet, and prosperity, with an additional aim of enhancing universal peace within a broader scope of freedom. Pakistan was one of the first countries to adopt the SDGs 2030 agenda as the national development agenda through the Parliament of Pakistan. A dedicated SDGs Section has been formed at the federal level in the Ministry of Planning, Development & Special Initiatives (MoP&SI) to monitor and to coordinate as a national coordinating entity. The 17 SDGs have been adopted under three priorities:

Priority 1: 2, 3, 4, 6, 7, 8 & 16

Priority 2: 1, 5, 9, 10, 11 & 17

Priority 3: 12, 13, 14 & 15

The UNDP is currently supporting the MoP&SI for localizing the SDGs and returning the following project outputs:

a. Mainstreaming SDGs in Plans, Policies and Resource Allocation aligned to 2030 Agenda

b. SDGs monitoring, reporting and evaluation capacities strengthened

c. Financing flows increasingly aligned with 2030 Agenda

d. Innovative approaches applied to accelerate progress on priority SDGs

Based on the SDGs 2030 Agenda, the GoP has also launched "Vision 2025"; a comprehensive development strategy aiming to transform Pakistan into an economically vibrant, knowledge-based, and democratic country. The vision outlines a roadmap for sustainable development, focusing on various sectors such as the economy, energy, education, governance, and infrastructure.

2.5 International Finance Corporation (IFC)

The International Finance Corporation (IFC) Performance Standards provide a framework for sustainable and responsible business practices for projects and companies that IFC finances. The specific Performance Standards relevant to climate change mitigation and adaptation are:

- **Performance Standard 1 (PS1) – Assessment and Management of Environmental and Social Risks and Impacts.** PS1 focuses on the assessment and management of environmental and social risks and impacts throughout the life cycle of projects**.** Under the PS1, some key actions focusing on risks, mitigation and adaptation include:

- **Risk Assessment**
  - Projects are required to assess potential environmental and social risks, including those related to climate change.
  - Climate-related risks may include changes in precipitation patterns, temperature extremes, sea-level rise, and other climate impacts that could affect the project.
- **Mitigation Measures**
  - Projects should include measures to prevent, minimize, or offset adverse environmental and social impacts.
  - Where applicable, projects are expected to incorporate climate change mitigation measures, such as reducing greenhouse gas emissions and enhancing energy efficiency.
- **Adaptation Measures**
  - Climate change adaptation measures should be considered as part of the project design, particularly if the project is in a region vulnerable to climate impacts.
  - Adaptation strategies may involve building resilience to changing climate conditions, such as extreme weather events.

- **Performance Standard 3 (PS3) – Resource Efficiency and Pollution Prevention** Under PS3, the IFC emphasizes the importance of addressing climate change impacts by incorporating measures for mitigation and adaptation. Some key actions related to climate action within PS3 are:
  - **Climate Change Mitigation**
    - Projects are expected to identify opportunities for greenhouse gas (GHG) emissions reduction and energy efficiency.
    - Mitigation measures are encouraged, and, where feasible and cost-effective, projects are expected to implement actions to reduce their carbon footprint.
  - **Climate Change Adaptation**
    - Projects are required to assess potential climate change impacts on their operations.
    - Adaptation measures should be integrated into project design to enhance resilience to the physical impacts of climate change.
    - Consideration should be given to potential changes in precipitation patterns, sea-level rise, increased frequency and intensity of extreme weather events, and other climate-related risks.
  - **Renewable Energy and Energy Efficiency**
    - Projects that involve energy generation or consumption are expected to maximize energy efficiency.

- Support for renewable energy sources is encouraged to reduce reliance on fossil fuels and contribute to climate change mitigation.

2.6 Equator Principles

The Equator Principles (EP) is a risk management framework adopted by financial institutions for determining, assessing, and managing environmental and social risk in project finance. It is primarily applied to large infrastructure and industrial projects. The Equator Principles provide a set of guidelines that financial institutions commit to when providing loans for projects, ensuring that these projects adhere to environmental and social standards.

- **Climate Change Mitigation:** The Equator Principles address climate change mitigation by requiring financial institutions to assess the carbon footprint and greenhouse gas emissions of projects. This involves considering cleaner technologies, energy efficiency, and emissions reduction strategies.

- **Climate Change Adaptation**: In the context of climate change adaptation, the Equator Principles emphasize the assessment of potential impacts on projects due to changing climate conditions. This includes considerations related to extreme weather events, sea-level rise, and other climate-related risks.

3 Area and Project Appreciation

3.1 Land-Use

In terms of land use, Thatta district lands can be categorized into five (5) main types: woods, rough grazing lands, areas under human settlements, lands unavailable or unsuitable for agriculture, and forests (DDMA, 2017).

The predominant land use in the project vicinity is agricultural, with informal rural settlements featuring huts, several fish ponds, and a small number of orchards. In addition, the region is home to privately-owned farmhouses and a few industrial mills, mainly engaged in crop processing. The area has an extensive irrigation network feeding from the Phenri Link Canal and Jaam Branch Canals and further distributing into small irrigation channels.

The project site along with the larger site vicinity was observed to have sporadic, sparse vegetation with a few trees. The ground is barren in nature, with medium-density, silty sand and sandy silt deposits in shallow soils. The project area is characterized by limited industrial activity with mostly flat topography. The surrounding area is dominated by agricultural activities, without any major construction. The planned construction of a tyre manufacturing plant is anticipated to introduce highly visible structures, creating a significant contrast with the non-industrial infrastructure in the project area.

Most of the development in the area conducted between 2006 - 2010, after the construction of coastal Highway which made area more accessible and easier for transportation of heavy machinery and raw material. Another rapid period of commercialization/ industrialization has been observed between the years 2006 to 2023. The percentage change in land use pre-2010 to 2023 is as follows:

Land Use	**2006**	**2023**
Agricultural Area	53%	52%
Residential Area	4%	8%
Surface water bodies	2%	2%
Commercial / Industrial	11%	14%
Barren/ Open Land	34%	23%

3.2 Topography

Thatta District has a varied geographical area with an average elevation of Thatta district is >200m in the northern part while southern part has the height almost equal to mean seas level of that is <20m near Keti Bunder (DDMA, 2017). The north-western region of the district known as Kohistan has hilly area, including the Makli Hills, an extension of the

Kirthar Range with limestone composition and valleys ornamented with grass or brushwood. Moving south, the environment changes to sandy, uncultivated areas. In the southeastern delta, there is an extent of salt waste, including Sirganda. Salt deposits between the Sir and Khori creeks. The riverine or katchho area stretches from Mirpur Bathoro to the Indus River's deltaic Tehsils of Kharo Chan and Keti Bander, with woods on both banks.

The topographical survey of the project land indicates that the area is primarily flat, with a gentle slope extending from north/northeast to south/southwest. The site's elevation ranges from 5m to 8.2m, with the land highly elevated on the roadside. Some parts of the project land hold a slightly higher elevation. Notably, contour lines with minor and major intervals of 1.00m and 0.20m, respectively.

3.3 Water Resources

- **Surface Water Hydrology**

Thatta district contains a well stretched and diverse water network, comprising of numerous streams, freshwater lakes such as Keenjhar, Hadero, and Murdani, canal network and the River Indus (G. S. Solangi et al., 2017). Four talukas of the district (Thatta, Keti Bander, Ghorabari, and Mirpur Sakro) are the areas where Indus River meets the Arabian Sea with the coastline spanning up to 270 km within the city.

Despite the availability of an extensive water drainage network, the province faces water shortages during the dry spell and often fails to fulfil the water requirement below Kotri Barrage. Due to lack of freshwater in downstream Kotri sea water intrusion is a key phenomenon in the area.

The riverine area of Sindh is approximately 2.112 million acres along both sides of the River Indus, exhibits surface drainage patterns similar to areas with basin and range landforms in warm to hot arid regions. Irrigation in Sindh relies largely on the canal network that is diverting water from the river. Studies conducted specifically for district Thatta indicates gradual decrease in flow of the main tributaries of the River Indus, with minimum observed flows downstream at 0.29 MAF due to its location at the tail end of the River Indus. Consequently, district Thatta faces water scarcity, especially during dry periods between December and January when there is no flow from upstream side.

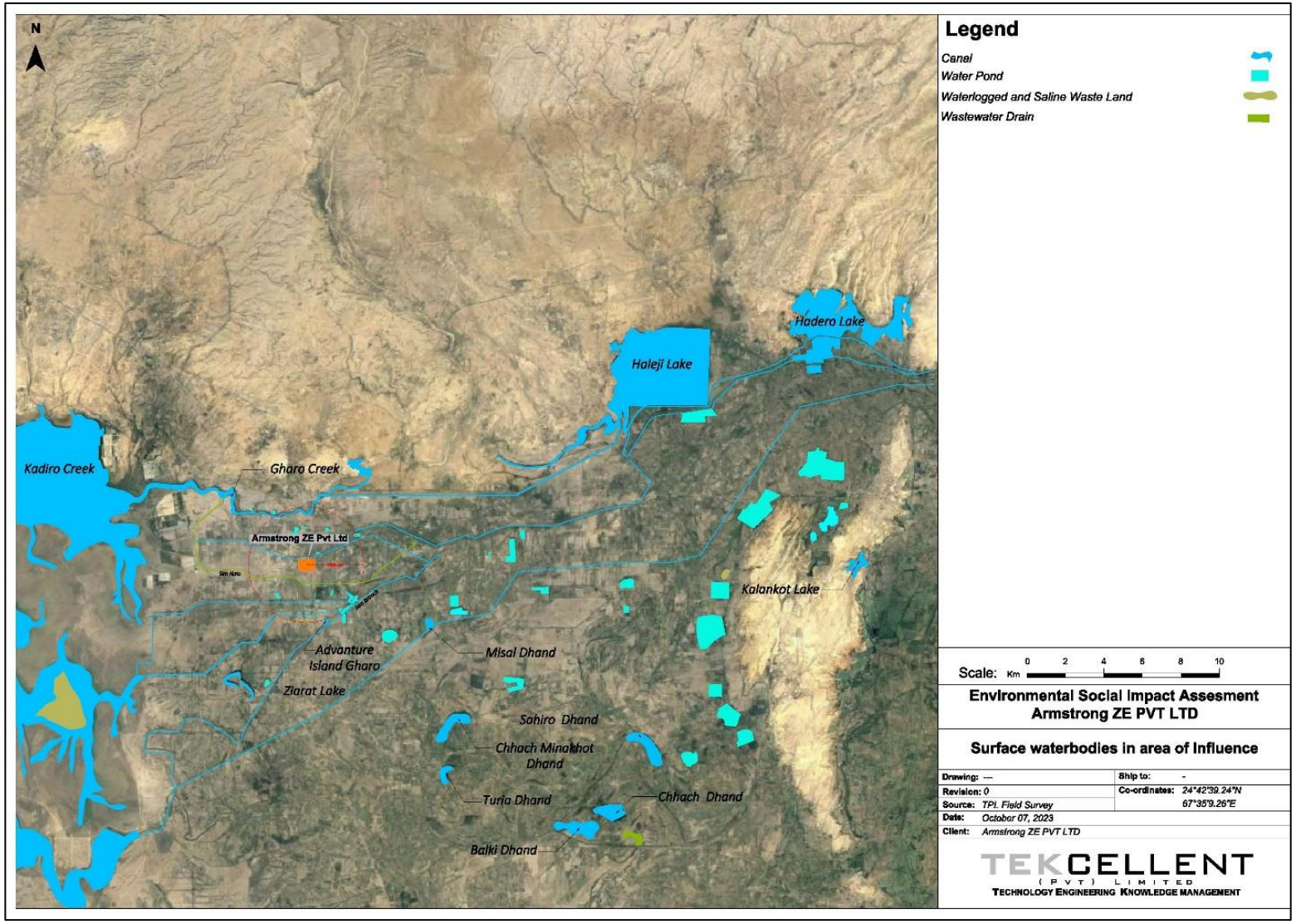
a. Macro-Environment

An inter-connected network of water bodies exist in the immediate macro-environment. These include Keenjhar Lake located 43 kilometers to the northeast, and Hadero Lake at a distance of 28 kilometers in the same direction. Haleji Lake is situated 18 kilometers in northeast. Additionally, the Gharo creek traverses within a 3-kilometer radius of the site perimeter which ends up in the Arabian Sea located 43 km west from the site.

b. Micro-environment

An intricate network of irrigation channels is present in the project AoI to fulfil agricultural needs. These mainly include Khari Sir Canal, Phenri Canal, Jam Branch, and Chach Canal that facilitate the flow of water throughout the area. Phenri canal holds significance as it passes adjacent north of the site, augmenting the hydrological dynamics of the surrounding landscape. The canals Phenri and Kheeran are sourced from Hadero Lake while Jam branch which is located further south is sourced from Keenjhar Lake. All these canals further bifurcate into small branches to irrigate agricultural lands.

Map showing Surface Waterbodies Near the Project Area



- **Baseline Surface Water Usage and Quality**

Site survey reveals that local residents use surface water only for domestic purposes, such as washing and cleaning. Interviews from nearby locals suggest that they refrain from using surface water for drinking purposes due to concerns about the water quality, however, consumed by domestic animals and other wildlife.

The quality of surface water is a significant concern, especially in areas used for drinking, as the measured TDS in the identified surface water bodies ranges from 392 to 1,120 ppm. Seawater intrusion has aggravated the issue. Secondary data also suggests unsatisfactory quality, as per the guideline provided by local regulatory (Sindh Environmental Quality Standards), specifically for drinking water use in Thatta district. (Drinking water quality assessment in Southern Sindh (Pakistan) June 2011).

- **Groundwater Hydrology**

In Pakistan, groundwater is the major source of drinking water. Sindh covers Pakistan's lower Indus Plain. The Indus plain aquifer is well-known for its abundance of groundwater resources.

The southern region of Sindh, Pakistan, borders the Arabian Sea. The water of Sindh is not suitable for drinking purposes due to being highly susceptible to contamination, particularly by arsenic (Shahab et al., 2016). Although lower Indus Plain that forms major part of Sindh province has abundant groundwater resources, the quality of groundwater in low-lying, deltaic, and flood plain zones of Sindh is significantly influenced by salinity due to sea-water intrusion as well as contamination of arsenic, fluoride, and microbial pollution. Due to low precipitation and limited flow of the Indus River, people in these regions rely significantly on groundwater for drinking and irrigation.

The Thatta district, in particular, is contaminated by seawater intrusion, which contains different trace metals. Most of the local inhabitants in the district extract groundwater by using hand pumps drilled into shallow aquifers at depths ranging from 5 metres to 12 metres. The people in the project area similarly supplement their water supplies by extracting groundwater from hand pumps. The groundwater quality was found to be variable (good to brackish). At some locations, tube wells are also installed to fulfil water needs for agricultural purposes (Ashraf et al., 2007). Municipal supply from WASA Hyderabad is also another important source of water in the wider region. Primary information regarding water availability in the area was gathered to establish the baseline conditions for water availability and quality in the immediate vicinity of the site. The findings revealed that groundwater is currently being utilized to meet the everyday water requirements including drinking. A preliminary assessment of groundwater quality has indicated acceptable to moderately acceptable quality with TDS ranging from 368 to 1250 ppm. However, local populace has raised the concern of hand-pump water turning saline within 3 to 4 years.

3.4 Project Description

Pakistan faces a huge gap in supply and market demand of locally manufactured tyres which is majorly being fulfilled by low-cost Chinese tyres or through grey channels. Additionally, regulatory challenges on the import restrictions and increased duties on several goods including tyres have further intensified availability of the tyres. Therefore, AZE has decided to setup a tyre manufacturing plant in the province of Sindh, Pakistan, to curb the supply and demand gap of local market players in tyre sector. The project will manufacture 3 categories of tyres, that is, Passenger Car Radial (PCR), Light Tyre Radial (LTR) and 4*4 tyres at a rate of 5,000 tyres/day and 1.65 million tyres annually.

3.4.1 Project Location

The project site of AZE is located at 24°42'43.08"N, 67°35'18.99"E along the Gharo-Keti Bandar Highway (N-110), approximately 3 km south of Gharo town, Taluka Mirpur Sakro, District Thatta, in the Sindh province of Pakistan. Coordinates of the site boundary are as follows:

Points	Latitude	Longitude
AZE-1	24°42’47.99” N	67°35’07.69” E
AZE-2	24°42’48.72” N	67°35’31.78” E
AZE-3	24°42’38.38” N	67°35’31.22” E
AZE-4	24°42’38.19” N	67°35’07.84” E

The area is located on the outskirts of Karachi approximately 26 km southeast and can easily be accessed through National Highway (N-5) highway.

The vicinity within 3 km radius of the site is only sparsely populated, consisting predominantly of agricultural land, interspersed by barren land and small, informal, nomadic settlements. A few industries present nearby include Tapal Wood Working Industry and Jelani Rice mills. Other nearest landmarks include Daniyal farms, Green World farm house and Salfar farms. While a canal runs along the northern boundary of the site which receives water from the upstream, Jam branch. As of now, the site is an empty land with construction activities underway towards the southern boundary. The remaining area was observed to have sparse vegetation comprising primarily of shrubs and a few date palms.

3.4.2 Project Components

In a wider context, the main elements of the Project and their inclusion in the environmental and social appraisal comprise construction of the following:

- Raw material storage area
- Carbon Black feeding area
- Tyre Building Machines and equipment setting area
- Finished good Storage area, and
- Docking area

Other supporting facilities that will be as per the construction plan include the following:

- Worker's facilities, including labour accommodation and bachelor's hostel
- Dining area
- Waste warehouse
- Sulphur and Oil storage areas, coal yard and lubricating oil warehouse
- General Sub-station and refrigeration and air compressor stations
- Machine shop and spare parts warehouses
- Boiler room and Tyre Testing R &D laboratory
- Fire station, and
- Fuel Dispenser area

3.4.3 Summary of Project Activities

The project activities can be divided into four (4) major categories including Planning and Pre-Construction; Construction Phase; Operation and Maintenance Phase, and Decommissioning Phase.

Planning and Preconstruction Phase

The pre-construction has three major activities which have completed:

- Identification of land area and site;
- Site surveys including topographic, technical feasibility study and geo-technical investigations.
- Necessary approvals and clearances

Construction phase

As of writing of the report, construction activity has commenced for the Labour Accommodation and Bachelor's Hostel after receiving the NOC from SEPA. The timeline for both activities' completion is until July 2024. Apart from this, there is no timeline available that details the planned Project phases from construction to operation. However, as indicated by the project management, the construction will tentatively be completed in three phases:

- Phase I – Bachelors and Labor Accommodation (*construction works have already commenced under the contractor, Shamsi Builders*)
- Phase II – Utility Buildings (*tender for technical and commercial solution has been floated to pre-qualified bidders. The bids will be closed by February 15, 2024*)
- Phase III – Production Area and Infrastructure (*tender for drawings and contract documents are under preparation by the proponent and will be issued to pre-qualified bidders by February 15, 2024. The bids will be closed by the end of the month*).

The activities to be performed during the construction phase will include the following:

- Site clearance such as excavation, piling and filling (already observed to be ongoing);
- Construction of labor accommodation and bachelor's hostel;
- Construction of manufacturing building and offices, roads and parking areas;
- Construction of auxiliary facilities such as equipment and supplies storage area; water storage tanks, fuel storage tanks, soak pits etc.;
- Installation of water, electricity, gas and drainage systems;
- Construction of warehouse for raw material, finished goods and coal yard;
- Installation of tyre manufacturing area;
- Construction of wastewater treatment plant and waste storage areas;
- Safe disposal of all construction debris, excavated earth and groundwater being pumped out from excavations; and
- Commissioning.

O & M Phase

The activities for the operations and maintenance phase will include the following:

- Routine operations of tyre manufacturing;
- Routine maintenance of production machinery and equipment;

- Regular inspection and calibration of quality control and testing equipment;
- Continuous monitoring and optimization of manufacturing processes;
- Inspection and maintenance of utilities, including water, electricity, and gas systems;
- Ongoing upkeep of infrastructure, buildings, and roads;
- Management of waste disposal and environmental compliance;
- Training programs for employees on safety protocols and best practices; and
- Periodic audits to ensure adherence to regulatory and safety standards.

At this stage, no further details regarding activities to be performed during the O&M Phase are available from the proponent, which will be made part of the main ESIA report, when received.

Decommissioning Phase

The decommissioning phase of the Armstrong Tyre Manufacturing Project will encompass critical activities, including demolition, site clean-up, waste disposal, demobilization of workers, and a final site review. The typical age of a tyre manufacturing plant can vary based on factors such as technological advancements, maintenance practices, and market demand. However, many tyre manufacturing facilities are designed to have a lifespan ranging from 20 to 40 years or more. It's important to note that during this time frame, periodic upgrades, maintenance, and equipment replacement may occur to keep the facility in line with evolving industry standards and environmental regulations.

After a certain number of years, some older plants may face challenges related to outdated technology, increased maintenance costs, or difficulty meeting modern efficiency and environmental standards. At this point, companies might consider either substantial renovations or the construction of a new, more advanced facility. It is also worth noting that market conditions and global economic factors can influence the decision to invest in new facilities or extend the life of existing ones.

Based on above factors, if there is an event where decommissioning becomes necessary at the end of the project's life, a separate Environmental Site Assessment process must be conducted. This is because the baseline conditions of the project and its surroundings are likely to undergo significant changes. This requirement further warrants the development of a distinct Environmental and Social Management Plan (ESMP) specifically tailored for the decommissioning phase. This strategic approach ensures a thorough and environmentally responsible conclusion to the project, addressing potential shifts in environmental conditions over time.

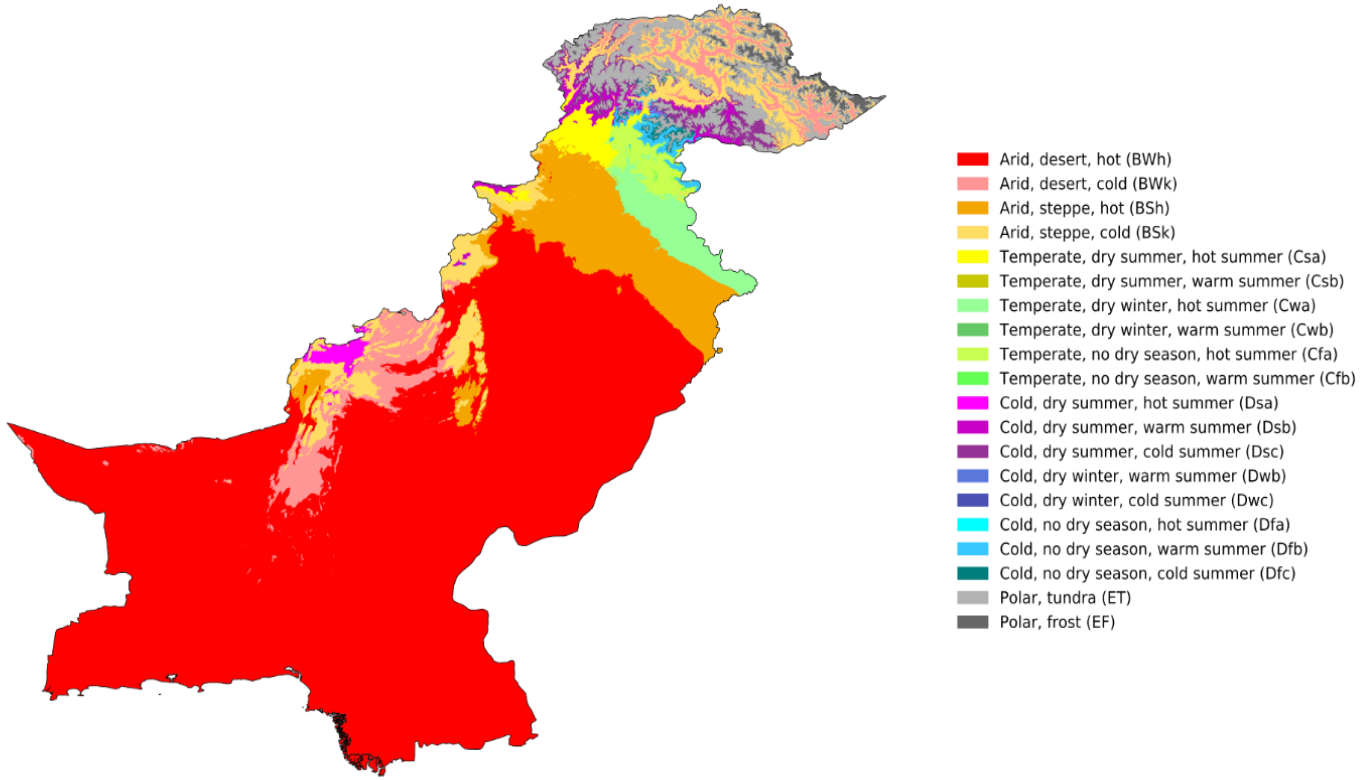
4. Climate Change Risk Assessment (CCRA)

4.1. Baseline Climate Overview

Pakistan has an arid climate, with regional variation defined by its topography. The south of the country is generally dry and hot along the low-laying lands of the Indus River, and the temperature tends to get cooler in the mountainous northern regions. Pakistan has four recognized seasons, a cool, dry winter from December to February, followed by a hot, dry spring from March to May, the summer rainy monsoon season which goes from June through September and lastly, the retreating monsoon lasting from October to November.

Based on the data from the Pakistan Meteorological Department (PMD), about 34.1% of the land is classified as hyper arid, 28.8% as arid, 30.8% as semi-arid, 3.6% as sub-humid and 2.8% as humid to very humid (Second National Climate Communication, Pakistan). The temperatures can have large variations throughout the country rising to high as 50 – 54 °C in southern Pakistan in summers to falling below freezing in some parts of northern Pakistan in winters (Second National Climate Communication: Pakistan). The Köppen-Geiger climate classification which divides the climate zones across the world into different categories. The major categories are Zone A (tropical), Zone B (arid), Zone C (warm/mild temperate), Zone D (continental) and Zone E (polar). The classification for Pakistan is shown in the ***Exhibit 1***.

Sindh is located in the southeastern region of Pakistan, in which comes under Climate Zone E, as shown in the Exhibit 2. Zone E has coastal cities near the Arabian Sea that are mostly arid to hyper-arid. The province has a hot and dry climate, classified as a hot desert climate (BWh) according to the Köppen-Geiger climate classification system, refer ***Exhibit 3***. Sindh is divided into three climatic zones: Siro, Wicholo and Lar. The three zones are divided geographically: Siro is located in Upper Sindh, Wicholo located in Central Sindh and Lar is located in Lower Sindh.



Source: Beck et al.: Present and future Köppen-Geiger climate classification maps at 1-km resolution, Scientific Data 5:180214, doi:10.1038/sdata.2018.214 (2018)

Exhibit 1-The Köppen-Geiger Climate Classification map for Pakistan (1980-2016)

Source: (https://www.nature.com/articles/sdata2018214)

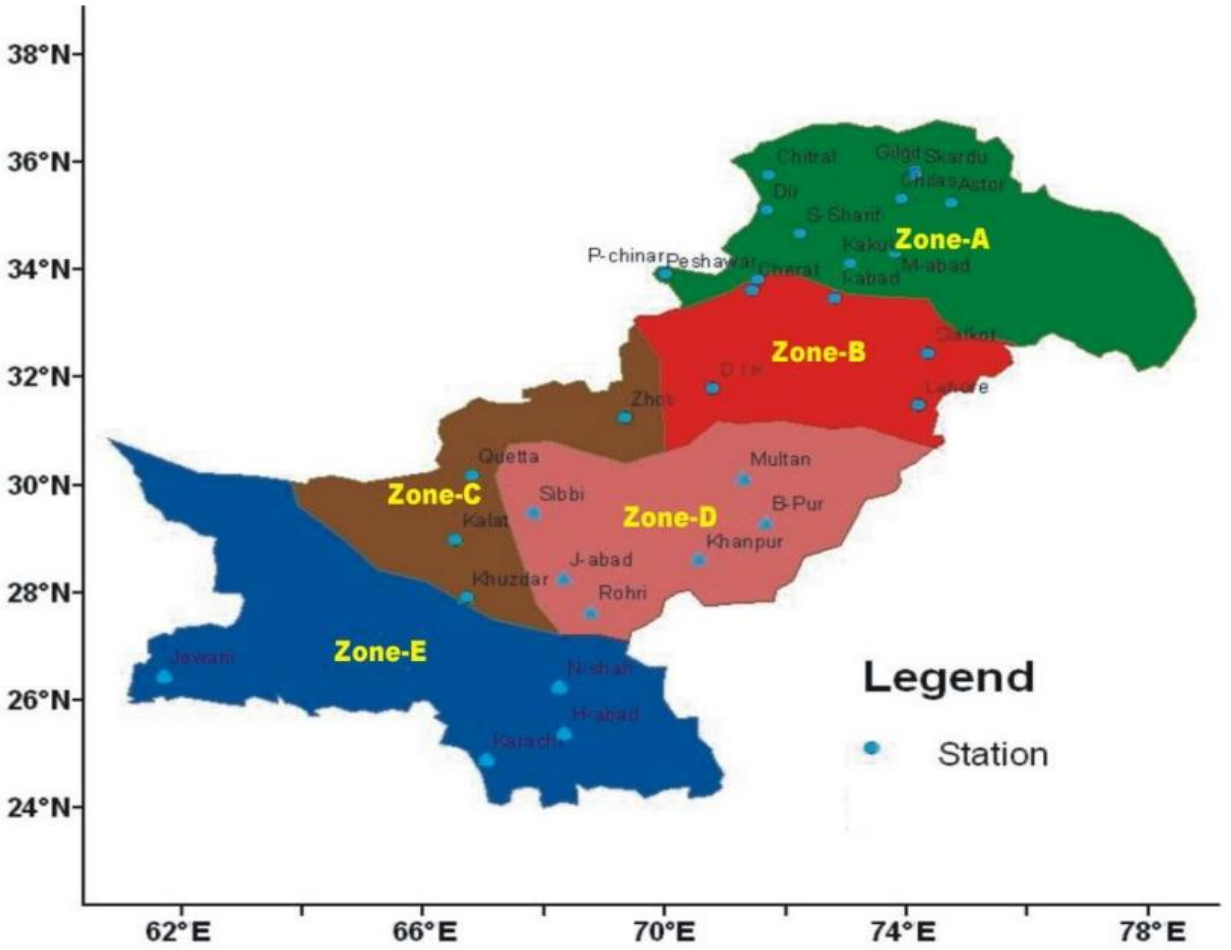


Exhibit 2- Map showing Climate Zones of Pakistan

Source: [(PDF) Rainfall Trends in Different Climate Zones of Pakistan. Pakistan Journal of Meteorology, Vol. 9, Issue 17: Jul 2012 (researchgate.net)]

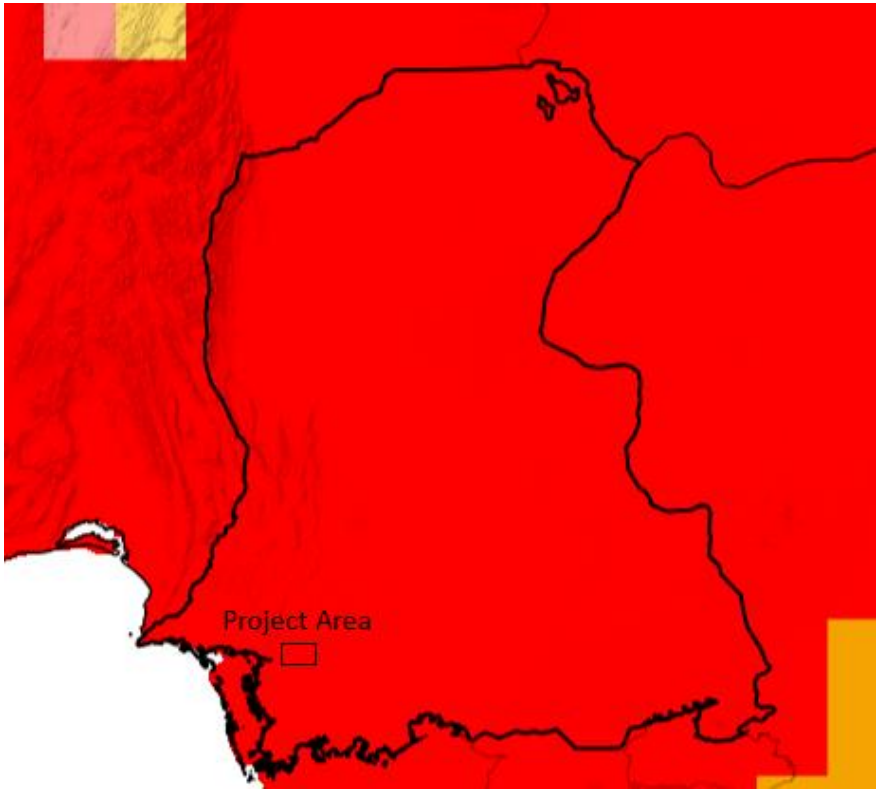


Exhibit 3- Map of Sindh showing the Köppen-Geiger climate classification and the rectangle shows the location of the project area

Source: WB Climate Change Knowledge Portal

a. Temperature

From 1991 to 2020, the mean surface air temperature of Sindh was 27.26 ºC, surpassing the country average of Pakistan which is 21.38 ºC. Sindh exhibits the highest average maximum surface air temperature at 34.78 ºC in the country (WB Climate Change Knowledge Portal). Between 1985 – 2005, the decadal mean temperature rise for Pakistan was 0.39 ºC compared to the global value of 0.177 ºC (Second National Climate Communication: Pakistan - 183625_Pakistan-NC2-1-Pakistan - Second National Communication on Climate Change 2018.pdf (unfccc.int)). In Sindh, the maximum mean temperature of 30°C occurs in June and July, while the minimum mean temperature falls around 10°C during the month of January, based on data from 1991 to 2020 as shown in the ***Exhibit 4*** below.

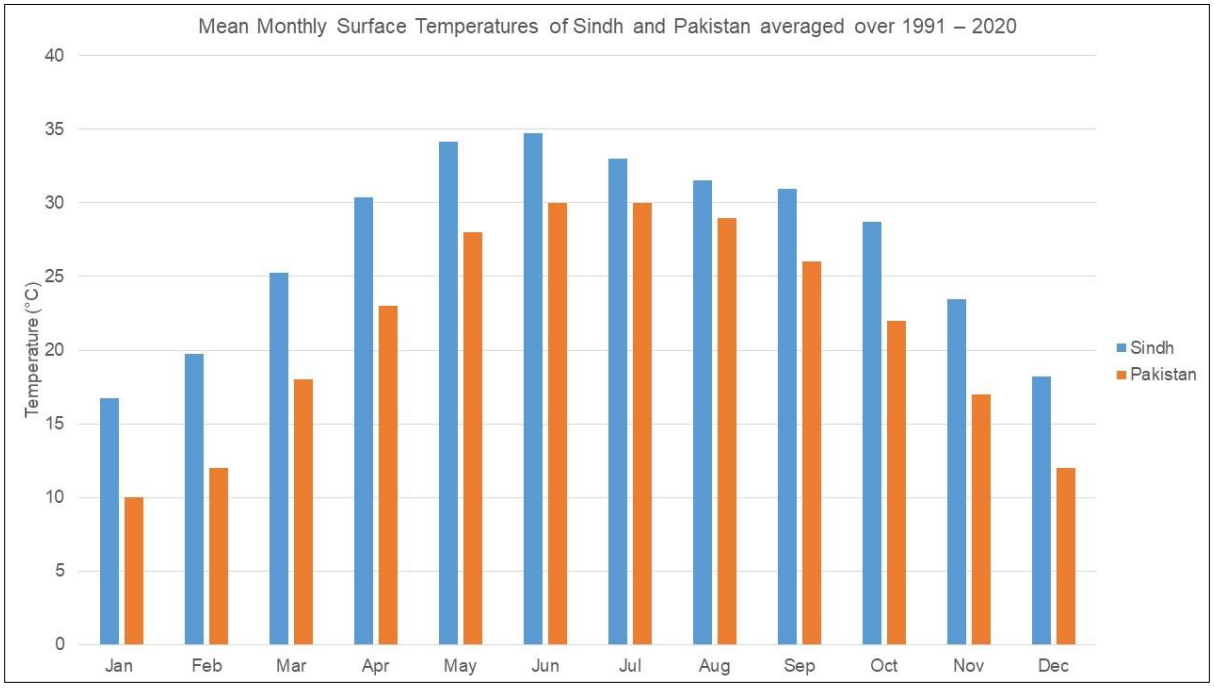


Exhibit 4- Average Mean Surface Temperatures for Pakistan and Sindh from 1991 – 2020

Source: WB Climate Change Knowledge Portal

Siro has the highest temperature compared to the other region as it is located along the thermal equator. Central Sindh is characterized by dry hot days and warm nights, and has maximum temperatures from 43 – 46 ºC. The project site is located in Lower Sindh, which has a damper and humid maritime climate. Lower Sindh has maximum temperatures of about 35 – 38 ºC. The project is located in Gharo, Thatta District in Sindh. The average

maximum temperature in Thatta is 33.8 °C while the average minimum temperature is 21.9 °C[1]. Refer to ***Exhibit 5***.

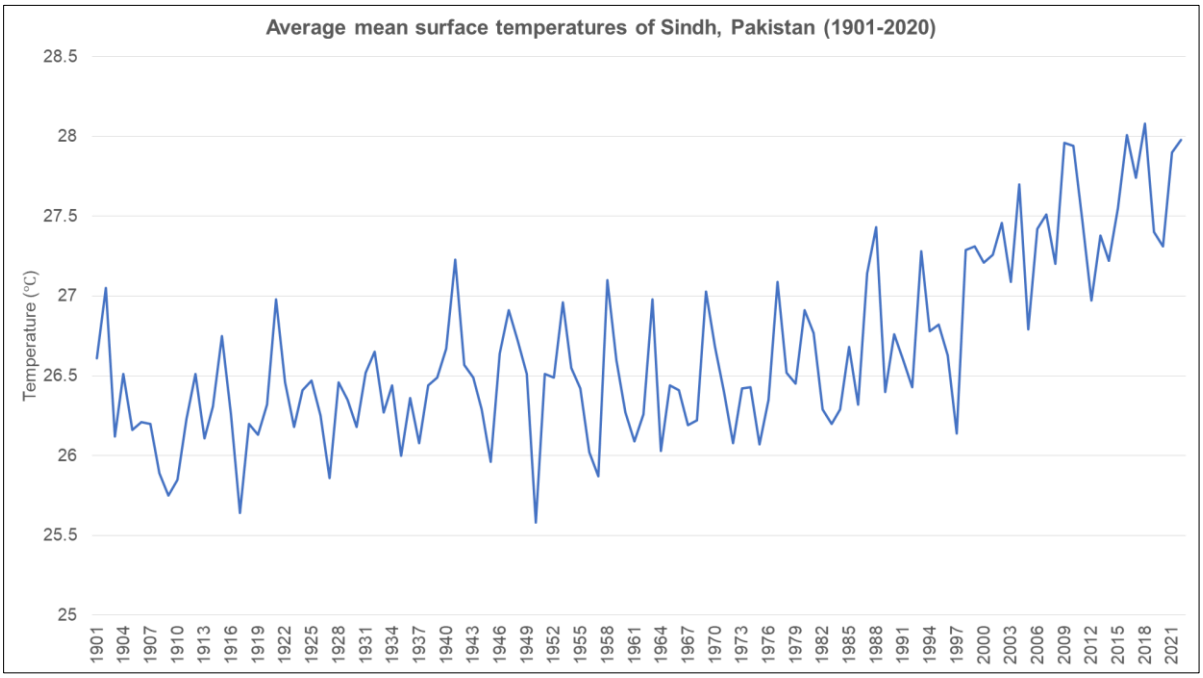


Exhibit 5- Mean Average Surface Air Temperature for Sindh from 1901-2022

Source: WB Climate Change Knowledge Portal

b. Precipitation

Most of the country experiences minimal rainfall, with the exception of the northern region where monthly rainfall can surpass 200 mm during the monsoon season (WB Climate Change Knowledge Portal). In comparison, Sindh receives relatively lower rainfall, measuring 158 mm, as opposed to the national average of 289.45 mm. Thatta records an annual rainfall of 151.85 mm. The occurrence of El-Nino Southern Oscillation (ENSO) events significantly influences the amount of rainfall, with a general tendency for reduced precipitation.

The ***Exhibit 6 and Exhibit 7*** illustrates that, over the period from 1991 to 2020, Thatta experienced its highest average precipitation in the months of July and August, ranging between 48 mm and 51 mm.

[1] Sindh Hazard and Risk Atlas – Thatta - Sindh Hazard & Risk Atlas-Thatta (dmis-pdma.gos.pk).

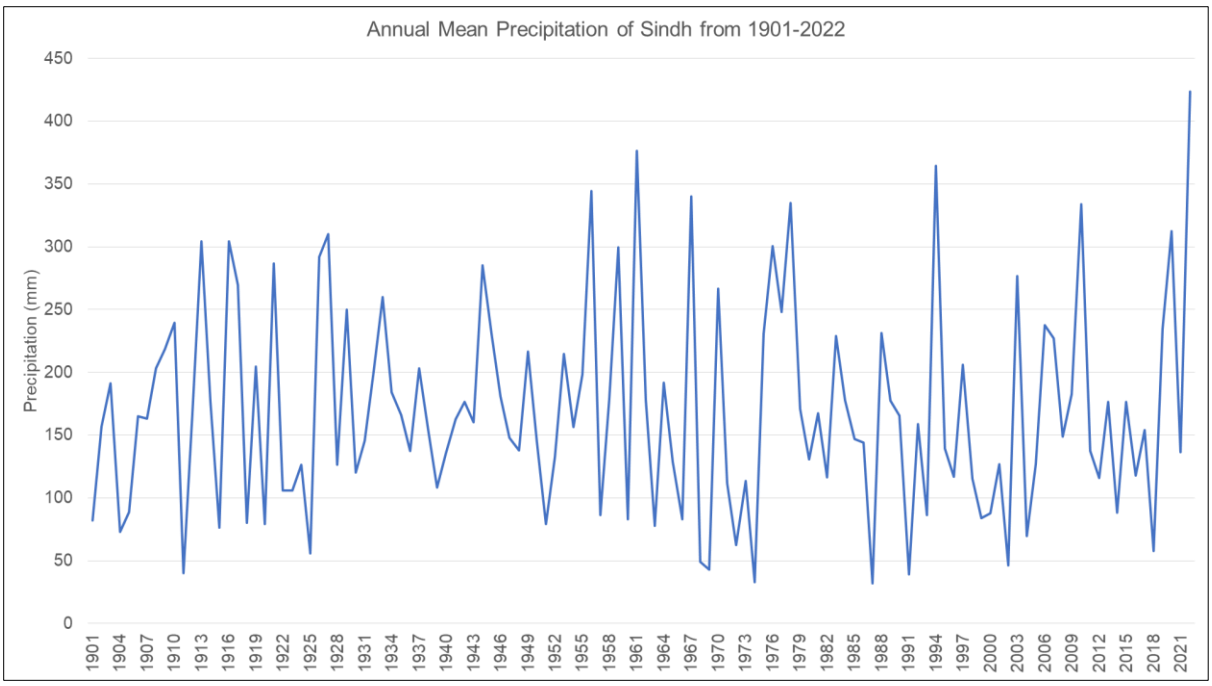


Exhibit 6- Average Annual Precipitation for Sindh from 1901 – 2022

Source: WB Climate Change Knowledge Portal

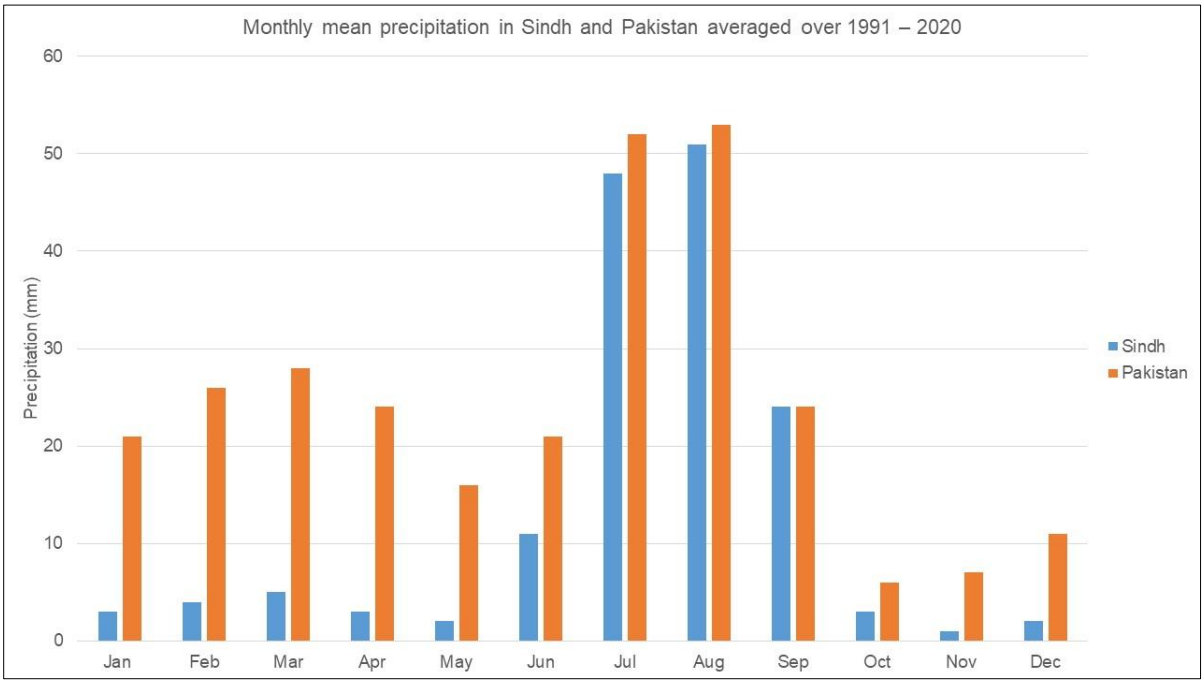


Exhibit 7-Average Annual Precipitation for Pakistan and Sindh from 1991 – 2020

Source: WB Climate Change Knowledge Portal

c. Wind Speed and Direction:

Persistent winds are a year-round phenomenon in the coastal areas of Sindh, reaching peak velocities during the monsoon season, notably in July. In the lower Sindh region, which encompasses the project area, south-western winds dominate in the summer, while north-eastern winds prevail in the winter (GEMS, 2017). During the southwest monsoons, wind speeds range from 46 km/h to 72 km/h, while in the winter season, northeast winds typically reach speeds of 9 km/h to 18 km/h (SGS, 2013). Sindh boasts an average wind speed of 5.68 m/s (Global Wind Atlas), surpassing the national average for Pakistan, which stands at 2.43 m/s (Teal Earth Tool, 2024). The annual average wind speed for Sindh recorded from 1950 to 2022 is illustrated in ***Exhibit 8***. The wind rose for Pakistan, the province of Sindh and the project area is given in ***Exhibit 9, 10 and 11***. While, the seasonal variation over this period is depicted in ***Exhibit 12.***

In 2023, Sindh recorded an average wind speed of 3.56 m/s, exceeding the national average for Pakistan (2.43 m/s). The windiest month was August, with the highest average wind speed reaching 5.37 m/s. Conversely, February emerged as the calmest month, with the lowest average wind speed recorded at 2.62 m/s.

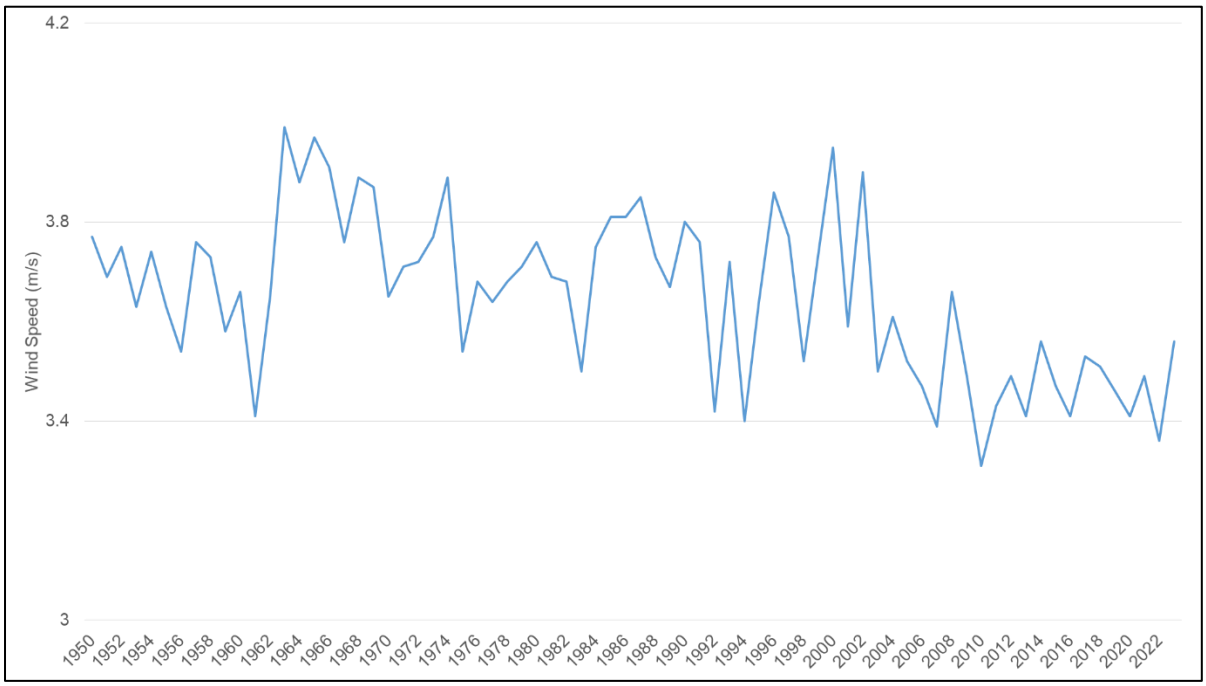


Exhibit 8-Average wind speed for Sindh

Source: Teal Earth Tool

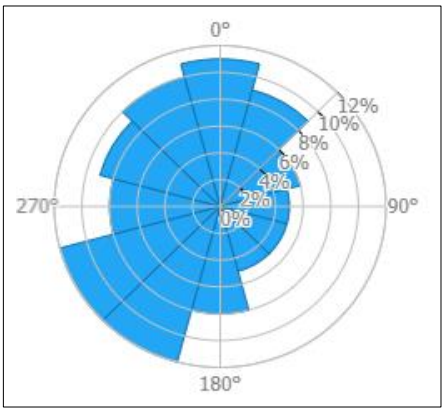


Exhibit 9-Wind Speed Rose for Pakistan

Source: Global Wind Atlas

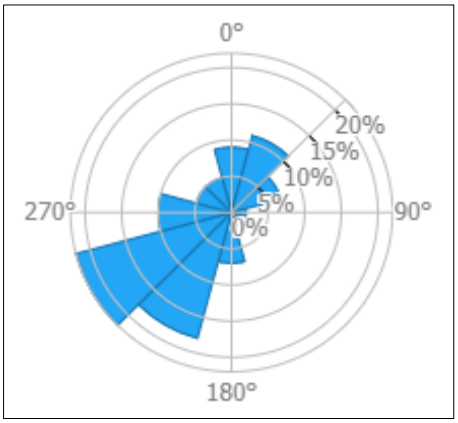


Exhibit 10- Wind Speed Rose for Sindh

Source: Global Wind Atlas

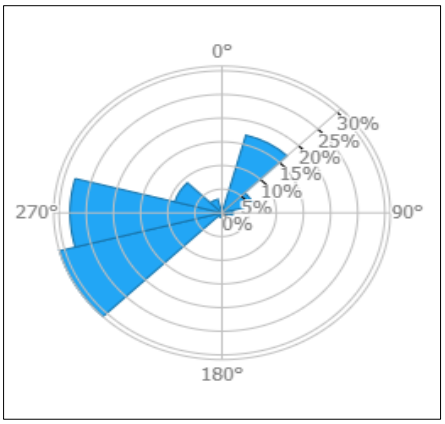


Exhibit 11- Wind Rose for the Project Area in Gharo

Source: Global Wind Atlas

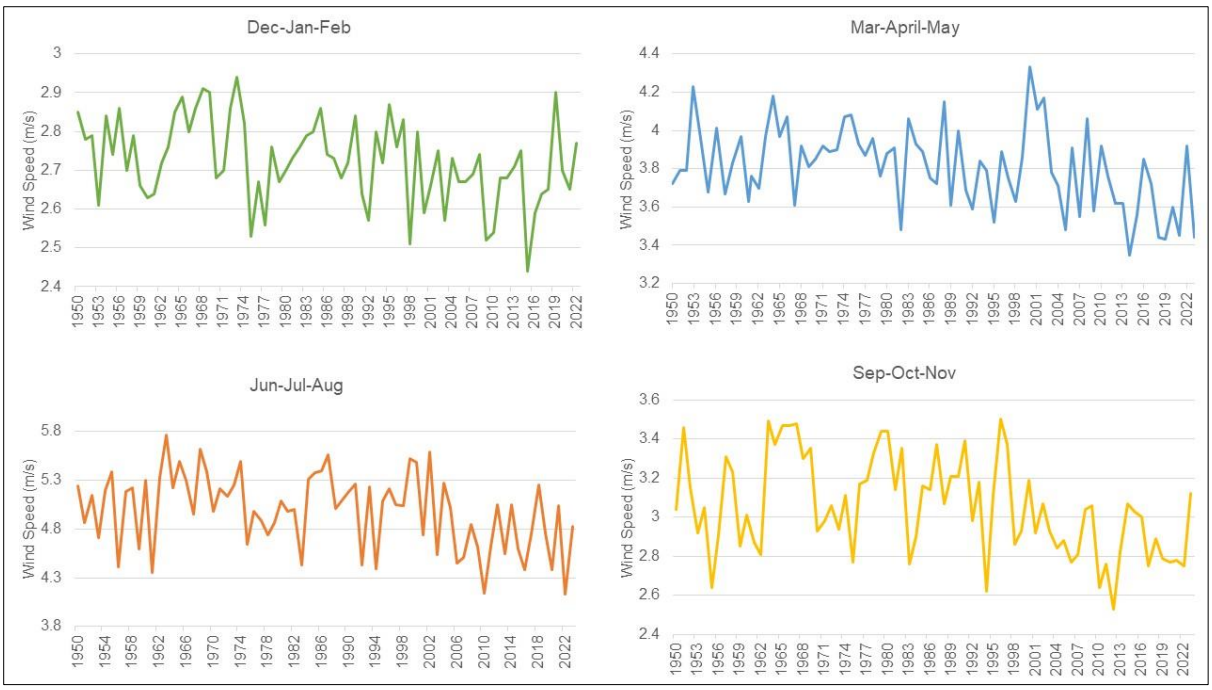


Exhibit 12-Average wind speed for the months of December, January and February for Sindh

Source: Teal Earth Tool

d. Humidity:

In Sindh, the relative humidity typically fluctuates within the range of 40% to 60%. The coastal belt of Sindh, particularly in the lower part of the province where the study area is situated, significantly influences air humidity. April registers notably low humidity levels, averaging at only 45%, indicating a relatively dry period. Conversely, August emerges as the most humid month, with an average relative humidity of 69%.

In Thatta, the most humid period occurs on average from July to September, while lower humidity levels are observed during December to February. ***Exhibit 13*** presents the average monthly values of relative humidity in percentage over the period from 2001 to 2020 for Sindh.

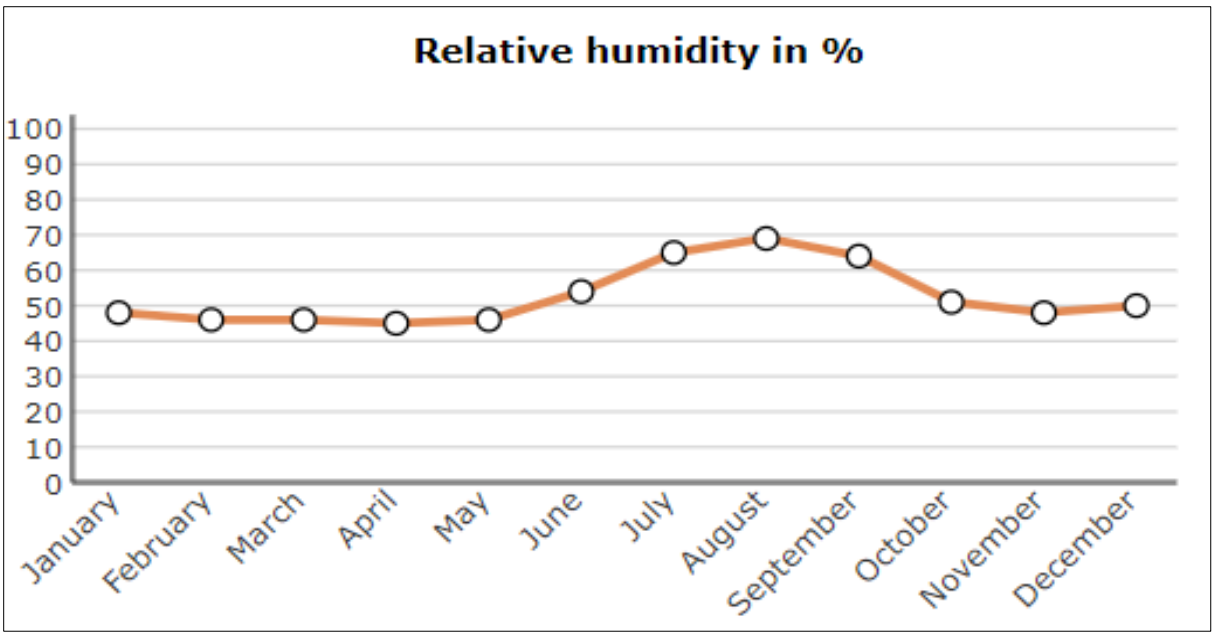


Exhibit 13-Average Monthly Values of Relative Humidity in percentage of the Last 20 Years for Sindh, Pakistan

Source: https://www.worlddata.info/asia/pakistan/climate-sindh.php

4.2. Extreme Climate Events

Floods

The frequency of flood episodes has increased in Pakistan over the past two decades. The flood episodes of 2010 and 2022 caused considerable damage throughout the country. The floods in 2010 started as a result of heavy monsoon rainfall in northern part of Pakistan in last week of July and continued till August. The flash flood caused by monsoon precipitation in northern Pakistan surged downriver into Sindh and Balochistan. This flooding event caused substantial damage to agricultural lands in Thatta (Britannica, 2023). The region was also affected during the flood episode of July and August 2022 when heavy torrential rainfall and flash floods resulted in considerable damage to infrastructure, crops, livelihoods, and causing substantial displacement in Thatta (SRSO, 2022).

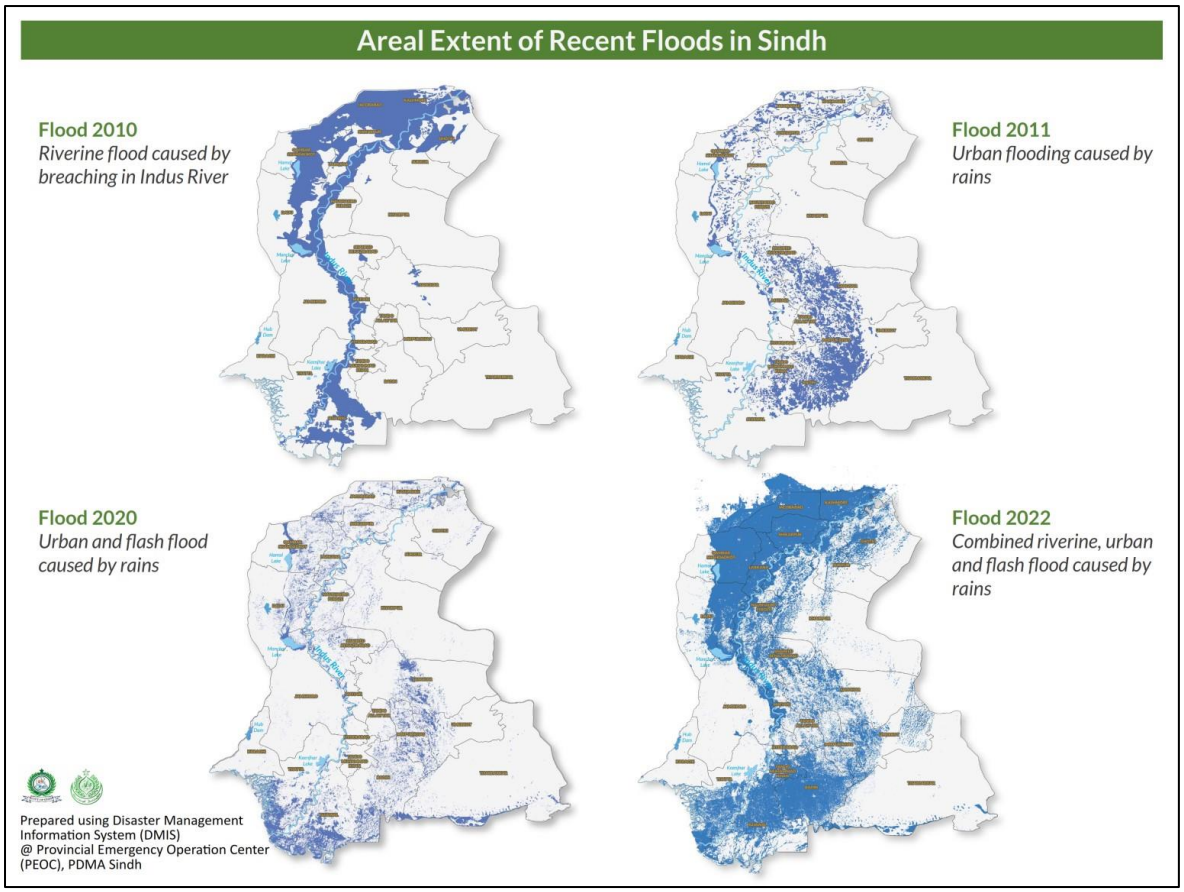


Exhibit 14 - Maps showing the extent of Inundation due to Past Floods in Sindh

Source: https://pdma.gos.pk/flood-2022-maps/

Heat waves

Heat wave is defined as a period of 3 or more days where the daily temperature is above the long-term moving 95th percentile of daily mean temperature. During 1997-2015, an estimated 126 heat waves occurred in Pakistan and the current median probability of the occurrence of a heat wave in Pakistan is 3%. The country faced one of its deadliest heat waves in 2015, where an estimated 65,000 people were hospitalized and over 1,200 heat-related casualties were recorded in Sindh.

Drought

Drought refers to an extended period of reduction in water supply. Usually, a drought is preceded by time periods of below average precipitation. There are five general categories of drought, meteorological, agricultural, hydrological, socioeconomic and ecological drought. These categories are described in the exhibit below.

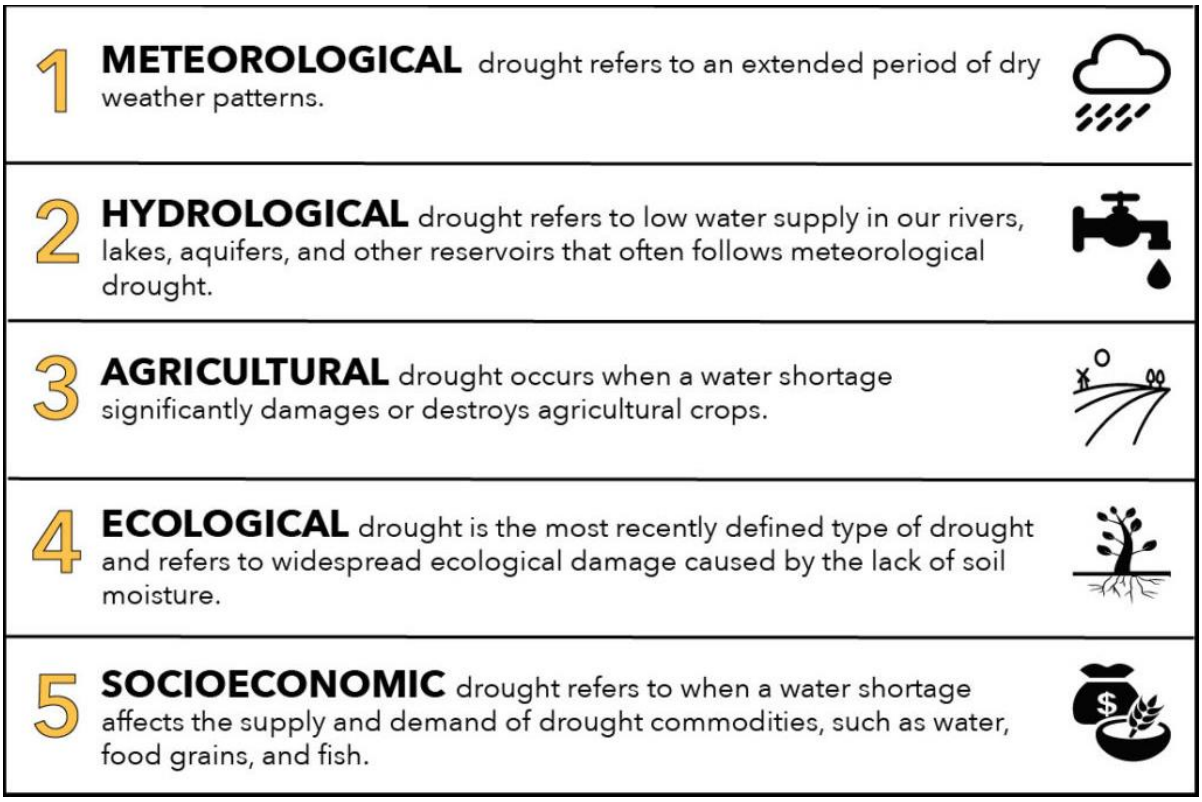


Exhibit 15 - Drought types

Source: https://livingwithdrought.com/what-is-drought/

Pakistan is likely to be affected by exposure to meteorological and hydrological droughts (ADB Climate Risk Country Profile). Severe meteorological droughts are defined by a standardized precipitation evaporation index (SPEI) of less than -2. Currently, Pakistan faces a 3% annual probability of the occurrence of a meteorological drought. Historically from 1985-2005, the Annual SPEI Index was -0.01.

According to Pakistan Meteorological Department, moderate to severe in eight of Sindh's districts. Historically, six droughts have occurred in Sindh since 1900, with the most recent one in 2022(https://pdma.gos.pk/drought/). The drought in 1999 lasted nearly two years and affected approximately 1.4 million people, and also led to the depletion of groundwater down to 30-40 feet.

Storms / Cyclones

Coastal belt of Pakistan (especially in Sindh and Balochistan) is prone to cyclones and associated storm surges just during the pre-monsoon (May and June) and post-monsoon (September to November) seasons. In Sindh, three (3) coastal districts including Karachi, Thatta and Badin are highly vulnerable to cyclone hazards. Tropical cyclones generally develop over Arabian Sea in low latitude and dissipate after they move over land. Some of the major tropical cyclones hit the coastal areas of Pakistan occurred during May 1902, June 1926, June 1964, November 1993, June 1998, May 1999, June 2007 and 2011 and June 2014. In

May 1999, Cyclone 2A hit the coastal area of Thatta, Umerkot, Mirpur Khas, Badin, Hyderabad, and Tharparker. This has been the most destructive cyclone in recent years to hit Pakistan as a strong Category 3 equivalent storm, killing 6,200 people in the country (Dawn, 2023). Keti Bunder town in district Thatta was wiped out by tropical cyclone four (4) times in the recent history. The cyclones of 2010 (Phet) and 2011 (Keila) also occurred during the recent years, out of which cyclone 03A, nick named Phet on June 6, 2010 caused significant damages in District Thatta. The Sindh-Makran coastal areas received heavy torrential rain, measuring up to 370 mm in some areas.

Cyclone Nanauk occurred recently in 2014, which hit the coastal areas of Oman by June 15, 2014 but caused intermittent rainfall, together with gusty-winds in coastal areas of Sujawal, Thatta. Protective embankment of Keti Bunder in Thatta was damaged, as a result of which more than 30 villages including Keti Bander, Kharochhan and Ghorabari were flooded (Geo News, 2014).

Thatta, Badin and Mirpurkhas received heavy rainfall with high winds and dust storm due to cyclonic storm Takutae during May 2021. On September 30, 2021, severe Cyclonic Storm Shaheen, a tropical cyclone that originated from the remnants of Cyclonic Storm Gulab, had peripheral effect on Thatta, Badin, Mirpurkhas, Tharparkar, Umerkot, and Sanghar districts in the form of high winds and intermittent rainfall. Although the frequency of District Thatta, Sindh along Pakistani coast is low, yet they cause considerable damage, when they occur. Hence the possible occurrence of a future cyclone with severe consequences is quite rare but cannot be ruled out (NDMA, 2007).

Hailstorm

Hailstorm present a great danger to the agricultural practices present in Thatta. The cropped land is damaged by hailstorms, which occur during the monsoon season, and this situation can be worsened by heavy rainfall and high spend winds. Annually, crops and fruits are severely damaged, which results in huge losses to the agricultural sector (DDMP Thatta – GoS, 2017).

The baseline established from secondary sources was validated through consultations carried out on the field with various community and other stakeholders in the project vicinity.

4.3. Climate Change Trends and Projections

Scenarios and Pathways

The Intergovernmental Panel on Climate Change (IPCC) was formed by the United Nations Environmental Programme (UNEP) and the World Meteorological Organization (WMO) in 1998. It assesses the advances in science related to climate change and provides periodic assessment reports. These reports give an overarching summary of the current scientific

literature on the drivers of climate change, risks and impacts, and strategies for mitigation and adaptation (IPCC Official Website).

Along with information on current literature, the assessment reports also provide information for future projections. The Fifth Assessment Report (AR5) published in 2013, provided a set of scenarios which can be used for future projections called the Representative Concentration Pathways (RCPs). These pathways were based on future greenhouse gases (GHG) concentrations and are defined by their respective radiative forcing (RCP 2.6, RCP 4.5, RCP 6.0 and RCP 8.5).

In 2021, the Sixth Assessment Report (AR6) on climate change introduced the Shared Socio-economic Pathways (SSPs). The development of SSPs was based on describing a range of possible futures where technological, environmental and political trajectories vary. The SSPs are used in conjunction with RCPs and as such, an updated list of RCPs was included in AR6 with additional RCP scenarios. The SSPs are based on a number of scenarios which consider the challenges in terms of adaptation and mitigation. These new pathways consider factors such as population growth, GDP, urbanization, etc. The scenarios are defined as Sustainability (SSP1), Middle of the Road (SSP2), Regional Rivalry (SSP3), Inequality (SSP4), and Fossil-fueled development (SSP5). The table below shows the various SSPs along with their corresponding RCPs. The key scenarios are briefly described as follows.

SSP	Corresponding RCP	Radiative Forcing in 2100 (W/m2)	Expected Global Temperature Change	Characterization
SSP1	RCP1.9	1.9	1.5 °C	The low emission scenario which assumes focus on sustainability towards the end of current century.
SSP2	RCP4.5	4.5	2.7 °C	A middle of the road scenario, which assumes no further climate policies.
SSP3	RCP7.0	7.0	-	An intermediate scenario where countries focus on regional issues rather than global issues.
SSP5	RCP8.5	8.5	3.3 °C – 5.7 °C	The high emission scenario assumes massive fossil fuel dependent economic growth.

The Coupled Model Intercomparison Project (CMIP) is an ensemble climate model consisting of various climate models, contributing to different regions and sectors, from around the world. The combined model is used as a data source for future projections.

The selection of scenario has to be based on the context of the project, the location of the project and the selected timeframe. In line with National Climate Communications of Pakistan (NAP and Second NCC), the radiative forcing selected for the future projections will be 4.5 W/m^2 and 8.5 W/m^2. A conservative approach has been taken in the selection of the scenario. This approach was adopted because of Pakistan's vulnerability to climate change. Pakistan was ranked 8th on the Long-Term Climate Risk Index by Germanwatch in 2021. The INFORM Risk Index provides risk profiles of 191 countries and provides data on the country's human and natural hazard risks, vulnerability of the community, and coping capacity of local infrastructure and institutions. The index is divided into categories of Hazard and Exposure, Vulnerability and Lack of Coping Capacity and is numbered from 0 – 10, with a higher score representing higher risk of exposure, vulnerability or lack of coping capacity. The INFORM Risk Index for Pakistan is tabulated as follows:

Riverine Flood (0-10)	Tropical Cyclone (0-10)	Drought (0-10)	Vulnerability (0-10)	Lack of Coping Capacity (0-10)	Overall Inform Risk Level (0-10)	Rank (1-191)
9.5	7.1	3.0	5.9	5.3	6.1	23

During 1981 – 2005, the decadal mean temperature rise in the country was 0.39 °C compared to the rest of the world (Second National Climate Communication).

The scenarios used for this assessment will be SSP2-4.5 and SSP5-8.5. The chosen scenarios are described below:

- **SSP2-4.5:** An intermediate emissions and 'middle-of-the-road' scenario. The scenario assumes that emissions peak around 2040 and decline afterwards due to policy interventions. At the end of the 21st century warming is expected to be up to 2.6 °C. This scenario is aligned with the Paris Agreement.

- **SSP5-8.5:** Described as a 'business-as-usual' high-emissions scenario. In this scenario, global emissions continue to rise until the end of the century.

Timeframes

The short-term timeframe selected for this assessment is until 2040 and to account for extended operations, the long-term timeframe will be until 2080.

Future Trends and Projections of Meteorological Variables

Meteorology is the branch of science that focuses on the atmosphere and its phenomena, it is used in the study of weather, weather forecasting and composition of the atmosphere. Meteorological variables are used to aid in these observations and predictions. Meteorological variables including temperature, precipitation, wind speed among others are detailed as follows;

i. Temperature

Indicator	Baseline Information	Future Trend
Average Mean Surface Air Annual Temperature	During 1991 - 2020, the average mean surface air temperature of Pakistan was 21.38 ^{o}C, and the mean average surface temperature of Sindh was 27.26 ^{o}C.	An increasing trend is observed in the last 70 years and as per future projections, the temperature is expected to rise more rapidly. This is in line with current information, which shows that Pakistan has a higher decadal temperature rise as compared to the rest of the world. • For short-term projections (2020-2039), the mean average temperature for Pakistan is expected to increase to 21.23 ^{o}C for SSP 2-4.5 and 21.4 for SSP5-8.5 respectively. For Sindh, under SSP2-4.5 scenario the mean air temperature is projected to increase by 0.73 ^{o}C and under SSP5-8.5 scenario, the mean air temperature is projected to increase by 0.85 ^{o}C. • From long-term projections (2060-2079), the annual mean temperature for Pakistan will be 23.00°C under SSP2-4.5 and 24.91°C under SSP5-8.5. In Sindh under SSP 2-4.5 scenario the average mean air temperature is projected to increase by 1.40 ^{o}C and under SSP5-8.5, the average mean air temperature is projected to increase by 1.91 ^{o}C.
Average Max Surface Air Annual Temperature	The average maximum surface air temperature of Sindh was 34.78 ^{o}C from 1991-2020.	The average maximum surface air temperature is projected to increase in the future. • For short-term projections (2020-2039), under SSP 2-4.5 scenario the average maximum surface air temperature in Sindh is projected to increase by 0.66 ^{o}C. Under SSP5-8.5 scenario, the average maximum surface air temperature is expected to rise by 0.78 ^{o}C. • For long-term projections (2060-2079), under SSP 2-4.5 scenario the rise in the average maximum surface air temperature in Sindh is expected to be 1.9 ^{o}C, and under SSP 5-8.5 scenario, the average maximum surface air temperature is expected to rise by 2.89 ^{o}C.

Historical trends for mean surface air temperature along with the future projections for Pakistan and Sindh are shown in the exhibits as follows.

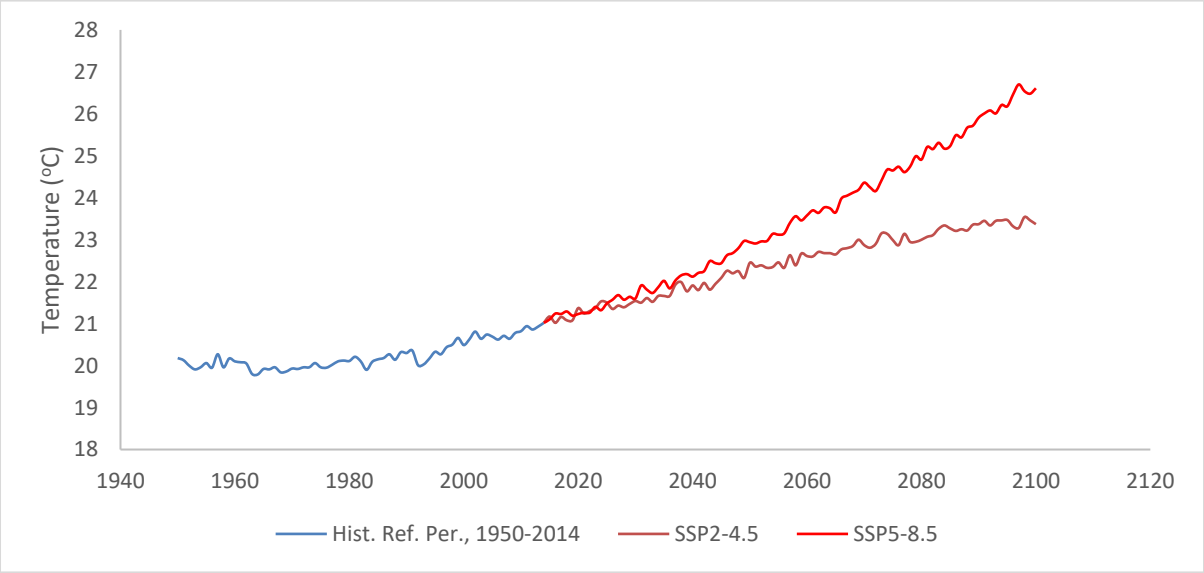


Exhibit 16- Graph that shows future projections for the average mean surface air temperature for Pakistan along with the historical data from 1950-2014

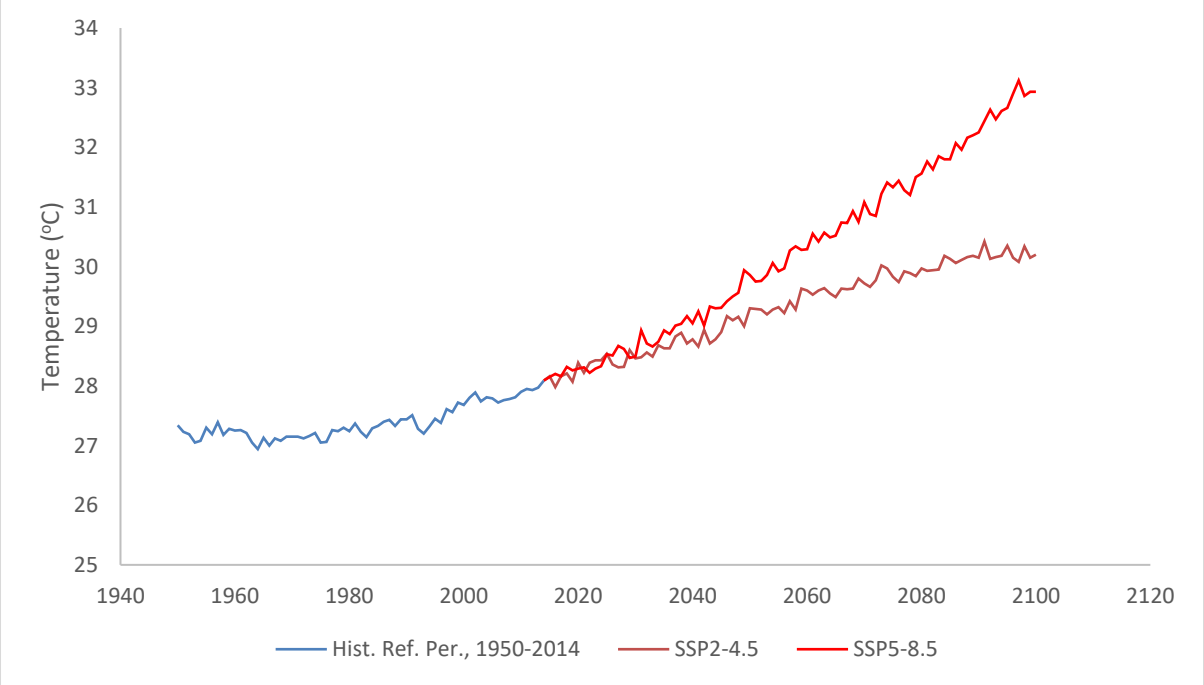


Exhibit 17- The average mean surface air temperature graph for Sindh, which shows the historical data along with future projections

An increasing trend is observed in the last 70 years and as per future projections, the temperature is expected to rise more rapidly. This is in line with current information, which shows that Pakistan has a higher decadal temperature rise as compared to the rest of the world.

ii. Precipitation

Indicator	Baseline Information	Future Trend
Average Annual Precipitation	• During 1991-2020, the average precipitation for Pakistan was 289 mm. • During 1991-2020, the average precipitation for Sindh was 158 mm.	The average annual precipitation is expected to increase in the future. • For short-term projections (2020-2039) in Pakistan, average precipitation for SSP 2-4.5 scenario is projected to be 406.15 mm and for SSP 5-8.5 scenario, it is expected to be 463.96 mm. Under the SSP 2-4.5 scenario the yearly average precipitation In Sindh is projected to increase up to 223 mm, and under SSP 5-8.5 scenario, it is expected to increase up to 236 mm. • Long-term projections (2060-2079) indicate that in Pakistan, in 2080, there will be a total annual precipitation of 432.57 mm under SSP2-4.5 and a total annual precipitation of 509.89 mm under SSP5-8.5 (World Bank Group). Under SSP2-4.5 the average annual precipitation In Sindh will increase up to 260 mm, and under SSP5-8.5, the increase is expected to be up to 290 mm.

The exhibits below show the historical trend and future projection for average annual precipitation for Pakistan and Sindh.

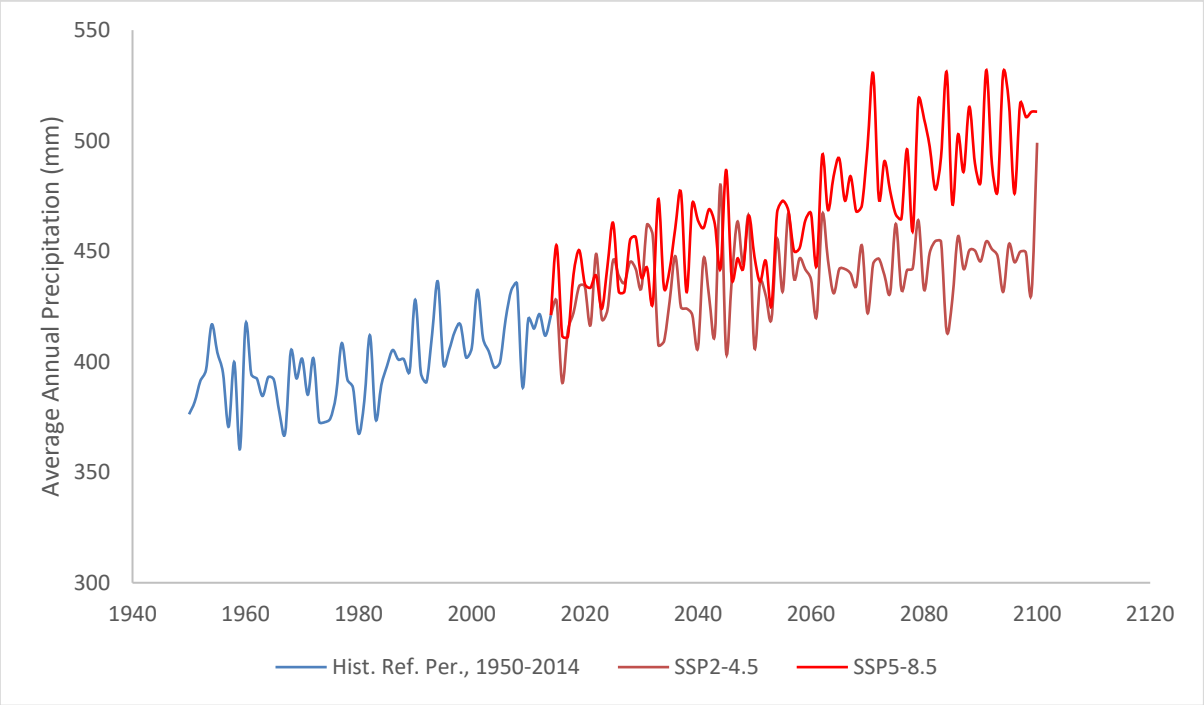


Exhibit 18- Graph for the Average Annual Precipitation for Pakistan, showing the historical data along with future projections

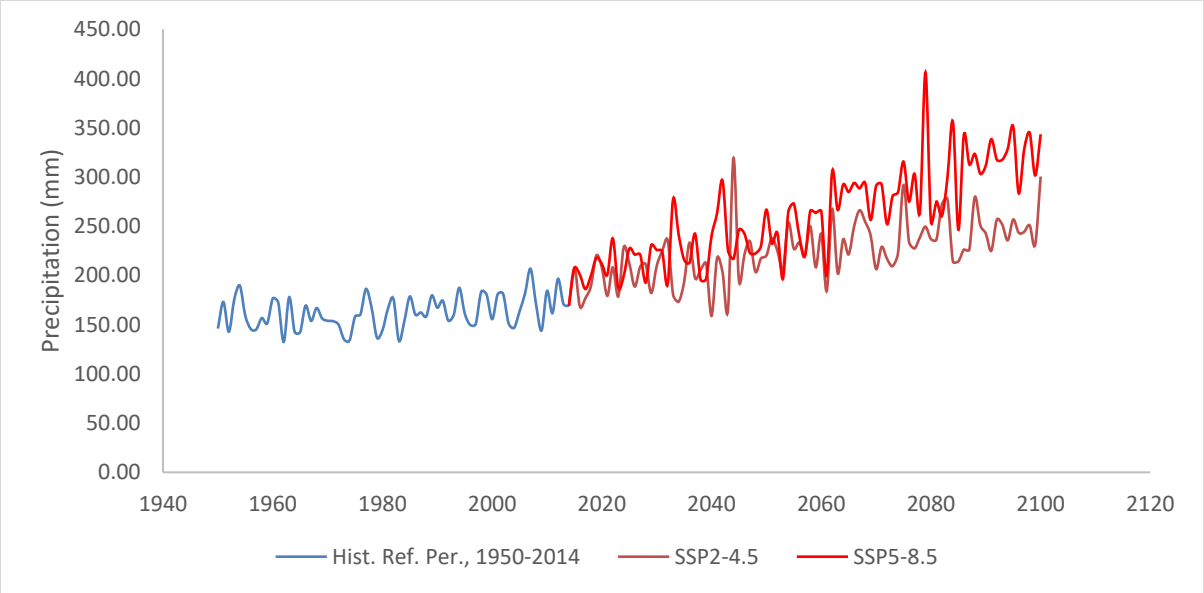


Exhibit 19- Graph for the Average Annual Precipitation in Sindh, which shows the historical data along with future projections

iii. Wind Speed

Indicator	Baseline Information	Future Trend
Wind Speed	• During 1950-2023, the average wind speed in Pakistan was 2.43 m/s. • In Sindh, specifically in the project area in Thatta District, the current average wind speed is 5.68 m/s.	The average wind speed is expected to increase in the future. • In 2040 under SSP2-4.5 scenario, the average wind speed In Pakistan is expected to be 2.55 m/s and under SSP5-8.5 scenario, the average wind speed is projected to increase to 2.57 m/s. • In 2080 under SSP2-4.5 scenario, the average wind speed In Pakistan is expected to be 2.55 m/s and under SSP5-8.5 scenario, the average wind speed is expected to increase to 2.88m/s.

The exhibit below shows the historical trend and future projection for Average Annual Wind Speed for Pakistan.

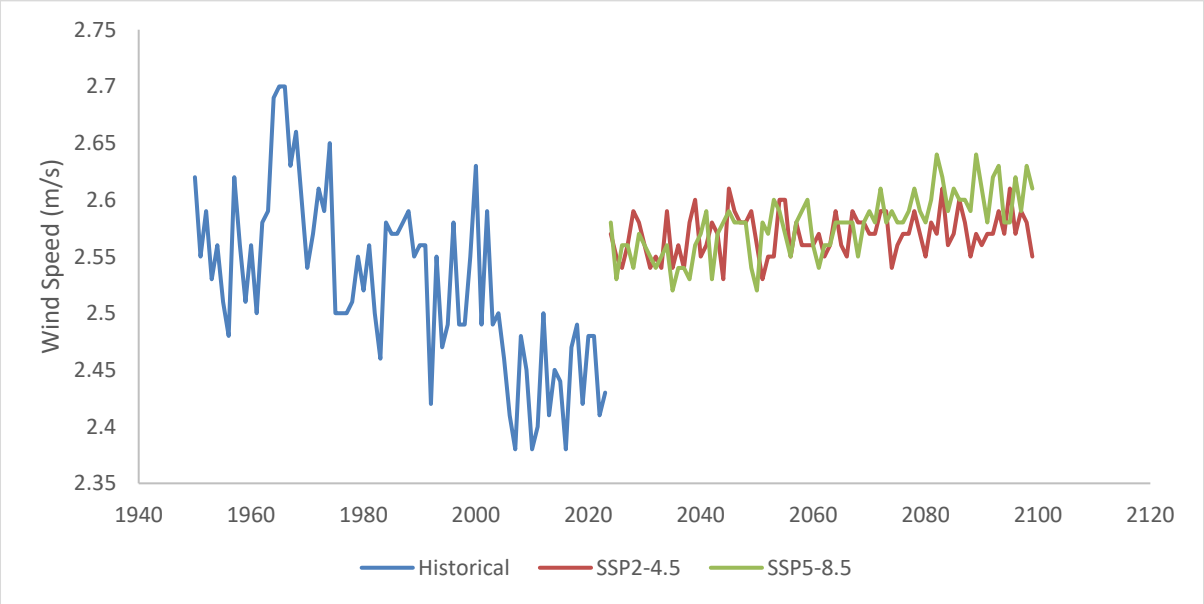


Exhibit 20-Graph for the Average Annual Wind Speed for Pakistan, which shows the historical data along with future projections

4.4 Climate Change Hazards

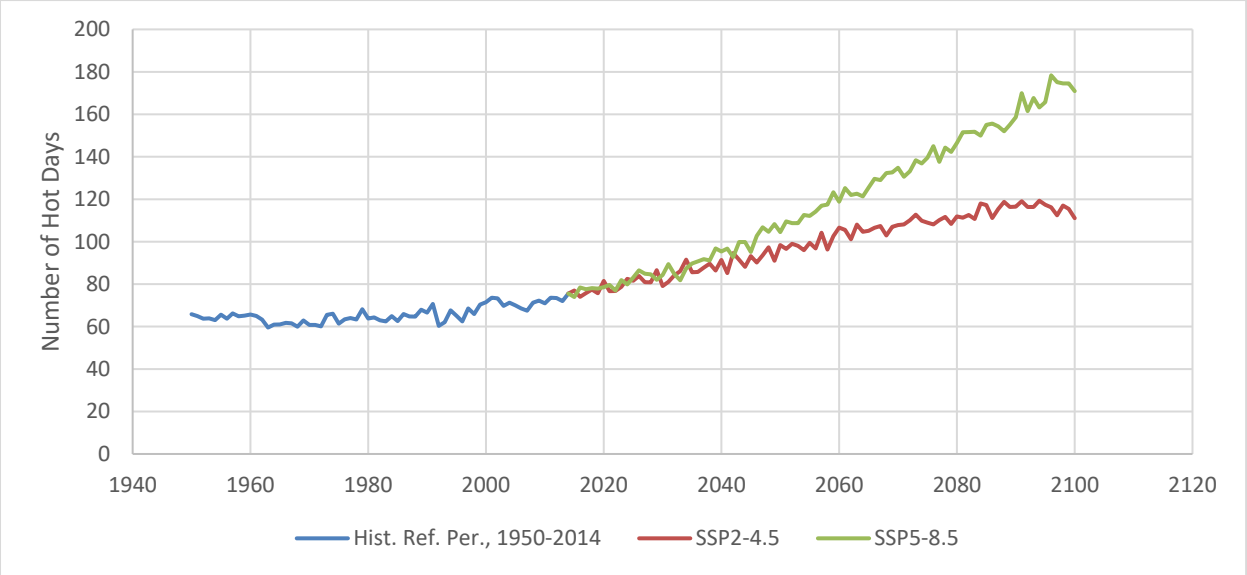
Climate hazards are weather-related, hydrometeorological events that can cause harm to humans, property, livelihoods, resources and the environment. ***Acute hazards*** are short-term, event-driven hazards that include extreme climate events such as hurricanes, floods or drought. ***Chronic hazards*** are long term trends that indicate shifts in climate patterns, examples include rising temperatures and increasing precipitation.

Extreme Heat (Tmax > 40 °C)

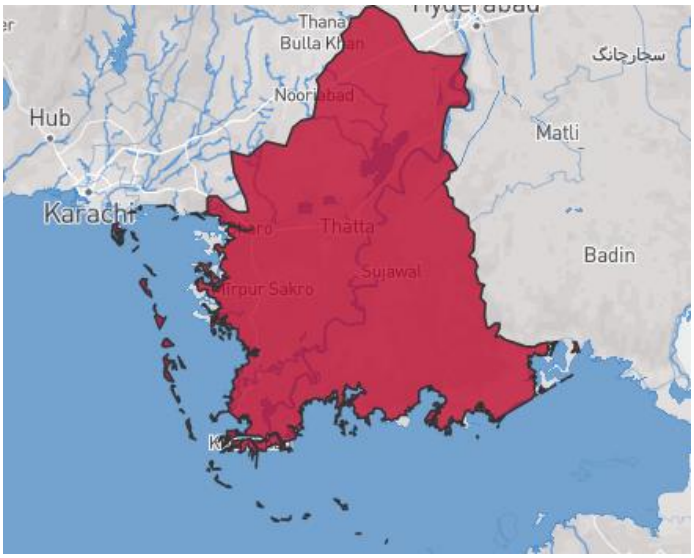
Extreme heat is the number of days in a year where the maximum temperature exceeds 40 °C[2].

Baseline Information	Future Trend	Tool Used
During 1995-2014, extreme heat was recorded in 71 days on average in a year, within Sindh.	It is expected that the number of hot days will increase in the future. • For short-term projections, under SSP 2-4.5 scenario the number of hot days in Sindh are expected to increase up to 83 days. For SSP5-8.5 scenario, the number of hot days is expected to increase up to 85 days. • For long-term projections, under SSP 2-4.5 scenario the number of hot days in Sindh are projected to increase up to 106 days and under SSP5-8.5, the number of hot days is projected to increase up to 131 days.	World Bank Climate Change Knowledge Portal
Thatta is categorized with a hazard level of 'High'. This indicates that prolonged exposure to extreme heat, resulting in heat stress, is expected to occur at least once in the next five years.	Thatta is expected to have a temperature increase in the next fifty years which will be slightly higher than the worldwide average.	ThinkHazard

[2] World Bank Climate Change Knowledge Portal (CCKP). The hazard level for extreme heat is assessed by using the Wet Bulb Globe Temperature (oC). (Source: ThinkHazard



Graph for the number of hot days (T_{max} > 40 °C) for Sindh (World Bank Climate Change Knowledge Portal).

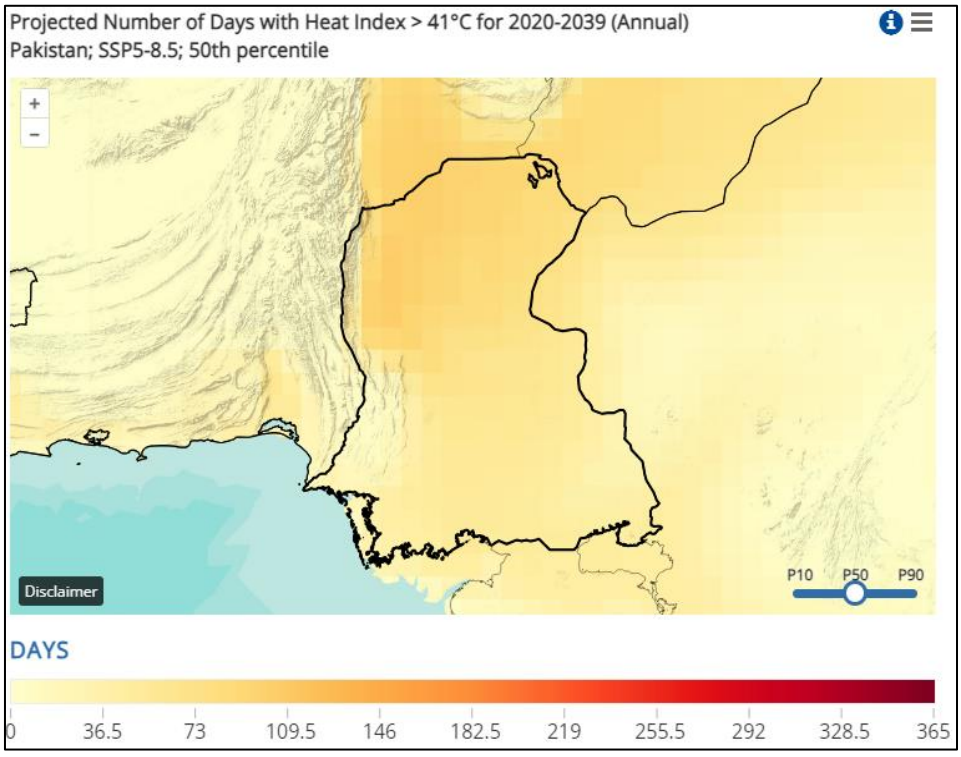


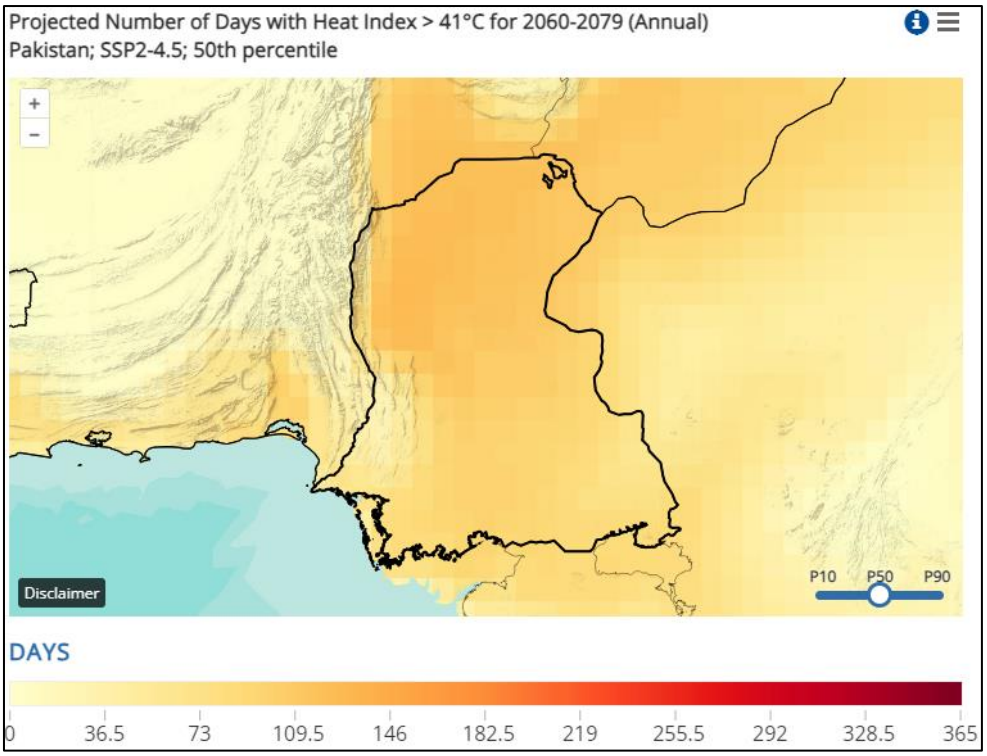
Source: https://thinkhazard.org/en/report/23693-pakistan-sindh-thatta-district/EH

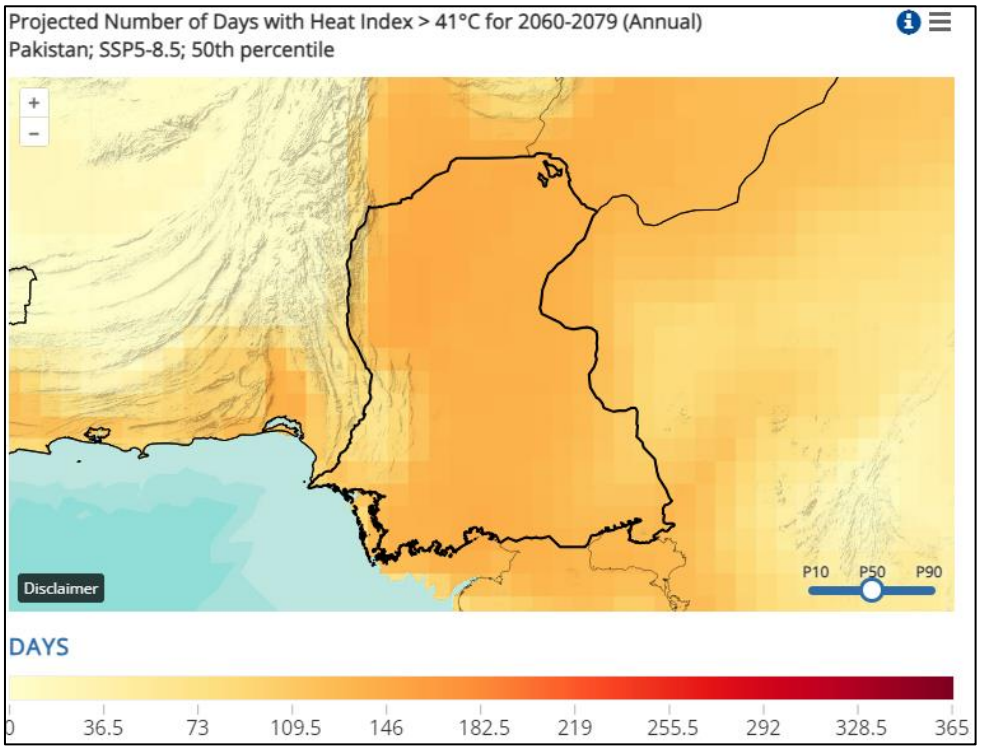
Days with Heat Index > 41 °C

Heat index is the temperature perceived by the human body when relative humidity is combined with the air temperature. The annual number of days with heat index more than 41 °C is assessed for future projections using CCKP.

Baseline Information	Future Trend	Tool Used
During 1995-2014, the average annual number of days with heat index greater than 41 °C was 57 days for Sindh.	The number of days with heat index > 41 °C is expected to increase in the future. • During 2020-2039, under SSP 2-4.5 scenario the average annual number of days with heat index > 41 °C is projected to increase to 78 days in Sindh. Under SSP5-8.5 scenario, it is projected to increase up to 80 days. • Under long-term projections, under SSP2-4.5 scenario the average annual number of days with heat index > 41 °C are projected to be 96 days, and under SSP 5-8.5 scenario, the annual average number of days with heat index > 41 °C is projected to increase up to 130 days.	World Bank Climate Change Knowledge Portal







Heat Wave

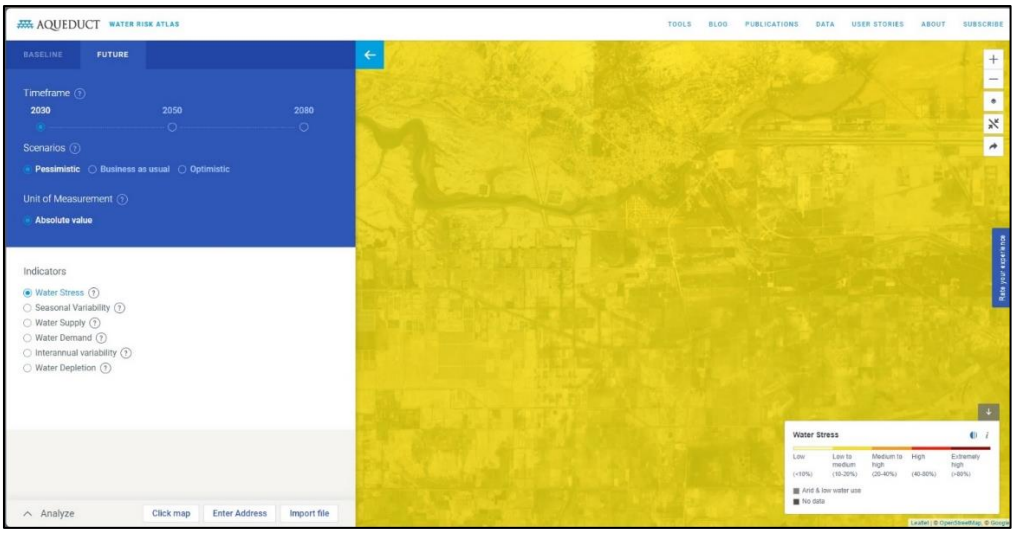
A heat wave is a period of three or more days where the daily temperature is above the long-term moving 95th percentile of the daily mean temperature.

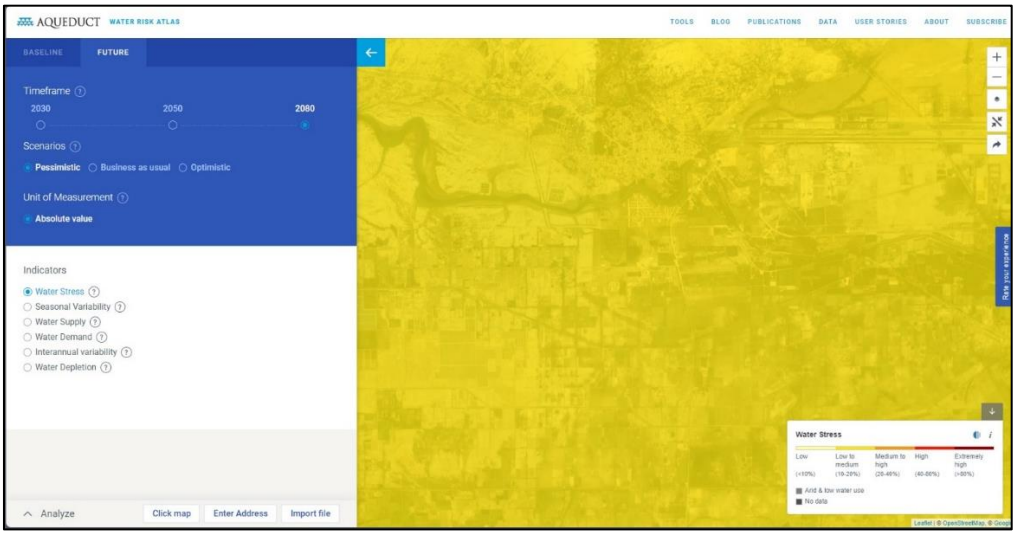
Baseline Information	Future Trend	Literature Referred
During 1997-2015, Pakistan experienced 126 heat waves. The current median annual probability of a heat wave occurring anywhere in Pakistan is 3%.	The probability of a heat wave occurring in Pakistan is expected to increase in the future. • For short-term projections (2020-2039), under RCP 8.5 the probability of a heat wave occurring anywhere in Pakistan is expected to be around 5%. • For long-term projections (2060-2079), under RCP 8.5 the probability of a heat wave occurring anywhere in Pakistan is expected to be around 18%.	ADB Climate Risk Profile for Pakistan

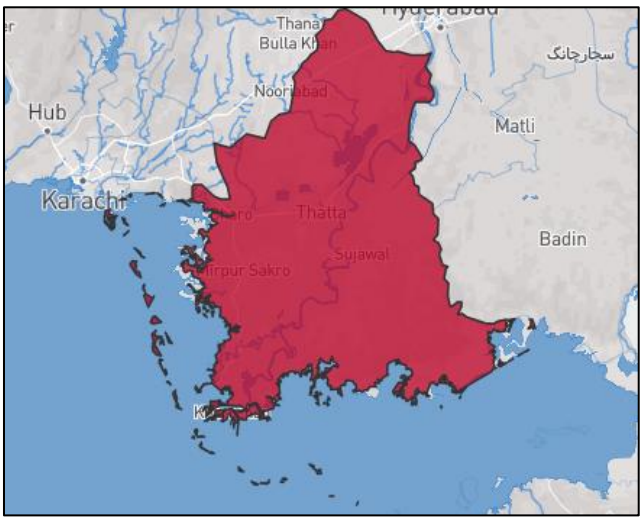
Water Stress and Scarcity

Water stress is defined as the ability or lack of ability to meet human and ecological demands for water, it includes factors such as water scarcity, which is a ratio of human water consumption to water supply, water quality, environmental flows and water accessibility.).

Baseline Information	Future Trend	Tools Used
In 2015, the annual water stress for the project area in Gharo was low-to-medium (10-20%). Water stress in the project area has not changed significantly in the past due to no major change in the land use. Aqueduct Water Risk Atlas defines water stress as the measure of the ratio of total water demand to available renewable surface and groundwater supplies. Domestic, industrial, irrigation and livestock use are included in the total water demand. Renewable supplies include the impact of upstream consumptive water users and large dams on downstream water availability. Higher values indicate more competition among users.	• For short-term (2015-2045) and long-term (2065-2095) projections, under SSP 5 - 8.5 scenarios the water stress is not expected to change (medium 10-20%). • Projections for SSP 2-4.5 are not available in this tool. There is possibility of land use change in the future, with some industrial facilities planned in the area, which is expected to have a significant impact on the water stress.	Aqueduct Water Risk Atlas
The hazard level of water scarcity is categorized as 'High' for Thatta. This indicates that droughts are expected to occur on average every 5 years. ThinkHazard defines water scarcity as the lack of freshwater resources to meet annual water demand.	An increase in the hazard level is expected in the future due to the effects of climate change.	ThinkHazard





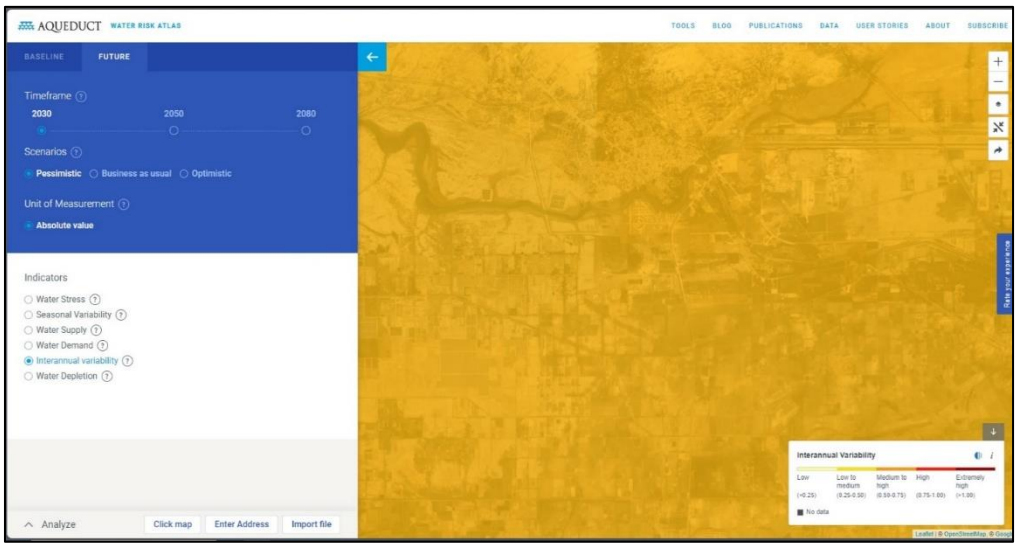


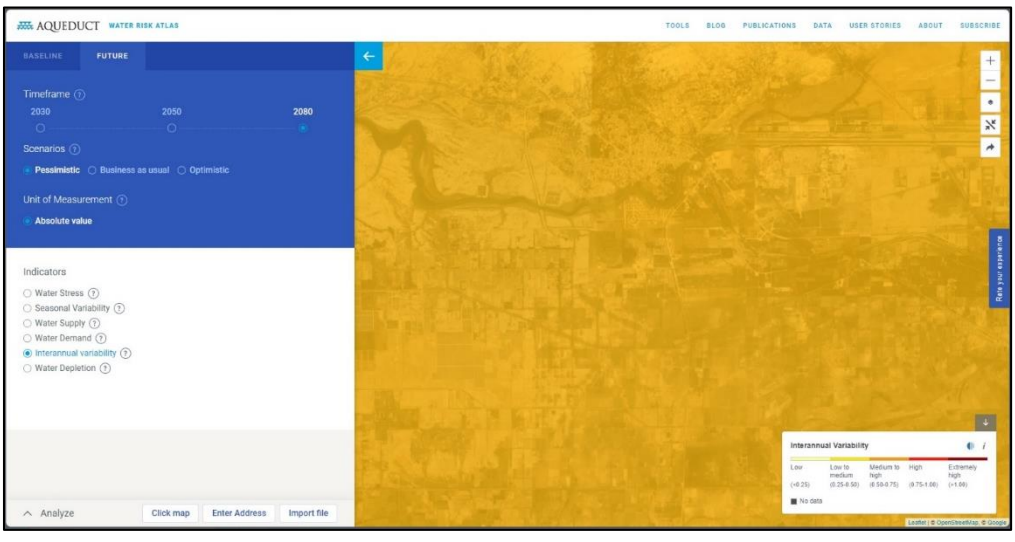
Source: https://thinkhazard.org/en/report/23693-pakistan-sindh-thatta-district/DG

Interannual Water Variability:

Aqueduct Water Risk Atlas is used for the assessment of interannual variability, which measures the variability of available of water supply on a year-to-year basis. Increasing values point towards larger variations from year-to-year.

Baseline Information	Future Trend	Tool Used
Under baseline conditions, the interannual variability in the project area is low-medium (0.25-0.50).	The interannual variability is expected to Increase in the project area. For short-term (2015-2045) and long-term projections (2065-2095), under the SSP 5 - 8.5 scenario the interannual variability for the project site is projected to increase to medium-to-high (0.50 - 0.75). Projections for SSP 2-4.5 are not available in this tool.	Aqueduct Water Risk Atlas





Consecutive Dry Days Contributing to Drought:

Consecutive dry days is the longest period without significant precipitation of at least 1 mm. Data for consecutive dry days is available for CMIP5 in the CCKP, however data for CMIP6 is not available. Therefore, CMIP5 is used for this hazard and to stay consistent with the selected scenarios, RCP 4.5 and RCP 8.5 are selected for future projections.

Baseline Information	Future Trend	Tool Used
• During 1986-2005, the historical number of consecutive dry days in Pakistan were 125 days. • During 1986-2005, the number of consecutive dry days in Sindh were 191 days.	The number of consecutive dry days is expected to increase. • Under short-term projections (2020-2039), the number of consecutive dry days in Pakistan are projected to be 115 days and under RCP 8.5, the consecutive dry days are projected to be 122 days. Under RCP 4.5, the number of consecutive dry days to Sindh are projected increase up to 342 days, and under RCP 8.5, the consecutive dry days are projected to increase up to 339 days. • For long-term projections (2060-2079), Projections indicate that in Pakistan, in 2080, average number of consecutive dry days will be 112.65 days under RCP 4.5 and 125.52 days under RCP 8.5 (World Bank Group). Under RCP 4.5, the number of consecutive dry days in Sindh are projected to be 340 days and under RCP 8.5, the number of consecutive dry days are projected to increase to 341 days.	World Bank Climate Change Knowledge Portal

Drought:

The Annual Standardized Precipitation-Evotranspiration (SPEI) Index is used as an indicator for future possible drought conditions. The Annual SPEI Index has positive and negative ranges where values greater than 2 are considered extremely wet, 1.5-2 is very wet, 1-1.5 moderately wet, − 1 to 1 normal, − 1.5 to − 1 moderately dry, − 2 to − 1.5 severely dry, and values below − 2 extremely dry (Vicente-Serrano et al. 2010; Li et al. 2015; Yao et al. 2019; Zarei and Moghimi 2019). https://www.researchgate.net/figure/SPEI-droughtindexcategories_tbl1_283244485#:~:text=SPEI%20has%20positive%20and%20negative,(Vicente%2DSerrano%20et%20al.

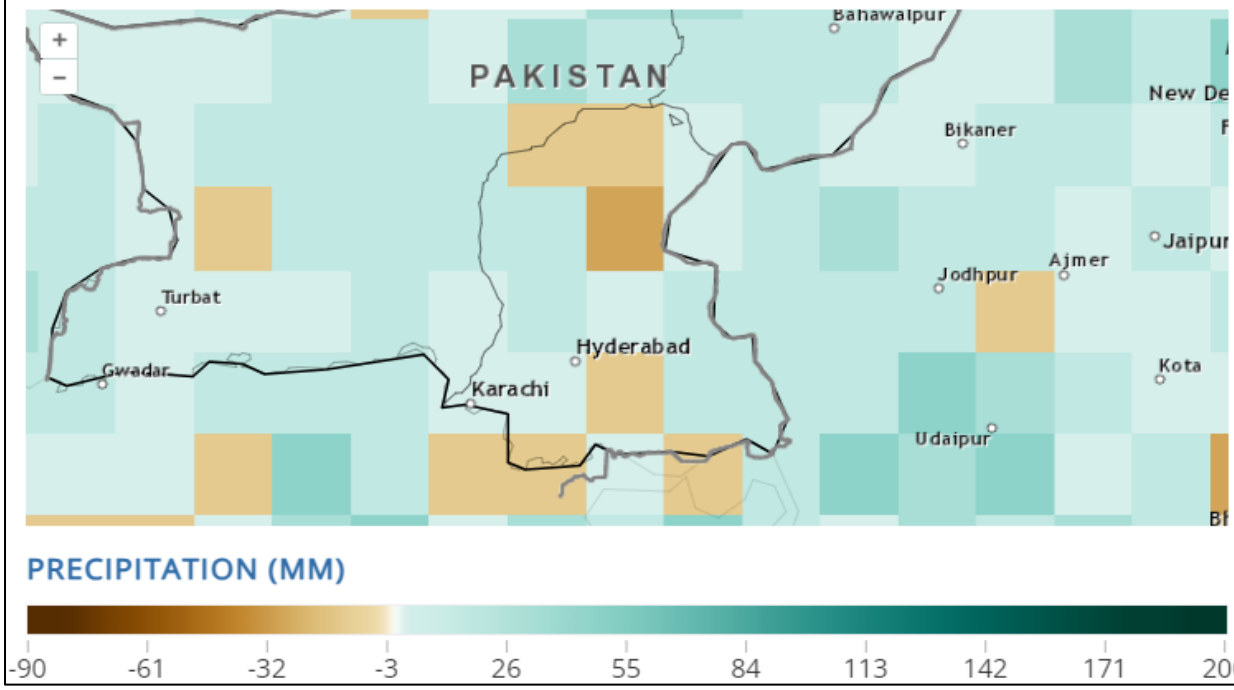
Baseline Information	Future Trend	Tool Used
During 1985-2005, the Annual SPEI Drought Index in Pakistan was -0.01. The Annual SPEI Drought Index for Sindh on December 2023 was -0.19.	The Annual SPEI Drought Index is expected to decrease in the future, leading to more dryer conditions. • For short-term projections (2020-2039), under RCP 4.5 the annual SPEI drought index for Sindh is projected to be -0.22 and under RCP 8.5 the index is projected to be -0.09 (There is low confidence on this value as it seems to defy the prevailing pattern of increasing negative SPEI Drought Index values). • For long term projections (2060-2079), Sindh is projected to have an index value of -0.56 and under RCP 8.5 the index is projected to be -0.80.	WB Climate Change Knowledge Portal

Largest 5-day Cumulative Precipitation Contributing to Flooding:

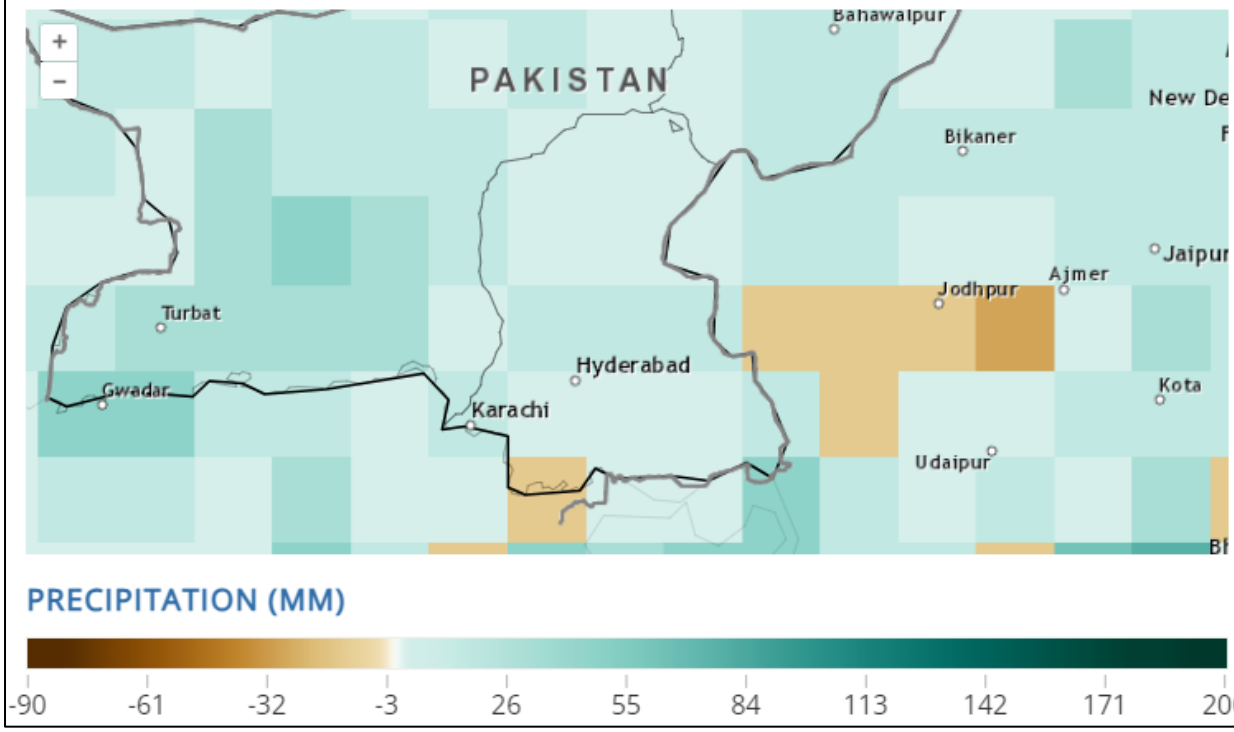
The average of the largest 5-day consecutive precipitation measured in mm.

Baseline Information	Future Trend	Tool Used
During 1985-2014, the largest 5-day cumulative precipitation in Sindh was 119.71 mm.	The largest 5-day cumulative precipitation is projected to increase in the future. • For short-term projections (2035-2064), under SSP 2-4.5 scenario the largest 5-day cumulative precipitation in Sindh is expected to increase by 1.73 mm, and under SSP5-8.5 scenario it is expected to increase by 8.51 mm. • For long-term projections (2060-2089), under scenario SSP 2-4.5 the average largest 5-day cumulative precipitation for Sindh is projected to increase by 23.6 mm and under scenario SSP5-8.5, it is projected to increase by 27.4 mm.	World Bank Climate Change Knowledge Portal

Projected Largest 5-Day Cumulative Precipitation Anomaly;
SSP2-4.5; Global; 2035-2064 (center 2050)



Projected Largest 5-Day Cumulative Precipitation Anomaly;
SSP5-8.5; Global; 2035-2064 (center 2050)



Projected Largest 5-Day Cumulative Precipitation Anomaly;
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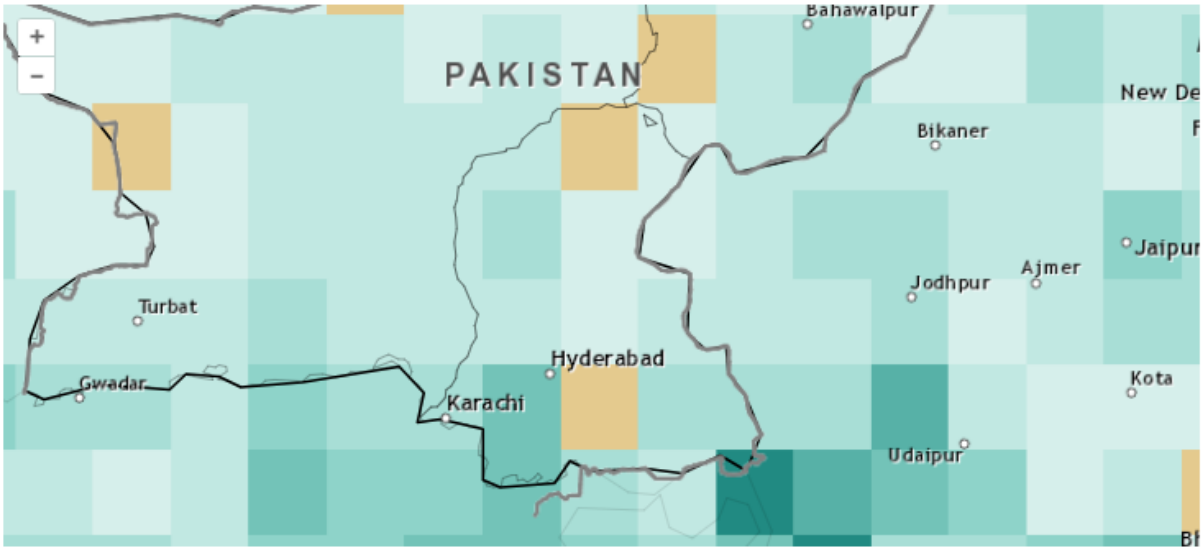
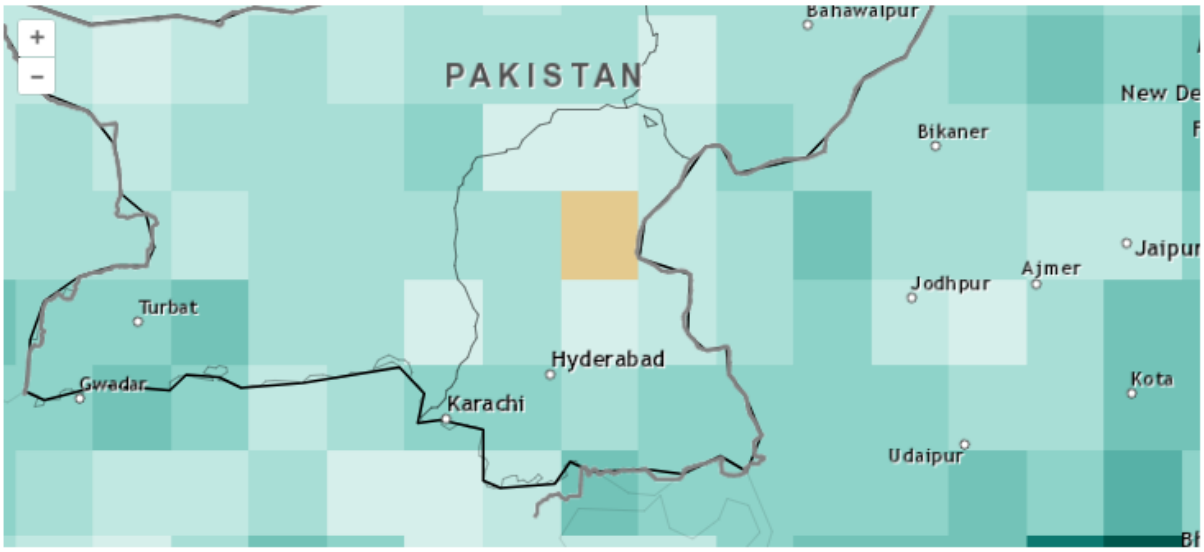


Projected Largest 5-Day Cumulative Precipitation Anomaly;
SSP5-8.5; Global; 2060-2089 (center 2075)



Average Largest 1-Day Precipitation Contributing to Flooding:

The average largest daily amount of precipitation measured in mm.

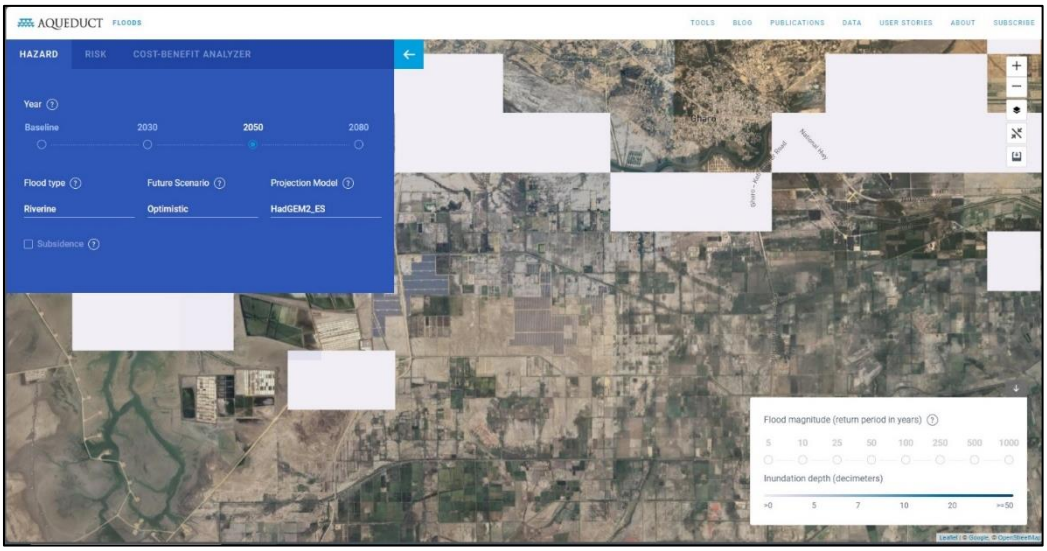
Baseline Information	Future Trend	Tools Used
During 1985-2014, the largest 1-day cumulative precipitation in Sindh was 57.37 mm.	An increase is expected in the average largest 1-day precipitation. • For short-term projections (2035-2064), under scenario SSP 2-4.5 the average largest 1-day precipitation in Sindh is expected to increase by 2.89 mm, and under scenario SSP5-8.5, it is expected to increase by 10.4 mm. • For long-term projections (2060-2089), under scenario SSP 2-4.5 the average largest 1-day precipitation for Sindh is projected to increase by 15.9 mm and under scenario SSP5-8.5, it is projected to increase by 14.9 mm.	World Bank Climate Change Knowledge Portal

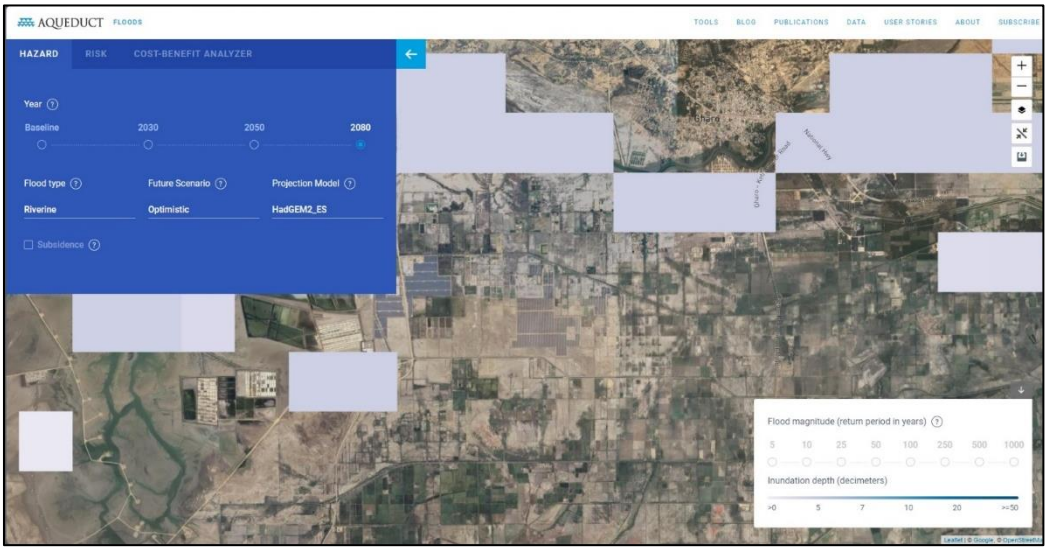
Riverine Floods and Inundation:

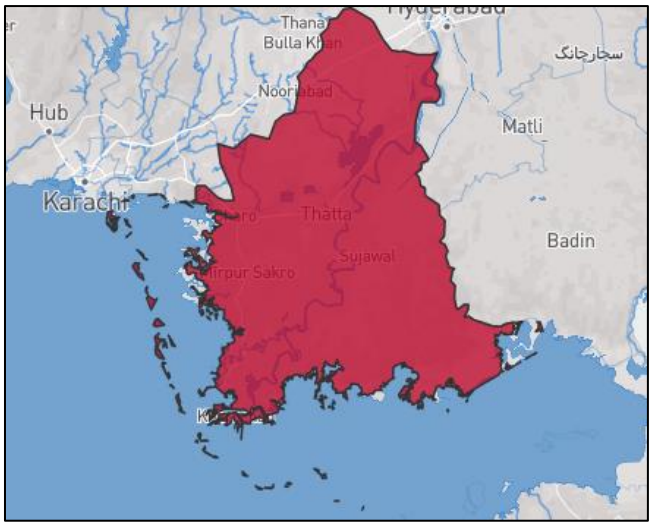
Riverine flood refers to the exceedance of the capacity of streams and rivers for their natural or constructed channels and this results in the overflow of water into adjacent dry land (https://hazards.fema.gov/nri/riverine-flooding).

Baseline Information	Future Trend	Tools Used
Riverine floods represent flooding from river overflow in Aqueduct Floods. From the baseline (2010) information available in this tool, riverine floods have caused inundation at a distance of approximately 1.25 km to the north, from the project area.	The extent of inundation (inundation area) due to riverine floods in the project surroundings is expected to remain the same, however the inundation depths are expected to increase in the coming years. • By 2050 and 2080 under the SSP 2-4.5 scenario, intrusion of riverine floods is projected to be 1.25 km away from the project area. However, the inundation depth will increase in 2080. • Projections for SSP 5-8.5 are not available in this tool.	Aqueduct Floods

The hazard level of river floods is categorized as 'High' for Thatta. This indicates that at least once in the next 10 years, potentially damaging and life-threatening river floods are expected to occur. In ThinkHazard, riverine floods is described as the overflow of river channels resulting from sustained or intense rainfall. The tool does not consider surface runoff and any flood protection measures.	An increase in the hazard level is expected in the future due to climate change.	ThinkHazard







Source: https://thinkhazard.org/en/report/23693-pakistan-sindh-thatta-district/FL

Sea Level Rise:

The increase in level of oceans throughout the world due to global warming is known as sea level rise (https://education.nationalgeographic.org/resource/sea-level-rise/).

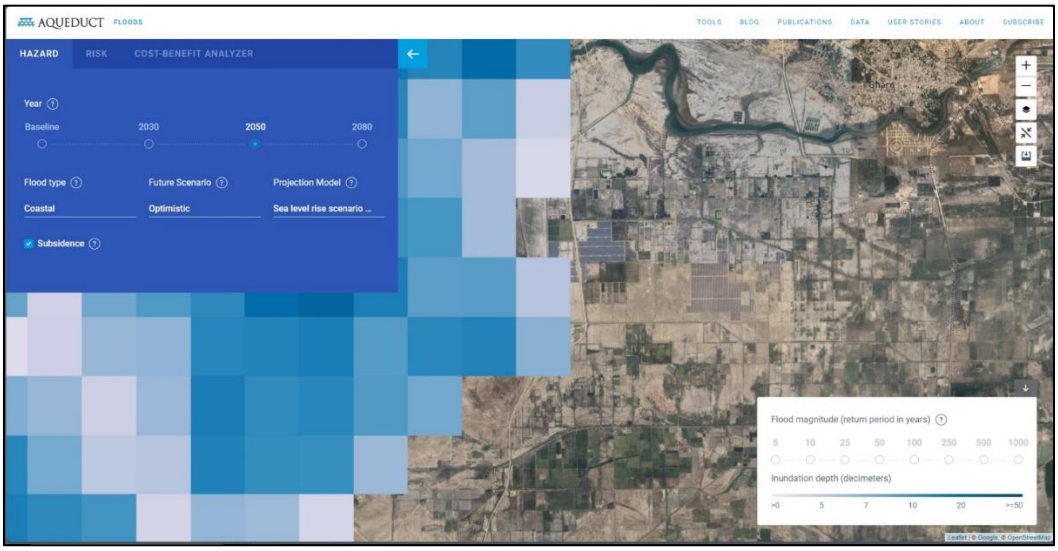
Baseline Information	Future Trend	Tool Used
During 2007-2016, sea level rise of 3.6 mm/year was observed at Karachi Port (Weeks at al. 2023). For Pakistan, the sea level rise at Karachi Port is used for historical data and future projections, as information for Karachi tide gauge has been collecting data since 1868 and is the most reliable available data.	During 2021-2040 under SSP 2-4.5 scenario, the sea level rise projected for the coast of Sindh is 0.14m, and under SSP 5-8.5, the expected sea level rise is 0.16m. During 2061-2080 under SSP 2-4.5 scenario, the sea level in Sindh is expected to rise by 0.35 m and under SSP 5-8.5 scenario, the rise is expected to be 0.46 m.	NASA Sea Level Projection Tool
Historical data for sea level rise is not available in this tool.	• For short-term projections (2021-2040), under SSP 2-4.5 and SSP 5-8.5 scenarios, the sea level in the South Asia region is expected to rise by 0.1 m. • For long-term projections (2081-2100) under SSP 2-4.5 scenario, the sea level rise is expected to be 0.5 m and for SSP 5-8.5 scenario, the sea level rise is projected to be 0.7 m.	IPCC WGI Interactive Atlas

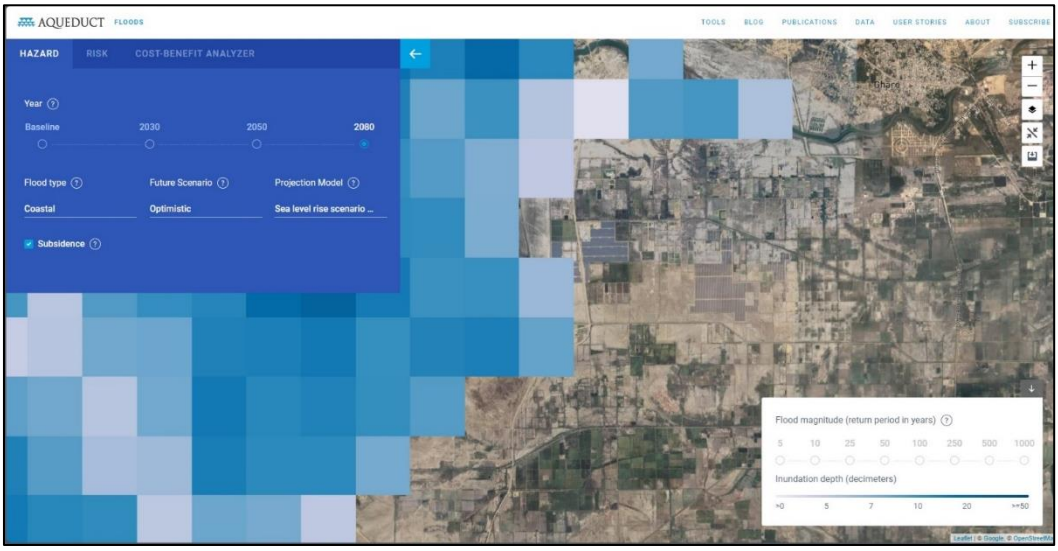
Coastal Flooding and Inundation:

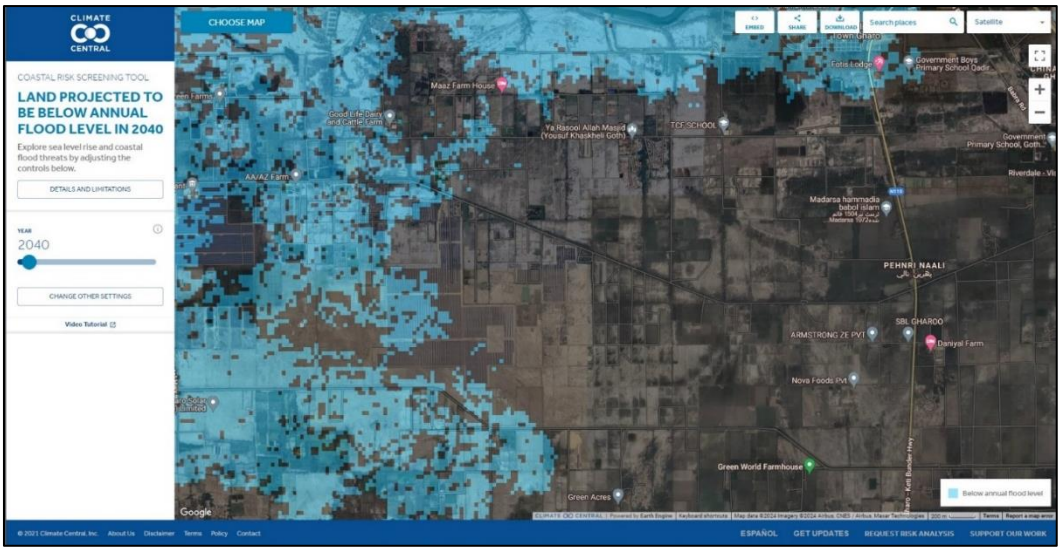
Coastal inundation refers to the flooding occurring due to abnormal rise in seawater level, as a result of coastal storm surge event.

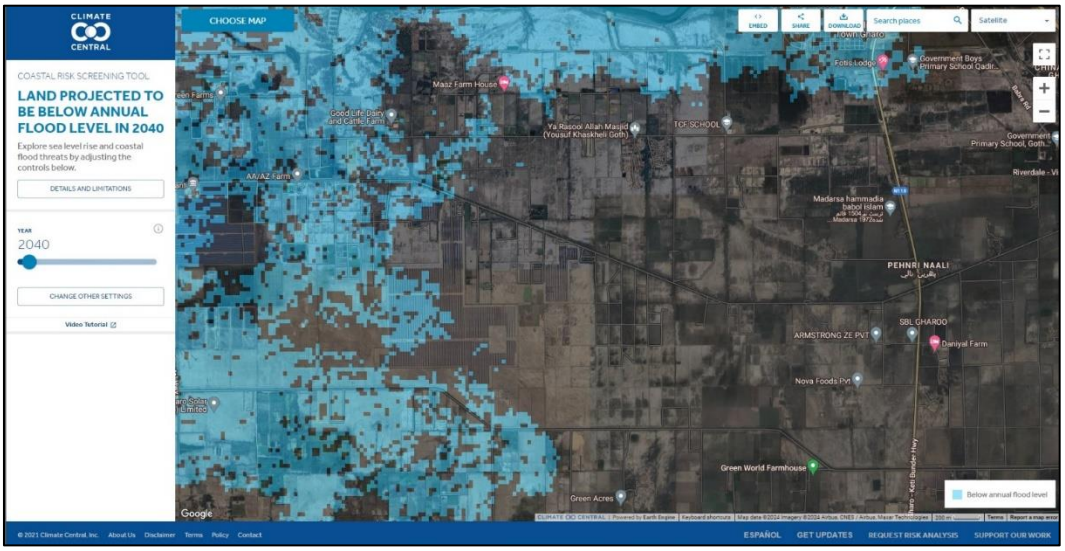
Baseline Information	Future Trend	Tool Used
Based on the 2010 coastal flood information, inundation due to coastal floods was about 5 km away from the project area. Future projections consider the sea level change simulations from the Responses to coastal climate change: Innovative Strategies for high End Scenarios – Adaptation and Mitigation (RISES-AM) project. There is a choice of three probabilities (5%, 50% and 90%), 50% was selected for this assessment. Human-induced subsidence, which is defined as the lowering of lands due to groundwater extraction is also considered in this analysis.	Inundation due to coastal floods is projected to move towards the project area. • By 2050 for SSP 2-4.5 scenario, intrusion of the coastal and creek waters will be approximately 2.17 km away from the project area. • By 2080 under SSP 2-4.5 scenario, inundation is projected to be about 1.52 km away from the project area. • Information is not available for SSP5-8.5 scenario in this tool.	Aqueduct Floods
Historical data is not available in this tool. The annual flood level is used to denote the water level at the shoreline that local coastal floods exceed on average once per year. The rising sea levels projections in the tool are taken from the 2022 sea level rise technical report from the US government (NOAA 2022), the IPCC Assessment Report 6 (AR6) or from earlier scientific research (Kopp et al. 2014, Kopp et al. 2017).	Intrusion from annual flood and rising sea levels is expected to move towards the project area. • By 2040 under SSP 2-4.5 and SSP 5-8.5 scenarios, coastal and creek waters are projected to inundate the land at a distance of about 1.54 km from the project area. • By 2080 under SSP 2-4.5 and SSP 5-8.5 scenarios, the coastal and creek waters are projected to inundate the land at a distance of about 1.51 km from the project area.	Climate Central: Coastal Risk Screening Tool

Baseline Information	Future Trend	Tool Used
Thatta is categorized as having a hazard level of 'High' for coastal floods. This is an indicator of potentially-damaging waves expected to flood the coast at least once in the next 10 years. Coastal flood is described as onshore flooding due to high tides, storm surge (due to high winds and low pressure), and wave set-up (energy transfer from offshore waves to the coast). Flood protection measures are not included in this assessment.	Extremes in sea levels are projected to rise with increasing global mean sea levels.	ThinkHazard






CLIMATE CENTRAL
COASTAL RISK SCREENING TOOL
LAND PROJECTED TO BE BELOW ANNUAL FLOOD LEVEL IN 2040
Explore sea level rise and coastal flood threats by adjusting the controls below.
DETAILS AND LIMITATIONS
YEAR
2040
CHANGE OTHER SETTINGS
Video Tutorial
CHOOSE MAP
Maaz Farm House
Good Life Dairy and Cattle Farm
Ya Rasool Allah Masjid (Yousuf Khaskheli Goth)
TCF SCHOOL
AA/AZ Farm
Madarsa hammadia babol islam
PEHNRI NAALI
SBL GHAROO
ARMSTRONG ZE PVT
Daniyal Farm
Nova Foods Pvt
Green World Farmhouse
Green Acres
Below annual flood level
ESPAÑOL
GET UPDATES
REQUEST RISK ANALYSIS
SUPPORT OUR WORK


CLIMATE CENTRAL
COASTAL RISK SCREENING TOOL
LAND PROJECTED TO BE BELOW ANNUAL FLOOD LEVEL IN 2040
Explore sea level rise and coastal flood threats by adjusting the controls below.
DETAILS AND LIMITATIONS
YEAR
2040
CHANGE OTHER SETTINGS
Video Tutorial
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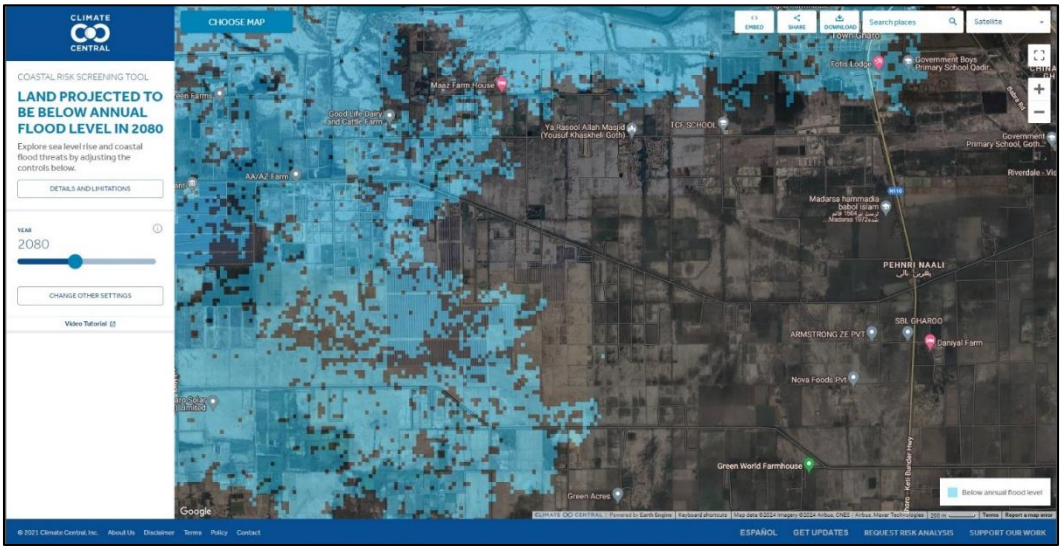
CLIMATE CENTRAL
COASTAL RISK SCREENING TOOL
LAND PROJECTED TO BE BELOW ANNUAL FLOOD LEVEL IN 2080
Explore sea level rise and coastal flood threats by adjusting the controls below.
DETAILS AND LIMITATIONS
YEAR
2080
CHANGE OTHER SETTINGS
Video Tutorial
CHOOSE MAP
Maaz Farm House
Good Life Dairy and Cattle Farm
Ya Rasool Allah Masjid (Yousuf Khaskheli Goth)
TCF SCHOOL
AA/AZ Farm
Madarsa hammadia babol islam
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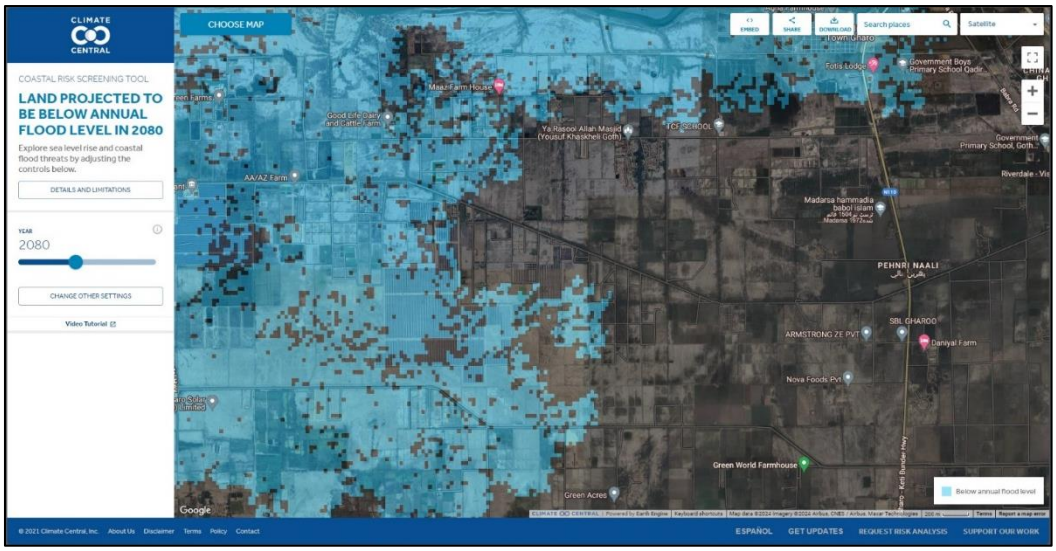
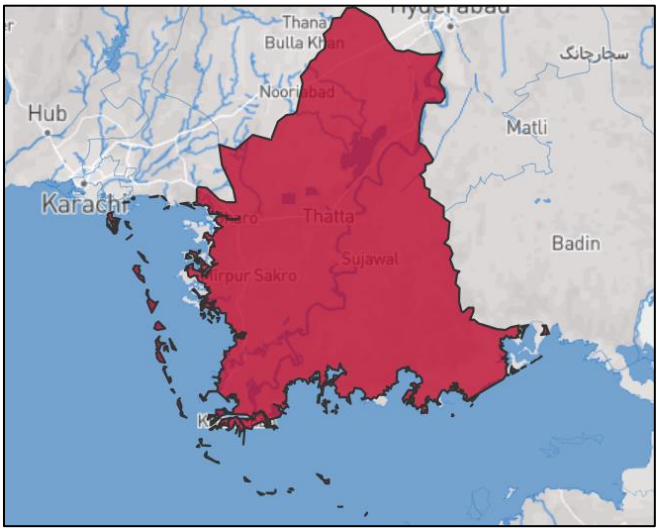


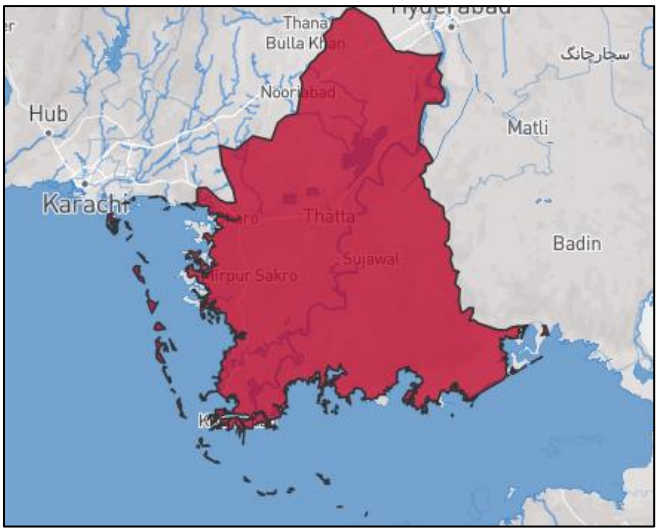


Source: https://thinkhazard.org/en/report/23693-pakistan-sindh-thatta-district/CF

Hurricane and Cyclone:

ThinkHazard is used for the assessment of hurricanes and cyclones hazard level in Thatta, the tool describes the hazard as the frequency of damaging tropical cyclone winds. Storm surges is not included in this hazard level.

Baseline Information	Future Trend	Tool Used
Cyclone hazard is classified as 'High' for the project area. There is more than a 20% chance of potentially-damaging wind speeds in the project area in the next 10 years.	While global average tropical cyclone wind speeds and precipitation is expected to increase in the future, the occurrence of tropical cyclones may remain unchanged or decrease in the future.	ThinkHazard



Source: https://thinkhazard.org/en/report/23693-pakistan-sindh-thatta-district/CY

Hailstorm:

Although there are past events of hailstorms in Sindh. The major impacts of hailstorms are on the agricultural sector (DDMP Thatta). Hail storms will not be further assessed in detail.

Tsunami:

Tsunami hazard level is assessed using the ThinkHazard tool, which describes the expected frequency of damaging tsunami waves. Coastal tsunami protection is not considered in this hazard level.

Baseline Information	Future Trend	Tool Used
Tsunami hazard is classified as 'Medium' for the project area. There is more than a 10% chance of a potentially-damaging tsunami in the next 50 years.	Global sea levels are expected to rise in the future, which may increase of tsunami on areas at risk. The risk is also dependent on regional sea level changes, which is hard to predict. There are no recorded occurrence of a tsunami in Thatta, therefore tsunamis will be not be assessed further in detail.	ThinkHazard

Wildfire:

ThinkHazard is used for the assessment of wildfire hazard level in Thatta. The tool uses the classification based on the Canadian Fire Weather Index, which considers weather factors that influence the likelihood a vegetation fire will ignite and spread. Amount of fuel or potential for an ignition source to be present is not considered.

Baseline Information	Tool Used
Although the hazard level for wildfires is stated as 'High' for Thatta, the methodology states that the classification does not consider the amount of fuel or potential for an ignition source to be present. Given that no historic events of wildfires have occurred in and near the project area and sources of ignition are not present in the area, wildfires will not be assessed further in detail.	ThinkHazard

Urban Flood:

ThinkHazard is used for the assessment of urban flood hazard level in Thatta. Urban flood is described in the tool as surface flooding of impermeable urban surfaces and overflow of saturated urban drainage systems and channels, resulting from sustained or intense rainfall.

Baseline Information	Tool Used
Urban flood hazard is classified as 'Low' for the project area. The project area and its surroundings are not classified as an urban area. Therefore, further assessment for urban flood will not be carried out.	ThinkHazard

Landslide:

ThinkHazard is used for the assessment of landslide hazard level in Thatta. Landslide susceptibility indicates the potential of landslides to occur, which is based on slope, soil and rock type, and vegetation cover.

Baseline Information	Tools Used
The hazard level for landslides is 'Very Low' for Thatta. Conditions in the area make localized landslides a rare phenomenon. Landslides will not be assessed further in this report.	ThinkHazard

Earthquake:

ThinkHazard is used for the assessment of earthquake hazard level in Thatta. The hazard level describes the expected frequency of damaging ground shaking. Liquefaction, permanent ground displacement, landslides and tsunamis are not included in this assessment.

Baseline Information	Tool Used
Earthquake hazard is classified as 'Medium' for earthquakes. Consideration for earthquakes is considered under the seismic provisions of the building code, for project structural design, in accordance with the seismic zone map. Earthquakes will not be assessed in this report.	ThinkHazard

4.5 Key Concepts and Definitions for Risk Assessment

- **Likelihood**

An indicator that a specific climate hazard may occur at a given location or region.

- **Severity**

The intensity of the climate hazard.

- **Climate Change Impact**

Climate change impacts are the consequences of climate change – both expected and realized – for natural and human systems.

- **Exposure**

The nature and degree to which a system is exposed to significant climatic variations.

- **Sensitivity**

The degree to which a built, natural or human system is directly or indirectly affected by or responsive to changes in climate conditions or related impacts.

- **Vulnerability**

The degree to which a system is susceptible to or unable to cope with adverse effects of climate change, including climate variability and extremes. It is often defined as a combined function of exposure and sensitivity to the effects of climate change, minus the adaptive capacity of a system.

- **Climate Risk**

A product of hazard, exposure, and climate change vulnerability, where interaction between the components is combined.

- **Physical Risk**

The potential of negative consequences due to climate change which arise due to acute and chronic climate hazards.

- **Transition Risk**

The potential of negative consequences due to climate change which arise due to transition to low-carbon policies. Its main drivers include policy and legal, technology, market and reputation risk.

- **Climate Change Adaptation**

Describes measures taken in response to actual or projected climate change in order to eliminate, minimize, or manage related impacts on people, infrastructure, and the environment.

- **Adaptive Capacity**

Describes the degree to which the physical elements of a system can absorb, withstand, or respond to climate change impacts without incurring damage.

- **Resilience**

The ability of a system and its component parts to anticipate, absorb, accommodate, or recover from the effects of a hazardous event in a timely and efficient manner, including through the preservation, restoration, or improvement of its basic structures and functions.

4.6 Hazard Screening for the Project

Based on the information provided on respective climate hazards in preceding sections, the screening of hazards is conducted in consideration of the likelihood of its occurrence and expected severity of the hazard at the project location. Subsequent to the screening, select hazards will be considered for Climate Impacts and Risk Assessment in the following sections.

Climate Hazard	Likelihood	Severity
Extreme Temperatures	Almost Certain	High
Increase in Extreme Hot Days and Days with Heat Index > 40 C	Almost Certain	High
Heat Wave	Possible	High
Water Stress and Scarcity	Likely	Moderate
Interannual Water Variability	Likely	Moderate
Drought	Likely	Moderate
Extreme Precipitation and Flash Flooding	Almost Certain	High
Riverine Flood and Inundation	Almost Certain	High
Sea Level Rise	Likely	High
Coastal Flood and Inundation	Almost Certain	Moderate
Hurricane and Cyclone / Extreme Winds	Possible	Low
Tsunami	Unlikely	Low

Wildfire	Rare	Low
Urban Flood	Unlikely	Low
Landslide	Unlikely	Low

Level of Likelihood	Definition
Almost Certain	More likely than not, probability greater than 50%
Likely	As likely as not, 50/50 score
Possible	Less likely than not but still appreciable, probability less than 50%, but still quite high
Unlikely	Unlikely but not negligible, probability low but noticeably greater than zero
Rare	Negligible, probability very low, close to zero

4.7 Tyre Manufacturing Sector - Vulnerability Baseline

Understanding the overall vulnerabilities of the tyre manufacturing industry to climate-related risks is important in order to recognize the challenges within the sector. Climate variability and extreme weather events pose significant challenges to various aspects of tyre manufacturing, distribution, and utilization. In this section, we delve into some of the sector's vulnerabilities to climate change, examining how fluctuations in temperature, water availability, and extreme events impact different stages of the tire industry's operations.

Supply Chain of Natural Rubber

The supply chain of raw materials needed for tyre production can be disrupted by extreme weather events such as floods, droughts, or hurricanes. This includes rubber, natural or synthetic, as well as other additives and materials required in the manufacturing process. One of the major concerns in the tyre industry is the vulnerability of the supply chain of natural rubber. Southeast Asia accounts for 90% of the world's natural rubber production, with Thailand producing 4,892,451 tons and Indonesia producing 3,045,314 tons in 2021.

These areas are reported to be significantly affected by climate change. Climate hazards such as droughts, floods or cyclones can affect the yield of rubber trees and in the case of cyclones, cause irreversible damage. Fluctuations in rainfall can cause soil erosion and delay tree maturation limiting the amount of natural rubber produced. Disruptions in the supply of natural rubber can affect operations and lead to delays in delivery of the final product. Additionally, it can lead to higher prices of natural rubber resulting in higher production costs for tyres and lower profits. Major tyre manufacturing companies have recognized the possible disruptions in the supply chain of natural rubber and it has led to the formation of the Global Platform for Sustainable Natural Rubber, an organization which works towards the sustainability of the natural rubber supply chain.

Water Stress

The tyre manufacturing process requires substantial water usage, particularly in cooling systems and the usage of steam in production processes. Water stress, scarcity, and quality issues due to droughts, water pollution, or competition for water resources can pose significant challenges to the sector's operations. Shortage of water can impact operations, which can lead to delays in the production and can limit the production capacity.

Extreme Precipitation and Floods

Climate-related events such as storms, flooding, or wildfires can disrupt transportation networks, causing delays or interruptions in the supply chain of raw materials, and distribution of finished products. This can lead to reduced production, inventory shortages, and increased costs. The general practice for the transportation of natural rubber is by shipping, since air transport is not feasible due to rubber being heavy, odorous and expensive to ship by air. Coastal floods and its impacts can cause disruptions at ports, leading to delays in companies receiving their raw materials. Flooding can lead to blockages of roads, affecting workers commuting in and out of the site. Additionally, there are increased probability of water and vector-borne diseases affecting worker health and safety. Areas vulnerable to wildfires can face disruptions in the transportation of raw materials and finished products due to blockages of roads.

Extreme temperatures, both hot and cold, can affect the efficiency of tyre manufacturing processes and equipment. There can be increased load expected on the cooling requirements and the equipment can be affected if cooling systems are not adequately maintained. Heatwaves may lead to overheating of machinery, while cold weather can impact the viscosity of materials used in tire production.

Changes in climate patterns and extreme weather events can impact tire performance and durability. For example, hotter temperatures may increase tire wear and reduce lifespan, while changes in precipitation patterns can affect driving conditions and demand for specific tire types (e.g., all-season, winter, or off-road tires).

4.8 Potential Climate Change Impacts

This section examines the impacts of climate hazards on the critical components of the project. The critical components of the project are broadly categorized as:

Project Infrastructure *– Building and Roads*

Utilities *– Water Supply, Drainage, and Electricity Infrastructure*

Project Operations *– Personnel, Supply of Raw Materials, Processes and Production, and Transportation of Finished Products*

Impacts on Project Infrastructure

Buildings

During high temperatures in the project area, the energy requirement of the facility may increase to maintain the air-conditioning and ventilation of the building areas.

Extreme variations in temperatures and prolonged exposure may cause expansion and contraction in the building materials, which can result in cracks and damages in the structure. Considering the variations in temperatures at the project location, this is not expected to have significant impact on the project. Expansion and contraction joints are also provisioned in the structure to avoid cracking and damages.

Water stress and droughts are expected to have minimal impact on the structure of buildings during operations phase. However, adequate availability of water during construction phase and proper curing requirements of concrete should be ensured to enable the strength of structure.

Building structures may be vulnerable due to accumulation of water during flooding. The effects may be more pronounced if water remains stagnant for a longer time. Inundation due to riverine and coastal floods is not expected at site, however, flash flooding can have a significant impact on buildings if water is not properly and promptly drained. Rainwater or floodwater can seep into the structure through cracks, if present, affecting the controlled indoor environment and structural integrity of the buildings. Algal growth is also probable in the built areas which are in contact with water / moisture for a longer time.

The facility will utilize water-cooled chillers to cater for the cooling requirements, there may be an increased load on the cooling system if the equipment is not maintained properly.

Roads

Extreme temperatures and heat waves are expected to have minimal impact on roads, but prolonged exposure can result in structural damage, if these are not properly maintained. The bitumen in the road surface can soften at higher temperatures, leading to the deterioration of roads, particularly during periods of heavy traffic. This effect generally

occurs at temperatures higher than 50°C. Minimal impacts are expected on the project site as extreme temperatures (>45 ^{o}C) are not expected in the region. Since the dark surface of the roads absorbs heat, it can heat up during the daytime causing overall increase in the surface heat at the project site.

Accumulation of flood water can affect the roads as water seeps into the asphalt. If an intense level of saturation occurs, it can weaken the bond between the bitumen and the aggregate, resulting in surface weakening. This can lead to effects such as the development of cracks, deformation and potholes.

Impacts on Utilities

Water Supply

During times of extreme heat, increased water demand can be expected due to additional cooling requirements as well as for domestic use. There will be increased pressure on utilities infrastructure as water requirements will be high. Pipes located outdoors can expand during higher temperature, which could lead to cracking in the pipes.

Water scarcity can affect the amount of stored water required at the site for operations. When coupled with periods of extreme heat, the intensity of the effects can worsen due to the expected increase in water consumption.

Increased water demand will result in higher withdrawals and increased stress on the groundwater table. The management of water supply will be crucial since the proposed tyre manufacturing process is expected to be using an estimated 65,000 gallons/day of water during operations. Water-cooled chillers will be catering to the cooling requirement in the facility, which makes the entire operation water-intensive. Interannual variability of water for the project site is projected to increase in the future. This could result in impacts on water storage and exert additional strain on water sources.

Precipitation and flood-related events can affect the quality of groundwater, as debris and waste mixed with floodwater can enter the water bores. Floodwaters may carry harmful bacteria and pollutants, which can contaminate the water used for domestic purposes, leading to health-related issues and illnesses. Impacts to water quality can lead to additional requirements for water treatment before it can be used for domestic purposes. Flood water can cause blockages in outdoor pipes.

Positive impacts may also be observed during extreme precipitation and floods, as the groundwater will be recharged, which is planned as the main source of water for the project.

Drainage

Extreme temperatures and heat waves are expected to have minimal impact on the drainage system as the pipes will mainly be located underground.

Flood waters, which contains debris and sediment, can enter pipes and cause blockages and damage the pipes. These effects can be more significant if there is stagnant water present for a long time.

Electricity Infrastructure

Extreme temperatures are expected to have minimal short-term impacts on transmission lines. However, the line rating, which is the maximum amount of electric current a transmission line can carry without overheating, can decrease during prolonged exposure to high temperatures.

The cooling requirements for the electrical panels and temperature sensitive equipment are expected to increase during high temperatures.

Prolonged exposure to stagnant flood water can affect the structural integrity of the transmission lines and can cause safety hazards and pose electrocution risks as well. Additionally, stagnant water can damage electrical equipment, if exposed, and increase the chances of an electrical fire, which can result in damages to the facility.

Impacts on Project Operations

Personnel:

During periods of extreme heat, workers and staff may experience decrease in productivity and increased fatigue. These effects will be more prominent among outdoor workers. Fatigue can increase the risk of workplace injuries, such as falls from ladders or injuries caused by machinery. Research indicates that working on days with temperatures exceeding 38°C showed a 6% increase in non-heat-related injuries. Especially during heatwaves, there is an expected increase in heat-related illnesses, such as heat cramps, heat exhaustion, and heat stroke. This will necessitate an increase in cooling requirements and management measures. Shortages in water supply can have an impact on workers' health and may lead to illnesses. These factors can lead to decreased productivity causing reduction in plant output.

During flood and precipitation events, there is an increased risk of outbreak of vector-borne diseases. If stagnant water accumulates at the site, accessibility may also be affected. Workers commuting to and from the site may encounter difficulties if there is stagnant water present on the roads.

Supply of Raw Materials

Flood-related events can have a significant impact on the supply of raw materials. Extreme precipitation and floods can affect yields of rubber trees and lead to delays in shipment of natural rubber. Blockages of roads due to the accumulation of water can also cause disruptions. Delays in receiving raw materials can affect the operations and plant output.

Temperature-sensitive raw materials like rubber compounds may be exposed to quality degradation if adequate storage conditions are not maintained.

Processes and Production

High temperatures can affect plant equipment and assets leading to decreased efficiency and capacity. These effects may lead to disruptions in the plant operations. Cooling requirements are expected to increase during periods of high temperatures.

For the proposed project, all sensitive plant equipment is planned to be located indoors under controlled conditions, so minimal impact is expected from extreme temperatures and heat waves.

Periods of water stress and scarcity can impact the operations. The tyre manufacturing process is water-intensive, and any disruptions in the water supply can significantly impact operations. If there are disruptions in the water-based cooling systems, the efficiency of the machines in the production and utility buildings can decrease, affecting the total production output. Water will also be required in the boiler for steam and heat requirements, and water shortages can lead to process disruptions and impacted operations.

Extreme precipitation and flood events can cause corrosion and damage to equipment if it is exposed to water or moisture. Minimal impact is expected on the plant's operation as equipment will be located indoors. However, prolonged exposure to stagnant water due to rain or floods leakages can cause seepage which can affect the building structure and cause corrosion in steel reinforcement.

Transportation of Products

Flood-related events can cause blockages of roads and transportation network, which can disrupt the delivery of products to the customer and port.

4.9 AZE-Adaptive Capacity and Project Vulnerabilities

This section examines AZE's adaptive capacity by assessing their knowledge and understanding of climate risks, and the measures they have undertaken in the proposed design and operations to adapt to climate change and alleviate the associated impacts.

Competence for Climate Change Risk Management

In the context of Pakistan, knowledge of climate risks and its management has not been mainstreamed in the typical competency requirements in an organization. Typically, the Health, Safety and Environment expertise in the organizations does not comprise extensive understanding of climate change and its effects, and have limited awareness of the causes and implications of climate change. The organizations usually prioritize immediate operational needs over long-term sustainability considerations. However, this situation needs improvement considering the climate change vulnerability of Pakistan. Organizations

should be well aware and capable of adapting to the changing climate in order to manage the risks to their businesses. Lack of knowledge leaves the project vulnerable to unforeseen consequences for which it may not be adequately prepared.

The CCRA study could serve as the initial step towards a robust management framework within AZE for climate change impacts. In view of the management requirements, AZE to further develop internal expertise in the domain of climate change and risk management. The climate-related management and coordination will need to be embedded in the responsibilities of resources in various functional areas of AZE, as applicable in the design, construction and operation phases of the project. It is essential for planning, coordinating and implementing the mitigation and adaptation measures in the context of climate change.

HSE Management Plans, Emergency Preparedness and Response Plans are being developed to manage the risks to project personnel and manpower during the construction and operation phases of the project. AZE is increasing the competence of its team to coordinate with all project stakeholders and manage all the activities.

AZE is familiar with the Key Performance Indicators relevant to their potential exposure to climate change risks, and is cognizant that exposure to those risks can have significant influence on their operations, supply chains, and overall business sustainability. AZE has identified some Key Performance Indicators (KPIs) relevant to assessing and managing the climate change risks relevant to their facility, including:

Energy Consumption and Greenhouse Gas Emissions:

KPIs: Total energy consumption, energy intensity (energy per unit of production), and greenhouse gas emissions.

Rationale: Monitoring and reducing energy consumption and emissions can help the plant mitigate its carbon footprint and assess its contribution to climate change.

Water Usage and Water Scarcity:

KPIs: Water consumption, water intensity (water per unit of production), and assessment of water scarcity in key locations.

Rationale: Climate change can influence water availability and quality, and monitoring water usage helps the plant understand and mitigate potential risks.

Waste Generation and Circular Economy Metrics:

KPIs: Amount of waste generated, recycling rates, and efforts towards a circular economy (reusing and recycling materials).

Rationale: Climate change concerns include waste management and resource efficiency. Reducing waste and promoting a circular economy align with sustainable practices.

Operational Resilience:

KPIs: Assessments of the plant's vulnerability to extreme weather events, such as floods, storms, or heatwaves.

Rationale: Identifying vulnerabilities and implementing measures to enhance operational resilience helps minimize disruptions caused by climate-related events.

Compliance with Environmental Regulations:

KPIs: Compliance with local and international environmental regulations related to climate change and emissions.

Rationale: Ensuring adherence to regulations helps the plant avoid legal issues and fosters a positive public image.

Employee Well-being and Safety:

KPIs: Employee safety incidents related to extreme weather events, heat stress, or other climate-related factors.

Rationale: Climate change can impact the health and safety of employees, and monitoring incidents helps in implementing measures to protect the workforce.

By monitoring these KPIs, AZE can gain insights into its climate change exposure, implement strategies to enhance resilience, and contribute to sustainable business practices.

Knowledge of Disaster Management Framework in the Project Area

AZE is new to the project area, and may not be familiar with the Disaster Management Structure for the District and its operational dynamics. It is essential to be well acquainted with the authorities, including the Provincial Disaster Management Authority - Sindh (PDMA) and the District Disaster Management Authority (DDMA). Understanding the organizational structure and its mandates will enable AZE to access necessary information and support in case of any emergencies and disasters. Review of the Disaster Management Plans (DMP) for District Thatta including resources and relevant information outlined within these plans, would also be helpful for AZE to operate in the project area. Understanding these plans allows the company to receive early warnings and alerts about potential hazards and disasters relevant to its operations, enabling proactive preparation and mitigation efforts to reduce potential losses and disruptions. Utilizing the resources provided, the company can identify the location of shelter places, hospitals, and alternate transportation routes. By familiarizing themselves with these authorities and plans, the

companies can use available assistance, such as technical expertise, and logistic support, to facilitate the recovery and restoration efforts.

There is no industrial activity in the near vicinity of the project site. The acceptance of land use change, local support and close coordination with the significant stakeholders of the area may be initially challenging for AZE. Considering the distance from established industrial zones / areas, certain services and amenities may not be typically available and accessible. This can lead to difficulties, such as identifying alternate drinking water sources, waste contractors, etc. in times of disruptions due to climate hazards.

Familiarity with International Standards and Reporting Frameworks

There are no sector-specific guidelines or sustainability standards in Pakistan for Tyre Manufacturing and there aren't any industry bodies or trade associations active in the sustainability space pertaining to this sub-sector. There are no regulatory requirements for management of Climate change impacts as yet. AZE has collaborated with IFC for investment and as part of its parent company and global network, AZE aspires to become a noteworthy player in the international market. It is essential to have the understanding of local and international standards and relevant regulations and requirements related to climate change management and reporting. It would enable AZE to better assess and manage the climate-related risks to its operations and supply chain.

By aligning with recognized standards, AZE can identify potential vulnerabilities, implement effective strategies to enhance resilience to climate impacts. Many markets and investors require companies to disclose their climate-related risks and opportunities in accordance with established reporting frameworks, such as the Task Force on Climate-related Financial Disclosures (TCFD) or the Global Reporting Initiative (GRI). Compliance with these frameworks enhances the company's credibility and access to capital markets, investment opportunities, and funding sources.

Company Policies

AZE has developed the Health, Safety and Environment (HSE) policy. The policy mentions of initiating programs that will support the conservation of energy use, pollution prevention and promote the efficient use of natural resources. There are no specific climate change risk management policies or practices as yet.

Climate change risk management will need to be taken up under a formal framework with relevant strategies and plans in place. The present assessment serves as the foundation for regular review and update of climate risks, and implementation of mitigation and adaptation measures during the design and operation phases of the facility.

Measures for Design and Operations

The buildings and utilities are being designed by specialist design consultants, following the design standards and codes mandated in Pakistan. The RCC structure is expected to be resilient towards higher temperatures and rains with adequate waterproofing and heat proofing provisions in the design, and proper workmanship by the contractors to adequately implement those design measures. AZE will be supervising all the contractor activities at site. The structure design is expected to have provision of expansion and contraction joints in the structure, where required.

Stormwater drainage system is being considered in the project design to manage the effects of flooding. The topography of the area, and the past and present flooding patterns were assessed to design the stormwater drainage system. The drainage system will be essential in reducing the impact of flood waters and preventing stagnant water at project site. The logistics dealing facility is planned to be constructed 4 feet above the access road to prevent the intrusion of flood waters.

Water-based chillers will be used for cooling purposes in the production facility. These cooling systems will be important for maintaining temperatures inside the plant building during times of extreme heat, to ensure that the equipment efficiency and operating conditions are not adversely affected.

For the proposed project, all sensitive plant equipment is planned to be located indoors under controlled conditions, so minimal impact is expected from extreme temperatures and heat waves.

During construction and operation phases, the HSE management and Emergency plans would include measures to be taken to ensure employee health and safety in consideration of climate change impacts. During extreme hot days and heatwaves, the measures may include stopping the work during peak hot hours, increasing the number of water stations across the site, regular health monitoring of workers, and the deployment of the Emergency Response Team to deal with emergencies. During operations, the work involving strenuous physical activity, especially outdoors, to be carried out during cooler hours of the day, water stations will be increased throughout the facility, and the Emergency Response Team will be tasked to deal with any emergencies.

To meet the water requirements during operations, the site plans to abstract groundwater from deeper aquifer so that there is sufficient and sustainable water availability for the operations. R.O plant and effluent treatment plant (ETP / Water recycling) is also proposed in the project design to manage the water quality and usage requirements. Adequate storage capacity is also provisioned in the project. Three underground storage tanks will be present at the site, and two of the three tanks will have capacities of 230,000 and 250,000 gallons

respectively. This will ensure that there is water storage capacity for 15 days to avoid any disruptions to operations and for domestic use.

During times of increased water consumption, there may be increased stress on the water storage and sources of water. If required, water may be purchased from either the local market or through water bowsers.

AZE plans to import natural rubber from Thailand. Thailand is reportedly vulnerable to climate hazards such as floods, tsunamis and droughts. These events could lead to decreased yields in rubber trees and cause disruptions and delays in the supply of natural rubber, affecting the project operations. AZE may adopt a proactive approach and discuss with the potential suppliers regarding their respective climate vulnerabilities, and which measures are taken by the suppliers to manage the risks.

AZE plans to undertake Water Resource Sustainability Assessment in coordination with the consultant, which would include water resource management plan. It will also comprise measures to exploit alternate sources for periods of water scarcity and droughts.

AZE's plans to use coal and biomass in the boilers for steam/heat generation required for the process. The boilers are capable of running completely on biomass as their primary fuel source. This enhances AZE's resilience against the potential decrease in supply of coal or any bans imposed on coal usage in the upcoming years. The manufacturing facility is also surrounded by agricultural fields which can further enable supply chain of biomass for the boilers.

The facility does not use any refrigerants. The manufacturing plant and office building are water cooled and are thus resilient against the emergence of any laws and regulations banning the usage of specific refrigerants.

As the design process is underway, there is still an opportunity of incorporating further design measures to increase resilience and have effective planning in place to mitigate the risks.

During the mixing and curing stages of the manufacturing process, controls are required for maintaining consistent temperatures. Fluctuations in temperature could result in disruptions in the process and delays in production. As all plant equipment will be located indoors, minimal impact is expected during temperature variations. The cooling systems will be crucial in maintaining temperatures inside the plant building to ensure that the equipment efficiency and condition is not affected. Cooling requirement are expected to increase during periods of high temperatures, and the cooling systems will have to be maintained and inspected regularly to avoid any disruption to the operations.

4.10 Risk Assessment

Selected Climate Hazards	Expected Exposure	Expected Sensitivity	Potential Impacts and Climate Change Vulnerability	Climate Risk
Extreme Temperatures	Project assets and operations, and personnel may be exposed to extreme temperatures.	Moderate	The manufacturing facility will have controlled conditions (temperature and humidity) in various areas, hence the operations are not expected to be very vulnerable. The provision and energy costs for adequate cooling and ventilation needs to be catered in the design and feasibility. Supply chain and logistics, commuting, and employees / labor working in open areas may be vulnerable. There is possibility of heat-related illnesses in the personnel, which needs to be included in the Health and Safety plan of the facility during construction and operation phases.	Moderate
Increase in Extreme Hot Days and Days with Heat Index > 40 C	Project assets and operations, and personnel may be exposed to extreme hot days.	Moderate		Moderate
Heat Wave	Project assets and operations, and personnel may be exposed to Heat Wave.	Moderate		High
Water Stress and Scarcity	Project may be exposed to water stress as there is expected increase in the industrial activity in the area, leading to increased water withdrawals from surface water and ground water sources.	Moderate	Project is vulnerable to water stress in the area as water is a main resource for tyre manufacturing process, and will be required for general works (construction and operation) and sanitary and potable water use. Water sustainability and management will become crucial as the	High

Selected Climate Hazards	Expected Exposure	Expected Sensitivity	Potential Impacts and Climate Change Vulnerability	Climate Risk
			industrial activity is expected to increase in the region in the coming years.	
Interannual Water Variability	Project may be exposed to variable water supply in different years which could have an impact on project operations.	Low	The project would require consistent water supply hence it could be vulnerable to variable supplies. Effective planning and water management will reduce the vulnerability.	Moderate
Drought	Project may be exposed to drought, as overall classification of Drought hazard is high in Sindh, however chances are not that high in the project area and immediate surroundings. There haven't been any major droughts recorded in the project area in the past.	Moderate	Project is vulnerable to drought in the changing climate, resilience measures at a project-level as well as area-level will help reduce the vulnerabilities. Project may arrange alternate sources and hence would be capable to managing the vulnerability.	Moderate

Selected Climate Hazards	Expected Exposure	Expected Sensitivity	Potential Impacts and Climate Change Vulnerability	Climate Risk
Extreme Precipitation and Flash Flooding	Project assets and operations, supply chain and logistics, and personnel may be exposed to extreme precipitation events.	Moderate	The manufacturing facility will have the built structure of reinforced cement concrete which is typically capable of withstanding extreme precipitation. Adequate design measures for flood protection and resilience towards extreme precipitation, and effective emergency response planning will reduce the vulnerability. However, damage to surrounding infrastructure and supply chain disruption is possible due to flash floods. Reduced access to the Site during construction and operation phases.	Moderate
Riverine Flood and Inundation	Project assets and operations, supply chain and logistics, and personnel may get affected due to inundation occurring in nearby areas of the project.	High	The proximity to canal and water distribution channels in the area makes the Project vulnerable to localized flooding. Adequate design measures for flood protection and storm water drainage infrastructure will reduce the vulnerability.	High

Selected Climate Hazards	Expected Exposure	Expected Sensitivity	Potential Impacts and Climate Change Vulnerability	Climate Risk
Sea Level Rise	Project is not directly exposed to sea level rise as it is approximately 9 Kms away from the coastline.	Low	Project supply chain and logistics may be vulnerable to inundation due to sea level rise and resulting coastal floods due to storm surge. Effective management and early warning systems would help manage the vulnerabilities.	Low
Coastal Flood and Inundation	Project supply chain and logistics, and personnel commuting may get affected due to inundation occurring in nearby areas of the project.	Low		Moderate

Level of Sensitivity	Definition
LOW Sensitivity	Minimal infrastructure damage and disruption in operations for lesser duration; no permanent damage. Some minor restoration works and/or management measures may be required.
MODERATE Sensitivity	Considerable infrastructure damage and disruption in operations for significant duration, requiring moderate repairs.
HIGH Sensitivity	Extensive damage and disruption in operations for a longer duration, requiring extensive repairs.

5 Transition Risk Assessment

5.1 Overview

For this study, the term "Transition Risks" refers to the business-related risks that a company may face as a result of the economy transitioning to a low-carbon future or adapting to climate change-related policies, technologies, and market shifts. Transition risks can manifest in various forms as identified by the TCFD framework:

1. Policy and Legal Risks: Changes in government policies, regulations, and legislation aimed at mitigating climate change can have significant implications for businesses. This includes carbon pricing mechanisms, emission reduction targets, renewable energy incentives, and environmental standards. Companies may face compliance costs, fines, or market disruptions if they fail to adapt to new regulatory requirements or if they invest in assets that become obsolete due to regulatory changes.

2. Technology Risks: Rapid technological advancements, such as breakthroughs in renewable energy, energy storage, and carbon capture and storage (CCS) technologies, can disrupt traditional industries and business models. Companies that fail to invest in or adopt new technologies may face competitive disadvantages, operational inefficiencies, and declining market relevance. Conversely, companies that embrace innovation and incorporate sustainable technologies into their operations may gain a competitive advantage and enhance their resilience to transition risks.

3. Market Risks: Transition risks also encompass shifts in market dynamics driven by changing consumer preferences, technological advancements, and competitive pressures. Companies that fail to anticipate and adapt to these market trends risk losing market share, revenue, and profitability.

4. Reputation Risk: Increasing stakeholder awareness and scrutiny of ESG issues have heightened the importance of reputation management for businesses. Companies failing to uphold sustainable business practices may face reputational damage, loss of consumer trust, and investor skepticism. Conversely, companies that demonstrate strong environmental stewardship and proactive risk management may enhance their brand value and stakeholder relationships.

5.2 Methodology

The methodology aims to comprehensively assess the risks associated with transitioning to a low-carbon economy for a company. It involves reviewing commitments, policies, and future trends in the low-carbon economy, such as Pakistan's NDCs, future plans and the global energy outlook. Through this, it identifies potential transition risks across policy, technology, market, and reputation domains, and their potential impacts on AZE.

It also provides an outlook on developing the adaptive capacity to Transition Risks and proposes risk mitigation options, emphasizing proactive strategies like technology upgrades, R&D investments, and strategic partnerships. It offers insights about potential transition risks and their impact on AZE. The approach has been broken down into three key steps as follows:

5.2.1 Review of Commitments, Policies and Future-trends of Low-Carbon Economy

Pakistan NDCs 2021 and future plans

Pakistan's national development plans and sectoral priorities are aligned with its national vision for climate change. The updated NDC 2021 is anchored on the National Climate Change Policy (NCCP) for its implementation, and details key, high-priority mitigation actions in the transition to a low-carbon economy:

- *Renewable Energy: By 2030, 60 % of all energy produced in the country will be generated from renewable energy resources including hydropower.*
- *Transportation: By 2030, 30 % of all new vehicles sold in Pakistan in various categories will be Electric Vehicles (EVs).*
- *Coal: From 2020, new coal power plants are subject to a moratorium, and no generation of power through imported coal shall be allowed, increased focus on coal gasification and liquefaction for indigenous coal.*
- *Land-Use Change & Forestry: continued investments in Nature based Solutions.*

As per the updated NDCs, Pakistan intends to set a cumulative ambitious aim of conditional and unconditional reductions in its emissions. Pakistan aims to reduce 50% of its projected BAU emissions by 2030 from a 2015 baseline. Of the 50% target, 15% will be contributed by unconditional reduction measures, while 35% is dependent upon external financial support.

IEA World Energy Outlook 2023 for Asia Pacific

Stated Policies Scenario

A scenario which reflects current policy settings based on a sector-by-sector and country-by-country assessment of the energy-related policies that are in place as of the end of August 2023, as well as those that are under development. The scenario also takes into account currently planned manufacturing capacities for clean energy technologies.

Announced Pledges Scenario

A scenario which assumes that all climate commitments made by governments and industries around the world as of the end of August 2023, including Nationally Determined Contributions (NDCs) and longer-term net zero targets, as well as targets for access to electricity and clean cooking, will be met in full and on time.

5.2.2 Identification of Possible Transition Risks and Potential Impacts on Business

Transition Risks	Impact Description	Source
Policy and Legal Risks		
1. Pakistan Decarbonization Plans	Pakistan's decarbonization plans include the implementation of climate change mitigation policies in the areas of: Energy Generation, Energy Efficiency and Energy Conservation, Transport, Urban Planning & Waste Management, Industries, Agriculture and Livestock, Carbon Sequestration and Forestry. These policy measures aim to reduce emissions by 50% by 2030, of which 15% of reductions are unconditional, and do not depend on external financial support. Moreover, according to IEA WEO 2023, total emissions (Mt CO_2e) in the Asia Pacific are expected to decrease by 23% from 2022 to 2050 according to the Stated Policies Scenario, and by 69% from 2030 to 2050 according to the Announced Pledges Scenario. Adherence to these policy measures and reductions in emissions could require costly upgrades to energy production and manufacturing processes, or impose fines for non-compliance.	Pakistan NDC 2021 IEA WEO 2023
2. International Maritime Organization (IMO) Regulation	With the shipping sector's focus shifting towards reducing carbon emissions, particularly with the IMO establishing targets for 2050, it is anticipated that marine fuel expenses will rise during the transition to more eco-friendly fuels. Consequently, shipping costs are expected to increase, affecting both the procurement and sale of products via international sea routes.	IEA WEO 2023
3. Mandatory Energy Audits	The National Energy Efficiency and Conservation Authority (NEECA) intends to continue their existing initiative of mandating energy audits for industries. Under this mandate, businesses will be required to undergo mandatory energy audits aimed at analyzing their energy consumption patterns and identifying inefficiencies. These audits will serve as supporting initiatives for the objective of improving energy efficiency, and reducing energy-related emissions. Non-compliance with NEECA's requirement may incur penalties, increased operational costs, and	Pakistan NDC 2021 NEECA

Transition Risks	Impact Description	Source
	damage to a company's reputation, impacting its finances and market competitiveness.	
4. Implementation of Carbon Pricing Mechanism	Carbon pricing refers to initiatives that put an explicit price on GHG emissions, i.e. a price expressed as a $ value per ton of carbon dioxide equivalent emitted ($/$tCO_2e$). The introduction and practice of "Polluter Pays Principle" will be implemented, and the MoCC will explore and adopt cap-and-trade schemes, and carbon levies to manage industrial emission efficiency. The NDRMF has indicated that power and agriculture sectors/industries would be key target areas for the carbon emissions trading system, while export-oriented industries are already taking voluntary initiatives. This could potentially result in increased price of raw materials sourced from agricultural sector and reduced profitability for AZE. It would also increase competition between tyre exporters, as there is an increase in demand for low-carbon products in the international market.	Arab News.pk Pakistan NDC 2021
5. IFC Investment	As per IFC's ambition for Paris alignment, an investment by the IFC is considered *Paris-Aligned* if it actively contributes to pathways for decarbonization, or if it supports initiatives that do not exacerbate climate issues. Furthermore, IFC Performance Standards (PS) establish standards that the client must meet throughout the life of an investment by IFC. PS-3 promotes the ability of private sector companies to adopt resource efficiency, pollution prevention/control in line with internationally disseminated technologies and practices. Non-compliance with IFC's requirements to reduce project's operational emissions could lead to reduced investor confidence and pose a risk to investment. Moreover, lack of transparent communication regarding reduction targets and achieved reductions could also pose reputational risks for AZE.	World Bank: Joint MDB Methodol-ogical Principles of Assessment of Paris Agreement Alignment of New operations IFC-PS
Technology Risks		

Transition Risks	Impact Description	Source
6. Demands for New Technology	Tyres do not directly emit GHGs during their usage. However, the quality and performance of a Tyre has an impact on the efficiency of energy/fuel usage by a vehicle due to various factors such as a tyre rolling resistance, braking performance, wet grip performance. Many countries have set minimum standards for quality and introduced Tyre labelling systems to identify high-quality and high-performance tyres. The increase in demand for such tyres may result in increased capital expenditures if AZE adapts to the market demand by producing improved products. Furthermore, failure to respond to minimum quality criteria can result in decreased revenues.	
7. Emergence of Sustainable Materials	Emergence of alternative materials with lower environmental footprints may disrupt traditional manufacturing processes and necessitate R&D investments focusing on the usage of the newer products in AZE's manufacturing processes. This can result in modification in the processes and products and may cause additional expenditures for AZE.	
8. Adoption of Electric Vehicles (EVs)	By 2030, it is aimed that 30% of all new vehicles sold in Pakistan will be EVs. This % share of EVs in sale of passenger cars and heavy-duty trucks is stipulated to increase up to 90%. The increased supply of electric vehicles in the Pakistani market may reduce the need for traditional tyres, prompting the company to diversify its product portfolio or invest in new technologies.	Pakistan NDCs 2021 National Electric Vehicles Policy 2020-25 (NEVP 2019)
Market Risks		
9. Decline in the Production of Coal and Oil in the Asia Pacific	Coal production in the Asia Pacific is expected to decrease by 40% from 2022 to 2050 according to the Stated Policies Scenario, and by 66% from 2030 to 2050 according to the Announced Pledges Scenario. This reduction in the production of fuels could impact the availability of coal for the boiler. National/provincial level initiatives in support of these policies could cause disruptions in the supply chain and operations of AZE. Furthermore, AZE may be required to reduce its coal usage and adopt renewable/low-carbon alternative fuels to align	IEA WEO 2023

Transition Risks	Impact Description	Source
	itself with the announced pledges and stated policies.	
10. EU's Carbon Border Adjustment Mechanism (CBAM)	The EU's Carbon Border Adjustment Mechanism (CBAM) is the EU's tool to put a fair price on the carbon emitted during the production of carbon intensive goods that are to enter in the EU, and to encourage cleaner industrial production in non-EU countries. CBAM will apply in its definitive regime from 2026, while the current transitional phase lasts between 2023 and 2026. This gradual introduction of the CBAM is aligned with the phase-out of the allocation of free allowances under the EU Emissions Trading System (ETS) to support the decarbonization of EU industry. If AZE plans to penetrate the EU market, CBAM could transform into an export/trade barrier if AZE fails to lower its emissions. Furthermore, AZE would need to allocate additional CAPEX for energy transition and decarbonization initiatives.	EU Taxation Customs
11. Decline in Demand for Traditional Tyres	Shift in consumer preferences towards eco-friendly tyres or alternative transportation solutions may reduce demand for traditional Tyre products. The automotive industry is experiencing increased demand for low carbon materials and products, while consumers are increasingly encouraged to utilize alternative transport solutions such as public transport. Adapting to these shifts in consumption patterns will be necessary to avoid decreased revenues due to decreased demands.	
12. Increased Competition from Sustainable Tyre Manufacturers	Entry of competitors offering sustainable Tyre options may intensify competition and impact the company's market share. Following the latest regulations, and the emergence of new business and start-ups offering increasingly innovative solutions and products, can increase competition in the market for low-cost sustainable products.	

Transition Risks	Impact Description	Source
13. Disruption in Supply Chain	Dependency on suppliers utilizing carbon-intensive processes or materials may lead to supply chain disruptions due to regulatory changes or shifts in market demand for sustainable sourcing. These regulatory changes will occur at a national and global level, and will introduce uncertainties and disruptions in AZE's supply chain which could slow down procurement, production and distribution processes resulting in reduced revenues.	
14. Costs of Greening the Tyre Production	The adoption of sustainable, low-carbon practices involves the integration of several initiatives (e.g. enhancement of efficiencies, increase in circularity, additions and replacement of technologies and materials etc.) Introduction of these initiatives, replacing high carbon (fossil-based) raw materials with low carbon (renewable) raw materials, and redesigning production processes to enable higher circularity could incur higher operational costs and require significant CAPEX allocation. This would result in higher retail prices in an already competitive landscape and result in lower profitability for the company.	
Reputation Risks		
15. Stakeholder Expectations of Transparent Communication and adherence to Committed Targets	There are expectations of increasing demands for transparent communication of environmental impacts by regulatory authorities, investors, and customers. Failure to communicate transparently regarding products and operational performance may impact investor confidence and result in reduced investments. Furthermore, lack of transparent communication can result in claims of greenwashing from the public, damaging the company's reputation and brand image.	
16. Human Resource Retention	Following the increased awareness of climate change and its impacts, there is increased scrutiny by employees and technical specialists on their employer's performance. Attraction and retention of human resources and technical specialists can become a challenge, and potentially impact costs, and revenues if the project is perceived to negatively contribute to climate mitigation.	

5.2.3: Assessment of Adaptative Capacity and Risk Mitigation Options

Current Adaptive Capacity in context of Transition Risks

AZE's primary energy source is electricity supply from KE, and the usage of coal and biomass in boilers. Following the decarbonization plans of the electricity supplier, Scope 2 emissions from the usage of electricity are expected to decrease. Furthermore, the boilers are capable of running completely on biomass as their primary fuel source which enhances AZE's resilience against the potential decrease in supply of coal in the upcoming years. The manufacturing facility is also surrounded by agricultural fields which can further enable efficient biomass procurement for the boilers.

The facility also does not use any refrigerants. The manufacturing plant and office building are water cooled and are thus resilient against the emergence of any laws and regulations banning the usage of specific refrigerants.

Further Transition Risk-Mitigation Options

To effectively mitigate the potential transition risks and improve resilience, AZE must adopt a multifaceted approach that encompasses proactive strategies across various fronts. AZE can invest in technology upgrades and process optimization to enhance energy efficiency and reduce emissions. By aligning operations with these policies early on, AZE can minimize the financial impact of compliance and position itself as leaders in sustainability.

AZE can also investigate R&D efforts aimed at innovating sustainable materials and adapting to emerging trends such as electric vehicles. By staying ahead of the curve and investing in cutting-edge technologies, AZE can meet evolving consumer demands and gain a competitive edge in the market. Furthermore, AZE can consider diversifying their product portfolio to include eco-friendly options and explore opportunities in renewable energy sources. Additionally, fostering strategic partnerships and collaborations with suppliers who prioritize sustainability can help mitigate supply chain disruptions and ensure the continuity of operations.

By openly communicating on environmental performance and progress towards sustainability goals, AZE can build trust with investors, customers, and regulatory authorities, thereby enhancing resilience to reputational risks.

Overall, AZE's adaptive capacity to these transition risks lies in their ability to embrace change, innovate, and proactively address challenges head-on. By integrating sustainability into core business strategies and operations, AZE can navigate the transition towards a decarbonized economy and thrive in an increasingly competitive and dynamic market landscape.

5.3 Summary of Transition Risks

The Transition Risks table lists potential challenges that may be faced by AZE, spanning policy and legal, technology, market, and reputation domains. This list is non-exhaustive. From Pakistan's decarbonization plans to regulations in importing countries, AZE faces pressures to comply with emission reduction ambitions, necessitating costly upgrades and potential fines for non-compliance. Additionally, technological shifts towards sustainable materials and electric vehicles pose R&D investment requirements, while market dynamics such as declining coal and oil production and EU's Carbon Border Adjustment Mechanism demand transitions to renewable fuels and heightened capital allocation for energy transition.

Amidst these transitions, transparent communication and adherence to commitments are crucial to maintain investor confidence and brand reputation, safeguarding against potential sales and profit declines and any risks to company reputation.

5.4 Transition Management

Transition management framework is provided in Section-7 which assists to identify, assess, and mitigate risks associated with the transition to a low-carbon economy. It outlines the potential transition risks, risk management framework and proposed departmental responsibilities for managing the risks. It includes the measures to safeguard AZE from adverse transition-related impacts and ensure compliance with relevant regulations and standards.

It aims to ensure a smooth and orderly transition while minimizing potential negative impacts on the project and its stakeholders. For effective risk mitigation, implementation of the plan should be continuously monitored, and the plan should be updated in line with emerging requirements and associated risks.

6 GHG Estimation & Alternatives Assessment

6.1 Introduction to Greenhouse Gases (GHGs) and The Paris Agreement

In the pursuit of sustainable development, understanding and mitigating the environmental impact of projects are critical considerations involved in combating climate change. One pivotal aspect of this process is the assessment of Greenhouse Gas (GHG) emissions. GHGs are atmospheric compounds that trap heat, leading to the greenhouse effect and inducing global warming. The major GHGs include carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and fluorinated gases. Human activities concerning energy usage, particularly the burning of fossil fuels, industrial processes, and deforestation have significantly increased GHG concentrations in the atmosphere. Once the GHG emissions have been quantified, the overall Carbon Footprint expressing the total GHG emissions as carbon dioxide equivalent (CO_2e) is determined using each GHG's Global Warming Potential (GWP) values.

The Paris Agreement, adopted in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC), is a landmark international accord designed to address the global climate crisis. Signed by nearly every country, it aims to limit global temperature rise well below 2 degrees Celsius above pre-industrial levels, with an ambition to limit it to 1.5 degrees Celsius. This global accord holds particular significance for Pakistan, given Pakistan's vulnerability to climate change-induced events like floods, droughts, and extreme weather conditions. In 2015, Pakistan, along with many other nations, pledged their commitment to the Paris Agreement, and committed to submit nationally determined contributions (NDCs) outlining Pakistan's efforts to reduce GHG emissions, adapt to the impacts of climate change, and enhance climate resilience. According to the latest NDCs 2021, Pakistan aims to reduce emissions by 50% by 2030 from a 2015 baseline.

6.2 Purpose of the GHG Estimation

Armstrong ZE (AZE) is seeking financing from IFC for the development of a tyre manufacturing facility at Gharo. As per IFC's ambition for Paris alignment, the impact of financed projects is considered when evaluating the project. This is because Multilateral Development Banks (MDBs) such as the IFC made a commitment in 2017 and 2018 to align their financial activities with the objectives outlined in the Paris Agreement. The IFC's pledge to Paris Alignment adheres to the Joint MDB Methodological Principles for evaluating alignment.

An investment by the IFC is considered aligned if it actively contributes to pathways for decarbonization, or if it supports initiatives that do not exacerbate climate issues. Additionally, in terms of climate adaptation and resilience, alignment involves effectively

managing climate-related physical and transition risks through mitigation and adaptation measures.

To be deemed "Paris-aligned," an operation must meet criteria for both mitigation and adaptation/resilience, which are assessed through two Building Block (BB) questionnaires.

BB 1 Questionnaire: Mitigation

The BB1 questionnaire characterizes operations as either "aligned" or "not aligned" with the mitigation objectives of the Paris Agreement. It evaluates whether the operation is consistent with a low-greenhouse gas development trajectory for the country and does not hinder the transition to a decarbonized economy, both locally and globally. Operations considered aligned include those that directly reduce GHG emissions, those in line with country-specific decarbonization pathways, and those with minimal impact on climate change.

BB 2 Questionnaire: Adaptation and Resilience

BB2 assesses operations' alignment with the adaptation goals of the Paris Agreement. Operations are categorized as “aligned” or “not-aligned” based on their management of significant physical climate risks, alignment with national adaptation strategies, and contributions to climate-resilient development pathways, wherever possible.

Relevance to the Project

The assessment of GHG emissions informs the requirements of BB1, and also enables IFC to determine their scope 3 emissions arising from their investments. For the assessment of GHG emissions of this project, IFC had shared the data requirements with AZE. The data provided by AZE to IFC was also shared with Tekcellent, and Tekcellent conducted additional consultations with AZE for the verification and reconciliation of the shared data. The consultations provided key information regarding processes, and additional relevant data was shared with Tekcellent, which has formed the basis of the GHG estimation.

6.3 Scope of the GHG Estimation

Tekcellent has utilized internationally recognized standards such as the *GHG Protocol Corporate Standard*. This standard has been developed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), and provides a comprehensive methodology for companies to measure and report their GHG emissions. The standard defines the operational boundaries for the assessment of GHG emissions. These boundaries are defined by three different ‘Scopes’:

Scope 1: direct emissions from sources owned and/or controlled by a company

Scope 2: indirect emissions from the consumption of purchased energy including electricity, steam, heating etc.

Scope 3: indirect emissions in a company's value chain, categorized as upstream and downstream emissions of the reporting company.

With regards to GHG emissions, the IFC *Performance Standard 3 (PS3) – Resource Efficiency and Pollution Prevention* states that "*For projects that are expected to or currently produce more than 25,000 tons of CO_2-equivalent annually, the client will quantify direct emissions from the facilities owned or controlled within the physical project boundary, as well as indirect emissions associated with the off-site production of energy used by the project. Quantification of GHG emissions will be conducted by the client annually in accordance with internationally recognized methodologies and good practice.*"

Within the boundaries of the ESIA-CCRA, and the aforementioned requirement of IFC PS3, this GHG assessment focuses on the **estimated future activities of the project that will result in Scope 1 and Scope 2 emissions** during its **operational phase**. This assessment does not account for emissions arising from the construction phase of the project, or indirect emissions under Scope 3 (such as the production/transportation etc. of raw material and/or finished products to/from the project site), as these emissions are not under the direct operational control of the project.

6.4 Methodology

Under the scope of this assessment, the total GHG emissions and carbon footprint is calculated using the activity data method. This method involves the use of specific data points from activities that result in GHG emissions. The activity data required for calculations was provided by AZE and the following equations were used:

$$\boldsymbol{GHG\ emissions} = \boldsymbol{Activity\ Data} * \boldsymbol{Associated\ Emission\ Factor}\ (\boldsymbol{EF})$$

$$\boldsymbol{Carbon\ Fooprint} = \sum(\boldsymbol{Amount\ of\ GHG\ emitted} * \boldsymbol{GWP})$$

Where:

- *Activity data*: is the specific emissions-causing data arising from the facility's activities
  (E.g.: liters of specified fuel combustion in stationary gensets or vehicles, electricity consumption from non-renewable sources etc.).

- *Emissions Factors:* are factors that convert the activity data into estimated GHG emissions
  (E.g.: tons of CH4 per liter of diesel combustion by light-duty trucks).

- *GWPs:* are GHG-specific factors used to convert emissions from several different GHGs, considering their varying impacts on the climate, into one standardized unit of CO2e.
  (E.g.: 1 ton of CO2 = 1 ton of CO2e, 1 ton of CH4 = 28 tons of CO2e, 1 ton of HFC-22 = 1760 tons of CO2e).

The proposed project is in the planning and design phase, hence the GHG estimation relied on projected activity data provided by AZE, based on the plant design and overall operational strategy. The following information was coordinated, and finalized based on detailed discussions with AZE:

- Primary energy source for the manufacturing facility is electricity, which is proposed to be purchased from K-Electric. A diesel genset will serve as the backup energy source in case of unavailability of KE.

- As communicated by AZE, the average electrical load of the plant is 4 MW including 200 kW used by the office building. The hourly electrical load profile provided by AZE indicates that the yearly energy consumption would be **26,136,000 kWh per year**.

- The composition of fuel sources to be used in the boilers is **70% Lignite Coal and 30% Biomass** (primarily rice husk).

- There is no use of refrigerant gases in the manufacturing facility or in the office building. The air-conditioned areas of the facility will utilize water-cooled chillers.

- Fire suppression throughout the facility will be primarily based on sprinkler systems, and where required portable extinguishers may be available (negligible GHG impact).

The calculations are based on data for one (1) operational year, and follow the methodologies and emission factors specified in the *GHG Protocol Corporate Standard by WRI/WBCSD*, and the *Intergovernmental Panel on Climate Change (IPCC) 2006* GHG Inventory guidelines. Emission factor for purchased electricity are sourced from *KE's Sustainability Report 2023*[3]. The GWPs are taken from latest *IPCC Fifth Assessment Report (AR5)* over a 100-year time horizon. Where required, energy conversion factors were sourced from *US EIA*.

It has been indicated that the aforementioned information is a representative estimate of AZE's operations wherein the plant utilization would be at maximum of 85% (in the 3rd year and onwards), and the GHG emissions are representative of the same. The GHG emissions for the first operational year are expected to be less as the facility will be running on 65% plant utilization in the first year, and at 75% in the second year.

[3] K-Electric Sustainability Report 2023

Statement of Limitations

It should be noted that the data used for GHG emission estimation is projected, as the facility is currently not operational. Additionally, in conducting the emissions estimation for AZE, the following assumptions were made to facilitate the estimation process:

- It was assumed that the office building operates for only 8 hours per day at its 200-kW load.
- The biomass fuel source (rice husk) was categorized under the "*Agricultural by-products*" fuel type, and their associated emission factor from the IPCC was utilized.
- Emissions from the use of a diesel genset as backup in case of emergencies, have been included in the GHG estimation. In case of no power outages from KE, there will be no emissions from diesel combustion.
- The heating value of rice husk was determined from research[4], with the consideration that 1 kilogram of rice husk has a heating value of 14,611 BTU.
- It was assumed that all company cars used by AZE are petrol-based passenger vehicles.

These assumptions provide a basis for estimating emissions; however, certain limitations should be acknowledged. For instance, variations in actual operational hours of the office building or deviations from projected load profiles of the manufacturing areas may affect the accuracy of the emissions estimate. Additionally, uncertainties may arise from the assumed composition and quality of the biomass fuel source. Despite efforts to mitigate these limitations, interpretation of the emissions results should be conducted with caution, considering the underlying assumptions and associated uncertainties.

[4] IOWA State University Biomass Measurements and Conversions

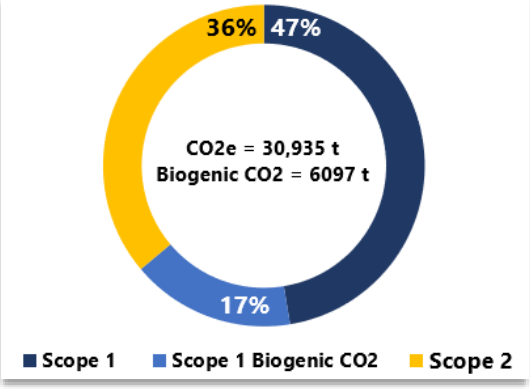
6.5 GHG Emission Estimates

The table below shows the scope and source of GHG emissions from AZE's operations and the resultant CO_2e of each source.

Scope	Source	Activity Data		GHG Emitted	Amount of GHG emitted (tons/yr)	CO_2 eq (tons/yr)
Scope - 1	Stationary Combustion – Diesel Genset **(backup)**	50,000	Liters/ Year	CO_2	134.20	134.20
				CH_4	0.005	0.15
				N_2O	0.0010	0.28
	Stationary Combustion – Coal in Boiler	8,250	Tons/ Year	CO_2	16,724.5	16,724.53
				CH_4	1.882622	52.71
				N_2O	0.273836	72.56
	Stationary Combustion – Rice Husk in Boiler	3,531	Tons/ Year	CO_2	0	0
				CH_4	1.6509	41.93
				N_2O	0.2167	52.09
				Biogenic CO_2	6096.56	0.0000
	Mobile Combustion – Company Cars (petrol)	200,000	Liters/ Year	CO_2	463.8861	463.88
				CH_4	0.020566	0.57
				N_2O	0.004280	1.1
Scope - 2	Purchased Electricity (location based) – K-Electric	26,136,000	kWh/ Year	CO_2 eq	→	13,382

Using the above information, AZE's emissions can be categorized as seen below.

Summary of Carbon Footprint	
Scope - 1	**17,554 tons CO_2e**
Stationary Combustion	17,088 tons CO_2e
Mobile Combustion	466 tons CO_2e
Fugitives Emissions	0
Scope - 2	**13,382 tons CO_2e**
Total Scope 1 + 2	**30,935 tons CO_2e**
Biogenic CO_2 emissions - Scope 1	**6,097 tons biogenic CO_2**



Analysis of GHG Emissions

The majority of AZE's emissions are expected to arise from the usage of purchased electricity (location-based) for the operation of electrical machines in the facility, and from the usage of coal in the boiler. Biogenic CO_2 emissions are also expected from the use of biomass (rice husk) in the boiler.

The overall projected emissions per year currently exceed IFC's reporting thresholds of 25,000 tons CO_2e per annum. However, AZE is currently considering alternatives to mitigate its GHG emissions in the future.

6.6 Alternatives for GHG Mitigation

Scope 1 and Scope 2 reduction alternatives

According to the IFC PS3, "*…, the client will consider alternatives and implement technically and financially feasible and cost-effective options to reduce project-related GHG emissions during the design and operation of the project. These options may include, but are not limited to, alternative project locations, adoption of renewable or low carbon energy sources, sustainable agricultural, forestry and livestock management practices, the reduction of fugitive emissions and the reduction of gas flaring*". AZE is committed to exploring various measures to effectively mitigate GHG emissions in the design and operation of the project.

AZE may conduct regular energy audits to identify areas of energy wastage, and measures will be considered to optimize energy consumption. Additionally, advanced control systems, lean manufacturing principles, and energy efficient technologies may be integrated to minimize energy usage.

Renewable energy integration is also being explored as a means to offset energy demand from traditional fossil fuel sources. Installation of on-site renewable energy generation systems such as solar panels or wind turbines, and power-purchase agreements with renewable energy providers is under consideration.

Moreover, the feasibility of utilizing higher composition of biomass should be evaluated as an alternative source of energy. This initiative will reduce emissions from the use of coal.

The biogenic emissions released from the use of biomass will increase, but those are considered to be carbon-neutral.

Scope 3 Reduction Alternatives

Scope 3 (emissions occurring outside the ownership and control of a company) account for 80-90% of total (scope 1+2+3) emissions in the manufacturing industry. Whilst not currently required by IFC or other stakeholders, AZE may consider initiatives for reducing scope 3 emissions in its value chain.

AZE may investigate the use of alternative materials with lower embedded carbon content for the production of tyres, such as bio-based or recycled rubber. Collaboration with suppliers to source raw materials from sustainable and low-carbon sources can be explored to reduce the carbon footprint of the supply chain. AZE may consider indigenous, plant-based, renewable alternatives for rubber. This may further optimize transportation logistics and reduce emissions associated with the transportation of raw materials.

Additionally, establishing comprehensive recycling programs to reclaim and reuse materials from scrap tyres can be explored, reducing the need for virgin raw material.

The implementation of these GHG mitigation alternatives in the future can contribute to reducing the GHG impact of tyre manufacturing operations. By prioritizing sustainability and considering innovative technologies and practices, AZE can play a pivotal role in mitigating climate change and driving the adoption of sustainable practices in their supply chain, thereby fostering an environmentally responsible industry.

The above measures have been further detailed under the Climate Change Mitigation and Transition Management in Section-7. AZE would be encouraged to develop detailed action plans in accordance with the management framework provided in this report.

7 Climate Change Management

In pursuit of achieving resilience to climate change, the Management Framework has been developed to address the Climate Change Risks to the project. In the context of physical climate risks, relevant adaptation measures for the critical components of the project have been identified. Its aim is to create a mechanism to enable and verify the efforts undertaken to address physical climate risks, thereby enhancing AZE's capacity to withstand and adapt to the changing climate.

In consideration of the transition to a low-carbon economy, mitigation measures have been proposed for the expected transition risks to AZE. It entails the climate change mitigation options (decarbonization), as well as the risk mitigation for transition risks. It seeks to ensure the sustainability, resilience, and success of the project amidst changing economic, environmental, and regulatory landscapes. It intends for a smooth and orderly transition while minimizing potential negative impacts on the project and its stakeholders.

AZE will be required to internally coordinate within its departments and with the external stakeholders to implement the adaptation and mitigation measures, and specify suitable timelines and frequency for each measure.

7.1 Climate Change Adaptation

The potential climate change impacts were identified for the critical components of the project, and the vulnerabilities were also discussed in the previous sections. Based on the impacts, vulnerabilities and resulting risks on the project, suitable adaptation measures have been identified as follows.

Risks	Adaptation Measures and Opportunities for Resilience
Inadequate Adaptive Capacity	• Develop expertise in climate change risk management and understanding of local and international standards and relevant regulations and requirements related to climate change management and reporting. • Assess the overall climate change risk management requirements and assign the team with relevant tasks, including description of management's role in assessing and managing climate-related risks and opportunities. The governance of climate change management within the organization and manufacturing facility needs to be clearly established, as for the overall Environmental and Social Management. • Review the Climate-related impacts, risks and opportunities identified in this assessment, and align the mitigation measures as applicable to respective departments, for various stages of the project. • Review the climate change management framework (Adaptation Management, Transition Management, Mitigation Management) and develop monitoring and action plans accordingly. • Maintain proper log of climate-related events and occurrences in the project area along with the description of consequences. • Develop understanding of international reporting frameworks such as the TCFD and GRI. • Establish the schedule for bi-annual/annual review of climate-related events occurred in the area and the climate change management plans for revision and upgrades. • Be well acquainted with relevant authorities, including the Provincial Disaster Management Authority - Sindh (PDMA) and the District Disaster Management Authority (DDMA). Review the Disaster Management Plans (DMP) for District Thatta including resources and relevant information outlined within these plans. Understanding of these plans would enable AZE to receive early warnings and alerts about potential hazards and disasters relevant to its operations, enabling proactive preparation and mitigation efforts to reduce potential losses and disruptions. • In order to assume the role of an active community member in the project area, AZE could explore the opportunities of collaboration with the respective public departments, NGOs, businesses, and other stakeholders in the domain of climate change. In the context of climate vulnerabilities of the area, AZE may include measures in their CSR framework as well. AZE may refer to the following to seek further guidance. *Sindh Private Sector Partnership Strategy on Disaster Risk Reduction - https://pdma.gos.pk/Documents/Reports/DRR%20Strategy%20UNDP%20final%20(Sindh).pdf*

Risks	Adaptation Measures and Opportunities for Resilience
	Role Of Private Sector In Climate Action https://www.csccc.org.pk/attachments/news-bulletin/Role%20of%20Private%20Sector%20in%20Climate%20Action%20(1).pdf *Private Sector Participation in Disaster Recovery and Mitigation* https://documents1.worldbank.org/curated/en/589341609771914404/pdf/Private-Sector-Participation-in-Disaster-Recovery-and-Mitigation.pdf https://www.gdrc.org/uem/disasters/dm-privatesector.html • AZE communicated its eagerness to play a vital role to promote sustainable practices in collaboration with local industries and others. AZE plans to consider the practices in future once the facility is established. However, it can start exploring and researching on the areas which will help in reduction of carbon footprint and enhance the circular economy. Some of the measures will have to be incorporated during the design phase as well. Some of the international initiatives which can be followed and referred include: *Tire Industry Project by WBCSD* https://www.wbcsd.org/Sector-Projects/Tire-Industry-Project https://sustainabilitydriven.info/ *Environmental Key Performance Indicators for Tire Manufacturing* https://www.wbcsd.org/download/file/15553 https://sustainability.ustires.org/resources/
Physical Risks to Project Infrastructure - Buildings	• Design measures to be considered to reduce heat gain and improve insulation and heat proofing, and to take advantage of natural air for ventilation and decrease the need for cooling. AZE has informed that these measures are being incorporated in the design. • Expansion and contraction joints to be provisioned in the structural design to avoid cracks in buildings. • Adequate availability of water during construction and proper curing of concrete to enable the strength of structural elements. • Proper waterproofing of structural elements to protect from damage. • Adequate gradients in the roof design for drainage during extreme precipitation. • Consider increased risk of flooding in the design of facility: flood • protection measures and barriers, increased capacity of drainage and storm water infrastructure, make use of dry floodproofing strategies where applicable. • Use corrosion resistant materials in the design. • Constructing all buildings at an elevation to prevent intrusion of flood water. • Use of green roofs and vegetation/plantation within the facility and immediate surroundings. • Incorporate impermeable surfaces in the facility design, where possible, to facilitate groundwater recharge.

Risks	Adaptation Measures and Opportunities for Resilience
	• Effective planning for energy use optimization and introduce measures for energy efficiency. • Avoid leakages from the air-conditioned areas to enhance control over indoor temperature levels. • Regular inspections and maintenance of buildings. • Regular maintenance and re-filling of water-cooled chillers to avoid disruptions and equipment depreciation. • Manage moisture within the building structure and prevent dampness or condensation that could lead to issues such as mould growth. • Routine cleaning of the stormwater drainage system. • Emergency Response Planning during construction and operation phases.
Physical Risks to Project Infrastructure - Roads	• Conduct regular inspection and preventive maintenance to avoid damages and defects. • Identify routes that may be prone to blockages due to the accumulation of flood water. • Establish alternate routes that can be used during blockages due to flood water. • Routine cleaning of the stormwater drainage system is essential to prevent the accumulation of debris and sediment, which can enter the system during flooding and inundation.
Physical Risks to Utilities – Water Supply	• Water Resource Sustainability Assessment to be carried out to ensure sustainable water supply during the construction and operation phases, considering impacts of changing climate. It should explore alternate water sources to meet the demand of project operations, incorporate water conservation strategies which may involve researching methods to reduce water usage in processes, conducting regular water audits, and implementing rainwater harvesting measures. Preliminary water resource management plan is being developed under the ESMF. • Groundwater levels should be monitored, especially during expected periods of water scarcity. Implement groundwater recharge measures. • Adequate water storage to be maintained at site. • Proper covering of tanks, storage areas, pipelines, ponds to avoid evaporation losses. • Build storm water storage tanks and introduce rainwater harvesting measures on project-level and community-level to increase resilience to water shortages.

Risks	Adaptation Measures and Opportunities for Resilience
	• Innovation in waste water treatment and increase in reuse/recycling practices, increase water use efficiencies. • Maintain coordination with disaster management agencies and institutional bodies for increase in adaptive capacity. • Industry sector guidelines such as the National Water Conservation Strategy for Pakistan 2023 - 2027 and other relevant international best practices could be followed for water-efficient operations. • Water quality monitoring and upgrades in the R.O and ETP, as required.
Physical Risks to Utilities – Drainage	• Routine cleaning of the stormwater drainage system is essential to prevent the accumulation of debris and sediment, which can enter into the system during floods.
Physical Risks to Utilities – Electricity Infrastructure	• Conduct regular inspection and preventive maintenance to prevent damage to components. • Temperature in the electrical panel room should be well-maintained, as cooling requirements may increase during periods of high temperatures. • Drainage system should be well-maintained to avoid accumulation of stagnant water during floods. • Distribution Boards and other sensitive equipment should have adequate safeties in place. • If outdoor trenches / trays are present for cables, proper covering should be in place to prevent intrusion of water during rains and flooding.
Physical Risks to Project Operations – Personnel	• Ensure sufficient shading is provided to workers during the construction and operation phases in hot days / heat waves. • Adjust working hours to align with cooler times of the day and incorporate frequent breaks. • Ensure that workers and staff have comfortable working conditions. • Ensure multiple water stations are available throughout the facility. • Routine health checkup for workers. • Offer training and information to workers and staff on heat-related illnesses, prevention measures, heat waves and other extreme events and first-aid procedures in case of such occurrences. • Prevent disruptions to water-cooled chillers through regular monitoring and preventive maintenance. • Provide training and ensure capacity building for water conservation practices. • Flood education, awareness and emergency management training for the employees.

Risks	Adaptation Measures and Opportunities for Resilience
	• Ensure routes for workers commuting in and out of the site are not affected. Identify alternate routes that can be accessed when there are road blockages.
Physical Risks to Project Operations – Supply of Raw Materials	• Evaluate and potentially adjust storage conditions for temperature-sensitive materials like rubber compounds to prevent quality degradation. • Identify alternate routes for receiving raw materials in the event of road blockages due to floods. • Maintain sufficient quantities of critical raw materials in anticipation of periods of expected heavy precipitation. • Explore alternate sources of raw materials and assess the sustainability of supply chain in a changing climate. • Establish alternate sources and supply chain of biomass for boiler, considering climate change impacts to various agricultural by-products (rice husk etc.) which are vulnerable in the local region. • Proper covering and protection of raw material storage areas, and waste infrastructure within the facility.
Physical Risks to Project Operations – Production	• Maintain optimal operating conditions and establish controls for sensitive equipment. Ensure that buildings receive adequate cooling during periods of high temperatures to maintain optimal temperature levels and prevent damage to plant and equipment. • Implement adequate preventive maintenance, especially for equipment susceptible to overheating or malfunctioning. • Adequate arrangement of backup power and sufficient fuel storage at site, in case of grid supply shortages. • Proper measures for waste management and adequate covering of raw material and waste storage areas to control decomposition and potential odors, and reduce risk of fire incidents. • Diversify the energy mix especially captive generation by adding renewable sources to lessen the external dependance for power requirements. • Maintenance of water-cooled chillers, especially before the expected periods of increased cooling requirements. • Regular inspections to check for leakages through which flood or rain water or moisture can enter/seep through the buildings. • Allocate sufficient budget for necessary repair and recovery measures after extreme events. • Conduct water audits to identify areas for improvement in water usage and to identify any leakages in the production area and utilities. • Conduct energy audits and implement energy efficiency measures.

Risks	Adaptation Measures and Opportunities for Resilience
Physical Risks to Project Operations – Transportation of Products	• Ensure that finished products are adequately stored in shaded areas/warehouse. • Identify alternate routes for transportation and distribution of products in the event of road blockages due to rains and floods.

7.2 Climate Change Mitigation and Transition

The transition risks to the project were discussed in Section-5. Based on the risks, suitable mitigation measures have been identified as follows. Each risk mitigation measure is defined to address specific challenges and uncertainties related to transitioning to more sustainable practices in the tyre manufacturing industry. Collaboration across departments and proactive planning are essential for successfully navigating these transitions and minimizing associated risks. It may also be worthwhile to quantify the financial implications of the various risks, and the costs associated with mitigating those risks over the short and long-term time periods.

Transition Risks	Mitigation Measures and Opportunities for Resilience
Policy and Legal Risks:	
Pakistan's Decarbonization Plans	• Policy Alignment: Ensure overall alignment between government policies and industry practices to support the transition to low-carbon technologies and practices • Energy Efficiency and Renewable Energy: Implement energy efficiency measures and invest in renewable energy sources such as solar PV, wind, and biomass to transition away from fossil fuels and reduce carbon intensity • Risk Assessment and Management: Conduct regular risk assessments to identify potential challenges, and develop contingency plans and risk management strategies to mitigate potential disruptions and ensure business continuity during the transition.
International Maritime Organization (IMO) Regulations	• Local sourcing of raw materials where possible: Investigate local availability of raw materials and diversify sourcing options to reduce imported raw-material transportation and associated costs. • Recycling of raw materials: Establish comprehensive recycling programs to reclaim and reuse materials from scrap tyres, thereby reducing the need for virgin raw materials and minimizing waste generation.

Transition Risks	Mitigation Measures and Opportunities for Resilience
Mandatory Energy Audits	• Conduct regular energy audits: Regular energy audits help in identifying areas of energy wastage within the manufacturing processes, enabling the company to implement targeted improvements. • Implement energy-efficient technologies: This involves adopting machinery, equipment, and processes that consume less energy while maintaining or improving productivity. Examples include upgrading to more efficient lighting systems, installing energy-efficient motors, and optimizing HVAC systems. • Promote energy conservation practices: Encouraging employees to adopt energy-saving habits such as optimizing production schedules to minimize energy consumption during off-peak hours, and implementing energy-saving policies throughout the organization.
Implementation of Carbon Pricing Mechanisms	• Introduce emission reduction strategies: Implementing measures to reduce carbon emissions across various aspects of the business, such as improving energy efficiency, optimizing transportation logistics, and minimizing waste generation. • Invest in carbon offset projects: Supporting projects that help offset the company's carbon footprint, such as reforestation initiatives, renewable energy projects, or investments in carbon capture and storage technologies. • Explore renewable energy alternatives: Investing in renewable energy sources such as solar PV, wind, or hydroelectric power to reduce reliance on fossil fuels and lower carbon emissions associated with energy consumption.
IFC Project Investment	• Continuous compliance monitoring: Implement monitoring and evaluation mechanisms to ensure continuous compliance with IFC's requirements, including regular audits, assessments, and reporting procedures. • Establish clear benchmarks and performance indicators: to track the project's progress towards reducing operational emissions and meeting environmental standards outlined in PS-3.
Technology Risks:	
Demands for New Technology	• Invest in R&D for innovative tyre technologies: Allocating resources towards research and development to develop new tyre technologies that meet emerging market demands, such as tires designed for autonomous vehicles or those optimized for specific weather conditions. • Collaborate with technology partners: Partnering with research institutions, technology companies, and other stakeholders to

Transition Risks	Mitigation Measures and Opportunities for Resilience
	leverage expertise and resources in developing cutting-edge tyre technologies. • Adapt production processes accordingly: Modifying manufacturing processes to accommodate the production of new tyre technologies, which may involve investing in new equipment, retraining staff, and optimizing production workflows.
Emergence of Sustainable Materials	• Research alternative materials with lower environmental footprints: Conducting research to identify and evaluate alternative materials that have lower environmental impacts compared to traditional materials used in tyre manufacturing, such as recycled rubber or bio-based materials. • Invest in green technologies: Investing in technologies that enable the use of sustainable materials in tyre manufacturing processes, such as advanced recycling technologies or innovative production methods. • Modify manufacturing processes: Adapting manufacturing processes to incorporate sustainable materials, which may require adjustments to equipment, formulations, and quality control measures.
Adoption of Electric Vehicles (EVs)	• Develop EV-compatible tyres: Designing and producing tyres specifically tailored to the needs of electric vehicles, which may require considerations such as reduced rolling resistance for improved efficiency and specialized tread patterns for enhanced traction. • Diversify product portfolio to cater to EV market: Expanding the product portfolio to include tyres suitable for electric vehicles, including options for different vehicle types and usage scenarios. • Invest in battery technology research: Investing in research and development of battery technologies to support the growth of the electric vehicle market and address emerging challenges such as range anxiety and charging infrastructure.
Market Risks:	
Decline in the Production of Coal and Oil in the Asia Pacific	• Diversify energy sources: Transitioning to alternative energy sources such as natural gas, renewable energy, and nuclear power to reduce reliance on coal and oil for energy generation. • Invest in renewable energy projects: Investing in the development and deployment of renewable energy projects. AZE can explore the feasibility of integrating renewable energy sources, such as solar panels or wind turbines, into AZE's operations to offset energy demand from traditional fossil fuel sources. This may involve conducting feasibility studies, evaluating potential sites for

Transition Risks	Mitigation Measures and Opportunities for Resilience
	renewable energy installations, and negotiating power purchase agreements with renewable energy providers • Adopt energy-efficient technologies: Implementing energy-efficient technologies and practices across operations to reduce energy consumption and mitigate the impact of declining coal and oil production on energy availability and costs.
EU's Carbon Border Adjustment Mechanism (CBAM)	• Reduce carbon emissions: Implementing measures to reduce carbon emissions involves various strategies such as optimizing energy use, adopting renewable energy sources, and improving efficiency in production processes. • Implement carbon offset projects: Investing in carbon offset projects can help balance out unavoidable emissions by supporting initiatives like reforestation or renewable energy projects. • Invest in cleaner production methods: This involves upgrading equipment and processes to minimize carbon emissions and pollution, such as using cleaner fuels or implementing advanced manufacturing technologies.
Decline in Demand for Traditional Tyres	• Develop eco-friendly tyre options: Investing in research and development to create tyres with reduced environmental impact, such as those made from sustainable materials or designed for longevity. • Diversify product range: Expanding the product portfolio to include offerings that cater to emerging trends and preferences, such as electric vehicle tires or tires optimized for specific road conditions. • Invest in marketing and customer education: Educating consumers about the benefits of eco-friendly tyres and creating targeted marketing campaigns to highlight these advantages.
Increased Competition from Sustainable Tyre Manufacturers	• Enhance product differentiation: Emphasizing unique features or benefits of the company's tyres compared to competitors, such as superior performance, durability, or environmental credentials. • Invest in sustainable manufacturing practices: Continuously improving manufacturing processes to minimize environmental impact, reduce waste, and enhance sustainability credentials. • Strengthen brand reputation for sustainability: Actively promoting the company's commitment to sustainability through marketing, partnerships with environmental organizations, and transparent reporting.

Transition Risks	Mitigation Measures and Opportunities for Resilience
Disruption in Supply Chain	• Diversify supplier base: Identifying alternative suppliers and establishing relationships with them to reduce dependency on single sources. • Establish contingency plans: Developing backup plans to mitigate the impact of disruptions, such as stockpiling critical materials or securing alternative transportation routes. • Invest in supply chain resilience measures: Implementing technologies and practices to enhance visibility, traceability, and flexibility within the supply chain.
Costs of Greening the Tyre Production Process	• Optimize production processes to reduce costs: Identifying inefficiencies and implementing measures to streamline operations and reduce resource consumption. • Explore government incentives for green initiatives: Researching and leveraging available subsidies, tax credits, or grants aimed at supporting environmentally friendly initiatives. • Collaborate with suppliers to negotiate better prices for eco-friendly materials: Working closely with suppliers to find cost-effective solutions and possibly forming partnerships to drive down costs.
Reputation Risks:	
Stakeholder Expectations of Transparent Communication and Adherence to Committed Targets	• Enhance communication strategies: Developing clear and transparent communication channels to keep stakeholders informed about the company's environmental performance, goals, and progress. • Provide regular updates on environmental performance: Issuing periodic reports or updates that detail the company's environmental initiatives, achievements, and challenges. • Engage stakeholders in decision-making processes: Soliciting feedback and input from stakeholders to ensure alignment with their expectations and concerns.
Human Resource Retention	• Implement reasonable employee retention strategies: Offering competitive salaries, benefits, and opportunities for career advancement to attract and retain talented employees. • Offer training and development opportunities: Providing ongoing training and development programs to enhance employee skills and job satisfaction. • Promote a culture of environmental stewardship: Fostering a workplace culture that values environmental responsibility and encourages employees to contribute to sustainability initiatives.

7.3 Monitoring and Evaluation

Monitoring and evaluation mechanisms play a crucial role in tracking progress of initiatives, and addressing emerging issues related to the adaptation to a changing climate and transition to low-carbon an economy. These mechanisms involve the systematic collection, analysis, and interpretation of data to assess the effectiveness of policies, initiatives, and investments aimed at increasing the adaptive capacity, reducing carbon emissions and promoting sustainability. By monitoring trends in metrics such as greenhouse gas emissions, energy consumption, renewable energy adoption, and other relevant metrics, AZE and its stakeholders can identify areas of success, areas needing improvements, and any updates required in the management plans.

Key components of monitoring and evaluation include setting clear indicators and targets, establishing baseline data, and regularly measuring and reporting on progress towards these goals. To effectively monitor and evaluate progress, the following approach may be considered:

1. **Define Clear Objectives and Targets:** Clearly define the objectives and set specific, measurable, achievable, relevant, and time-bound (SMART) targets. This provides a clear framework for monitoring progress.

2. **Establish Baseline Data:** Collect baseline data on key indicators related to greenhouse gas emissions, energy consumption, renewable energy deployment, and other relevant factors for adaptation and mitigation. Baseline data serves as a reference point for measuring progress.

3. **Select Appropriate Indicators:** Choose indicators that accurately measure progress towards the defined objectives. Indicators should be relevant, reliable, and easy to track over time. Consider both quantitative and qualitative indicators to capture the full range of impacts.

4. **Implement Regular Data Collection:** Establish systems for regular data collection to track changes in selected indicators over time. Ensure that data collection methods are standardized, consistent, and reliable to facilitate meaningful analysis.

5. **Analyze and Interpret Data:** Analyze collected data to assess progress towards targets and identify trends, patterns, and areas of concern. Interpretation of data should also consider contextual factors, such as policy changes, economic conditions, and/or technological advancements.

6. **Conduct Stakeholder Engagement:** Involve relevant stakeholders, including government agencies, businesses, civil society organizations, and communities, in the monitoring and evaluation process. Stakeholder engagement enhances transparency, accountability, and ownership of the transition process.

7. **Use Performance Metrics:** Develop performance metrics to evaluate the effectiveness of specific initiatives and interventions.

8. **Incorporate Feedback Mechanisms:** Establish mechanisms for collecting feedback from stakeholders on the effectiveness of policies and programs. Feedback mechanisms help identify emerging issues, challenges, and opportunities for improvement.

9. **Review and Adapt Strategies:** Regularly review monitoring and evaluation findings to assess progress and identify areas requiring adjustment or refinement in the adaptation and mitigation strategies.

10. **Communicate Results:** Communicate monitoring and evaluation results to stakeholders through clear, accessible, and transparent reporting mechanisms.

7.4 Climate-Related Opportunities

In the Tyre manufacturing industry, there are various climate-related opportunities that extend beyond conventional environmental stewardship. Energy and resource efficiency is a major avenue for leveraging climate opportunities. These initiatives enable opportunities for reduction in long-term operational costs and innovation in business. The use of modern machinery and climate-friendly technologies also enable cost reductions as a result of reduced energy and raw material usage, while delivering products with reduced carbon intensities. Research and development in these areas foster a culture of innovation which positions companies at the forefront of rapidly evolving landscape of sustainability in the automotive industry. Businesses gain competitive advantage through diversification in the product ranges.

Another avenue for leveraging climate consciousness is the adoption of sustainable materials in Tyre production. Exploring eco-friendly alternatives, such as bio-based rubber or recycled materials, not only reduces the carbon footprint but also caters to a growing market of environmentally conscious consumers. There is a growing market for tyres that offer better fuel efficiency, longer lifespan, and are made from recycled or renewable materials. Tyre manufacturers can capitalize on this trend by exploring new markets and customers, developing and marketing tyres that align with consumer values, contributing to brand loyalty and positive public perception. It also enables strategic networking and partnerships with innovative recycling companies.

From a regulatory and trade perspective, international bodies are increasingly emphasizing on environmental regulations and environmental taxes. Manufacturers that proactively adopt green practices, adhere to emission standards, and demonstrate commitment to reducing their carbon footprint can not only comply with existing regulations but also stay ahead of competition and potential future requirements. Regulatory alignment can enhance

export base, ensure market access, reduce legal risks, and position the company favorably in the global sustainability landscape.

Climate-related opportunities, if leveraged effectively, can not only mitigate the impact of transition risks but also drive sustainable growth in the manufacturing industry. Potential opportunities arising from the country and AZE's transition to a low carbon economy are listed as follows. It can also assist in the assessment of financial implications of mitigating transition risks in line with AZE's finalized business strategy and operations.

- Alignment with the country's decarbonization plans presents an opportunity for industries to invest in subsidized renewable energy sources and energy-efficient technologies. AZE can leverage government incentives and subsidies to transition towards cleaner production methods, reducing operational costs while meeting regulatory demand.
- Mandatory energy audits provide an opportunity for industries to identify energy-saving opportunities and implement cost-effective efficiency measures. Investing in energy-efficient technologies and practices can reduce energy consumption, lower operating costs, and enhance competitiveness in the market.
- Adoption of carbon pricing mechanisms by the country encourages industries to invest in emission reduction strategies and low-carbon technologies, provides the opportunity to incentivize innovation and monetize emission reductions through carbon trading schemes.
- The anticipated growth in EV adoption offers an opportunity for tyre manufacturers who produce specialized tyres for EVs. Investing in R&D and production of EV-specific tyres can enable AZE to tap into a growing market segment and support the transition to sustainable mobility.
- The shift towards renewable energy sources presents an opportunity for industries to invest in subsidized renewable sources, reduce reliance on fossil fuels and mitigate supply chain disruptions. Transitioning to cleaner alternatives can also enhance energy security, resilience to market changes, and reduce costs stemming from energy purchases.
- Implementing carbon reduction initiatives and transitioning towards sustainable production methods not only helps companies avoid penalties under the CBAM, but also ensures competitiveness in the European markets.
- Adapting to consumer preferences for eco-friendly tyres and/or alternative transportation solutions can drive innovation and market diversification. Investing in the R&D of sustainable tyre products that are increasingly resistant to weather-related impacts and improve fuel/energy usage efficiency, and expanding product offerings can

capture new market opportunities, enhance brand reputation and maintain market competitiveness.

- Investing in green technologies and sustainable practices can drive operational efficiencies and cost savings in the long term. Implementing energy-efficient manufacturing processes and optimizing resource utilization can reduce production costs and improve profitability.
- Enhancing transparency and accountability in performance reporting can strengthen stakeholder trust and reputation. Investing efforts in sustainability reporting frameworks and proactively engaging stakeholders can build brand credibility and loyalty, driving long-term value creation. Transparent communication of efforts and results may also boost investor confidence and secure increased investments and funding from banks.

8 Alignment with Paris Agreement

Alignment with Paris Agreement is of immense importance to financing agencies and lenders. In accordance with the Joint MDB Methodological Principles for Assessment of Paris Agreement Alignment of New operations, an operation must meet criteria for both mitigation and adaptation/resilience, which are assessed through two Building Block (BB) questionnaires. An operation needs to be aligned with mitigation (BB1) and adaptation and resilience (BB2) parts of the framework to be considered "Paris-aligned."

BB 1 Questionnaire: Mitigation

The BB1 questionnaire characterizes operations as either "aligned" or "not aligned" with the mitigation objectives of the Paris Agreement. It evaluates whether the operation is consistent with a low-greenhouse gas development trajectory for the country and does not hinder the transition to a decarbonized economy, both locally and globally. Operations considered aligned include those that directly reduce GHG emissions, those in line with country-specific decarbonization pathways, and those with minimal impact on climate change.

BB 2 Questionnaire: Adaptation and Resilience

BB2 assesses operations' alignment with the adaptation goals of the Paris Agreement. Operations are categorized as "aligned" or "not-aligned" based on their management of significant physical climate risks, alignment with national adaptation strategies, and contributions to climate-resilient development pathways, wherever possible.

The GHG Estimation Assessment is detailed in Section-6, which could assist IFC with the finalization of BB1 response and inform the ***Mitigation-Alignment*** of project. The climate change mitigation measures and opportunities for decarbonization and transition towards low-carbon economy have been detailed in Section-7.

To assist with the BB2 Response, detailed physical risk assessment has been undertaken and the adaptation measures and opportunities for resilience identified for the construction and operation phases have been detailed in Section-7. It will inform the ***Adaptation-Alignment*** of the project.

The measures for climate change mitigation and adaptation have been integrated under the Climate Change Management framework presented in Section-7 of the report.

APPENDIX F – CLIMATE CHANGE BASELINE & CLIMATE CHANGE IMPACT ON ENVIRONMENTAL & SOCIAL RECEPTORS

Climate Change Impacts on Environmental and Social Receptors

Parameters	Hazards	Impacts					
		Agriculture	**Groundwater/ Water Sources**	**Health and Community**	**Ecosystem (including fisheries, and livestock's)**	**Infrastructure**	**Mangroves**
Temperature	Extreme Temperature Rise	Higher evapotranspiration rates, causing heat stress on crops adversely impact yields and change the quality of agricultural products. Cotton production, in particular, is highly susceptible to climate change due to its sensitivity to elevated temperatures, water scarcity, and increased evapotranspiration. A 1°C temperature rise can lead to a 24% reduction in cotton plant yield during the vegetative stage and an 8% reduction at the flowering stage.	Extreme temperature is leading to depletion and contamination, impacting the intrusion of saline water into freshwater systems. In Sindh, heightened evapotranspiration strains the irrigation system, aggravating water scarcity. Projected temperature increases are anticipated to exacerbate evapotranspiration, compounding water shortages and precipitating acute crises. Globally, including Pakistan, groundwater contamination, particularly by nitrates, is a major concern. Elevated temperatures worsen this issue by facilitating nitrate leaching from fertilizers into groundwater.	In Sindh, community exhibit a higher susceptibility to heat-related illnesses. Climate-induced health issues encompass cardiopulmonary ailments due to extreme temperatures, vector-borne diseases notably malaria and dengue fever, as well as temperature-related mortalities during prolonged heat spells. An anticipated global temperature rise of 1.0–3.5°C by 2100 elevates the vulnerability to vector-borne diseases, notably malaria and dengue fever in tropical and subtropical regions. Dengue fever, previously unreported in the area, is emerging as a threat to local communities.	Escalating temperatures in Sindh pose a significant threat to agriculture, livestock, and overall food security in the country. Adverse effects include compromised livestock health, reduced productivity, and reproductive challenges. Heat stress can reduce the rate of animal feed intake and effect the fish stocks, heightening food security risks for households dependent on livestock and fisheries.	Inadequate temperature insulation infrastructures in the area are vulnerable due to record-breaking temperatures and humidity, posing challenges for the community and livestock. The expansion and contraction of materials in extreme heat pose risks to various structures, including buildings and animal shelters.	Coastal mangrove areas, crucial for ecological balance, confront challenges from changing temperatures and rainfall. High temperatures contribute to hypersaline conditions, hastening mangrove degradation. Research indicates that extreme temperatures adversely impact mangroves' development, physiology, and biochemistry. However, anticipated increases in future surface temperature are also expected to influence tree development, promoting higher growth rates during warmer periods and, consequently, increasing mangrove mortality.
	Heat Waves	The increasing frequency and intensity of heat waves in Sindh pose a growing threat to agriculture, causing heat stress, higher water requirements, and increased respiration rates, ultimately reducing productivity. Heat waves during Spring in 2006, 2007, 2010, and 2011 significantly reduced wheat yields, while temperatures exceeding 32°C induce heat stress in cotton crops. These heat events result in flower/fruit drop and leaf burn, exacerbating water shortages that adversely impact agricultural productivity. Projected increases further pose challenges to sustainable crop production, particularly in meeting elevated water demands with limited surface water and unsuitable saline groundwater (Ghazala et al., 2009).	Heatwaves can further diminish water availability, impacting both surface water and groundwater resources for crops, animals and human beings. The depleted water table in Sindh pose challenges for farmers, hindering the use of canal water for irrigation and livelihood.	Prolonged heatwaves cause significant and irreversible damage through sunburn and heat strokes in both humans and animals. The 2015 heat wave in Sindh, affecting areas like Thatta and Karachi, led to a notable increase in heat-related deaths and illnesses, approximately 65,000 hospitalizations and over 1,200 heat-related casualties were recorded in overall Sindh. Health experts observed a rise in mortality, morbidity, and heat-related conditions like heat exhaustion and heatstroke. Furthermore, heatwaves significantly hamper labour productivity.	Heat waves disrupt ecosystems, causing heat stress in livestock and altering fish distribution, leading to fatalities due to changes in oxygen levels. This results in reduced livestock productivity, affecting both meat and milk production and causing overall losses in livestock.	Heat waves can damage infrastructure like roads, shelters and buildings, resulting from the expansion and contraction of materials due to temperature fluctuations.	These heat events result in leaf burn, exacerbating water salinity and shortages that adversely impact Mangroves growth.
Precipitation	Extreme Precipitation	Changes in precipitation patterns impact cropping	The increasing frequency of intense rainfall events poses	Extreme precipitation introduces a range of	Extreme rainfall has significantly affected livestock	Persistent rainfall and compromised infrastructure	Protected forests, including mangrove forests and

Parameters	Hazards	Impacts					
		Agriculture	**Groundwater/ Water Sources**	**Health and Community**	**Ecosystem (including fisheries, and livestock's)**	**Infrastructure**	**Mangroves**
		season schedules, increase crop stresses, alter irrigation water needs, and elevate the risk of pests and diseases, negatively affecting agricultural productivity. The heavy monsoon rain impacted nearly 57% (2.8 million hectares) of farmland in Sindh, causing decreased output for cotton, and rice. Prolonged standing water in many areas of Sindh results in the loss of seasonal crops and poses a risk for disease spread, exacerbating the impact on agricultural productivity.	challenges such as waterlogging, crop destruction, and difficulties in water management. Sea intrusion is a major cause of brackish water in coastal areas, threatening coastal aquifers.	challenges, including travel hazards, flooded roads, limited access to dry wood for cooking, as well as concerns related to waste runoff and sewerage overflow, leading to an increased risk of waterborne diseases.	and fisheries by diminishing freshwater flow in the canal, causing contamination and resulting in the spread of various diseases. Altered rainfall patterns are affecting the vegetation cover in the area, resulting in limited pasture with low nutritive quality.	created impediments in delivering aid and transporting the ill to hospitals. Essential components, including roads or pathways, and markets, suffered significant damage, rendering many inaccessible.	rangelands, are at risk from environmental stressors such as changes in freshwater availability, environmental flows, sea level rise, and increased precipitation. Mangroves, being highly sensitive to precipitation changes, may experience impacts on their growth, biodiversity, and overall health. Elevated precipitation can result in greater riverine discharge, potentially amplifying sediment inputs to estuarine mangroves.
	Floods	In 2010, the floods in Thatta, Sindh, destroyed standing crops like paddy, cotton, and vegetables. Subsequently, the 2022 torrential monsoon rain, following a heatwave, led to a 20% reduction in Sindh's wheat harvest. This 2022 flood damaged standing crops, grain storage, livestock, and infrastructure, significantly impacting Sindh's agriculture. The analysis indicated that 2.5 million hectares (18% of Sindh's total area) were inundated, with 1.1 million hectares being cropland. About 57% (2.8 million hectares) of cropland was affected out of the 4.9 million hectares of agricultural area in Sindh. Expected production losses were significant, with 88% for cotton (3.1 million bales), 80% for rice (1.8 million tons), and 61% for sugarcane (10.5 million tons)	The risk of flooding can affect river discharge into the sea recharging groundwater aquifers, and providing temporary relief to aquifer stress. This influence can alter the balance between fresh water and seawater. Sea intrusion poses a major threat to coastal aquifers, causing brackish water in coastal areas.	Extensive flooding in the province has disrupted access and mobility, impacting communities' livelihoods and causing a significant rise in food prices and inflation. The inundated sewerage in the area resulted in challenges such as sanitation issues, waterborne diseases, displacement, and disruptions. Thatta, severely affected by the floods of 2010 and 2011, grapples with numerous health challenges. Nationally, the 2010 floods impacted over 20.2 million people, displacing around 11 million, including 7 million from Sindh. The floods resulted in approximately 411 deaths in Sindh. The 2022 floods in Sindh unfolded as a "humanitarian disaster of epic proportions," leaving at least half a million people displaced due to unsafe drinking water. These floods escalated waterborne diseases like diarrhoea, cholera, and dengue.	The floods in Sindh have led to substantial losses in the livestock sector, causing food insecurity and a decline in overall health. Massive devastation of 2010 flood includes the loss of thousands of animals and widespread damage to poultry farms, with around 115,500 livestock perishing and approximately 5 million surviving ones directly affected. These floods extensively damage spanning crops, livestock, fisheries, poultry, and on-farm water distribution infrastructure. Recent floods in Sindh, such as those in 2010, 2011, 2012, and 2013, and most recently in September 2022, have profoundly affected the livestock and aquaculture sectors. The floods in September 2022 alone resulted in the loss of an estimated 1.4 million heads of ruminants (3% of the total), 7 million heads of poultry (4% of the total), and over 80% of aquaculture ponds in Sindh.	In 2011, heavy rainfall-induced floods significantly damaged public infrastructure in Sindh. Floods, with their potential for extensive infrastructural damage to houses, shelters and towns, also resulted in the destruction of critical infrastructure like roads and pathways. This widespread destruction of rural infrastructure and irrigation systems poses threats to public health and national security. Additionally, the unprecedented damage caused by the 2022 floods to agriculture crops, livestock, and infrastructure, including storage facilities with millions of tons of grain, raised the risk of an unprecedented food security crisis in the country.	Existing evidence indicates that the duration and intensity of tidal flooding significantly affect the growth and survival of Avicennia marina constituting 90% of the coastal Mangroves. Environmental stressors such as high salinity and reduced freshwater supply can induce stress in Avicennia marina mangroves. The decline of mangroves in Sindh's coastal areas is linked to reduced reproduction and overall coastal erosion (may occur due to flooding). Recent years have witnessed adverse effects on mangroves due to sea intrusion, leading to a decrease in freshwater supply to the Indus River delta. The anticipated rise in mean sea level is expected to positively impact the development of A. marina by modifying conditions in the intertidal area under a semi-arid climate, influencing seedling recruitment and the overall expansion of mangroves.
Wind	Strong breeze	Strong breezes exceeding 40 km per hour in the months of May and June create severe wind erosion in lower Sindh,	Not Applicable.	Strong wind blow significantly hinders the use of firewood for cooking, contribute to air pollution and cause adverse	Strong winds have damaged infrastructure, compromising shelters and fences, and impacting the well-being of	The Sindh Daily Situation Report dated June 14th, 2023, warns of the potential harm from intense squally winds to	Not Applicable.

Parameters	Hazards	Impacts					
		Agriculture	**Groundwater/ Water Sources**	**Health and Community**	**Ecosystem (including fisheries, and livestock's)**	**Infrastructure**	**Mangroves**
		impacting cultivated and heavily grazed areas. The wind-induced soil erosion contributes to nutrient depletion and diminished soil fertility. These extreme winds pose a threat to crops during flowering and fruiting stages, resulting in economic losses and reduced yields. Additionally, high winds cause physical damage to crops, including lodging, breakage, and uprooting, further contributing to yield reduction.		impacts on respiratory health. Socioeconomic assessments in Thatta district highlight widespread impoverished living conditions in surveyed villages. These districts exhibit low adaptive capacity, marked by weak infrastructure and governance, intensifying the health implications resulting from strong winds.	animals. In certain weather conditions, particularly scorching summer winds, there is an increased risk of fires affecting to crops, which may also burn down homes and livestock. Strong breeze can disrupt fish populations and their habitats, impacting the local ecosystem and the availability of fish for the community.	fragile structures, such as kutcha houses and solar panels, with implications for socioeconomic conditions. This risk is exacerbated by insufficient and poor infrastructure. Additionally, these winds pose a threat to the integrity of shelters and fences housing animals.	
	Storms and Cyclones	Cyclones and storms, brings moisture inland from oceans, contribute to flooding and hurricanes. The south-central districts of Sindh, known for major horticultural production, are particularly vulnerable to cyclones and flooding. In 1999, a severe cyclone caused extensive damage to agriculture and infrastructure in Sindh. Cyclones pose a consistent threat to major crops like wheat, cotton, and rice impacting yields and leading to the destruction of key commercial crops in the region. The impact on crops includes widespread damage to land and infrastructure, loss of standing crops, disrupting normal agricultural activities.	Not Applicable	A severe cyclone in 1999 affected over 600,000 people in Sindh, destroying over 82,000 houses, causing extensive damage to agricultural land and infrastructure, and resulting in loss of lives and substantial harm to the region's health and well-being. Moreover, cyclone Biparjoy, in 2023, caused displacement and health issues in Thatta district.	Cyclones, although has never been hit, bring storm surges that have led to home flooding. The Final Situation Report on Cyclone 2-A in Sindh underscores extensive damage to agricultural land, infrastructure, and the fishing industry. The overall negative impact of floods, and cyclones on crops, livestock, and water management systems is a significant concern.	In 1999, a severe cyclone struck the Eastern coast of Sindh, causing extensive damage to agriculture and infrastructure. Additionally, the tropical cyclone Yemyin in 2007, affected around 1.65 million people in Sindh and Balochistan, resulting in widespread infrastructure damage. Subsequent to that, the years 2010 and 2011 witnessed consecutive cyclone induced floods and heavy rains in Sindh, affecting millions and causing substantial damage to both personal and public properties.	Hurricanes and cyclones pose a significant threat to mangroves, leading to tree uprooting at seaward margins from wave activity and damage from strong winds.
Humidity	Heat Stress	Extreme heat weather, with dry or humid conditions, significantly impacts crop yield, mainly rice and cotton production. Research shows that high temperatures and humidity leads to indirect moisture stress, impacting the quality and weight of rice grains. Prolonged heat stress with lower air humidity hampers plant growth and photosystem activities. Cotton crops, in particular, experience heat stress when temperatures	Reduced Indus River flow and diversion through link canals have intensified water scarcity in the region, resembling a drought-like situation, with notable impacts on agriculture and the availability of drinking water.	In Sindh, elevated temperatures of up to 45°C, accompanied by stagnant wind, high humidity, and inadequate infrastructure, contribute to a growing frequency of heat wave incidents. This escalating trend poses increased risks of heat-related morbidity, alongside a higher prevalence of diseases like diarrhea, skin infections, respiratory issues, and vector-borne diseases such as malaria and dengue in the region.	Heat stress in livestock and fisheries, caused by high temperatures and humidity, reduces productivity, fertility, and animal wellbeing. Livestock suffer from decreased feed intake and growth, while fisheries experience changes in reproduction and migration, leading to population declines.	Elevated humidity levels can detrimentally impact infrastructure, causing harm to materials like wood through issues such as swelling, rotting, corrosion, and warping. Furthermore, this excess moisture accelerates the deterioration of common house materials, diminishing their strength and durability over time.	Seasonal changes in humidity impact the microclimate within the mangrove, favoring its growth due to the positive influence on transpiration rates.

Parameters	Hazards	Impacts					
		Agriculture	**Groundwater/ Water Sources**	**Health and Community**	**Ecosystem (including fisheries, and livestock's)**	**Infrastructure**	**Mangroves**
		surpass 32°C. The increasing frequency and intensity of heat stress in Sindh are causing severe repercussions for agriculture.					
	Mold and Mild dew formation	Mold and mildew formation in crops have resulted in spoilage, diminishing both quality and market value. Elevated humidity significantly contributes to the spread of diseases, thus reducing agricultural productivity. Increased humidity fosters the proliferation of Shifts in insect, pest, and pathogen populations, exacerbating these problems.	Not Applicable.	Not Applicable.	Heightened humidity causing mold and mildew formation harms livestock by posing health risks, causing feed spoilage, and compromising the quality of poultry products. In cattle production, the presence of mold in grain may lead to mycoses and mycotoxicosis, resulting in diverse health issues.	Humidity can impact the functionality of structures, resulting in issues such as condensation, mildew, stains, slippery surfaces, equipment damage, and the corrosion and deterioration of infrastructure materials.	Mold and mildew formation in mangroves can have a substantial impact, contributing to the decline and disease occurrence in these vital ecosystems. Research suggests a correlation between fungal diversity in mangrove forests and plant diseases.

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Climate Baseline and Projections

Pakistan is situated in a temperate zone, showcasing a climate that varies across its diverse topography. The coastal areas and lowland plains along the Indus River experience dry and hot conditions, while the northern uplands and Himalayan regions exhibit a gradual shift to cooler temperatures. Notably, Sindh is recognized as a hot desert region.

El Niño significantly influences climate variability in Pakistan, with anomalies in temperature and flood frequency correlated with the El Niño cycle (ADB, 2021).

In developing nations like Pakistan, climate change poses a substantial impediment to progress on environmental, social, and economic fronts, leading to both voluntary and forced migrations within the country. Evident consequences include heightened droughts, increased flooding, unpredictable weather patterns, and shifts in agriculture, diminished freshwater resources, and biodiversity loss

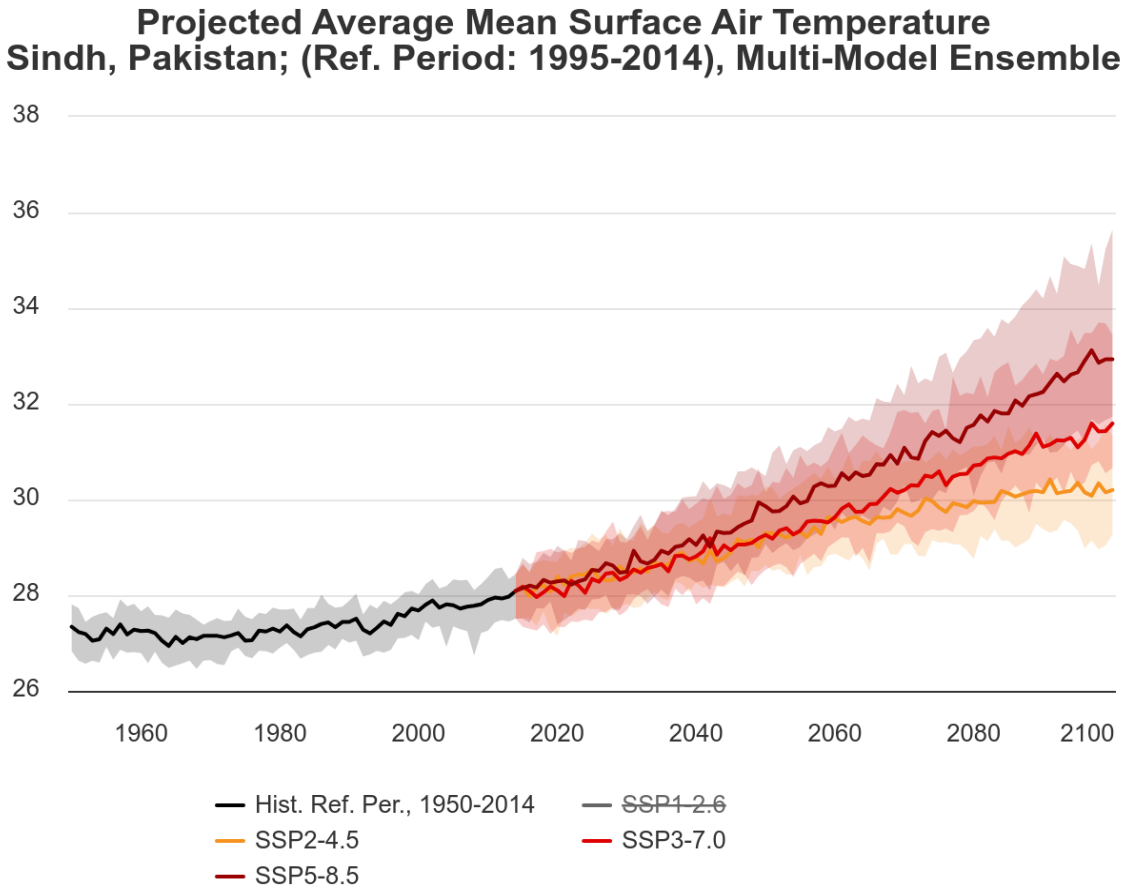
Pakistan was ranked 8th on the Long-Term Climate Risk Index by German watch in 2021. The INFORM Risk Index provides risk profiles of 191 countries and provides data on the country's human and natural hazard risks, vulnerability of the community, and coping capacity of local infrastructure and institutions. The index is divided into categories of Hazard and Exposure, Vulnerability and Lack of Coping Capacity and is numbered from 0 – 10, with a higher score representing higher risk of exposure, vulnerability or lack of coping capacity. The 2024 INFORM Risk Index for Pakistan is tabulated as follows, which places Pakistan at an overall risk level of 6.1.

Riverine Flood (0-10)	*Tropical Cyclone (0-10)*	*Drought (0-10)*	*Vulnerability (0-10)*	*Lack of Coping Capacity (0-10)*	*Overall Inform Risk Level (0-10)*	*Rank (1-191)*
9.5	7.1	3.0	5.9	5.3	6.1	23

From 1981 to 2005, the decadal mean temperature rise in the country was 0.39 ^{o}C compared to the global average (MoCC, 2018). Pakistan's vulnerability to climate change impacts is well-documented. Recurrent extreme weather events in the past decade, such as floods, droughts, cyclones, and heatwaves, have taken a toll on life, property, and economic growth. The 2010 and 2022 super flood alone caused widespread devastation, resulting in numerous casualties and substantial economic damage. The severe heatwave in 2015, primarily affecting Sindh Province, led to over 1,200 heat-related deaths. Climate parameters that led to the Impacts of climate hazards onto the environment and social hazards are given as following:

1.1 Temperature

From 1991 to 2020, Pakistan experienced an average mean surface air temperature of 21.38 °C, with Sindh specifically recording a mean average surface temperature of 27.26 °C and an average maximum surface air temperature of 34.78 °C during the same period (CCKP). Examining historical trends along with the future projections for Sindh from 1950 to 2100, with a reference period of 1995 to 2014, the graph below depicts a clear upward trajectory in mean surface air temperature over the last 70 years. Future projections indicate an even more accelerated rise in temperatures for Sindh, highlighting a concerning trend in the region.

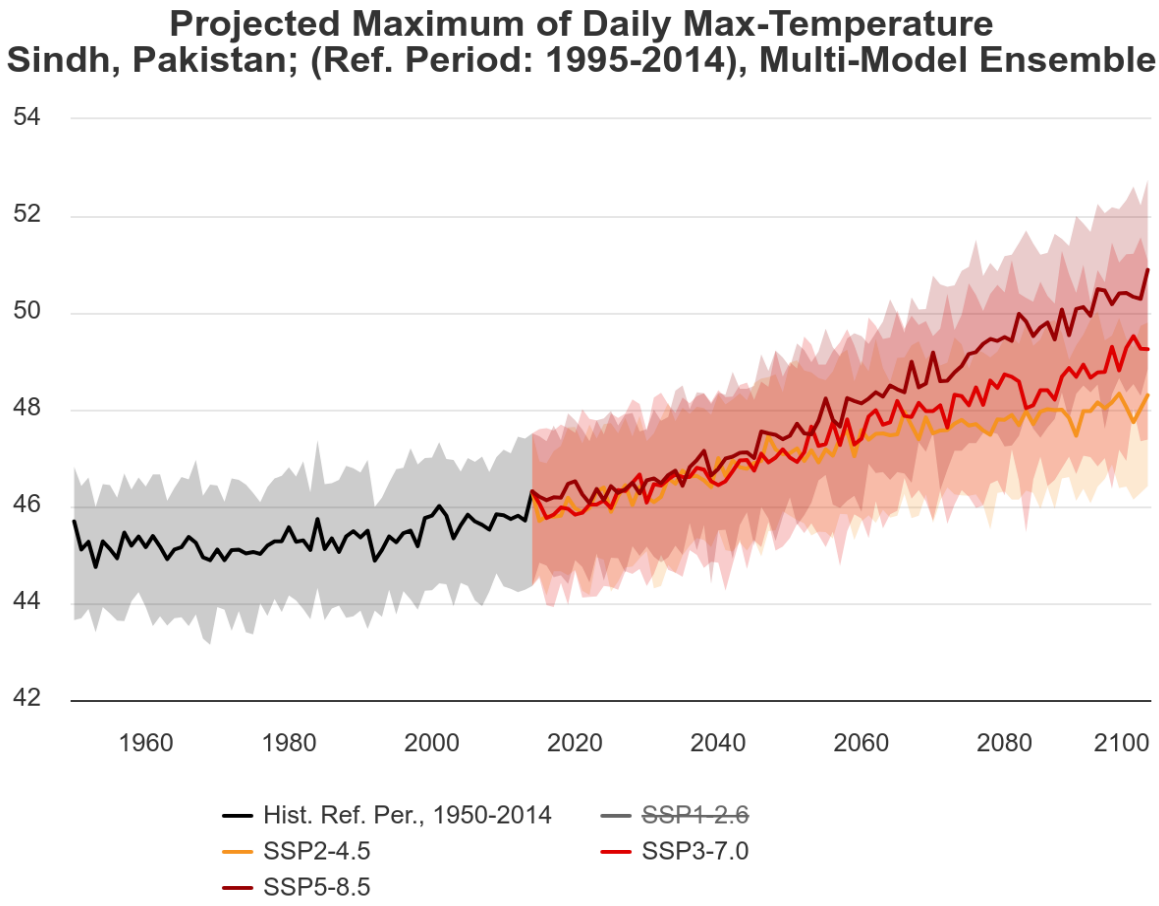


In the short-term projections (2020-2039) for Sindh, there is an expected increase in mean annual air temperature by 0.73 °C under SSP2-4.5 scenario, 0.66 °C under SSP3-7.0 scenario, and 0.85 °C under SSP5-8.5 scenario. Moving to long-term projections (2060-2079), Sindh is anticipated to experience an average mean annual air temperature rise of 1.99 °C under SSP 2-4.5, 2.43 °C under SSP3-7.0, and 3.12 °C under SSP5-8.5. The rise in temperature leads to potential hazards, exerting a significant impact on both environmental receptors and the community.

1.1.1 Extreme Temperature

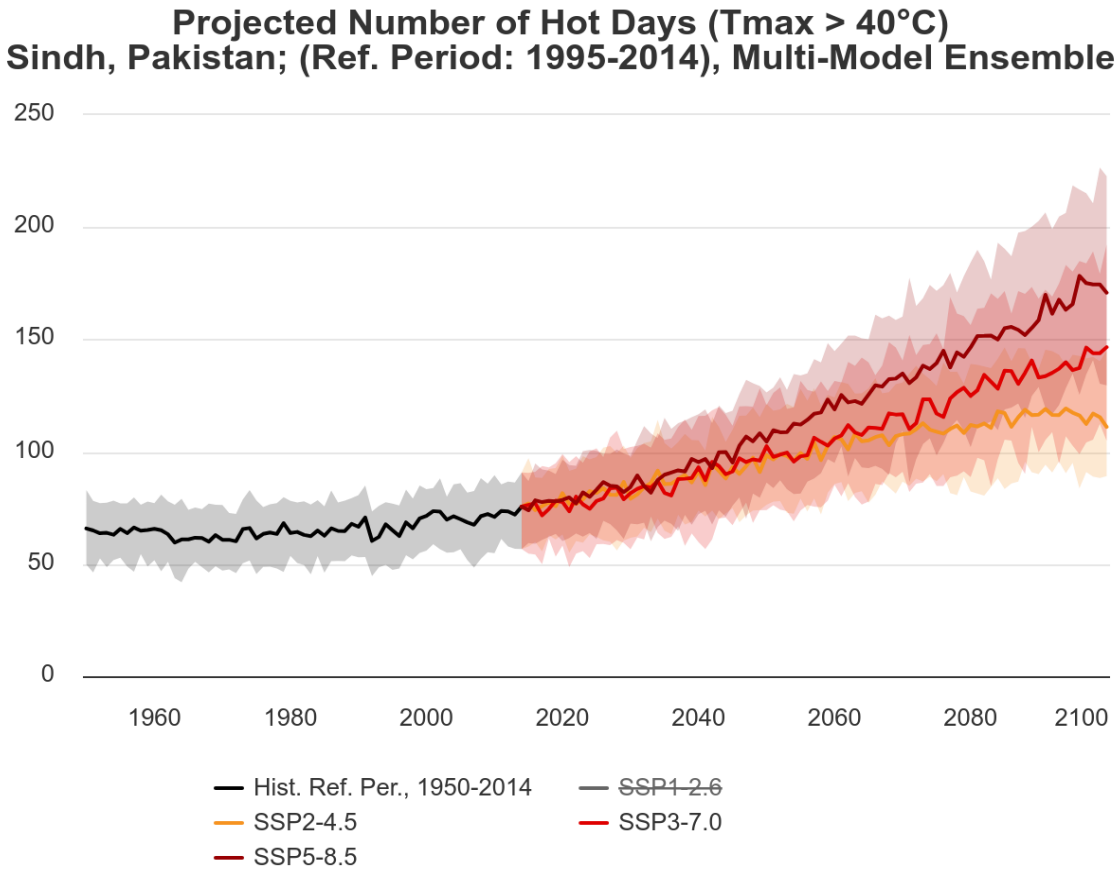
The latest report from the Intergovernmental Panel on Climate Change (IPCC, 2013) indicate that the ongoing greenhouse gas emissions will lead to increased global warming. It is virtually certain that there will be a higher frequency of hot temperature extremes over most land areas in the next fifty years, with regional variations in warming patterns. The temperatures in Thatta, Sindh are projected to rise slightly more than the global average over the next fifty years (ThinkHazard, 2020).

Analysing historical trends and future projections for Sindh from 1950 to 2100, with a reference period from 1950 to 2014, the graph below clearly illustrates an upward trajectory in the annual projected mean maximum daily temperatures over the past 70 years.



From 1995 to 2014, Sindh experienced an annual average extreme temperature of 45.7 ºC. Short-term projections (2020-2039) for Sindh, using the reference period of 1995-2014, indicate an expected rise in annual mean maximum daily temperatures by 0.56 ºC under SSP2-4.5 scenario, 0.67 ºC under SSP3-7.0 scenario, and 0.68 ºC under SSP5-8.5 scenario. Looking ahead to long-term projections (2060-2079) with the same reference period, Sindh is projected to undergo an average annual maximum daily temperature increase of 1.94 ºC under SSP 2-4.5, 2.37 ºC under SSP3-7.0, and 3.10 ºC under SSP5-8.5.

Furthermore, the analysis for the number of hot days (Tmax > 40 °C) from 1995 to 2100, with the reference period of 1995-2014 is shown below.

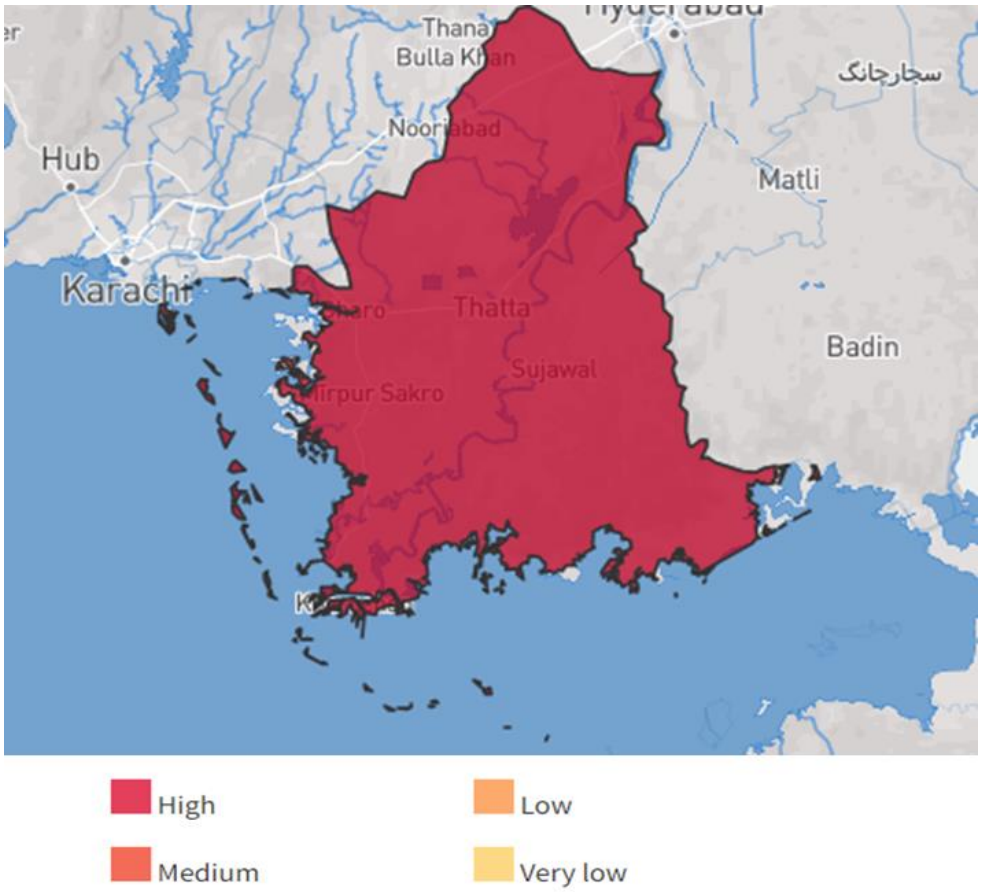


In the reference period, Sindh experienced an annual average of 71 days with extreme heat. In the short-term projections (2020-2039) for Sindh, the mean annual hot days (Tmax > 40°C) is projected to increase to 83 days under SSP2-4.5 scenario, 81 days under SSP3-7.0 scenario, and 85 days under SSP5-8.5 scenario. Looking ahead to long-term projections (2060-2079), Sindh is anticipated to witness an average annual rise in the hot days (Tmax > 40°C) to 106 days under SSP 2-4.5, 115 days under SSP3-7.0, and 131 days under SSP5-8.5.

1.1.2 Heat Waves

Heat wave is defined as a period of 3 or more days where the daily temperature is above the long-term moving 95th percentile of daily mean temperature. The Thatta District has been classified at high risk of extreme heat. This means that prolonged exposure to extreme heat and heat waves, resulting in heat stress, is expected to occur at least once in the next five years (ThinkHazard, 2020). Extreme heat hazards are assessed using the daily maximum Wet Bulb Globe Temperature (WBGT), a widely acknowledged indicator with relevance for human health and multiple sectors, including infrastructure. Studies commonly employ thresholds like <28°C (slight/low), 28-32°C (moderate/high), and >32°C (severe/very high)

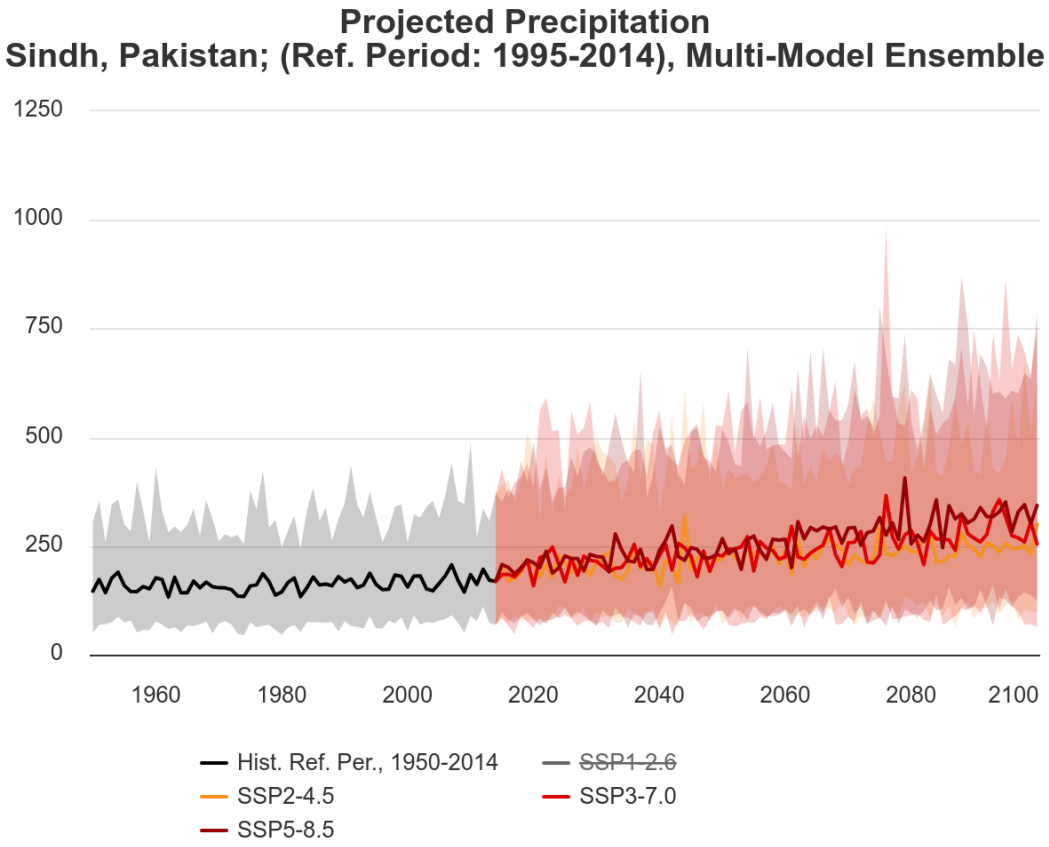
to classify heat stress risk. This influences design decisions and underscores the considerable impact on personnel and stakeholders (World Bank, 2017).



According to the ADB Climate Risk Profile for Pakistan, short-term projections from 2020 to 2039 under RCP 8.5 suggest a 5% likelihood of a heat wave occurring anywhere in the country. In the long term, spanning from 2060 to 2079 under the same scenario, there is an expected increase in the probability of a heat wave to approximately 18% across Pakistan.

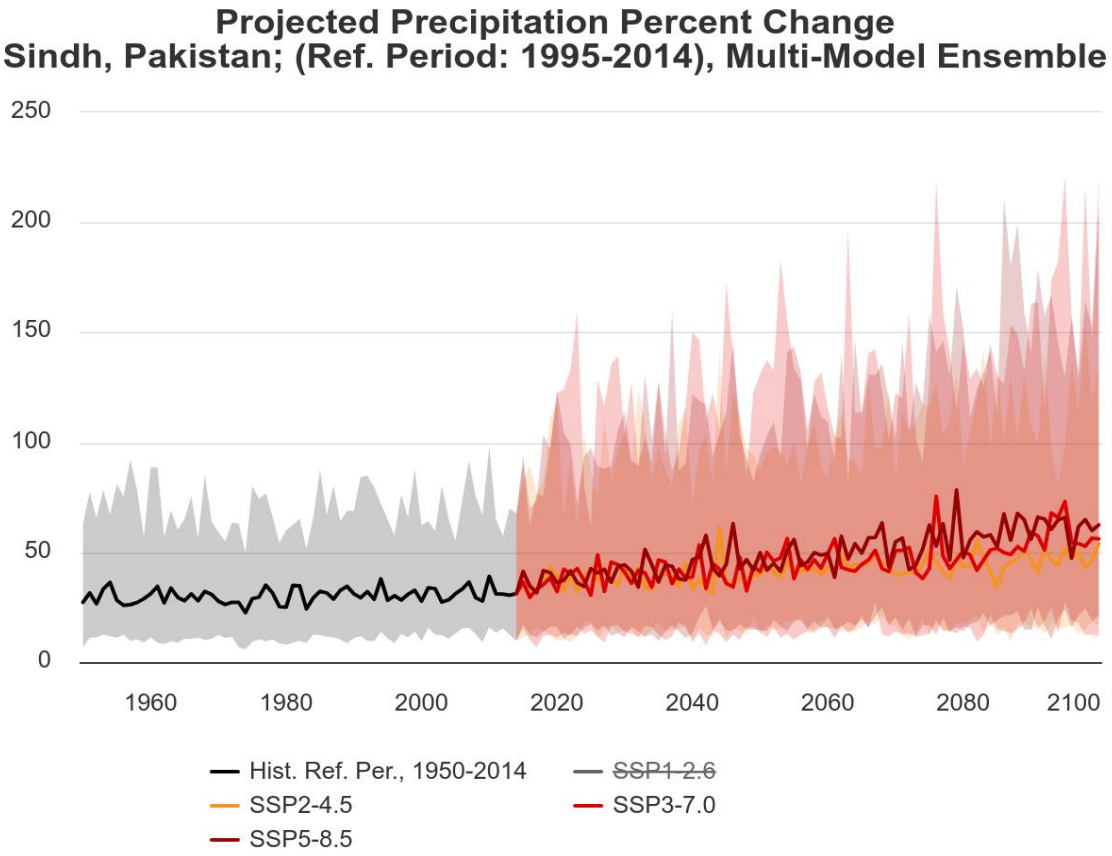
1.2 Precipitation

From 1991 to 2020, Pakistan experienced an average precipitation of 289 mm, with Sindh recording an average of 158 mm during the same period. The graph below illustrates the historical trend and future projections for the average annual precipitation in Sindh from 1950 to 2100, with a reference period of 1995 to 2014. These projections indicate a trend towards heightened precipitation levels in Sindh over both short-term and long-term periods, considering various Shared Socioeconomic Pathways (SSPs).



In the short-term projections (2020-2039) for Sindh, under the SSP 2-4.5 scenario, annual precipitation is anticipated to rise to 223 mm, while SSP3-7.0 forecasts an increase up to 231 mm, and SSP 5-8.5 suggests a rise up to 236 mm. Looking at long-term projections (2060-2079), SSP2-4.5 predicts an annual precipitation increase up to 260 mm, SSP3-7.0 forecasts a rise up to 269 mm, and SSP5-8.5 projects the rise up to 290 mm.

The projected precipitation percent change for Sindh under different Shared Socioeconomic Pathways (SSPs) with a reference period from 1995 to 2014 is illustrated below.

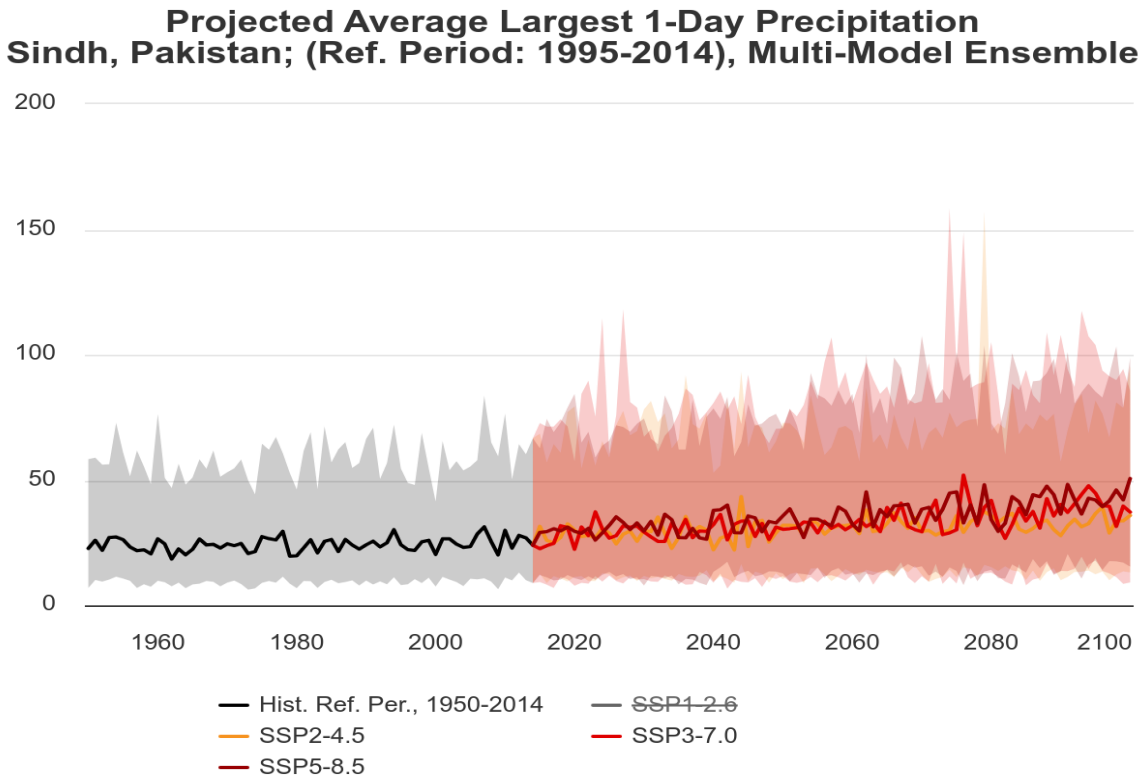


From 2020 and 2039, short-term projections for precipitation percent change in Sindh under SSP2-4.5 indicates a 9% increase, SSP3-7.0 suggests a 12% rise, and SSP5-8.5 forecasts the rise up to 13%. In the long term (2060-2079), more significant shifts are projected, under SSP2-4.5 a 17% rise is expected, SSP3-7.0 forecasts a 22% increase, and SSP5-8.5 projects a 25% increase.

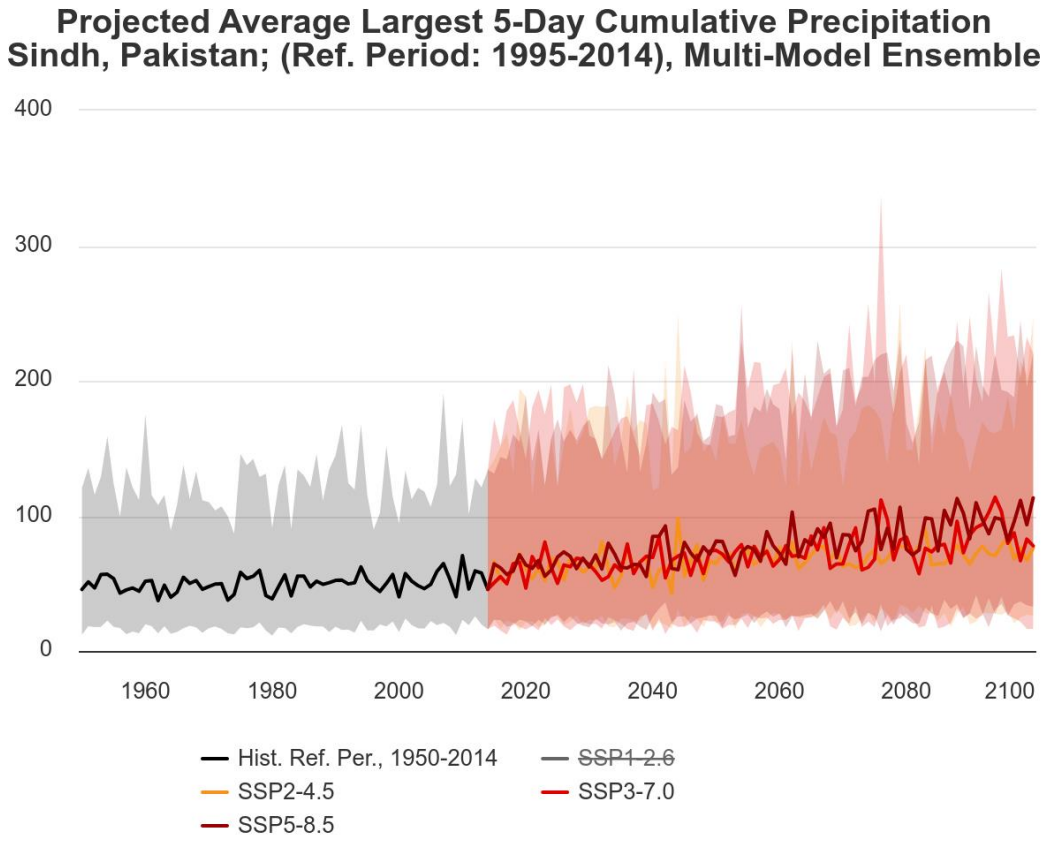
The escalation in precipitation gives rise to potential hazards, exerting a substantial impact on both environmental components and the local community.

1.2.1 Extreme Precipitation

Historical trends and future projections for an average largest 1-day cumulative precipitation in Sindh from 1950 to 2100, with a reference period from 1950 to 2014, are shown below. From 1995 to 2014, Sindh experienced an average largest 1-day cumulative precipitation of 25 mm, with the highest 90th percentile reaching 59.34 mm.



Projections indicate an expected increase in this metric. In the short term (2020-2039), under SSP 2-4.5 and SSP3-7.0, Sindh is expected to witness a 6 mm rise, while SSP5-8.5 projects a 5 mm increase. Looking to the long term (2060-2079), under SSP 2-4.5, a 13 mm increase is projected, SSP3-7.0 anticipates a 16 mm rise, and under SSP5-8.5, a significant 23 mm increase is expected. Sindh's average largest 5-day cumulative precipitation historical trends and future projections from 1950 to 2100, with a reference period from 1950 to 2014, is also illustrated in the following charts.



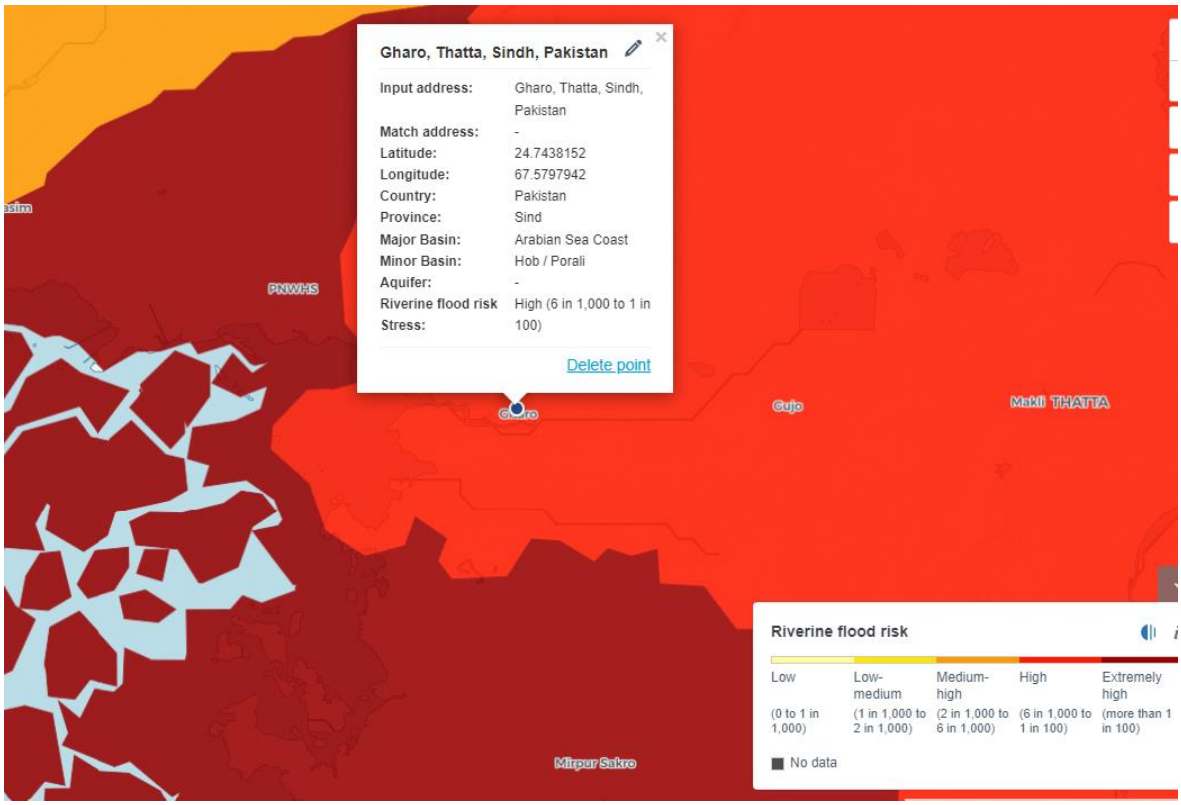
From 1995 to 2014, Sindh experienced its highest average 5-day cumulative precipitation at 51.96 mm, with the 90th percentile measuring 124.05 mm. Future projections indicate a rising trend in the largest average 5-day cumulative precipitation. In the short term (2030-2039), it is expected to increase by 38 mm under SSP 2-4.5, 31 mm under SSP 3-7.0, and 36 mm under SSP5-8.5. For the long term (2060-2079), projections expect an increase of 56 mm under SSP 2-4.5, 71 mm under SSP 3-7.0, and 87 mm under SSP5-8.5.

1.2.2 Floods

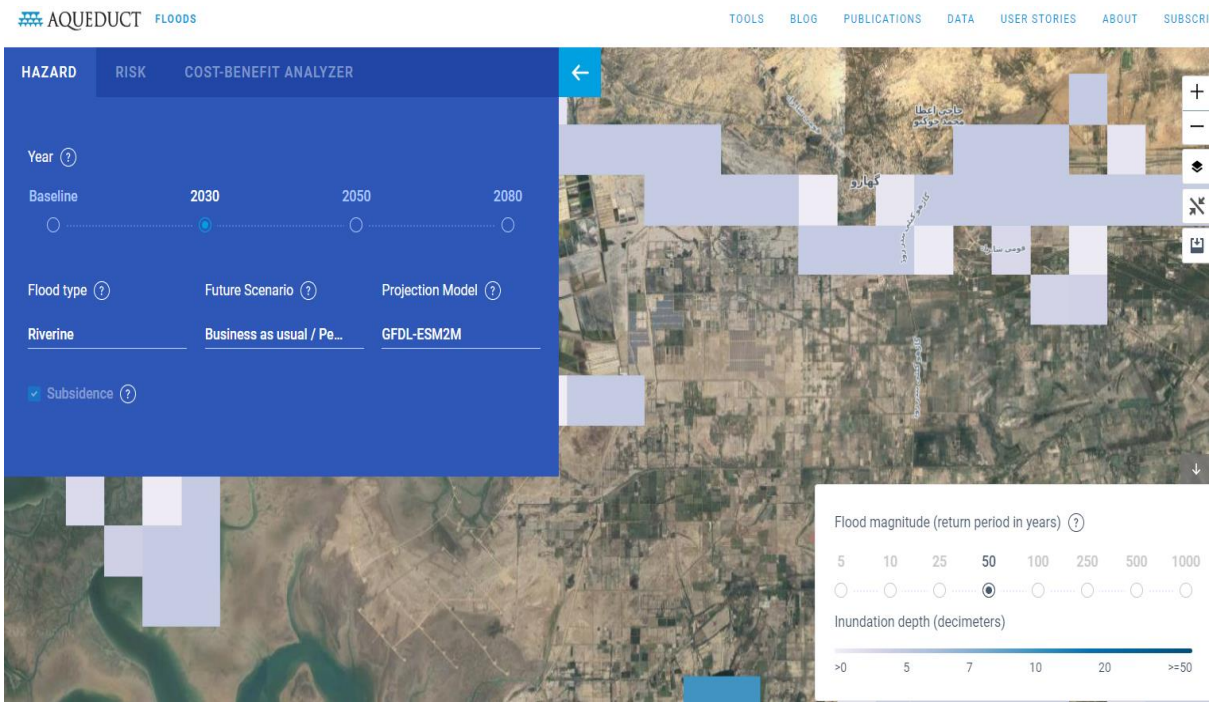
In the last two decades, Pakistan has faced increased flood occurrences, notably in 2010 and 2022, causing substantial damage, particularly in Sindh.

a. Riverine Floods:

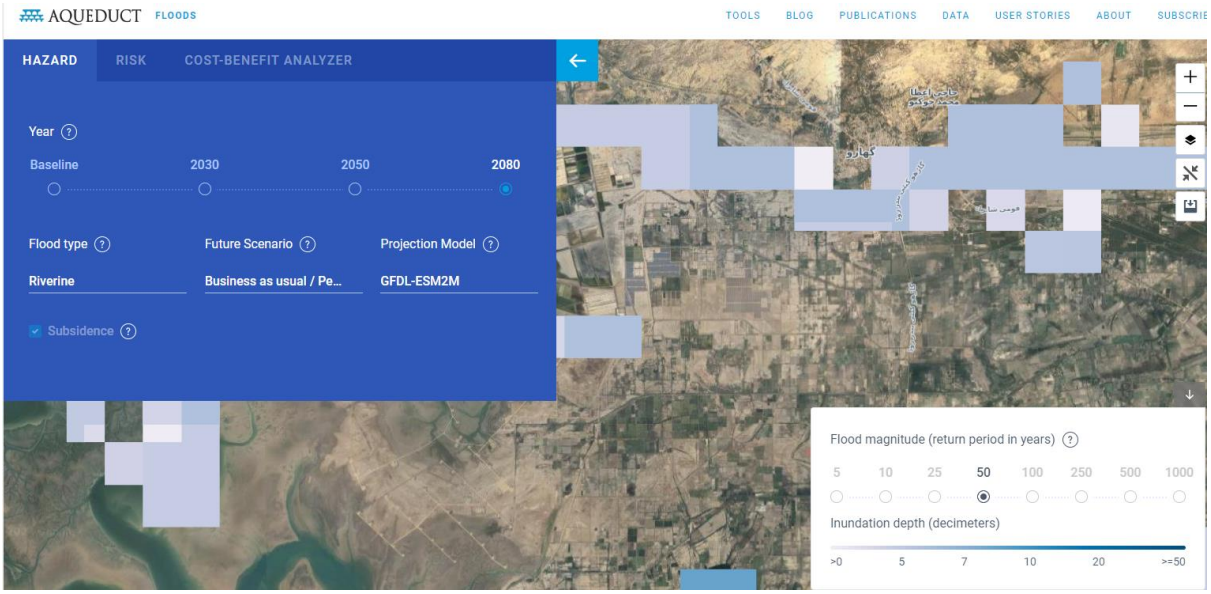
According to the 2010 baseline data from the Aqueduct tool, riverine floods led to flooding 1.25 km north of the project area. The map below illustrates the risk of riverine flooding as high in the Gharo region.



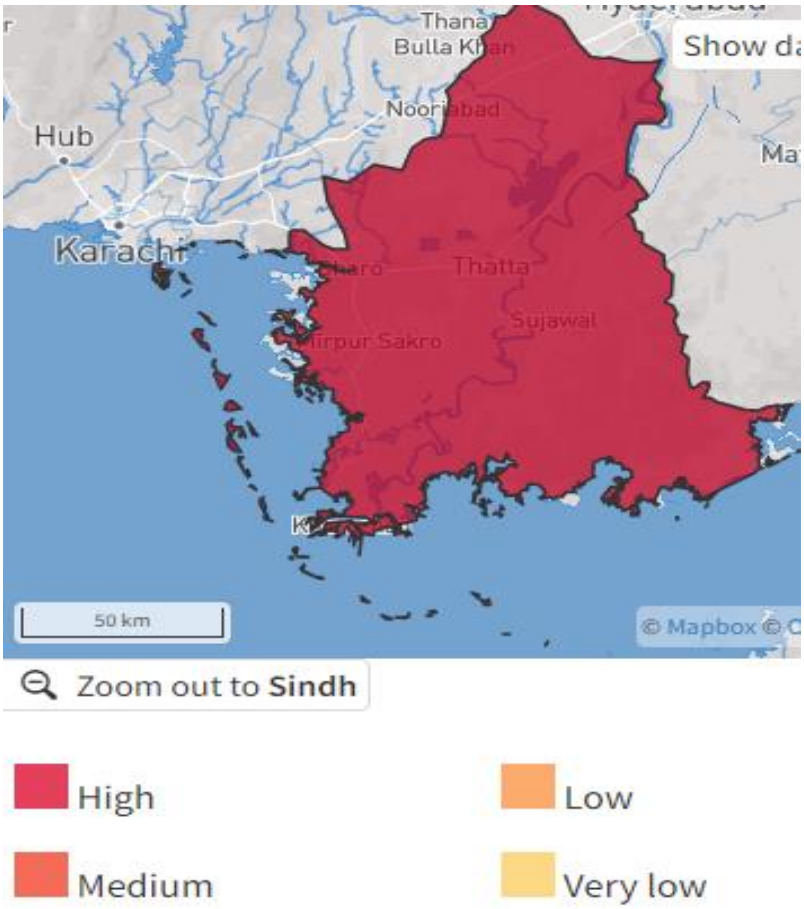
Although the projected inundation area around the project is expected to stay the same, there is an anticipated increase in inundation depths in the future as shown in the following figure.



In this assessment, we considered the 50-year flood magnitude return period (A 5-year flood (20% probability) is less severe than a 50-year flood (2% probability)-Aqueduct tool). Looking ahead to 2030 and 2080 as shown below, under the SSP 3 RCP-8.5 (Business as usual) scenario, riverine flood intrusion is expected to be 1.29 km away from the project area, with an increase in inundation depth by 2080.



Riverine floods are also defined as the overflow of river channels resulting from sustained or intense rainfall, excluding surface runoff and flood protection measures from consideration. The hazard level for river floods in Thatta is categorized as 'High,' as shown in the given map indicating an expectation of potentially damaging and life-threatening river floods occurring at least once in the next 10 years (ThinkHazard, 2020).



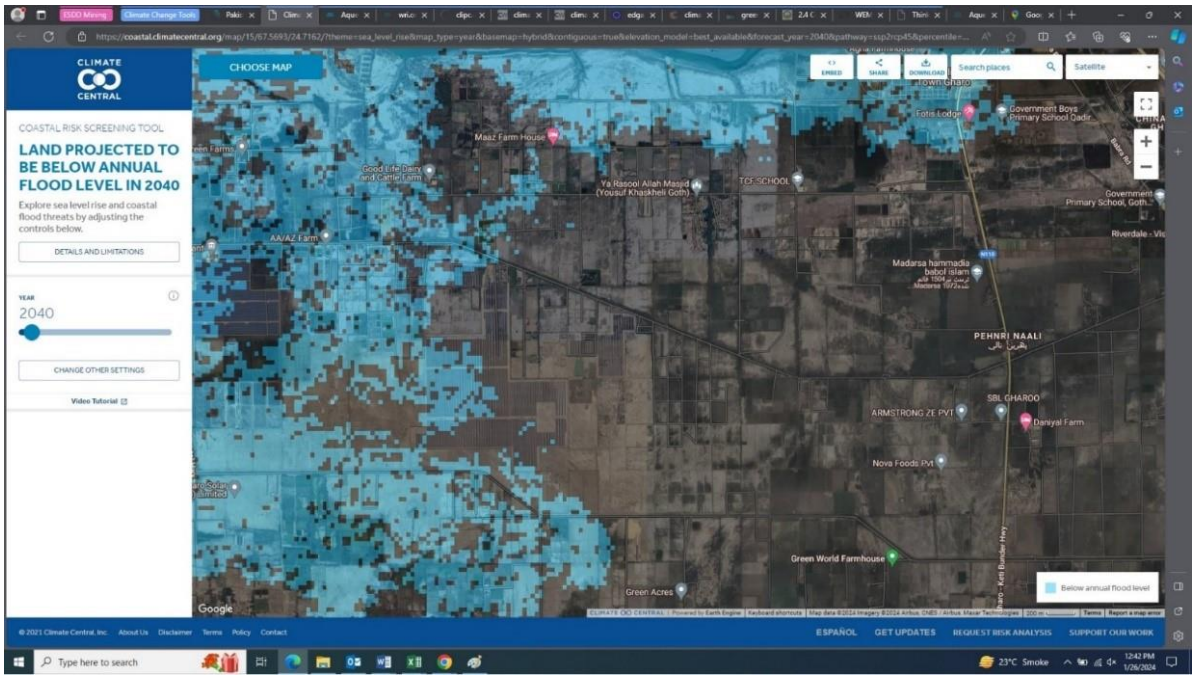
b. Coastal Floods:

Coastal inundation refers to the flooding occurring due to abnormal rise in seawater level, as a result of coastal storm surge event. **Error! Reference source not found.** illustrates the risk of coastal flooding as medium high in the Gharo region.

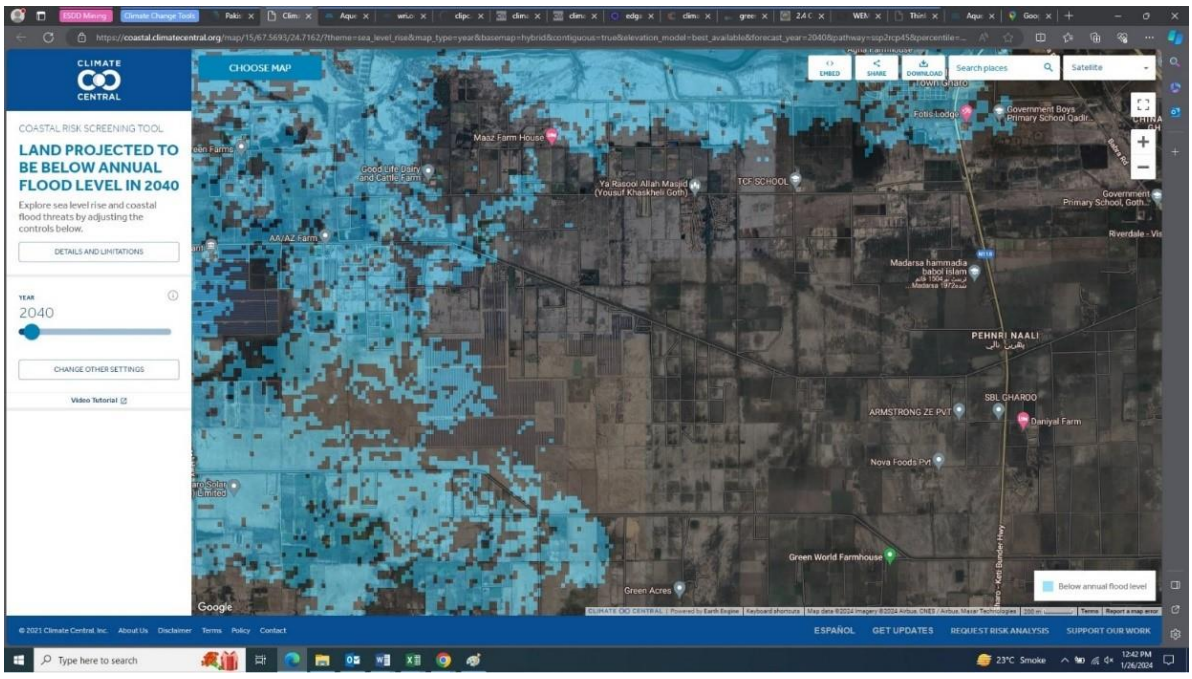
Based on the 2010 coastal flood information, inundation due to coastal floods was about 5 km away from the project area (Aqueduct).

According to Aqueduct tool, the assessment considered future sea level change simulations from the RISES-AM project, focusing on the 50-year flood magnitude return period (a 5-year flood (20% probability) is less severe than a 50-year flood (2% probability)). The analysis also considers human-induced subsidence, defined as land lowering due to groundwater extraction. The projected inundation from coastal floods is expected to advance into the project region as illustrated in **Error! Reference source not found.**. This also indicates that riverine flood intrusion is expected to be 1.68 km away from the project area, with an increase in inundation depth by 2080 while simulating for 2030 and 2080, under the SSP 3 RCP-8.5 (Business as usual) scenario.

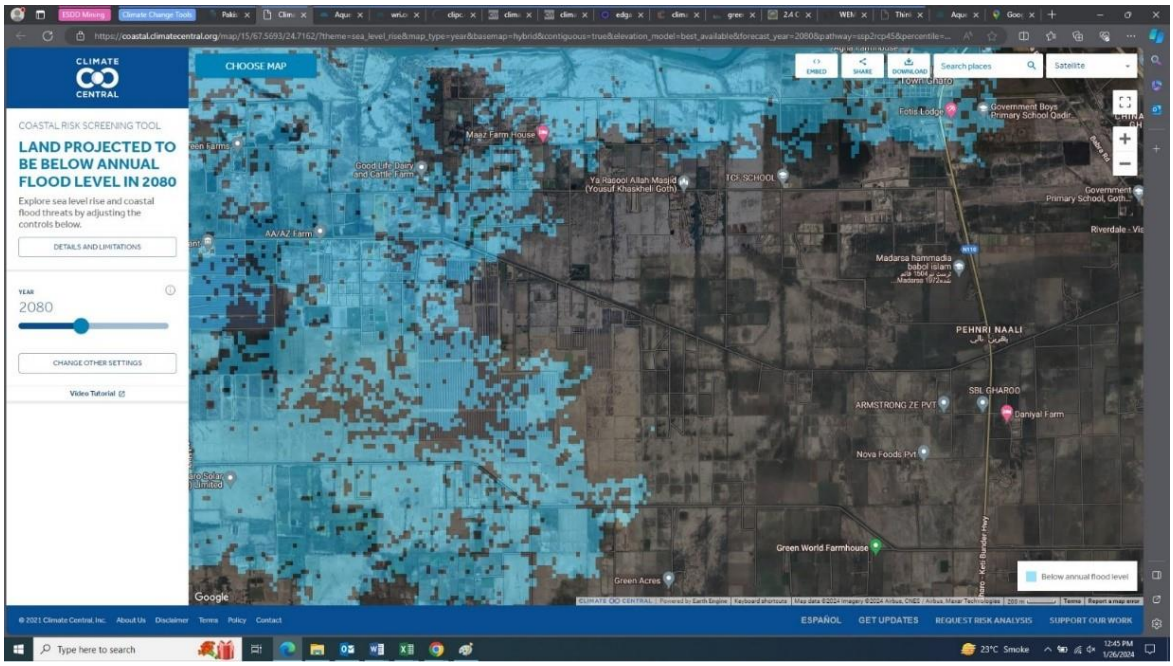
According to the Climate Central- Coastal Risk Screening Tool shown below, anticipated intrusion from annual floods and rising sea levels is expected in the project area.



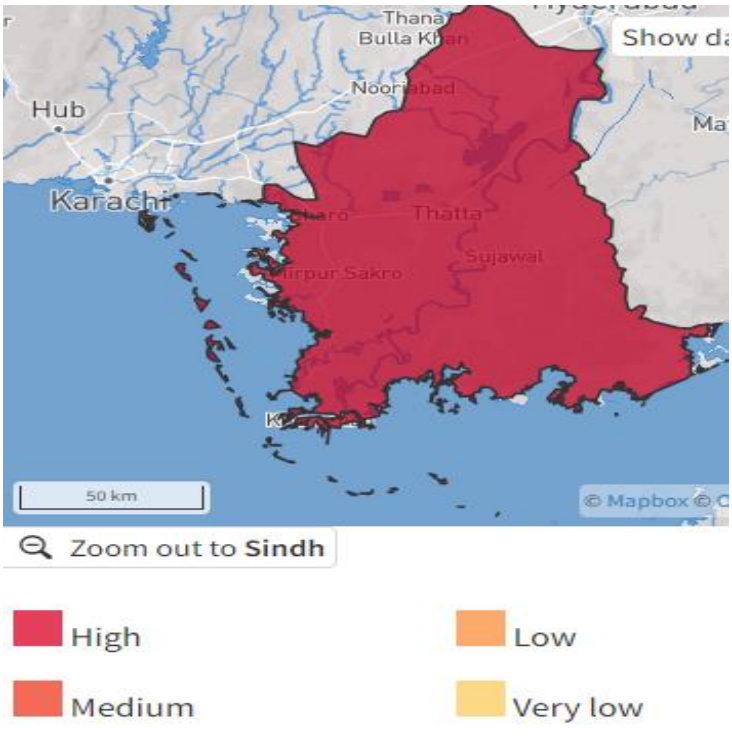
The projections reflect that in 2040, under SSP 2-4.5 and SSP 5-8.5 scenarios, coastal and creek waters are expected to flood the land approximately 1.54 km from the project area by 2040.



Moreover, the creek waters are anticipated to flood the land approximately about 1.51 km from the project area by 2080 as shown below.



Thatta is categorized as having a hazard level of 'High' for coastal floods as shown below. This is an indicator of potentially-damaging waves expected to flood the coast at least once in the next 10 years (ThinkHazard, 2020).



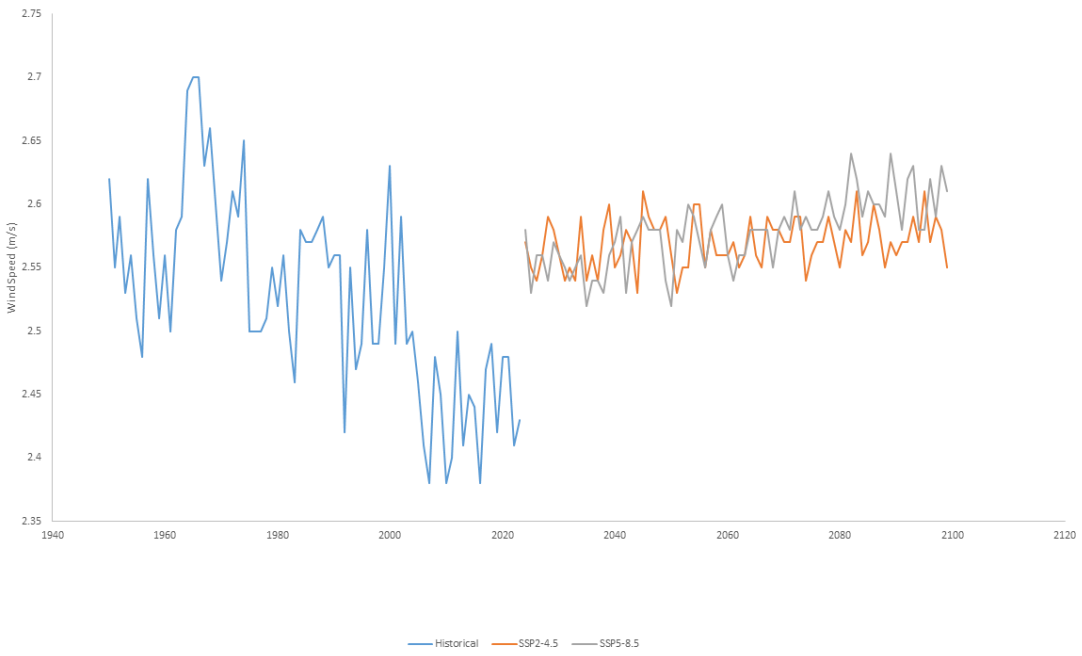
Coastal flood is described as onshore flooding due to high tides, storm surge (due to high winds and low pressure), and wave set-up (energy transfer from offshore waves to the coast). Flood protection measures are not included in this assessment. Extremes in sea levels are projected to rise with increasing global mean sea levels.

1.3 Wind

From 1950 to 2023, Pakistan maintained an average wind speed of 2.43 m/s. Sindh, situated in the southern part of the country and renowned for its coastal areas and the Gharo-Jhimpir wind corridor, has been a focal point for wind resource assessment (Pakistan Meteorological Department).

In the Wind Mapping Project aimed at energy generation along the Sindh coast, including Thatta, data collected from September 2003 to August 2005 indicated annual average wind speeds at 50 meters reaching 6.7 m/s in Thatta and 6.6 m/s in Gharo. Thatta experiences fluctuating wind speeds throughout the year, peaking from April to September, with average speeds surpassing 8.6 m/s. The wind patterns in Sindh, influenced by temperature and topography, demonstrate higher speeds, particularly during the monsoon season. Projections indicate an anticipated increase in the average wind speed in the future (PMD, 2013). The average wind speed is expected to increase in the future.

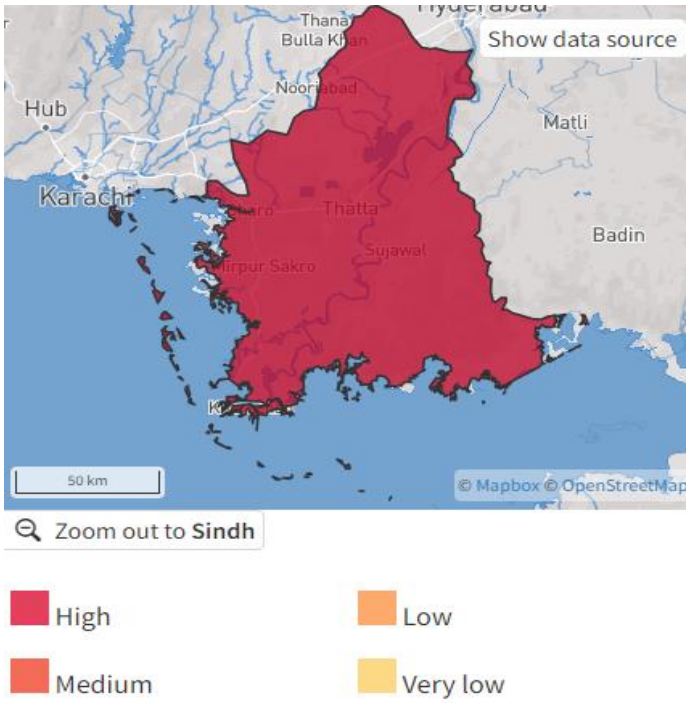
The graph below illustrates the historical trend and future projections for Average Annual Wind Speed in Pakistan. In 2040, Pakistan's average wind speed is expected to be 2.55 m/s under SSP2-4.5 scenario and 2.57 m/s under SSP5-8.5 scenario. By 2080, the average wind speed is projected to remain at 2.55 m/s under SSP2-4.5, while SSP5-8.5 envisions an increase to 2.88 m/s.



1.3.1 Strong Wind / Breeze

From 2018-2023, SUPARCO's records indicate that the prevailing robust sea winds, originating mainly from the west and southwest during June to September, exhibited an

average speed of 7-10 m/s. The district is categorized at High risk due to prevalence of strong winds as shown below.



1.3.2 Storms and Cyclones

An assessment of hurricane and cyclone hazards in Thatta carried out by (ThinkHazard, 2020), focused on the frequency of damaging tropical cyclone winds and excluding storm surges. Thatta is categorized with a High cyclone hazard as illustrated in **Error! Reference source not found.**, projecting a likelihood of over 20% for potentially damaging wind speeds in the coming decade. It's essential to note that damages may result not only from winds but also from cyclone-induced heavy rainfall, flooding, and coastal floods in coastal areas.

Looking forward, global projections suggest an increase in tropical cyclone wind speed and rainfall, with an anticipated decrease or stability in overall cyclone frequency. However, specific ocean regions may experience a substantial rise in the frequency of the most intense cyclones. This highlights the potential for heightened hazard levels in areas currently impacted by tropical cyclones (IPCC, 2013).

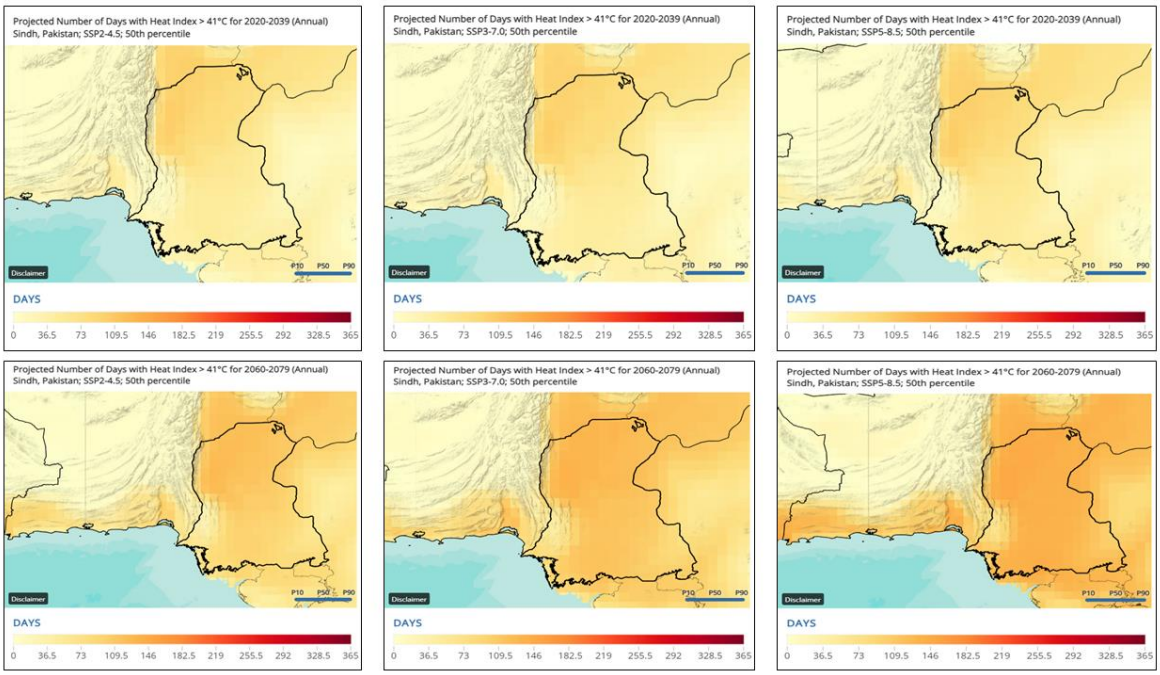
1.4 Humidity

Elevated humidity in Thatta has adverse effects on both individuals and the environment.

1.4.1 Heat Stress (Days with Heat Index > 41 °C)

The heat index, reflecting perceived temperature when humidity is considered, is assessed for future projections in Sindh using CCKP.

Between 1995 and 2014, Sindh experienced an average of 33.22 days annually with a heat index exceeding 41 °C. Future projections indicate a notable increase in these occurrences as illustrated below. Projections for 2020-2039 under different scenarios (SSP 2-4.5, SSP 3-7.0, SSP5-8.5) indicate rises to 58.15, 57.06, and 61.36 days, respectively. Long-term projections (2060-2079) anticipate further increases, reaching averages of 96.49, 111.19, and 130.33 days under the same scenarios.



1.4.2 Mold and Mildew Formation

Mold and mildew are forms of fungi, flourish in humid conditions.

1.5 References

MoCC. (2018). *Second National Communication of Climate Change*. Ministry of Climate Change, Government of Pakistan. http://www.gcisc.org.pk/SNC_Pakistan.pdf

PMD. (2013). *An Investigation on Wind Power Potential of Sindh*. Pakistan Meteorological Department.

ThinkHazard. (2020). *Thatta District Report*. GFDRR.

World Bank. (2017). *EH-GLOBAL-VITO-5*. Geonode-Gfdrrlab.Org. https://www.geonode-gfdrrlab.org/layers/hazard:intensity_returnperiod5y

World Bank Group - Climate Change Knowledge Portal - https://climateknowledgeportal.worldbank.org/country/pakistan/climate-data-projections

APPENDIX G – BORELOGS

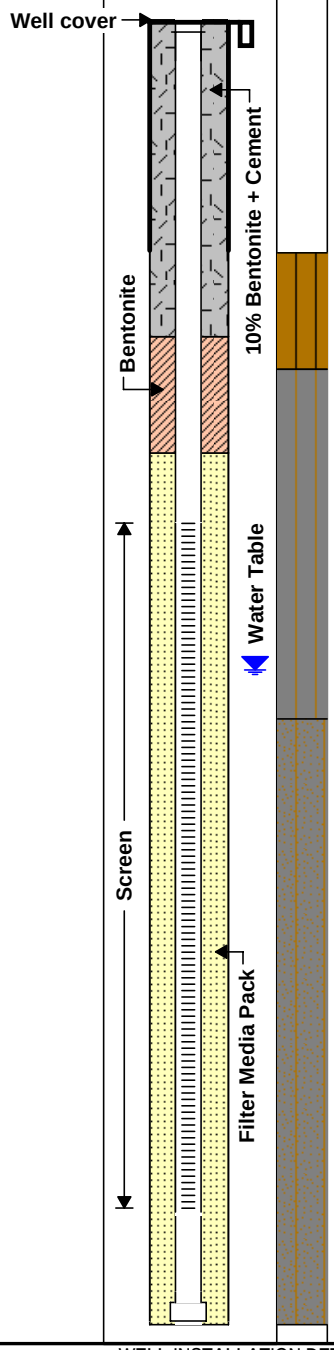
SOIL BORE / MONITORING WELL LOG MW-AZE-01

PROJECT ID: AZE | **COMPLETION DATE: 19 Jan 24** | **BORE LOG ID: SB-AZE-01**

SITE ID: AZE | **LOGGER: M.Rehan Uddin** | **NORTHING: 24°42'42.34"**

TOW ELEVATION: 99.352 | **DRILLER: Ahmed & Abdur Rehman** | **EASTING: 67°35'30.41"**

DATE	TIME	SOIL SAMPLE ID	DESCRIPTION	ODOR	PID (ppm)	REMARKS
			Ground Surface			
19 Jan 24	11:35	SB-AZE-01-05	Wet Brown Low Plasticity Silt with Sands (ML)	Odorless	0.2	U
19 Jan 24	11:45	SB-AZE-01-10	Wet Greyish -Brown Low Plasticity Silt with Sands (ML)	Odorless	0.0	U
19 Jan 24	12:00	SB-AZE-01-20		Odorless	0.0	U
19 Jan 24	12:15	SB-AZE-01-30	Wet Greyish -Brown Silty sands (SM)	Odorless	0.4	D
19 Jan 24	12:25	SB-AZE-01-40		Odorless	0.0	D



BORING DETAILS:

Bore Hole Diameter: 100 mm

Total Depth: 4.6 mbgs

Bore Hole Converted To: MW-AZE-01

Dry Auger: 0 mbgs to 1.8 mbgs

Rock Drilling: -

First Occurrence of Groundwater: 1.8 mbgs

Actual Groundwater Level (Before Purging): 1.790

WELL INSTALLATION DETAILS:

Diameter: 50 mm

Monitoring Well Depth: 4.590 mbgs

Screen: 1.160 mbgs to 4.120 mbgs

Filter Media Pack: 0.860 mbgs to 4.6 mbgs

Bentonite Seal: 0.360 mbgs to 0.860 mbgs

SR Cement + 10% Bentonite: 0 mbgs to 0.360 mbgs

Ground Completion: 1.0 mbgs

REMARKS:

U: Undisturbed sample
D: Disturbed sample
LS: Sample sent for laboratory analysis
WT: Water first encountered
SW: Static water level
RD: Start of rock drilling
ED: End of rock drilling

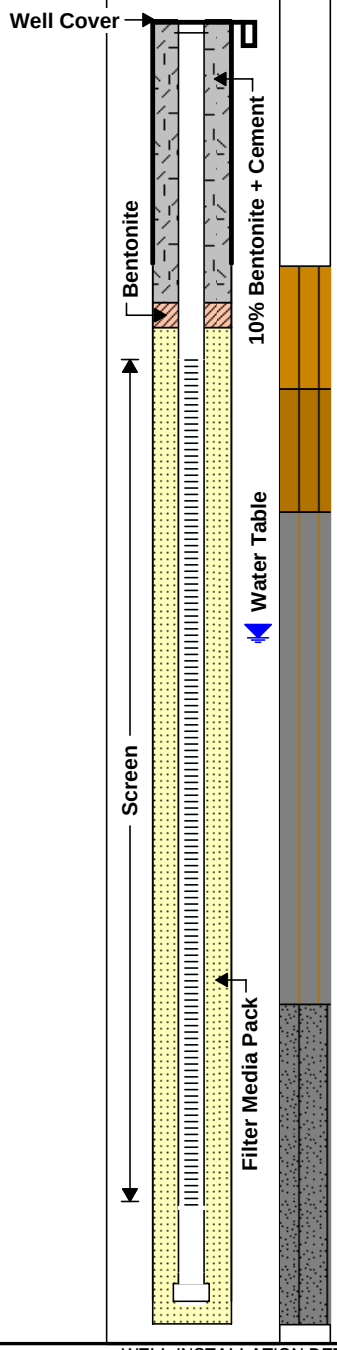
SOIL BORE / MONITORING WELL LOG MW-AZE-02

PROJECT ID: AZE | **COMPLETION DATE: 20 Jan 24** | **BORE LOG ID: SB-AZE-02**

SITE ID: AZE | **LOGGER: M.Rehan Uddin** | **NORTHING: 24°42'47.78"**

TOW ELEVATION: 99.263 | **DRILLER: Mujahid & Mulazim** | **EASTING: 68°42'59.65"**

DATE	TIME	SOIL SAMPLE ID	DESCRIPTION	ODOR	PID (ppm)	REMARKS
			Ground Surface			
20 Jan 24	11:35	SB-AZE-02-05	Moist Brown Low Plasticity Silt with Sands (ML)	Odorless	0.4	U
20 Jan 24	11:45	SB-AZE-02-10	Wet Brown Low Plasticity Silt with Sands (ML)	Odorless	0.2	U
20 Jan 24	11:55	SB-AZE-02-20	Wet Greyish -Brown Low Plasticity Silt with Sands (ML)	Odorless	0.7	U
20 Jan 24	12:10	SB-AZE-02-30	Wet Grey Silty sands (SM)	Odorless	0.4	D
20 Jan 24	12:25	SB-AZE-02-40		Odorless	0.3	D



BORING DETAILS:

Bore Hole Diameter: 100 mm

Total Depth: 4.300 mbgs

Bore Hole Converted To: MW-AZE-02

Dry Auger: 0 mbgs to 1.8 mbgs

Rock Drilling: -

First Occurrence of Groundwater: 1.80mbgs

Actual Groundwater Level (Before Purging): 1.510 mbgs

WELL INSTALLATION DETAILS:

Diameter: 50 mm

Monitoring Well Depth: 4.210 mbgs

Screen: 0.380 mbgs to 3.820 mbgs

Filter Media Pack: 0.250 mbgs to 4.300 mbgs

Bentonite Seal: 0.150 mbgs to 0.250 mbgs

SR Cement + 10% Bentonite: -1 mbgs to 0.150 mbgs

Ground Completion: 1.0 mbgs

REMARKS:

U: Undisturbed sample
D: Disturbed sample
LS: Sample sent for laboratory analysis
WT: Water first encountered
SW: Static water level
RD: Start of rock drilling
ED: End of rock drilling

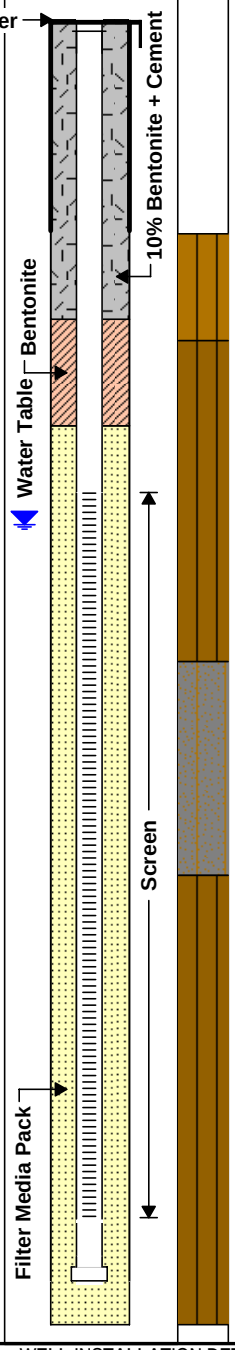
SOIL BORE / MONITORING WELL LOG MW-AZE-03

PROJECT ID: AZE | **COMPLETION DATE: 18 Jan 24** | **BORE LOG ID: SB-AZE-03**

SITE ID: AZE | **LOGGER: M.Rehan Uddin** | **NORTHING: 24°42'47.24"**

TOW ELEVATION: 100.00 | **DRILLER: Ahmed & Abdur Rehman** | **EASTING: 67°35' 14.89"**

DATE	TIME	SOIL SAMPLE ID	Well	LEGEND	DEPTH (M)	DESCRIPTION	ODOR	PID (ppm)	REMARKS
			Well Cover; 10% Bentonite + Cement; Bentonite; Water Table; Screen; Filter Media Pack		-1				
					0	Ground Surface			
18 Jan 24	11:50	SB-AZE-03-05				Moist Brown Low Plasticity Silt with Sands (ML)	Odorless	0.1	U
18 Jan 24	12:00	SB-AZE-03-10			1	Wet Brown Low Plasticity Silt with Sands (ML)	Odorless	0.0	U
18 Jan 24	12:10	SB-AZE-03-20			2		Odorless	0.0	U
18 Jan 24	12:30	SB-AZE-03-30			3	Wet Greyish -Brown Silty sands (SM)	Odorless	0.0	D
18 Jan 24	12:40	SB-AZE-03-40			4	Wet Brown Clayey Silts (ML)	Odorless	0.0	D
18 Jan 24	12:50	SB-AZE-03-50			5		Odorless	0.1	D



BORING DETAILS:

Bore Hole Diameter: 100 mm

Total Depth: 5.100 mbgs

Bore Hole Converted To: MW-AZE-03

Dry Auger: 0 mbgs to 1.5 mbgs

Rock Drilling: -

First Occurrence of Groundwater: 1.5 mbgs

Actual Groundwater Level (Before Purging): 2.360 mbgs

WELL INSTALLATION DETAILS:

Diameter: 50 mm

Monitoring Well Depth: 4.9 mbgs

Screen: 1.21 mbgs to 4.61 mbgs

Filter Media Pack: 0.9 mbgs to 5.1 mbgs

Bentonite Seal: 0.4 mbgs to 0.9 mbgs

SR Cement + 10% Bentonite: -1 mbgs to 0.4 mbgs

Ground Completion: 1 mbgs

REMARKS:

U: Undisturbed sample
D: Disturbed sample
LS: Sample sent for laboratory analysis
WT: Water first encountered
SW: Static water level
RD: Start of rock drilling
ED: End of rock drilling

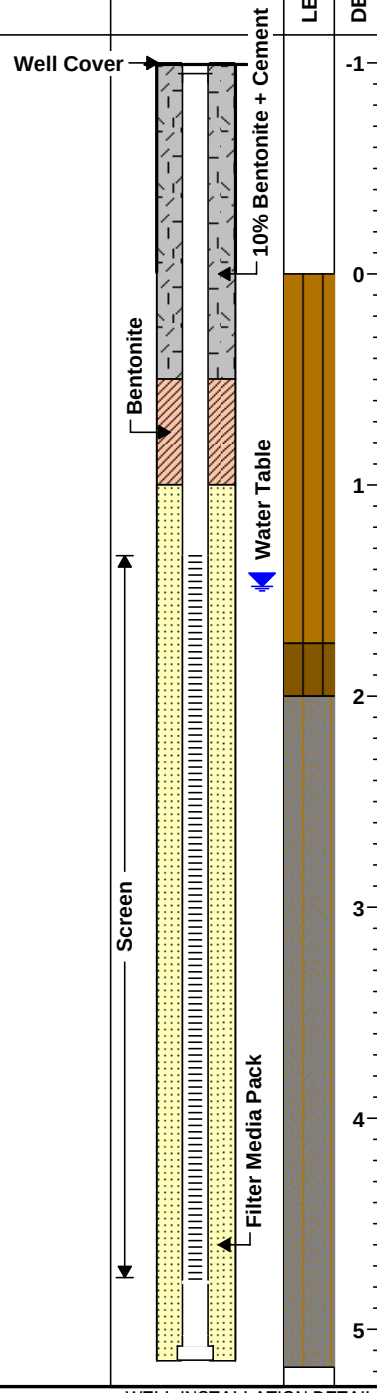
SOIL BORE / MONITORING WELL LOG MW-AZE-04

PROJECT ID: AZE | **COMPLETION DATE: 17 Jan 24** | **BORE LOG ID: SB-AZE-04**

SITE ID: AZE | **LOGGER: M.Rehan Uddin** | **NORTHING: 24°42'39.23"**

TOW ELEVATION: 100.006 | **DRILLER: Ahmed & Mulazim** | **EASTING: 67°35'09.26"**

DATE	TIME	SOIL SAMPLE ID	ODOR	PID (ppm)	REMARKS
17 Jan 24	15:15	SB-AZE-04-05	Odorless	0.2	U
17 Jan 24	15:25	SB-AZE-04-10	Odorless	0.3	U
17 Jan 24	15:35	SB-AZE-04-20	Odorless	0.1	U
17 Jan 24	16:35	SB-AZE-04-30	Odorless	0.1	D
17 Jan 24	16:50	SB-AZE-04-40	Odorless	0.4	D
17 Jan 24	17:00	SB-AZE-04-50	Odorless	0.0	D



BORING DETAILS:

Bore Hole Diameter: 100 mm

Total Depth: 5.1816 mbgs

Bore Hole Converted To: MW-AZE-04

Dry Auger: 0 mbgs to 1.75 mbgs

Rock Drilling: -

First Occurrence of Groundwater: 1.75 mbgs

Actual Groundwater Level (Before Purging): 1.480 mbgs

WELL INSTALLATION DETAILS:

Diameter: 50 mm

Monitoring Well Depth: 5.15 mbgs

Screen: 1.335 mbgs to 4.77 mbgs

Filter Media Pack: 1.0 mbgs to 5.15 mbgs

Bentonite Seal: 0.5 mbgs to 1.0 mbgs

SR Cement + 10% Bentonite: -1 mbgs to 0.5 mbgs

Ground Completion: 1.0 mbgs

REMARKS:

U: Undisturbed sample
D: Disturbed sample
LS: Sample sent for laboratory analysis
WT: Water first encountered
SW: Static water level
RD: Start of rock drilling
ED: End of rock drilling

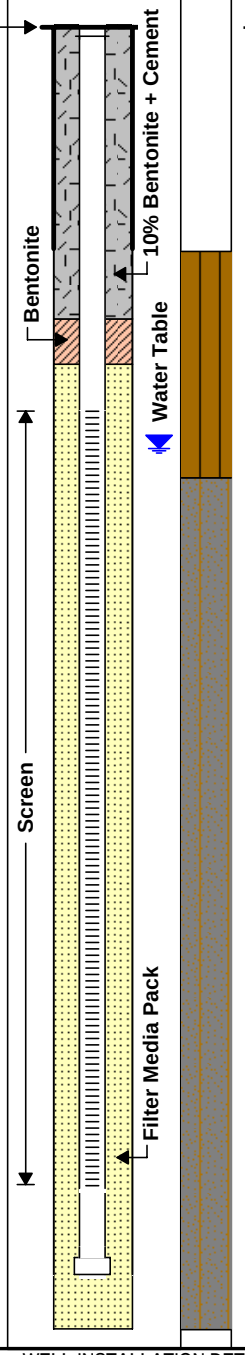
SOIL BORE / MONITORING WELL LOG MW-AZE-05

PROJECT ID: AZE | **COMPLETION DATE: 18 Jan 24** | **BORE LOG ID: SB-AZE-05**

SITE ID: AZE | **LOGGER: M.Rehan Uddin** | **NORTHING: 24°42'42.40"**

TOW ELEVATION: 99.739 | **DRILLER: Ahmed & Yawer** | **EASTING: 67°35'17.40"**

DATE	TIME	SOIL SAMPLE ID	DESCRIPTION	ODOR	PID (ppm)	REMARKS
			Ground Surface			
			Wet Brown Low Plasticity Silt with Sands (ML)			
18 Jan 24	14:50	SB-AZE-05-05		Odorless	0.6	U
18 Jan 24	15:00	SB-AZE-05-10		Odorless	0.0	U
			Wet Greyish Brown Silty sands (SM)			
18 Jan 24	15:10	SB-AZE-05-14		Odorless	0.3	U
18 Jan 24	15:20	SB-AZE-05-20		Odorless	0.0	U
18 Jan 24	15:35	SB-AZE-05-30		Odorless	0.1	D
18 Jan 24	15:45	SB-AZE-05-40		Odorless	0.0	D



BORING DETAILS:

Bore Hole Diameter: 100 mm

Total Depth: 4.760 mbgs

Bore Hole Converted To: MW-AZE-05

Dry Auger: 0 mbgs to 1.8 mbgs

Rock Drilling: -

First Occurrence of Groundwater: 1.8 mbgs

Actual Groundwater Level (Before Purging): 1.870 mbgs

WELL INSTALLATION DETAILS:

Diameter: 50 mm

Monitoring Well Depth: 4.520 mbgs

Screen: 0.705 mbgs to 4.14 mbgs

Filter Media Pack: 0.5 mbgs to 4.760 mbgs

Bentonite Seal: 0.3 mbgs to 0.5 mbgs

SR Cement + 10% Bentonite: -1 mbgs to 0.3 mbgs

Ground Completion: 1 mbgs

REMARKS:

U: Undisturbed sample
D: Disturbed sample
LS: Sample sent for laboratory analysis
WT: Water first encountered
SW: Static water level
RD: Start of rock drilling
ED: End of rock drilling

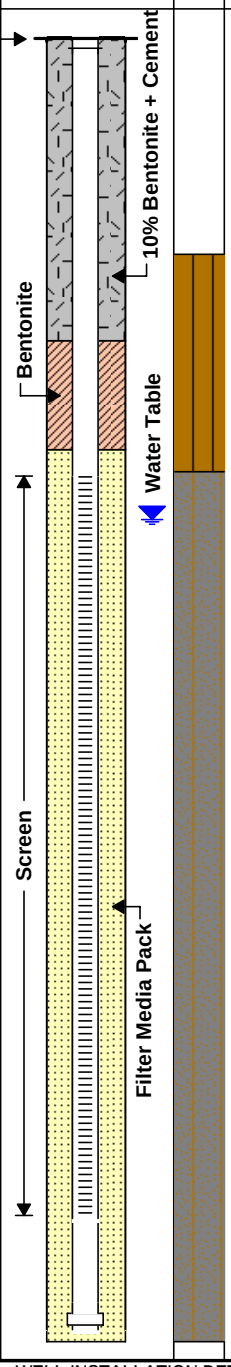
SOIL BORE / MONITORING WELL LOG MW-AZE-06

PROJECT ID: AZE | **COMPLETION DATE: 21 Jan 24** | **BORE LOG ID: SB-AZE-06**

SITE ID: AZE | **LOGGER: M.Rehan Uddin** | **NORTHING: 24°42'38.55"**

TOW ELEVATION: 99.824 | **DRILLER: Abdur Rehman & Mulazim** | **EASTING: 67°35'21.35"**

DATE	TIME	SOIL SAMPLE ID	DEPTH (M)	DESCRIPTION	ODOR	PID (ppm)	REMARKS
			-1				
			0	Ground Surface			
21 Jan 24	11:40	SB-AZE-06-05		Moist Brown Low Plasticity Silt with Sands (ML)	Odorless	0.5	U
21 Jan 24	11:50	SB-AZE-06-10	1	Wet Greyish Brown Silty Sands (SM)	Odorless	0.4	U
21 Jan 24	12:00	SB-AZE-06-20	2		Odorless	0.1	U
21 Jan 24	12:10	SB-AZE-06-30	3		Odorless	0.2	D
21 Jan 24	12:20	SB-AZE-06-40	4		Odorless	0.1	D
21 Jan 24	12:30	SB-AZE-06-50	5		Odorless	0.1	D



BORING DETAILS:

Bore Hole Diameter: 100 mm

Total Depth: 5.0 mbgs

Bore Hole Converted To: MW-AZE-06

Dry Auger: 0 mbgs to 2.0 mbgs

Rock Drilling: -

First Occurrence of Groundwater: 2.0 mbgs

Actual Groundwater Level (Before Purging): 1.220 mbgs

WELL INSTALLATION DETAILS:

Diameter: 50 mm

Monitoring Well Depth: 4.950 mbgs

Screen: 1.02 mbgs to 4.440 mbgs

Filter Media Pack: 0.9 mbgs to 5.0 mbgs

Bentonite Seal: 0.4 mbgs to 0.9 mbgs

SR Cement + 10% Bentonite: 0 mbgs to 0.4 mbgs

Ground Completion: 1 mbgs

REMARKS:

U: Undisturbed sample
D: Disturbed sample
LS: Sample sent for laboratory analysis
WT: Water first encountered
SW: Static water level
RD: Start of rock drilling
ED: End of rock drilling

ATTACHMENTS

ATTACHMENT A – COMBINED SITE LAYOUT

SECTION Y1 - Y1

SECTION X - X

SECTION X1 - X1

OTHER'S PROPERTY

1st. LINK FROM JAM BRANCH CANAL, START FROM GUL MANDA GUJJO

PUBLIC STREET (NEED TO FURNISH)

PUBLIC STREET

OTHER'S PROPERTY

1st. LINK FROM JAM BRANCH CANAL, START FROM GUL MANDA GUJJO

PUBLIC STREET

OTHER'S PROPERTY

201.168 [660'-0"]

69.494 [228'-0"]

657.606 [2157'-6"]

306.629 [1006'-0"]

142.329 [466'-11"]

89.400 [293'-4"]

30.000 [98'-5"]

W A R E H O U S E

Raw material warehouse

WASTE WAREHOUSE

FINISH GOODS WAREHOUSE

SPINNING SHED

SPINNING SHED

SPINNING SHED

COAL YARD 100.0 x 10.0 HEIGHT 1020.0m²

ASH YARD 12.0 x 12.0 x 3.0 HEIGHT 432.0 m³

EFFLUENT TREATMENT PLANT AS PER SUPPLIER'S DWG.

TEMPORARY GRASSY AREA

TEMPORARY GRASSY AREA

TEMPORARY GRASSY AREA

TEMPORARY GRASSY AREA

Nitrogen power station

Distribution room

Sanding room

Rubber pallet

Spindle storage

Cord roll storage

TOILET BLOCK-02

230,000 GALLONS U.G.WATER TANK #3 12 x 22 x4.0

47.613 [156'-3"]

FUTURE BLOCK #1

FUTURE BLOCK #2

ASHA CAN #2

ASHA CAN #1

LOCAL BACHELOR'S HOSTEL EACH FLOOR 50-ROOM (08 #) EACH FLOOR =4150.0 ft²

SEPTIC TANK A&A-SPT-04

GATE

4500Ø CULVERT

3000Ø PIPE CULVERT

CYCLE TRACK

FENCE PARTITION

GRASSY AREA

??3.5??????≥200

??3.5??????≥200

??3.5??????≥200

??3.5??????≥200

WATER STORAGE:

U.G. WATER TANK #1 = 30.0m x 10.0m x 4.0m DEEP = 250,000 GALLONS

U.G. WATER TANK #2 = 15.0m x 10.0m x 4.0m DEEP = 125,000 GALLONS

U.G. WATER TANK #3 = 12.0m x 22.0m x 4.0m DEEP = 230,000 GALLONS

TOTAL WATER STORAGE ≈ 625,000 GALLONS

PIPE SPECIFICATION:

P1 = 100mm Ø uPVC PIPE

P2 = 150mm Ø uPVC PIPE

P3 = 200mm Ø uPVC PIPE

P4 = 300mm Ø uPVC PIPE

NOTE:

* FOR MACHINE LAYOUT, SEE SEPARATE DRAWING

REV.	DESCRIPTION	DATE	DESIGN	CHECK	REVIEW	APPROVE	P.M.
△		2022					

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QINGDAO XIANGJIANN INDUSTRIAL ENGINEERING CO.,LTD	用户 CLIENT	公司
	PROJECT	公司
总平面图	UNIT	厂区总体规划
	STAGE	方案图
SCALE 1:1000	PROFESSION 建筑	DWG NO. ***-XJG-*-**

CLIENT'S ENG.	
PROJECT DIRECTOR	M. RAZA
R.E.D.A.	QINGDAO XIANGJIANN INDUSTRIAL ENGINEERING CO. LTD.
ISSUE DATE	SEP. 27th, 2023

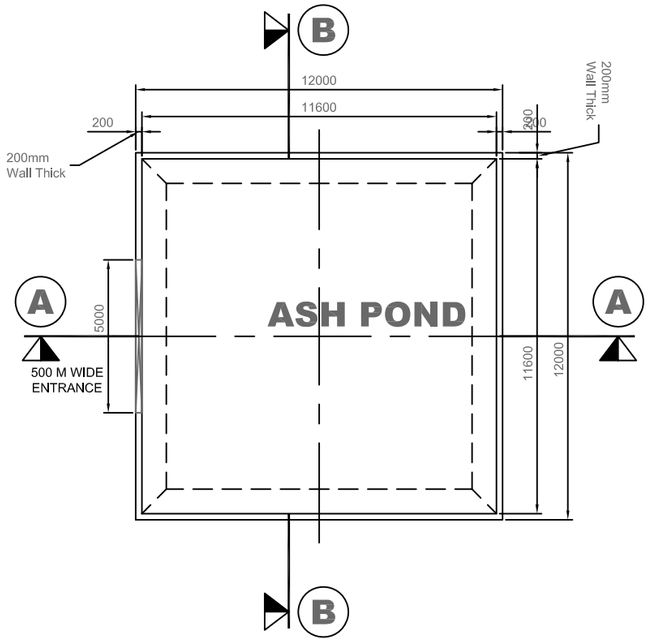
M/S. ARMSTRONG ZE. (PVT.) LTD.
(GHARO-KETI BUNDER ROAD)
AKBAR AND ASSOCIATES

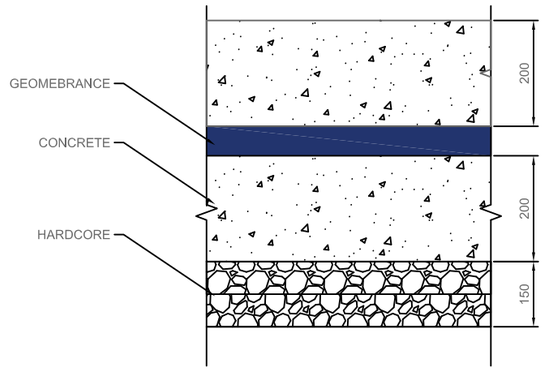
SITE PLAN
PLOT NO. 477, 478, 479 & 480
(50-ACRES & 25-GHUNTAS)

SCALE	1:1000	CHECKED	SALMAN
DATE	11-01-2023	APPROVED	Alaug gul
DRAWN	KHAN	REVISIONS	

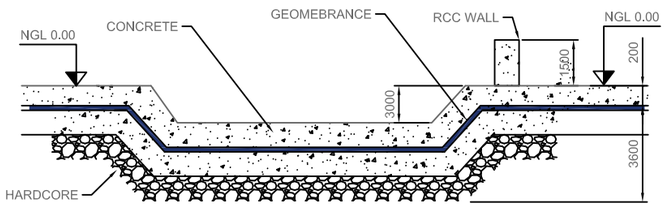
DRAWING NO. 1091-SP-01

ATTACHMENT B – PROPOSED COAL ASH POND DESIGN



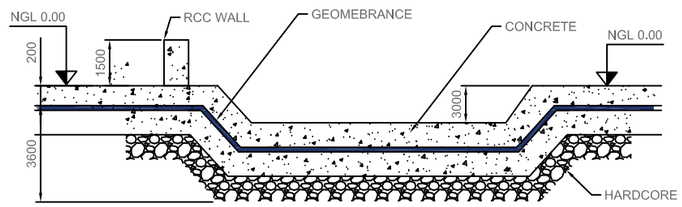


DETAILS OF FLOORING
Scale: NTS



SECTION A-A

Scale: NTS



SECTION B-B

Scale: NTS

Location:
Armstrong Tire Manufacturing Plant Keti Bandar Road,Gharo , Sindh.

Project:
Armstrong Tire Manufacturing Plant

LEGENDS & NOTES

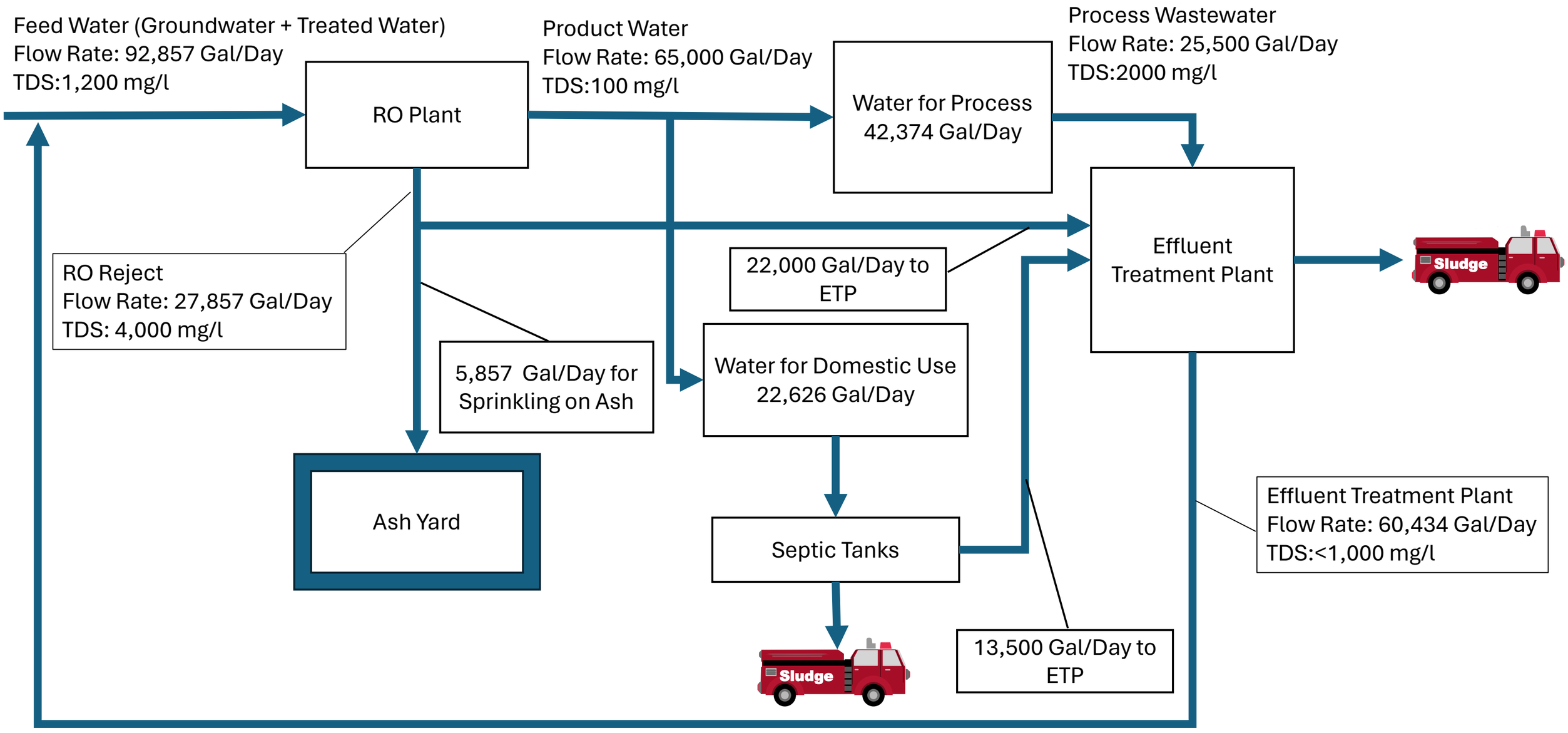
NOTE: ALL DIMENSIONS ARE IN Millimeters

Prepared By: MYK Approved By: Engr. AR	Drawing Nos: AZE-CAP-001	Rev:A

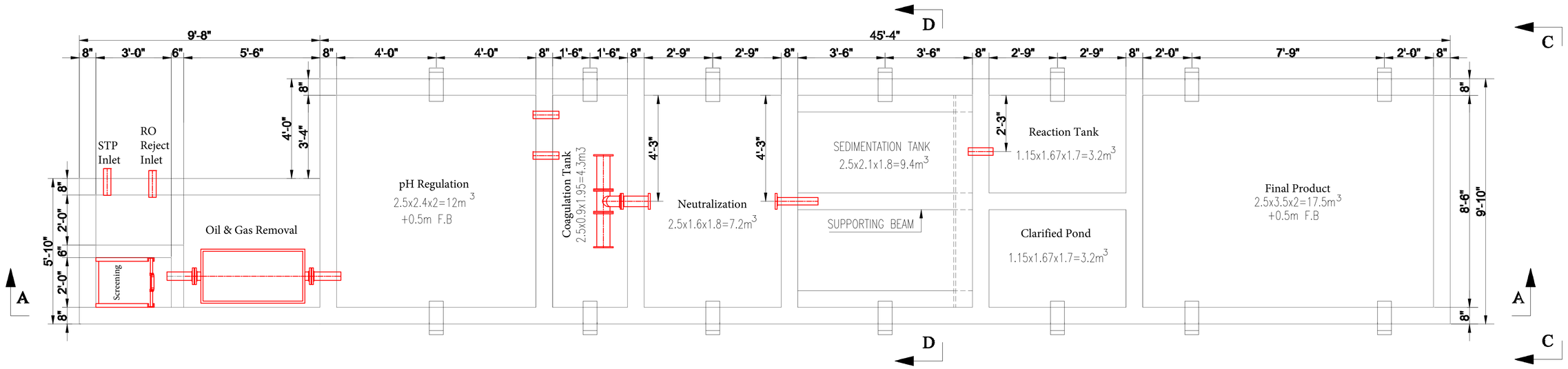
PROPSED LAYOUT OF COAL ASH POND

ATTACHMENT C – E.T.P LAYOUT & WATER BALANCE DIAGRAM

Water Balance for Armstrong ZE (Pvt.) Ltd.



Note: Sludge will be removed by Sindh Environmental Protection Agency (SEPA) certified vendor on Fortnightly basis. The estimated volume of sludge fortnightly basis is 30 m^3 from ETP and 3 m^3 from Septic Tanks.



Plant Layout

CLIENT

M/S. ARMSTRONG ZE (PVT.) LTD.

Design Consultant:

SECTOR

Plot # 47-B Main Khay-e-Shamsheer Phase V DHA,Karachi
021-35830670-1
www.molecule.pk

PROJECT

M/S. ARMSTRONG
(GHARO-KETI BUNDER ROAD)
PLOT NO. 477, 478, 479 & 480
(50-ACRES & 25-GHUNTAS)

REV.	DATE	DESCRIPTION

HVAC, MECHANICAL & PLUMBING CONSULTANTS

YOUSUF HASAN ASSOCIATES

305, 3rd FLOOR, ANUM ESTATE
SHAHRAH-E-FAISAL, KARACHI-75350, PAKISTAN
PHONE NO (921) 3432 1559 (921) 3438 9931,
FAX- 021-3432 1559
EMAIL ADDRESS: hasan@yhassociates.com

TITLE: INFRA STRUCTURE

DRAWING TITLE: LAYOUT OF E.T.P

DRAWING NO.		REVISION
2022-07-601		0
DRAWN BY	SERIAL NO.	DATE
SS	01	29/03/2024
PROJECT NO.	APPROVED BY	SCALE
2022-07-AZE		N.T.S

ATTACHMENT D – SOIL ANALYTICAL RESULTS

envirolab
Hattersley Science & Technology Park
Stockport Road, Hattersley, SK14 3QU

FINAL ANALYTICAL TEST REPORT

Envirolab Job Number: 24/00909
Issue Number: 1 **Date:** 07 February, 2024

Client: Tekcellent Private Limited
6/7/E, Street 22,
Mohammad Ali Society
Karachi 75350,
Pakistan

Project Manager: Amna Bano/Moinuddin Muhammad
Project Name: Armstrong ZE
Project Ref: AZE
Order No: O24J005-TPL-FN
Date Samples Received: 29/01/24
Date Instructions Received: 30/01/24
Date Analysis Completed: 07/02/24

Approved by:

Richard Wong
Client Manager

Envirolab Job Number: 24/00909

Client Project Name: Armstrong ZE

Client Project Ref: AZE

Lab Sample ID	24/00909/1	24/00909/2	24/00909/3	24/00909/4	24/00909/5	24/00909/6	24/00909/7	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	SB-AZE-01-20	SB-AZE-02-05	SB-AZE-02-10	SB-AZE-03-10	SB-AZE-04-05	SB-AZE-04-10	SB-AZE-05-10			
Depth to Top										
Depth To Bottom										
Date Sampled	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24			
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL			
Sample Matrix Code	1	3	1	5	3	3	3			
% Stones >10mm$_A$	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	% w/w	0.1	A-T-044
Arsenic$_D^{M\#}$	2	-	2	4	-	5	6	mg/kg	1	A-T-024s
Cadmium$_D^{M\#}$	<0.5	-	<0.5	<0.5	-	<0.5	<0.5	mg/kg	0.5	A-T-024s
Copper$_D^{M\#}$	9	-	5	16	-	26	21	mg/kg	1	A-T-024s
Chromium$_D^{M\#}$	16	-	13	24	-	32	32	mg/kg	1	A-T-024s
Lead$_D^{M\#}$	4	-	3	6	-	10	8	mg/kg	1	A-T-024s
Mercury$_D$	0.55	-	0.89	0.69	-	0.99	0.78	mg/kg	0.17	A-T-024s
Tin$_D$	<5	-	<5	<5	-	<5	<5	mg/kg	5	A-T-024s
Zinc$_D^{M\#}$	28	-	19	42	-	55	48	mg/kg	5	A-T-024s
TPH total (>C6-C40)$_A^{M\#}$	<10	-	<10	<10	-	<10	<10	mg/kg	10	A-T-007s
OCP+OPP Combined Pest Suite (incl. Atrazine and Simazine)										
Dichlobenil$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Tecnazene$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Trifluralin$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
alpha-Hexachlorocyclohexane (HCH)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Hexachlorobenzene (HCB) $_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Simazine$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Atrazine$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
beta-Hexachlorocyclohexane (HCH)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Quintozene (PCNB)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Chlorothalonil$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
delta-Hexachlorocyclohexane (HCH)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Triallate$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Heptachlor$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Aldrin$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Triadimefon$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Telodrin$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Isodrin$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Pendimethalin$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Heptachlor epoxide$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
trans-Chlordane (Gamma)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056

Lab Sample ID	24/00909/1	24/00909/2	24/00909/3	24/00909/4	24/00909/5	24/00909/6	24/00909/7	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	SB-AZE-01-20	SB-AZE-02-05	SB-AZE-02-10	SB-AZE-03-10	SB-AZE-04-05	SB-AZE-04-10	SB-AZE-05-10			
Depth to Top										
Depth To Bottom										
Date Sampled	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24			
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL			
Sample Matrix Code	1	3	1	5	3	3	3			
o,p-DDE (2,4)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Endosulphan I (Alpha)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
cis-Chlordane (Alpha)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
p,p-DDE (4,4)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Dieldrin$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
o,p-DDD (2,4)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Endrin$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Endosulphan II (Beta)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
p,p-DDD (4,4)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
o,p-DDT (2,4)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Endrin Aldehyde$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Endrin Ketone$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Endosulphan Sulphate$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
p,p-DDT (4,4)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
o,p-Methoxychlor$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
p,p-Methoxychlor$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Permethrin I (cis)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Permethrin II (trans)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Dichlorvos$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Mevinphos$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Demeton-S$_A$	-	<2.50	-	-	<2.50	-	-	mg/kg	0.5	A-T-056
Demeton-O$_A$	-	<2.50	-	-	<2.50	-	-	mg/kg	0.5	A-T-056
Phorate$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Dimethoate$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Propetamphos$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Diazinon (Dimpylate)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Disulfoton$_A$	-	<0.50	-	-	<0.50	-	-	mg/kg	0.1	A-T-056
Chlorpyrifos-methyl$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Parathion (Ethyl Parathion)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Methyl Parathion$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Pirimiphos-methyl$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Fenitrothion$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Fensulphothion$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056

Envirolab Job Number: 24/00909

Client Project Name: Armstrong ZE

Client Project Ref: AZE

Lab Sample ID	24/00909/1	24/00909/2	24/00909/3	24/00909/4	24/00909/5	24/00909/6	24/00909/7	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	SB-AZE-01-20	SB-AZE-02-05	SB-AZE-02-10	SB-AZE-03-10	SB-AZE-04-05	SB-AZE-04-10	SB-AZE-05-10			
Depth to Top										
Depth To Bottom										
Date Sampled	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24			
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL			
Sample Matrix Code	1	3	1	5	3	3	3			
Fenthion$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Malathion$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Chlorfenvinphos$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Chlorpyrifos$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Trichloronate$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Prothiofos (Tokuthion)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Ethion$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Triazophos$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Carbophenothion$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Phosalone$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Azinphos-methyl$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Azinphos-ethyl$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
Coumaphos$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056
gamma-Hexachlorocyclohexane (HCH)$_A$	-	<0.05	-	-	<0.05	-	-	mg/kg	0.01	A-T-056

Envirolab Job Number: 24/00909

Client Project Name: Armstrong ZE

Client Project Ref: AZE

Lab Sample ID	24/00909/1	24/00909/2	24/00909/3	24/00909/4	24/00909/5	24/00909/6	24/00909/7	Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	SB-AZE-01-20	SB-AZE-02-05	SB-AZE-02-10	SB-AZE-03-10	SB-AZE-04-05	SB-AZE-04-10	SB-AZE-05-10			
Depth to Top										
Depth To Bottom										
Date Sampled	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24	19-Jan-24			
Sample Type	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL	SOIL			
Sample Matrix Code	1	3	1	5	3	3	3			
PAH-16MS										
Acenaphthene$_A^{M\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	mg/kg	0.01	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	mg/kg	0.01	A-T-019s
Anthracene$_A^{M\#}$	<0.02	-	<0.02	<0.02	-	<0.02	<0.02	mg/kg	0.02	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	<0.04	-	<0.04	<0.04	-	<0.04	<0.04	mg/kg	0.04	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	<0.04	-	<0.04	<0.04	-	<0.04	<0.04	mg/kg	0.04	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	<0.05	-	<0.05	<0.05	-	<0.05	<0.05	mg/kg	0.05	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	-	<0.05	<0.05	-	<0.05	<0.05	mg/kg	0.05	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	-	<0.07	<0.07	-	<0.07	<0.07	mg/kg	0.07	A-T-019s
Chrysene$_A^{M\#}$	<0.06	-	<0.06	<0.06	-	<0.06	<0.06	mg/kg	0.06	A-T-019s
Dibenzo(ah)anthracene$_A$	<0.04	-	<0.04	<0.04	-	<0.04	<0.04	mg/kg	0.04	A-T-019s
Fluoranthene$_A^{M\#}$	<0.08	-	<0.08	<0.08	-	<0.08	<0.08	mg/kg	0.08	A-T-019s
Fluorene$_A^{M\#}$	<0.01	-	<0.01	<0.01	-	<0.01	<0.01	mg/kg	0.01	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	<0.03	-	<0.03	<0.03	-	<0.03	<0.03	mg/kg	0.03	A-T-019s
Naphthalene $_A^{M\#}$	<0.03	-	<0.03	<0.03	-	<0.03	<0.03	mg/kg	0.03	A-T-019s
Phenanthrene$_A^{M\#}$	<0.03	-	<0.03	<0.03	-	<0.03	<0.03	mg/kg	0.03	A-T-019s
Pyrene$_A^{M\#}$	<0.07	-	<0.07	<0.07	-	<0.07	<0.07	mg/kg	0.07	A-T-019s
Total PAH-16MS$_A$	<0.08	-	<0.08	<0.08	-	<0.08	<0.08	mg/kg	0.01	A-T-019s

Envirolab Job Number: 24/00909

Client Project Name: Armstrong ZE

Client Project Ref: AZE

Lab Sample ID	24/00909/8	24/00909/9						Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	SB-AZE-06-10	BDS-AZE-02								
Depth to Top										
Depth To Bottom										
Date Sampled	19-Jan-24	19-Jan-24								
Sample Type	SOIL	SOIL								
Sample Matrix Code	1	1								
% Stones >10mm$_A$	<0.1	<0.1						% w/w	0.1	A-T-044
Arsenic$_D^{M\#}$	3	2						mg/kg	1	A-T-024s
Cadmium$_D^{M\#}$	<0.5	<0.5						mg/kg	0.5	A-T-024s
Copper$_D^{M\#}$	10	10						mg/kg	1	A-T-024s
Chromium$_D^{M\#}$	21	19						mg/kg	1	A-T-024s
Lead$_D^{M\#}$	5	5						mg/kg	1	A-T-024s
Mercury$_D$	0.71	0.61						mg/kg	0.17	A-T-024s
Tin$_D$	<5	<5						mg/kg	5	A-T-024s
Zinc$_D^{M\#}$	39	33						mg/kg	5	A-T-024s
TPH total (>C6-C40)$_A^{M\#}$	<10	<10						mg/kg	10	A-T-007s

Envirolab Job Number: 24/00909

Client Project Name: Armstrong ZE

Client Project Ref: AZE

Lab Sample ID	24/00909/8	24/00909/9						Units	Limit of Detection	Method ref
Client Sample No										
Client Sample ID	SB-AZE-06-10	BDS-AZE-02								
Depth to Top										
Depth To Bottom										
Date Sampled	19-Jan-24	19-Jan-24								
Sample Type	SOIL	SOIL								
Sample Matrix Code	1	1								
PAH-16MS										
Acenaphthene$_A^{M\#}$	<0.01	<0.01						mg/kg	0.01	A-T-019s
Acenaphthylene$_A^{M\#}$	<0.01	<0.01						mg/kg	0.01	A-T-019s
Anthracene$_A^{M\#}$	<0.02	<0.02						mg/kg	0.02	A-T-019s
Benzo(a)anthracene$_A^{M\#}$	<0.04	<0.04						mg/kg	0.04	A-T-019s
Benzo(a)pyrene$_A^{M\#}$	<0.04	<0.04						mg/kg	0.04	A-T-019s
Benzo(b)fluoranthene$_A^{M\#}$	<0.05	<0.05						mg/kg	0.05	A-T-019s
Benzo(ghi)perylene$_A^{M\#}$	<0.05	<0.05						mg/kg	0.05	A-T-019s
Benzo(k)fluoranthene$_A^{M\#}$	<0.07	<0.07						mg/kg	0.07	A-T-019s
Chrysene$_A^{M\#}$	<0.06	<0.06						mg/kg	0.06	A-T-019s
Dibenzo(ah)anthracene$_A$	<0.04	<0.04						mg/kg	0.04	A-T-019s
Fluoranthene$_A^{M\#}$	<0.08	<0.08						mg/kg	0.08	A-T-019s
Fluorene$_A^{M\#}$	<0.01	<0.01						mg/kg	0.01	A-T-019s
Indeno(123-cd)pyrene$_A^{M\#}$	<0.03	<0.03						mg/kg	0.03	A-T-019s
Naphthalene $_A^{M\#}$	<0.03	<0.03						mg/kg	0.03	A-T-019s
Phenanthrene$_A^{M\#}$	<0.03	<0.03						mg/kg	0.03	A-T-019s
Pyrene$_A^{M\#}$	<0.07	<0.07						mg/kg	0.07	A-T-019s
Total PAH-16MS$_A$	<0.08	<0.08						mg/kg	0.01	A-T-019s

Report Notes

General
This report shall not be reproduced, except in full, without written approval from Envirolab.
The results reported herein relate only to the material supplied to the laboratory.
The residue of any samples contained within this report, and any received within the same delivery, will be disposed of **four weeks** after the initial scheduling. For samples tested for Asbestos we will retain a portion of the dried sample for a minimum of **six months** after the initial Asbestos testing is completed.
Analytical results reflect the quality of the sample at the time of analysis only.
Opinions and Interpretations expressed are outside our scope of accreditation.
The client Sample No, Client Sample ID, Depth to top, Depth to Bottom and Date Sampled are all provided by the client.
A deviating sample report is appended and will indicate if samples or tests have been found to be deviating. Any test results affected may not be an accurate record of the concentration at the time of sampling and, as a result, may be invalid.

Key

Superscript "#"	Accredited to ISO 17025
Superscript "M"	Accredited to MCertS
Superscript "U"	Individual result not accredited
None of the above symbols	Analysis unaccredited
Subscript "A"	Analysis performed on as-received Sample
Subscript "D"	Analysis performed on the dried sample, crushed to pass 2mm sieve.
Subscript "^"	Analysis has dependant options against results. Details appear in the comments of your Sample receipt
IS	Insufficient Sample for analysis
US	Unsuitable Sample for analysis
NDP	No Determination Possible
NAD	No Asbestos Detected
N/A	Not applicable

Asbestos
Asbestos in soil analysis is performed on a dried aliquot of the submitted sample and cannot guarantee to identify asbestos if only present in small numbers as discrete fibres/fragments in the original sample.
Stones etc. are not removed from the sample prior to analysis
Quantification of asbestos is a 3 stage process including visual identification, hand picking and weighing, and fibre counting by sedimentation/phase contrast optical microscopy if required. If asbestos is identified as being present but is not in a form that is suitable for analysis by hand picking and weighing (normally if the asbestos is present as free fibres) quantification by sedimentation is performed. Where ACMs are found a percentage asbestos is assigned to each with reference to 'HSG264, Asbestos: The survey guide' and the calculated asbestos content is expressed as a percentage of the dried soil sample aliquot used.

Assigned Matrix Codes

1	SAND	6	CLAY/LOAM	A	Contains Stones
2	LOAM	7	OTHER	B	Contains Construction Rubble
3	CLAY	8	Asbestos Bulk (Only Asbestos ID accredited)	C	Contains visible hydrocarbons
4	LOAM/SAND	9	Incinerator Ash (some Metals accredited)	D	Contains glass / metal
5	SAND/CLAY			E	Contains roots / twigs
Note: 7,8,9 matrices are not covered by our ISO 17025 or MCertS accreditation, unless stated above.					

Soil Chemical Analysis:
All results are reported as dry weight (<40°C).
For samples with Matrix Codes 1 - 6 natural stones, brick and concrete fragments >10mm and any extraneous material (visible glass, metal or twigs) are removed and excluded from the sample prior to analysis and reported results corrected to a whole sample basis. This is reported as '% stones >10mm'.
For samples with Matrix Code 7 the whole sample is dried and crushed prior to analysis and this supersedes any "A" subscripts
All analysis is performed on the sample as received for soil samples which are positive for asbestos or the client has informed asbestos may be present and/or if they are from outside the European Union and this supersedes any "D" subscripts.

TPH by method A-T-007:
For waters, free and visible oils are excluded from the sample used for analysis, so the reported result represents the dissolved phase only.
Results "with Clean up" indicates samples cleaned up with Silica during extraction.

EPH CWG (method A-T-055) from TPH CWG:
EPH CWG results have humics mathematically subtracted through instrument calculation.
Where these humic substances have been identified in any IDs from "TPH CWG with clean up" please note that the concentration is **NOT** included in the quantified results but present in the ID for information.

Electrical Conductivity of water by method A-T-037:
Results greater than 12900µS/cm @ 25^{o}C / 11550µS/cm @ 20^{o}C fall outside the accreditation range and as such are unaccredited.

Please contact your client manager if you require any further information.

Envirolab Deviating Samples Report

Hattersley Science & Technology Park, Stockport Road, Hattersley, SK14 3QU
Tel. 0161 368 4921 email. ask@envlab.co.uk

Client: Tekcellent Private Limited, 6/7/E, Street 22, Mohammad Ali Society, Karachi 75350, Pakistan

Project: Armstrong ZE

Clients Project No: AZE

Project No: 24/00909

Date Received: 30/01/2024 (am)

Cool Box Temperatures (°C): 11.7

NO DEVIATIONS IDENTIFIED

If, at any point before reaching the laboratory, the temperature of the samples has breached those set in published standards, e.g. BS-EN 5667-3, ISO 18400-102:2017, then the concentration of any affected analytes may differ from that at the time of sampling.

Envirolab Analysis Dates

Lab Sample ID	24/00909/1	24/00909/2	24/00909/3	24/00909/4	24/00909/5	24/00909/6	24/00909/7	24/00909/8	24/00909/9
Client Sample No									
Client Sample ID/Depth	SB-AZE-01-20	SB-AZE-02-05	SB-AZE-02-10	SB-AZE-03-10	SB-AZE-04-05	SB-AZE-04-10	SB-AZE-05-10	SB-AZE-06-10	BDS-AZE-02
Date Sampled	19/01/24	19/01/24	19/01/24	19/01/24	19/01/24	19/01/24	19/01/24	19/01/24	19/01/24
A-T-007s	06/02/2024		06/02/2024	06/02/2024		06/02/2024	06/02/2024	06/02/2024	06/02/2024
A-T-019s	06/02/2024		06/02/2024	06/02/2024		07/02/2024	06/02/2024	06/02/2024	06/02/2024
A-T-024s	06/02/2024		06/02/2024	06/02/2024		06/02/2024	06/02/2024	06/02/2024	06/02/2024
A-T-044	07/02/2024	07/02/2024	07/02/2024	07/02/2024	07/02/2024	07/02/2024	07/02/2024	07/02/2024	07/02/2024
A-T-056		07/02/2024			07/02/2024				

The above dates are the analysis completion dates, please note that these are not necessarily the date that the analysis was weighed/extracted.

End of Report

ATTACHMENT E – WATER ANALYTICAL RESULTS

PERAC RESEARCH & DEVELOPMENT FOUNDATION

Government of Pakistan, Ministry of Energy, Petroleum Division

TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001178-001
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	02-02-2024	**Sample Code**	23001141-01
Sample Description	**Ground Water Sample ID # "OW-AZE-01"**	**Sampling Date**	02-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	1.1	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	2.6	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	0.9399	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols,mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	8.0	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	Nil	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	Nil	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	Nil	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	Nil	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

The analyses based on Sample (s) provided to us by the Client. The interpretation or opinions expressed represent the best judgment (E. & O.E.). We have no responsibility and warranty or representation in connection with which such report is used.

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001178-001
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	02-02-2024	**Sample Code**	23001141-01
Sample Description	**Ground Water Sample ID # "OW-AZE-01"**	**Sampling Date**	02-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	450	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	95	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001178-001
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	02-02-2024	**Sample Code**	23001141-01
Sample Description	**Ground Water Sample ID # "OW-AZE-01"**	**Sampling Date**	02-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001178-002
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	02-02-2024	**Sample Code**	23001141-02
Sample Description	**Ground Water Sample ID # "OW-AZE-02"**	**Sampling Date**	02-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	12.12	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	21.2	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	0.8533	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols,mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	8.6	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	Nil	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	Nil	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	Nil	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	Nil	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001178-002
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	02-02-2024	**Sample Code**	23001141-02
Sample Description	**Ground Water Sample ID # "OW-AZE-02"**	**Sampling Date**	02-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	200	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	150	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

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Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001178-002
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	02-02-2024	**Sample Code**	23001141-02
Sample Description	**Ground Water Sample ID # "OW-AZE-02"**	**Sampling Date**	02-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001178-003
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	02-02-2024	**Sample Code**	23001141-03
Sample Description	**Ground Water Sample ID # "SW-AZE-04"**	**Sampling Date**	02-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	10.05	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	16	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	0.2169	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols,mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	2.0	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	0.5	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	Nil	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	Nil	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	Nil	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001178-003
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	02-02-2024	**Sample Code**	23001141-03
Sample Description	**Ground Water Sample ID # "SW-AZE-04"**	**Sampling Date**	02-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	160	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	105	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

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Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001178-003
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	02-02-2024	**Sample Code**	23001141-03
Sample Description	**Ground Water Sample ID # "SW-AZE-04"**	**Sampling Date**	02-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001178-004
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	02-02-2024	**Sample Code**	23001141-04
Sample Description	**Surface Water Sample ID # "SW-AZE-05"**	**Sampling Date**	02-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	Nil	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	Nil	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	0.0065	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols,mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	1.5	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	0.38	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	Nil	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA-4500CI B	Chloride (CI) , mg/L	56.8	<100 / <1.0
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	Nil	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	Nil	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001178-004
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	02-02-2024	**Sample Code**	23001141-04
Sample Description	**Surface Water Sample ID # "SW-AZE-05"**	**Sampling Date**	02-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	144	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	15	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001178-004
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	02-02-2024	**Sample Code**	23001141-04
Sample Description	**Surface Water Sample ID # "SW-AZE-05"**	**Sampling Date**	02-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-001
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-01
Sample Description	**Ground Water Sample ID # "DW-AZE-01"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	1.2	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	2.6	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	0.5771	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols, mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	4.1	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	1.1	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	2.328	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	Nil	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	0.562	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-002
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-01
Sample Description	**Ground Water Sample ID # "DW-AZE-01"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-001
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-01
Sample Description	**Ground Water Sample ID # "DW-AZE-01"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-002
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-02
Sample Description	**Surface Water Sample ID # "SW-AZE-01"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	1.78	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	5.3	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	0.712	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols, mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	4.3	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	10.61	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	3.024	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	Nil	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	1.883	< 3 / <0.2

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-002
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-02
Sample Description	**Surface Water Sample ID # "SW-AZE-01"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	35	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	15	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-002
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-02
Sample Description	**Surface Water Sample ID # "SW-AZE-01"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-003
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-03
Sample Description	**Surface Water Sample ID # "SW-AZE-02"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	14.17	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	26.67	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	2.1241	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols, mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	08	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	Nil	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	13.039	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	Nil	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	28.979	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-003
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-03
Sample Description	**Surface Water Sample ID # "SW-AZE-02"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	260	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	520	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-03
Sample Description	**Surface Water Sample ID # "SW-AZE-02"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

Prepared by	**Section In charge (E)**	**Head R&ASD**

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-004
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-04
Sample Description	**Ground Water Sample ID # "OW-AZE-03"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	Nil	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	Nil	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	0.281	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols,mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	3.1	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	Nil	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	0.729	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA-4500CI B	Chloride (CI) , mg/L	Nil	<100 / <1.0
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	Nil	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	0.5195	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-004
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-04
Sample Description	**Ground Water Sample ID # "OW-AZE-03"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	250	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	100	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-004
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-04
Sample Description	**Ground Water Sample ID # "OW-AZE-03"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-005
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-05
Sample Description	**Ground Water Sample ID # "OW-AZE-06"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	Nil	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	Nil	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	0.6771	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols,mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	7.0	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	Nil	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	Nil	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	Nil	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	0.6947	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-005
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-05
Sample Description	**Ground Water Sample ID # "OW-AZE-06"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	300	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001177-005
Customer's Ref	024J004-TPL-FN	**Reporting Date**	19-02-2024
Date	01-02-2024	**Sample Code**	23001135-05
Sample Description	**Ground Water Sample ID # "OW-AZE-06"**	**Sampling Date**	01-02-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-001
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-01
Sample Description	**Ground Water Sample ID # "MW-AZE-01"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	15	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	81	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	1.0973	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols,mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	8.4	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	10.1	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	Nil	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	0.251	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	0.4611	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	77.604	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-001
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-01
Sample Description	**Ground Water Sample ID # "MW-AZE-01"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
D-3921	Total Petroleum Hydrocabon,(TPH), mg/L	<0.5	100 /0.5
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	60	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	80	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-001
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-01
Sample Description	**Ground Water Sample ID # "MW-AZE-01"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-002
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-02
Sample Description	**Ground Water Sample ID # "MW-AZE-02"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	21	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	32	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	1.5162	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols,mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	8.4	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	11.3	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	5.9006	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	Nil	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	12.513	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-002
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-02
Sample Description	**Ground Water Sample ID # "MW-AZE-02"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
D-3921	Total Petroleum Hydrocabon,(TPH), mg/L	5.73	100 /0.5
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	20	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	50	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-002
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-02
Sample Description	**Ground Water Sample ID # "MW-AZE-02"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-003
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-03
Sample Description	**Ground Water Sample ID # "MW-AZE-03"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	32	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	122	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	2.9157	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols,mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	7.0	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	14.8	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	59.434	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	0.261	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	9.5212	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-003
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-03
Sample Description	**Ground Water Sample ID # "MW-AZE-03"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
D-3921	Total Petroleum Hydrocabon,(TPH), mg/L	2.15	100 /0.5
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	5	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-003
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-03
Sample Description	**Ground Water Sample ID # "MW-AZE-03"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-004
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-04
Sample Description	**Ground Water Sample ID # "MW-AZE-04"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	28	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	42	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	0.6917	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols,mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	4.2	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	11.2	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	82.422	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	0.3019	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	138.86	< 3 / <0.2

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-004
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-04
Sample Description	**Ground Water Sample ID # "MW-AZE-04"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
D-3921	Total Petroleum Hydrocabon,(TPH), mg/L	2.15	100 /0.5
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-004
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-04
Sample Description	**Ground Water Sample ID # "MW-AZE-04"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-005
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-05
Sample Description	**Ground Water Sample ID # "MW-AZE-05"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	17.3	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	29.3	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	0.2956	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols,mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	2.1	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	10.0	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	85.742	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	0.3103	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	0.3034	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	121.617	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-005
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-05
Sample Description	**Ground Water Sample ID # "MW-AZE-05"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
D-3921	Total Petroleum Hydrocabon,(TPH), mg/L	1.051	100 /0.5
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	100	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	120	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

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Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-05
Sample Description	**Ground Water Sample ID # "MW-AZE-05"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-006
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-06
Sample Description	**Ground Water Sample ID # "MW-AZE-06"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	15.38	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	26.67	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	1.0742	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols,mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	7.2	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	22.2	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	67.068	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	0.2510	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	98.277	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-006
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-06
Sample Description	**Ground Water Sample ID # "MW-AZE-06"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	250	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	300	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-006
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-06
Sample Description	**Ground Water Sample ID # "MW-AZE-06"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-007
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-07
Sample Description	**Ground Water Sample ID # "BDW-AZE-01"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
APHA-5520 B	Grease & Oil, mg/L	Nil	<10 / <2
APHA-5210-C	Biochemical Oxygen Demand (BOD5), mg/L	6.7	<30 / <2
APHA 5220-D	Chemical Oxygen Demand (COD), mg/L	10.6	<125 / <2
APHA-4500 NH3	Ammonia (NH3), mg/L	1.8107	<10 /<1
APHA-4500-F B	Fluoride (F), mg/L	Nil	20 / <1
APHA-4500S-F	Sulphide (S), mg/L	Nil	<1 / <0.5
APHA 5530 D	Phenolic Compounds as Phenols,mg/L	Nil	< 0.5 / <0.1
APHA-4500 N-B	Total Nitrogen, mg/L	9.0	<15/ <2
APHA-4500P.C	Phosphorus, mg/L	9.7	<5 / <1
APHA-3111-B	Aluminum (Al), mg/L	64.106	<3 / <0.1
APHA 3114-C	Arsenic (As), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Cadmium (Cd), mg/L	Nil	<0.1 / <0.1
APHA 3111B	Chromium (Cr), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Copper (Cu), mg/L	Nil	<0.5 / <0.1
APHA 3111B	Lead (Pb), mg/L	Nil	<0.2 / <0.1
APHA 3112B	Mercury (Hg), mg/L	Nil	<0.01/<0.01
APHA 3111B	Nickel (Ni), mg/L	Nil	<0.5 /<0.2
APHA 3111B	Zinc (Zn), mg/L	0.261	<2 / <0.2
APHA 4500 CN F	Cyanide (CN), mg/L	Nil	<1 /<0.1
APHA-3111-B	Tin (Sn), mg/L	Nil	< 2 /<0.2
APHA-3111B	Iron, mg/L	95.742	< 3 / <0.2

Prepared by	Section In charge (E)	Head R&ASD

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-007
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-07
Sample Description	**Ground Water Sample ID # "BDW-AZE-01"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
D-3921	Total Petroleum Hydrocabon,(TPH), mg/L	2.27	100 /0.5
APHA-9222B	Fecal E. C oli Counts / ml	Nil	<400(MPN/100ml / <100(MPN/100ml
APHA-9222A	Total Bacterial Counts / ml	225	<400(MPN/100ml / <100(MPN/100ml
APHA-9222B	Total Coliform, Counts / ml	70	<400(MPN/100ml / <100(MPN/100ml
USEPA 8081-A	Pesticide, ug/L		
"	Aldrin, µg/L	<1.0	1
"	a-BHC, µg/L	<1.0	1
"	b-BHC, µg/L	<1.0	1
"	d-BHC, µg/L	<1.0	1
"	g-BHC, µg/L	<1.0	1
"	a-Chlordane, µg/L	<1.0	1
"	B-Chlordane, µg/L	<1.0	1
"	4,4-DDD,µg/L	<1.0	1
"	4,4-DDE,µg/L	<1.0	1
"	4,4-DDT, µg/L	<1.0	1
"	Dieldrin, µg/L	<1.0	1
"	Alpha Endosulfan I, µg/L	<1.0	1
"	Beta Endosulfan II, µg/L	<1.0	1
"	Endosulfan sulphate, µg/L	<1.0	1
"	Endrin, µg/L	<1.0	1
"	Endrin aldehyde, µg/L	<1.0	1
"	Heptachlor, µg/L	<1.0	1
"	Heptachlor epoxide (isomer B), µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

The analyses based on Sample (s) provided to us by the Client. The interpretation or opinions expressed represent the best judgment (E. & O.E.). We have no responsibility and warranty or representation in connection with which such report is used.

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TEST REPORT

Customer's Name	M/s. Tekcellent Pvt. Ltd.	**Test Report No**	2324001173-007
Customer's Ref	024J004-TPL-FN	**Reporting Date**	16-02-2024
Date	31-01-2024	**Sample Code**	23001130-07
Sample Description	**Ground Water Sample ID # "BDW-AZE-01"**	**Sampling Date**	31-01-2024

TEST METHOD	PARAMETERS	TEST RESULTS	LOR/ LOD
USEPA 8081-A	Methoxychlor, µg/L	<1.0	1
"	Teterachloro-Methyl-xylene, µg/L	<1.0	1
"	Decachlorobiphenyl, µg/L	<1.0	1
"	Isodrin, µg/L	<1.0	1
"	Endrin ketone, µg/L	<1.0	1

Prepared by	Section In charge (E)	Head R&ASD

The analyses based on Sample (s) provided to us by the Client. The interpretation or opinions expressed represent the best judgment (E. & O.E.). We have no responsibility and warranty or representation in connection with which such report is used.

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ATTACHMENT F – SINDH ENVIRONMENTAL QUALITY STANDARDS (SEQS)

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PART-I

GOVERNMENT OF SINDH
SINDH ENVIRONMENT PROTECTION AGENCY

NOTIFICATION

NO.EPA/TECH/739/2014:- In exercise of the powers conferred under clause (g) of sub-section (1) of section of 6 of the Sindh Environmental Protection Act, 2014, the Sindh Environmental Protection Agency, with the approval of the Sindh Environmental Protection Council, is pleased to establish the following standards:-

1. (1) These Standards may be called the Sindh Environmental Industrial Waste Water, Effluent, Domestic, Sewerage, Industrial Air Emission and Ambient Airs, Noise for Vehicles, Air Emissions for Vehicles and Drinking Water Quality Standards, 2015.

(2) These Standards shall come into force at once.

2. In these Standards, unless there is anything repugnant in the subject or context –

(a) "Government" means the Government of Sindh;

(b) "Standards" means the Sindh Environmental Quality Standards.

SINDH ENVIRONMENTAL QUALITY STANDARDS FOR MUNICIPAL AND LIQUID INDUSTRIAL EFFLUENTS (mg/l, UNLESS OTHERWISE DEFINED)

S. No.	Parameter	Standards		
		Into Inland Waters	Into Sewage Treatment [5]	Into Sea [6]
1	2	3	4	5
1.	Temperature 40^0C or Temperature Increase *	$\leq 3^oC$	$\leq 3^oC$	$\leq 3^oC$
2.	pH value (H^+) .	6-9	6-9	6-9
3.	Biochemical Oxygen Demand (BOD)5 at 20^0C [1]	80	250	80**
4.	Chemical Oxygen Demand(COD) [1]	150	400	400
5.	Total Suspended Solids (TSS)	200	400	200
6.	Total Dissolved Solids (TDS)	3500	3500	3500
7.	Oil and Grease	10	10	10
8.	Phenolic compounds (as phenol)	0.1	0.3	0.3
9.	Chloride (as Cl^-)	1000	1000	SC***
10.	Fluoride (as F^-)	10	10	10
11.	Cyanide (as CN^-) total .	1.0	1.0	1.0
12.	An-ionic detergents (as MBAS)[2]	20	20	20
13.	Sulphate ($SO4^{2-}$)	600	1000	SC***
14.	Sulphide (S^{2-})	1.0	1.0	1.0
15.	Ammonia (NH3)	40	40	40
16.	Pesticides [3]	0.15	0.15	0.15
17.	Cadmium [4] ..	0.1	0.1	0.1
18.	Chromium (trivalent and hexavalent [4] ..	1.0	1.0	1.0
19.	Cooper [4]	1.0	1.0	1.0
20.	Lead [4]	0.5	0.5	0.5
21.	Mercury [4]	0.01	0.01	0.01
22.	Selenium [4]	0.5	0.5	0.5
23.	Nickel [4] ..	1.0	1.0	1.0
24.	Silver [4]	1.0	1.0	1.0
25.	Total toxic metals	2.0	2.0	2.0
26.	Zinc	5.0	5.0	5.0
27.	Arsenic [4]	1.0	1.0	1.0
28.	Barium [4]	1.5	1.5	1.5
29.	Iron	8.0	8.0	8.0
30.	Manganese	1.5	1.5	1.5
31.	Boron [4]	6.0	6.0	6.0
32.	Chlorine	1.0	1.0	1.0

Explanations:

1. Assuming minimum dilution 1:10 on discharge, lower ratio would attract progressively stringent standards to be determined by the Sindh Environmental Protection Agency. By 1:10 dilution means, for example that for each one cubic meter of treated effluent, the recipient water body should have 10 cubic meter of water for dilution of this effluent.
2. Methylene Blue Active Substances; assuming surfactant as biodegradable.
3. Pesticides include herbicides, fungicides, and insecticides.
4. Subject to total toxic metals discharge should not exceed level given at S. N. 25.
5. Applicable only when and where sewage treatment is operational and BOD5=80mg/l is achieved by the sewage treatment system.
6. Provided discharge is not at shore and not within 10 miles of mangrove or other important estuaries.

* The effluent should not result in temperature increase of more than 3^0C at the edge of the zone where initial mixing and dilution take place in the receiving body. In case zone is not defined, use 100 meters from the point of discharge.

** The value for industry is 200 mg/l

*** Discharge concentration at or below sea concentration (SC).

Note: 1. Dilution of liquid effluents to bring them to the STANDARDS limiting values is not permissible through fresh water mixing with the effluent before discharging into the environment.

2. The concentration of pollutants in water being used will be subtracted from the effluent for calculating the STANDARDS limits".

"SINDH ENVIRONMENTAL QUALITY STANDARDS FOR INDUSTRIAL GASEOUS EMISSION (mg/Nm^3, UNLESS OTHERWISE DEFINED)."

S. No.	Parameter	Source of Emission		Standards
1	2	3		4
1.	Smoke	Smoke opacity not to exceed		40% or 2 Ringleman Scale or equivalent smoke number
2.	Particulate matter	(a) Boilers and Furnaces		
	(1)	(i)	Oil fired	300
		(ii)	Coal fired	500
		(iii)	Cement Kilns	300

		(b) Grinding, crushing, Clinker coolers and Related processes, Metallurgical Processes, converter, blast furnaces and cupolas.	500
3.	Hydrogen Chloride	Any	400
4.	Chlorine	Any	150
5.	Hydrogen Fluoride	Any	150
6.	Hydrogen Sulphide	Any	10
7.	Sulphur Oxides [2] [3]	Sulfuric acid/ Sulphonic acid plants	
		Other Plants except power Plants operating on oil and coal	1700
8.	Carbon Monoxide	Any	800
9.	Lead	Any	50
10.	Mercury	Any	10
11.	Cadmium	Any	20
12.	Arsenic	Any	20
13.	Copper	Any	50
14.	Antimony	Any	20
15.	Zinc	Any	200
16.	Oxides of Nitrogen	Nitric acid Manufacturing unit.	3000
	(3)	Other plants except power plants operating on oil or coal:	
		Gas fired	400
		Oil fired	600
		Coal fired	1200

Explanations:-

1. Based on the assumption that the size of the particulate is 10 micron or more.
2. Based on 1 percent Sulphur content in fuel oil. Higher content of Sulphur will case standards to be pro-rated.
3. In respect of emissions of Sulphur dioxide and Nitrogen oxides, the power plants operating on oil and coal as fuel shall in addition to Standards specified above, comply with the following standards:-

A. **Sulphur Dioxide**

Sulphur Dioxide Background levels Micro-gram per cubic meter (ug/m^3) Standards.

Background Air Quality (SO_2 Basis)	Annual Average	Max. 24-hours Interval	Criterion I Max. SO_2 Emission (Tons per Day Per Plant)	Criterion II Max. ground level increment to ambient (One year Average)
Unpolluted	<50	<200	500	50
Moderately Polluted*				
Low	50	200	500	50
High	100	400	100	10
Very Polluted**	>100	>400	100	10

* For intermediate values between 50 and 100 ug/m^3 linear interpolations should be used.
** No projects with Sulphur dioxide emissions will be recommended.

B. Nitrogen Oxide

Ambient air concentrations of Nitrogen oxides, expressed as NO_X should not be exceed the following:-

Annual Arithmetic Mean $100ug/m^3$ (0.05 ppm)

Emission level for stationary source discharge before missing with the atmosphere should be maintained as follows:-

For fuel fired steam generators as Nanogram (10^0-gram) per joule of heat input:

Liquid fossil fuel	130
Solid fossil fuel..	300
Lignite fossil fuel	260

Note:- Dilution of gaseous emissions to bring them to the STANDARDS limiting value is not permissible through excess air mixing blowing before emitting into the environment.

Sindh Environmental Quality Standards for Motor Vehicle Exhaust and Noise

(i) **For in-use Vehicles**

S. No.	Parameter	Standards (maximum permissible limit)	Measuring Method	Applicability
1	2	3	4	5
1.	Smoke	40% or on the Ringleman Scale during engine acceleration mode	To be compared with Ringleman Chart at a distance of 6 meters or more.	Immediate effect
2	Carbon Monoxide	6 %	Under idling conditions: Non-dispersive infrared detection through gas analyzer.	
3.	Noise	85 db (A)	Sound-meter at 7.5 meter from the source.	

For new Vehicles

EMISSION STANDARDS FOR DIESEL VEHICLES

(a) For passenger Cars and Light Commercial Vehicles (g/Km)

Type of Vehicle	Category/Class	Tiers	CO	HC+ NOx	PM	Measuring Method	Applicability
1	2	3	4	5	6	7	8
Passenger Cars.	M 1: with reference mass (RW).	Pak-II, IDI	1.0	0.7	0.08		All imported and local manufactured
	up to 2500 kg. Cars with RW over 2500 kg. to meet NI Category standards	Pak-II DI	1.0	0.9	0.10	NEDC (ECE 15+ EUDCL.)	Diesel vehicles with effect from 01-07-2012
Light Commercial Vehicles	NI-I (RW<1250 Kg)	Pak-II IDI	1.0	0.70	0.08		
		Pak-II DI	1.0	0.90	0.10		
	NI-II(1250kg< RW < 1700 Kg)	Pak-II IDI	1.25	1.0	0.12		
		Pak-II DI	1.25	1.3	0.14		
	NI-III(RW< 1700 Kg)	Pak-II IDI	1.50	1.2	0.17		
		Pak-II DI	1.50	1.6	0.20		

Parameter Standards (maximum permissible limit) Measuring method

Noise	85 db (A)	Sound-meter at 7.5 meters from the source

(b) For Heavy Duty Diesel Engines and Large Goods Vehicles (g/Kwh)

Type of Vehicle	Catogry/ Class	Tiers	CO	HC	NOx	PM	Measuring Method	Applicability
1	2	3	4	5	6	7	8	9
Heavy Duty Diesel Engines	Turks and Buses	Pak-II	4.0	1.1	7.0	0.15	ECE-R-49	All Imported and local manufactured diesel vehicles with the effect 1-7-2012
Large goods Vehicles	N2(2000 and up	Pak-II	4.0	7.0	1.10	0.15	EDC	

Parameter Standards (maximum permissible limit) Measuring method

Noise 85 db (A) Sound-meter at 7.5 meters from the Source

Emission Standards for Petrol Vehicles (g/km)

Type of Vehicle	Category/ Class	Tier	Co	HC+ NOx	Measuring Method	Applicability
1	2	3	4	5	6	7
Passenger Cars.	M 1: with reference mass (RW): upto 2500 kg. Cars with RW over 2500 kg. to meet N1 Category standards	Pak-II	2.20	0.5	NEDC (ECE 15+ EUDC.)	All imported and new models * locally manufactured petrol vehicles with effect from 1st July, 2009**

Light Commercial Vehicles	NI-I (RW<1250 kg) NI-NI-II (1250kg> kg RW < 1700 Kg)	Pak-II	2.20	0.5	
		Pak-II	4.0	0.65	
		Pak-II	5.0	0.08	
	NI-III(RW> 1700 kg)				
Motor Rickshaws & Motor Cycles	2,4 strokes < 150 cc	Pak-II	5.5	1.5	ECER 40
	2,4 strokes > 150cc	Pak-II	5.5	1.3	

Parameter Standards (maximum permissible limit) Measuring method

Noise source	85 db (A)	Sound-meter at 7.5 meters from the

Explanations:

DI:	Direct Injection.
IDI:	Indirect Injection.
EUDCL:	Extra Urban Driving Cycle.
NEDC:	New European Driving Cycle.
ECE:	Urban Driving Cycle.
M:	Vehicles designed and constructed for the carriage of passenger and Comprising no more than eight seats in addition to the driver's seat.
N:	Motor vehicles with at least four wheels designed and constructed for the carriage of goods.
*	New model means both model and engine type change.
**	The existing models of petrol driven vehicles locally manufactured will immediately switch over to Pak-II emission standards but no late than 30th June, 2012.

SINDH ENVIRONMENTAL QUALITY STANDARDS FOR AMBIENT AIR

Pollutants	Time-weight average	Concentration in Ambient Air	Method of measurement
Sulphur Dioxide(SO2)	Annual Average*	80 µg/m³	Ultraviolet Fluorescence method
	24 hours**	120 µg/m³	
Oxides of Nitrogen as (NO)	Annual Average*	40 µg/m³	Gas Phase Chemiluminescence
	24 hours**	40 µg/m³	
Oxides of Nitrogen as (NO2)	Annual Average*	40 µg/m³	Gas Phase Chemiluminescence
	24 hours**	80 µg/m³	
O³	1 hour	130 µg/m³	Non dispersive UV absorption method
Suspended Particulate Matters(SPM)	Annual Average*	360 µg/m³	High Volume Sampling (Average flow rate not less than 1.1 in 3/minutes)
	24 hours**	500 µg/m³	
Respirable Particulate Matter PM10	Annual Average*	120 µg/m³	ß Ray absorption method
	24 hours**	150 µg/m³	
Respirable Particulate Matter PM2.5	Annual Average*	40 µg/m³***	ß Ray absorption method
	24 hours**	75 µg/m³	
Lead Pb	Annual Average*	1 µg/m³	ASS Method after sampling using EPM 2000 or equivalent filter paper
	24 hours**	1.5 µg/m³	
Carbon Monoxide(CO)	8 hours**	5 mg/m³	Non Dispersive Infra Red(NDIR) method
	1 hours**	10 mg/m³	

*Annual arithmetic mean of minimum 104 measurements in a year taken twice a week, 24 hourly and at uniform interval.

** 24 hourly/8 hourly values should be met 98% in a year, 2% of the time. It may exceed but not on two consecutive days.

***Annual Average limit of 40µ/m³ or background annual average concentration plus allowable allowance of 9µg/m³, whichever is lower.

Sindh Standards for Drinking Water Quality

Properties / Parameters	Standard Values for Sindh	WHO Standards	Remarks
Bacterial			
All water intended for drinking (e.Coli or Thermo tolerant Coliform bacteria)	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample	Most Asian countries also follow WHO standards
Treated water entering the distribution system (E.Coli or thermo tolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml sample	Must not be detectable in any 100 ml sample	Most Asian countries also follow WHO standards
Treated water in the distribution system (E.coli or thermo tolerant coliform and total coliform and total coliform bacteria)	Must not be detectable in any 100 ml sample In case of large supplies, where sufficient samples are examined, must not be present in 95% of the samples taken throughout any 12-month period	Must not be detectable in any 100 ml sample In case of large supplies, where sufficient samples are examined, must not be present in 95% of the samples taken throughout any 12-month period	Most Asian countries also follow WHO standards
Physical			
Colour	≤ 15 TCU	≤ 15 TCU	
Taste	Non objectionable/Acceptable	Non objectionable/Acceptable	
Odour	Non	Non	

	objectionable/Acceptable	objectionable/Accep table
Turbidity	< 5 NTU	< 5 NTU
Total hardness as $CaCO_3$	< 500 mg/l	---
TDS	< 1000	< 1000
pH	6.5 - 8.5	6.5 - 8.5
Chemical		
Essential Inorganic	***mg/Litre***	***mg/Litre***
Aluminium (Al) mg/l	≤ 0.2	0.2

Properties / Performance	Standard Values for Pakistan	Who Standards	Remarks
Antimony (Sb)	≤ 0.005 (P)	0.02	
Arsenic (As)	≤ 0.05 (P)	0.01	Standard for Pakistan similar to most Asian developing countries
Barium(Ba)	0.7	0.7	
Boron (B)	0.3	0.3	
Cadmium (Cd)	0.01	0.003	Standard for Pakistan similar to most Asian developing countries
Chloride (Cl)	< 250	250	
Chromium (Cr)	≤ 0.05	0.05	
Copper (Cu)	2	2	
Toxic Inorganic	***mg/Liter***	***mg/Litre***	
Cyanide (CN)	≤ 0.05	0.07	Standard for Pakistan similar to Asian developing countries
Fluoride (F)*	≤ 1.5	1.5	
Lead (Pb)	≤ 0.05	0.01	Standard for Pakistan similar to most Asian developing countries
Manganese (Mn)	≤ 0.5	0.5	
Mercury (Hg)	≤ 0.001	0.001	
Nickel (Ni)	≤ 0.02	0.02	

Properties / Performance	Standard Values for Pakistan	Who Standards	Remarks
Nitrate (NO_3)	≤ 0.50	50	
Nitrite (NO_2)	≤ 3 (P)	3	
Selenium (SE)	0.01 (P)	0.01	
Residual chlorine	0.2-0.5 at consumer end 0.5-1.5 at source	---	
Zinc (Zn)	5.0	3	Standard for Pakistan similar to most Asian developing countries

Properties / Performance	Standard Values for Pakistan	Who Standards	Remarks
Organic			
Pesticides mg/L		PSQCA No. 4639-2004, Page No. 4 Table No. 3 Serial No. 20-58 may be consulted.***	Annex II
Phenolic compounds (as Phenols) mg/L		≤ 0.002	
Polynuclear aromatic hydrocarbons (as PAH g/L)		0.01 (By GC/MS method)	
Radioactive			
Alpha Emitters bq/L or pCi	0.1	0.1	
Beta emitters	1	1	

*** PSQCA: Pakistan Standards Quality Control Authority

Proviso:

The existing drinking water treatment infrastructure is not adequate to comply with WHO guidelines. The Arsenic concentrations in some parts of Sindh have been found high then Revised WHO guidelines. It will take some time to control arsenic through treatment process. Lead concentration in the proposed standards is higher than WHO Guidelines. As the piping system for supply of drinking water in urban centers are generally old and will take significant resources and time to get them replaced. In the recent past, Lead was completely phased out from petroleum

products to cut down Lead entering into environment. These steps will enable to achieve WHO guidelines for Arsenic, Lead, Cadmium and Zinc. However, for bottled water, WHO limits for Arsenic, Lead, Cadmium and Zinc will be applicable and PSQCA Standards for all the remaining parameters.

Sindh Environmental Quality Standards for Noise

S. No.	Category of Area / Zone	Effective from 1st Jan, 2015		Effective from 1st January, 2015	
		Limit in dB(A) Leq *			
		Day Time	Night Time	Day Time	Night Time
1.	Residential Area (A)	65	50	55	45
2.	Commercial Area (B)	70	60	65	55
3.	Industrial Area (C)	80	75	75	65
4.	Silence Zone (D)	55	45	50	45

Note: 1. Day time hours: 6:00 a.m to 10:00 p.m

2. Night time hours: 10:00 p.m to 6:00 a.m

3. Silence zone: Zones which are declared as such by the competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts

4. Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.

* dB(A) Leq: Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

3. **Repeal and Savings.**

(1) The provisions of the Statutory Notification dated 10th August, 2000 and 18th October, 2010, issued by the Ministry of Environment, Government of Pakistan, to the extent of the Province of Sindh are hereby repealed.

(2) All actions taken, proceedings initiated shall be deemed to have been taken and initiated validly under the the provisions of these Rules.

DIRECTOR GENERAL
SINDH ENVIRONMENTAL PROTECTION AGENCY

Karachi: Printed at the Sindh Government Press
28-1-2016

ATTACHMENT G

AIR QUALITY ANALYSIS AND AIR DISPERSION MODELLING (ADM) RESULTS

1.1. Methodology for Baseline Ambient Air Quality Monitoring

At each of the locations, A1 and A2, a mobile van with the equipment mounted was stationed for 24 hours, during which continuous monitoring of each of the ambient air quality parameter was performed including SO_2, NO_x, CO, PM_{10} and $PM_{2.5}$.

The methodology for Ambient Air Quality monitoring including the equipment used and method for analysis of each analyte, is presented later in this attachment.

1.2. Discussion of Results

A comparison of the baseline ambient air quality data was done against the World Health Organisation (WHO) Ambient Air Quality Guidelines (2021) adopted by the International Finance Corporation (IFC), and the Sindh Environmental Quality Standards (SEQS) (2016).

$PM_{2.5}$ exceeded the WHO Ambient Air Quality Standards Ambient Air Quality Guidelines (AQG) for 24-hours at both, A1 and A2; however, it was within the prescribed SEQS limits. PM_{10} exceeded the AQG level at both A1 and A2, but was found within the 24-hours SEQS limits. NO_2 also exceeded the 24-hours AQG level marginally at both, A1 and A2. No exceedances were observed against the AQG levels and the SEQS for SO_2, CO and O_3.

The particulate matter and NO_2 exceedances can be attributed to the overall dry and dusty northeast winds blowing in the region, which is typical for this time of the year when the monitoring was performed (February 2024). No baseline ambient air quality data exists for the region and this monitoring attempted to provide some dataset regarding the prevalent air quality in the area. The marginal NO_2 may be attributed to the main Gharo-Keti Bandar Highway present nearby and the moderate to heavy vehicular traffic plying on it.

The ambient air quality data and its comparison against the applicable Sindh Environmental Quality Standards (SEQS) are provided in ***Table 1.1***.

Table 1.1. Baseline Ambient Air Quality Data and its Comparison with Applicable National Standards

Pollutant	Baseline Ambient Air Quality Data		SEQS (2016)	
	Average Baseline Concentration (A1)	**Average Baseline Concentration (A2)**	**Avg. Period**	**Standards**
Particulate Matter $PM_{2.5}$ (ug/m^3)	21.72	26.19	24 hrs	75
Particulate Matter PM_{10} (ug/m^3)	46.88	75.47	Annual	40
			24 hrs	150
Total Suspended Particulates (TSP)	68.60	101.66	Annual	360
			24 hours	500
Ozone O_3 (ug/m^3)	22.71	22.53	1 hour	130
NO_2 (ug/m^3)	28.32	27.88	Annual	40
			24 hrs	80
SO_2 (ug/m^3)	28.47	29.34	Annual	80
			24 hrs	120
CO (ug/m^3)	300	1,020	8 hrs	5,000
			1 hr	10,000

1.1. Air Dispersion Modelling (ADM) Results

A comparison of the Air Dispersion Modelling (ADM) Results is provided against the WHO Ambient Air Quality Standards (2021) adopted by IFC and the SEQS (2016) is provided below in ***Table 1.2***.

The ADM Results provide the proposed holistic impact status that is, including the impact of the project and the existing ambient air quality. Based on the ADM results, the incremental concentrations at A1 and A2 indicate no exceedance against the AQG levels for 24 hours and/or the SEQS. The incremental concentrations for TSP and CO were determined to be negative at A2, which is primarily because the 24-hour average baseline concentration values for TSP and CO are although averaged out; however, the individual data points showed a lot of variation, meaning that the average value may not be representative of the concentration of these pollutants in the area. This is likely due to the relatively dry and dusty conditions observed at the time of background monitoring, coupled with the data at A2 being influenced by the traffic plying on the nearby Gharo-Keti Bandar Highway.

Table 1.2. ADM Results and Incremental Concentrations from Proposed Project

Pollutant	Baseline Concentration (A1)	Baseline Concentration (A2)	ADM Scenario	ADM Results (A1)*	ADM Results (A2)*	Incremental Concentration due to Proposed Project (A1)	Incremental Concentration due to Proposed Project (A2)	WHO Ambient Air Quality Standards (2021) for IFC						SEQS (2016)	
								Avg. Period	Interim Target 1	Interim Target 2	Interim Target 3	Interim Target 4	AQG Level	Avg. Period	Standards
Particulate Matter $PM_{2.5}$ (ug/m^3)	21.72	26.19	Normal	-	-	-	-	Annual	35	25	15	10	5	24 hrs	75
			Extreme	-	-	-	-	24 hrs	25	50	37.5	25	15		
Particulate Matter PM_{10} (ug/m^3)	46.88	75.47	Normal	-	-	-	-	Annual	70	50	30	20	15	Annual	40
			Extreme	-	-	-	-	24 hrs	150	100	75	50	45	24 hrs	150
Total Suspended Particulates (TSP)	68.60	101.66	Normal	86.61	85.25	16.65	-16.41	-	-	-	-	-	-	Annual	360
			Extreme	86.61	85.25	16.65	-16.41							24 hours	500
NO_2 (ug/m^3)	28.32	27.88	Normal	33.50	29.50	5.18	1.62	Annual	40	30	20	-	10	Annual	40
			Extreme	33.50	29.50	5.18	1.62	24 hrs	120	50	-		25	24 hrs	80
SO_2 (ug/m^3)	28.47	29.34	Normal	41.00	31.00	12.53	1.66	24 hrs	125	50	-	-	40	Annual	80
			Extreme	42.50	32.50	14.03	3.16							24 hrs	120
CO (ug/m^3)	300	1,020	Normal	664.2	662.5	364.2	-357.5	24 hrs	7,000	-	-	-	4,000	8 hrs	5,000
			Extreme	664.4	664.5	364.4	-355.5	08 hrs	-				10,000	1 hr	10,000

Notes:

*= The value for ADM results for each analyte for Normal and Extreme Scenarios at locations, A1 and A2, have been interpreted from the contour maps provided in this same Attachment, as part of the ADM exercise

1.2. IFC 25% Rule

The IFC 25% Rule is intended to ensure that any single project in an area will not preclude other activities of economic development in the area based on overall air quality impacts and their relation to applicable AAQ Standards.

1.3. Discussion of Incremental Modelling Results Compared to the IFC 25% Rule

Using the IFC 25% Rule, the *incremental concentrations* due to the proposed project have been compared with 25% of the applicable AQG levels adopted by IFC. The results are presented below in ***Table 1.3***.

A comparison of the incremental concentrations with 25% of the standard indicates exceedance of SO_2 against 25% of the guideline values for both, *normal* and *extreme* modelling scenarios at location A1, while all other incremental concentrations of the modelled pollutants fall within 25% of the AQG levels (where applicable).

1.3.1. Construction Phase Mitigation Measures

Impacts emanating from the plant during the construction phase will be temporary in nature and may arise from movement of construction vehicles on unpaved land, land levelling activities, and transportation of plant equipment, machinery, etc.

In order to comply with the IFC Guidelines, Armstrong ZE will adopt the following additional mitigation and control measures:

- Plant trees in and around the site to hold topsoil and reduce dust generation near construction areas;
- Construction sites will be regularly sprinkled with water to keep the dust settled;
- All transportation vehicles bringing in coal and/or rice husks will be adequately covered including all storage areas to prevent any additional generation of dust; and
- All construction machinery and vehicles will be well-maintained and use low-emission engines.

1.3.2. Operation Phase Mitigation Measures

Armstrong ZE has committed to incorporate engineering controls for emissions into its boiler design including wet scrubbers that will be in place to control emissions from the boiler operations. However, to comply with emission levels after application of IFC's 25% rule, additional mitigation and control measures will be adopted by the plant, considering the practicalities:

- Lime Dosing will be used to minimise sulphur dioxide emissions, in the event that wet scrubbers are not able to maintain the emissions within regulatory limits;
- Use of low NO_x burners to keep emissions within the regulatory limits;
- Baghouse filters will be used to control particulates pollution, when required;
- Regular maintenance of boiler and the emission control equipment in place to ensure high efficiency;

- Implement continuous emissions monitoring systems in order to track and adjust operations in real-time to minimise the emissions;
- Establish “green buffer zones” or greenbelts around the plant so that the dense vegetation will absorb and disperse pollutants; and
- Engage in local community projects for air quality improvement such as urban greening, tree-plantation drives and/or supporting the local clean energy initiatives.

Table 1.3. Comparison of Incremental Concentrations with IFC 25% Rule

Pollutant	ADM Scenario	ADM Results (A1)	ADM Results (A2)	Incremental Concentration due to Proposed Project (A1)	Incremental Concentration due to Proposed Project (A2)	Avg. Period	AQG Level	25% of the AQG
Particulate Matter $PM_{2.5}$ (ug/m^3)	Normal	-	-	-	-	24 hrs	15	1.25
	Extreme	-	-	-	-			3.75
Particulate Matter PM_{10} (ug/m^3)	Normal	-	-	-	-	24 hrs	45	3.75
	Extreme	-	-	-	-			11.25
Total Suspended Particulates (TSP)	Normal	86.61	85.25	16.65	-16.41	-	-	-
	Extreme	86.61	85.25	16.65	-16.41			
NO_2 (ug/m^3)	Normal	33.50	29.50	5.18	1.62	24 hrs	25	2.5
	Extreme	33.50	29.50	5.18	1.62			6.25
SO_2 (ug/m^3)	Normal	41.00	31.00	12.53	1.66	24 hrs	40	10
	Extreme	42.50	32.50	14.03	3.16			
CO (ug/m^3)	Normal	664.2	662.5	364.2	-357.5	08 hrs	10,000	1000
	Extreme	664.4	664.5	364.4	-355.5			2500

1.4. Comparison of Proposed Plant Emission Rates with IFC Emissions Standards

The proposed emission rates for the plant under "*normal*" and "*extreme*" scenarios was provided, which has been compared against the IFC emission standards. The results are provided in ***Table 1.4***.

The results show all proposed emission rates to be well within the IFC emission standards. It is to be noted that since the plant boiler will run on coal and/or rice husk, the combustion technology type has been considered as boiler while the fuel type has been considered solid.

Table 1.4. Comparison of Proposed Emission Rates Against IFC Emission Standards

Pollutant	**Scenarios for Proposed Emission Rates**	**Expected Emission Rates**	**IFC Emissions Guidelines for Boiler Operating on Solid Fuel**
Particulate Matter (mg/Nm^3)	Normal	≤40	50 or up to 150 if justified by environmental assessment
	Extreme	40	
NO_2 (mg/Nm^3)	Normal	300	650
	Extreme	350	
SO_2 (mg/Nm^3)	Normal	500	2,000
	Extreme	650	
CO (mg/Nm^3)	Normal	75	-
	Extreme	80	

1.5. GIIP Stack Height

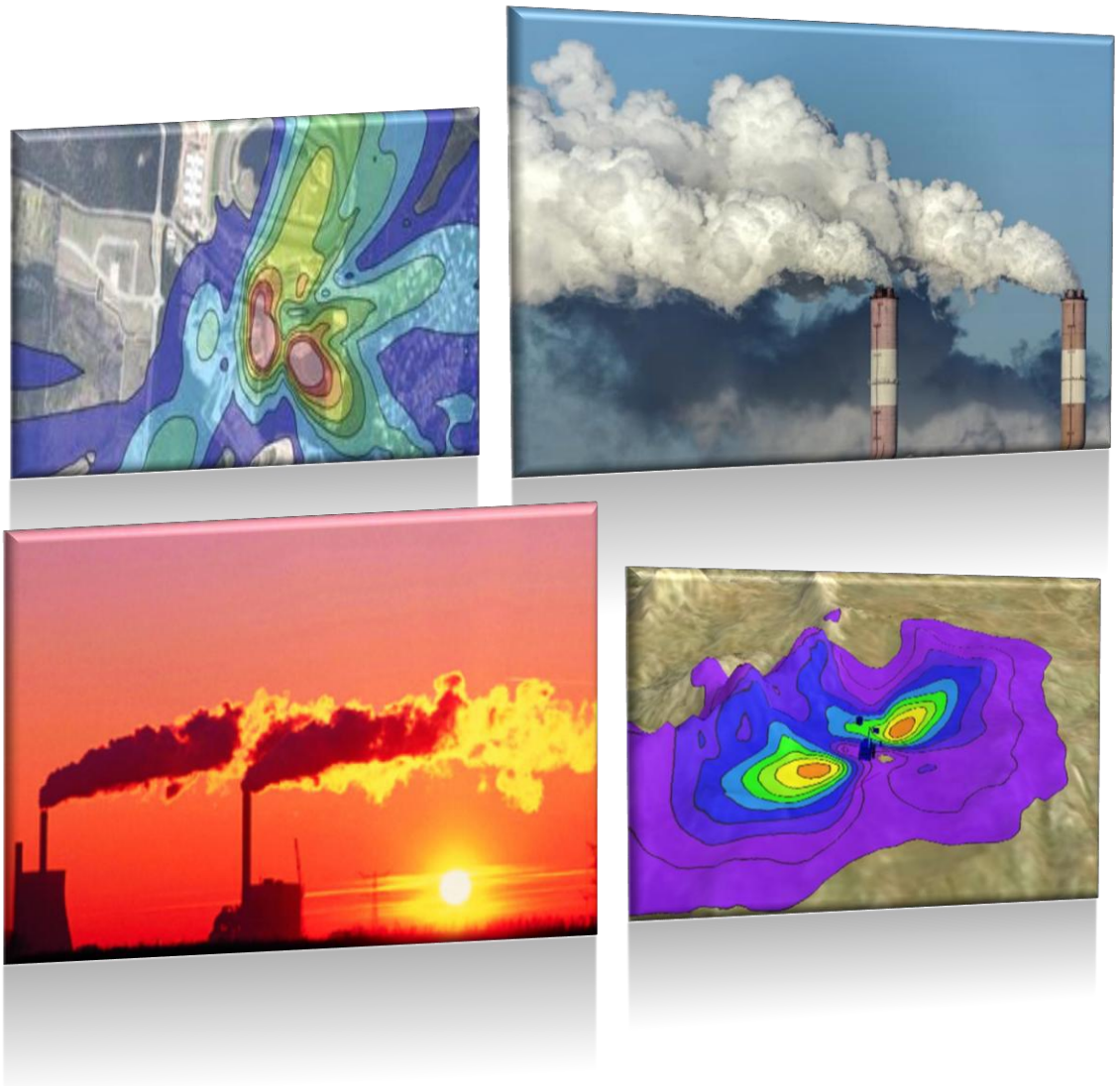
The Good International Industrial Practice (GIIP) for stack heights provides guidelines for the minimum stack heights required to ensure effective dispersion of emissions from industrial facilities. These guidelines are designed to prevent high concentrations of pollutants near the source and to reduce their impact on air quality and public health.

$Hg = H + (1.5 \times L)$	
where,	
H=	Height of nearby structure above the base of the stack
L=	Lesser dimension, height (h) or width (w) of the nearby Structures
Note: Nearby structure are the within or touching a radius of 5L but less than 800 meters	
Solution:	
The nearest heighted structure is boiler adjecent to the stack which is 12 meter long	
so,	
H=	12meter
Hg=	12+(1.5x12)
Hg=	12+18
Hg=	30 meters

10405-ES/R-08

SUPARCO

Plume Dispersion Modeling of Emissions from Tyre Manufacturing Plant in Gharo, Sindh



PAKISTAN SPACE & UPPER ATMOSPHERE RESEARCH COMMISSION (SUPARCO)

Disclaimer

This report is produced in compliance with the **Client Request** for **M/s Tekcellent (Pvt) Ltd.** The data in this report was modeled by SUPARCO. The information contained in this report is correct and up to date, to the best of our knowledge. The report, containing 32 pages, is prepared for sole and specific use of M/s Tekcellent Pvt. Ltd therefore it cannot be used in court of law for any negotiation or standardization. SUPARCO accepts no responsibility for changes made to this document by any third party, once report is submitted to the client.

Executive Summary

Air dispersion modelling exercise was carried out to determine the potential cumulative air quality impacts associated with the operation of the proposed Tyre Manufacturing facility, followed by a request received by M/s Tekcellent Pvt. Ltd

During normal operational phase, there will be 2 boilers of which only one boiler will be operational at all times, with each having a chimney stack of 1.5 metres, while the other boiler will only be used in case of maintenance shutdown of one of the boilers. During the extreme operational phase of the proposed Tyre Manufacturing plant, fuel to be used for the boiler will be 100% lignite coal. While during the normal operational phase, fuel to be used will be 70% lignite coal and 30% rise husk. The emission point within the proposed site will consist of 1 x stack.

The aim of the modelling was to determine whether or not the emissions from the boiler and generators on-site will result in a contravention of the applicable Sindh Environmental Quality Standards. The assessment was carried out using the air dispersion modelling software, i.e. AERMOD and the modelling has been carried out in accordance with the requirement of Environmental Impact Assessment (EIA).

All calculations are based on 6 years of WRF-Preprocessed Meteorological Data, AERMET/AERMOD (2018 to 2023), which was collected from Lakes Environmental Consultants Inc. (acquired by client "M/s Tekcellent Pvt. Ltd").

Predicted environmental concentrations were calculated for Nitrogen Oxides, Sulphur Oxides and Particulate Matter by adding existing ambient background

concentration data to the maximum predicted ground level concentrations from the model. This methodology ensures that both the modelled emissions and the existing background concentrations are taken into account when assessing the overall impact on ambient air quality. The calculated predicted environmental concentrations have then been compared against the relevant Air Quality Standards for Carbon monoxide, Oxides of Nitrogen, Oxides of Sulphur and Particulate Matter (TSP).

The modelling results indicate that the predicted environmental concentrations of the modelled pollutants for TSP, CO, SO_2 and NO_2 were well within the prescribed limits of SEQS for ambient air for both the scenarios (Extreme and Normal case).

While comparing with WHO Guidelines for SO2 and NO2 (normal/ extreme) modelling scenarios, results exceed from the prescribed limit of WHO guidelines whereas CO was found within the prescribed limit of WHO guidelines.

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Acronym	Description
SEPA	Sindh Environmental Protection Agency
AMS	American Meteorological Society
USEPA	US Environmental Protection Agency
CBL	Convective Boundary Layer
SBL	Stable Boundary Layer
PBL	Planetary Boundary Layer
AERMET	AERMIC Meteorological Preprocessor
SUPARCO	Pakistan Space & Upper Atmosphere Research Commission
NOx	Oxides of Nitrogen
NO_2	Nitrogen Oxide
$PM_{2.5}$	Particulate Matter upto 2.5 micrometer
PM_{10}	Particulate Matter upto 10 micrometer
SO_2	Sulfur Dioxide
CO	Carbon Monoxide
SEQS	Sindh Environmental Quality Standards

SECTION 1

1.0 INTRODUCTION

A Tyre Manufacturing Plant is going to be setup in the Gharo region of Taluka Mirpur Sakro, district Thatta, in the Sindh province of Pakistan. The said facility is located at Lat: 24.711967 N, and Long: 67.588608 E. The proposed Tyre Manufacturing Plant will manufacture vehicular tyres to cater locally, the growing demand for tyres used in passenger cars and 4x4 vehicles.

In this exercise, the dispersion of the criteria pollutants including CO, SO2, NO_2 and Particulate Matter (as TSP) was investigated using AERMOD software which is a USEPA regulatory model for industrial emissions of criteria pollutants. This model has also been used by leading environmental regulatory and protection agencies in the world.

1.1 BRIEF OVERVIEW OF AMBIENT AIR POLLUTANTS

1.1.1 Carbon Monoxide (CO)

Carbon Monoxide, with the chemical formula CO, is a colorless, odorless, and tasteless gas. It consists of one carbon atom covalently bonded to one Oxygen atom. Carbon Monoxide forms in preference to the more usual Carbon Dioxide when there is a reduced availability of Oxygen present during the combustion process. Carbon Monoxide has significant fuel value, burning in air with a characteristic blue flame, producing Carbon Dioxide. Despite its serious toxicity, CO plays a highly useful role in modern technology, being a precursor to myriad products.

1.1.2 Oxides of Nitrogen (NOx)

Nitrogen Oxides (NO_x), a mixture of Nitric Oxide (NO) and Nitrogen Dioxide (NO_2), are produced from natural sources, motor vehicles and other fuel

combustion processes. Nitric Oxide is colorless and odorless and is oxidized in the atmosphere to form Nitrogen Dioxide. Nitrogen Dioxide is an odorous, brown, acidic, highly-corrosive gas that can affect our health and environment. Oxides of Nitrogen are critical components of photochemical smog, Nitrogen Dioxide produces the yellowish-brown color of the smog.

All combustion processes produce Oxides of Nitrogen (NOX). NO2 and Nitric Oxide (NO) are both oxides of nitrogen and together are referred to as NOX. It is NO2 which is associated with adverse health effects. Motor vehicles account for about 70% of total NOX emissions. Other sources include the electricity supply and domestic wood burning. NOX is required in the production of Ozone and photochemical smog.

1.1.3 Sulfur Dioxide (SO_2)

Sulfur dioxide belongs to the family of sulfur oxide gases (SOx). These gases are formed when fuel containing sulfur (mainly coal and oil) is burned, and during metal smelting and other industrial processes. The major health concerns associated with exposure to high concentrations of SO2 include effects on breathing, respiratory illness, alterations in pulmonary defenses, and aggravation of existing cardiovascular diseases. Major subgroups of the population that are most sensitive to SO2 include asthmatics and individuals with cardiovascular diseases or chronic lung diseases (such as bronchitis or emphysema) as well as children and the elderly. Together, SO2 and NOX are the major precursors to acid rain, which is associated with the acidification of lakes and streams, accelerated corrosion of buildings and monuments, and reduced visibility.

1.1.4 Particulate Matter

Particulate Matter (PM) is a complex mixture consisting of varying combinations of dry solid fragments, solid cores with liquid coatings and small droplets of liquid. These tiny particles vary greatly in shape, size and

chemical composition, and can be made up of many different materials such as metals, soot, soil and dust. PM may also contain sulfate particles. PM may be divided into many size fractions, measured in microns (a micron is one-millionth of a meter). Sindh EPA regulates three size classes of particles - particles up to 2.5 microns (PM2.5), particles up to 10 microns (PM10) and Total Suspended Particulate as TSP. PM2.5 particles are a subset of PM10 whereas PM10 particles are subset of TSP.

Table-1.1(a) : Sindh Environmental Quality Standards for Ambient Air

Pollutants	Unit	Avg. Time	SEQS Standards
CO	µg/m^3	8 hrs 1 hr	5,000 10,000
NO_x as NO_2		Annual 24 hrs	40 80
SO_2		Annual 24 hrs	80 120
TSP		Annual 24 hrs	360 500

Table-1.1(b) : WHO Ambient Air Quality Guidelines

Parameter	Unit	Avg Period	Interim Target				AQG Level
			1	2	3	4	
Particulate Matter $PM_{2.5}$	µg/m^3	Annual	35	25	15	10	5
		24 hrs	75	50	37.5	25	15
Particulate Matter PM_{10}		Annual	70	50	30	20	15
		24 hrs	150	100	75	50	45
Ozone O_3		Peak Season	100	70	-	-	60
		8 hrs	160	120	-	-	100
NO_2		Annual	40	30	20	-	10
		24 hrs	120	50	-	-	25
SO_2		24 hrs	125	50			40
CO		24 hrs	7000	-	-	-	4000
		08 hrs					10,000

[a] 99th percentile (i.e. exceedance days per year).

[b] Average of daily maximum 8-hour mean O3 concentration in the six consecutive months with the highest six-month running-average O3 concentration.

Reference : https://iris.who.int/bitstream/handle/10665/345329/9789240034228-eng.pdf

1.2 OBJECTIVES

The major objectives of the current study were to:

(a) Study the dispersion of emissions from process stack of proposed tyre manufacturing Process Plant located at Gharo, Distt Thatta, Sindh for different modeling scenarios (Extreme & Normal case).

(b) Identify the impact areas/zones of these emissions around the plant and compliance with SEQS for ambient air.

1.3 STUDY AREA

AERMOD was used to study the impact zones of the dispersion of pollution emissions from Proposed Tyre Manufacturing Plant, located near Gharo town, Thatta District, Sindh. Detail of location of stacks along with study area are shown in table 1.2 and fig 1.1

Table-1.2: Location of Stacks

Stack Type/ Name	Coordinates
Boiler House	24°42'46.54"N, 67°35'22.20"E
Boiler - Stack 1	24°42'46.78"N, 67°35'22.81"E
Boiler - Stack 2	24°42'46.48"N, 67°35'22.86"E

Study Area

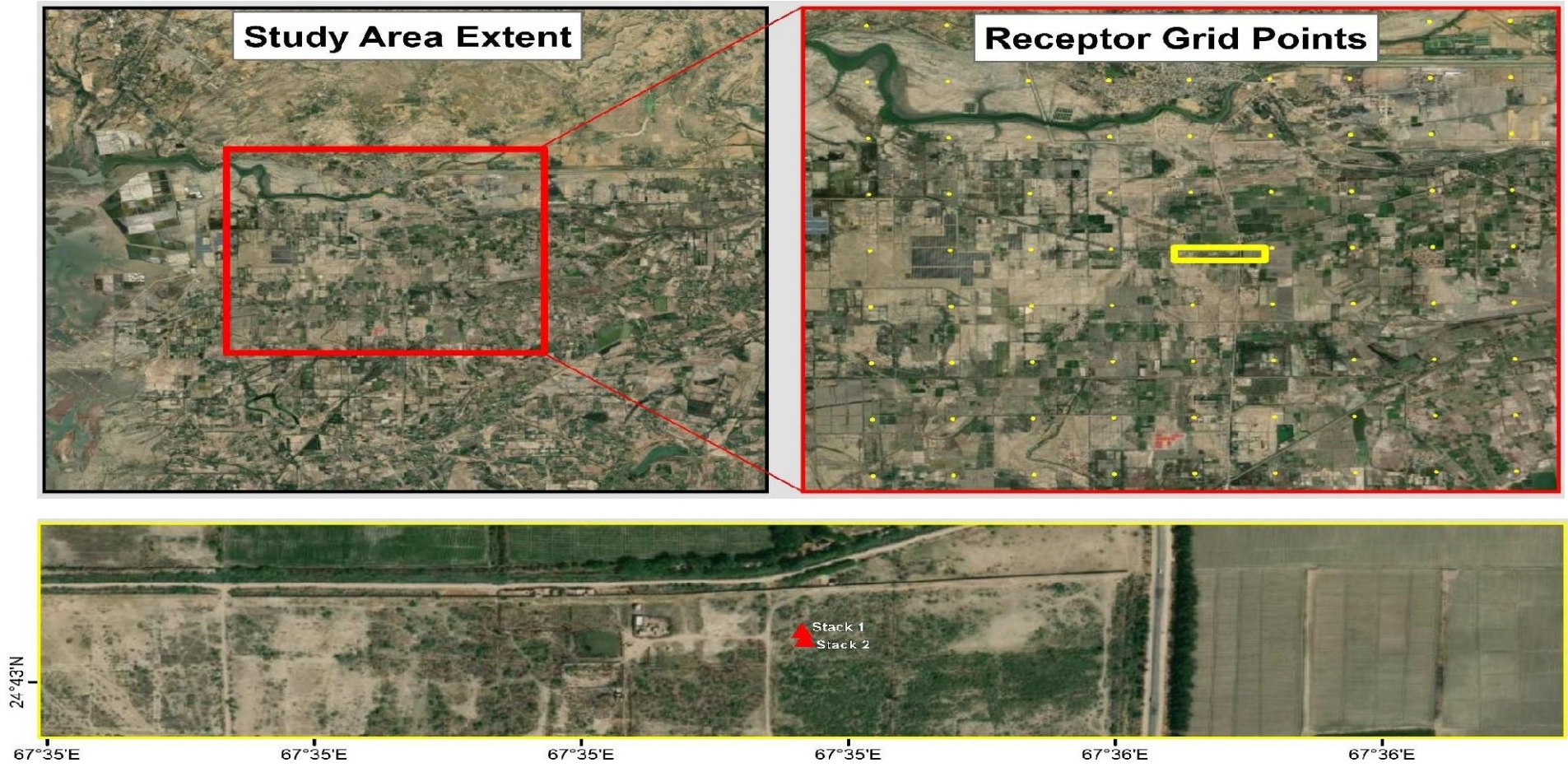

Figure 1.1Study Area of Proposed Tyre Manufacturing Facility,Gharo,Thatta,Sindh (Showing Extent (Domain),Stacks,and Receptor Grid)

SECTION 2

2.0 METHODOLOGY OF MODELING

2.1 GENERAL DESCRIPTION & INPUT (AN OVERVIEW)

AERMOD is an air pollutant dispersion model developed by the American Meteorological Society (AMS) / Environmental Protection Agency (US EPA) for regulatory purposes in the near field studies (up to 50 km x 50km) with simple and complex terrain. It is a steady-state model, in which the plume of emitted pollutants spreads both horizontally and vertically in accordance with the Gaussian distribution. The model is adapted for air pollutant dispersion modelling in complex terrain with the variability of vertical wind profile, temperature and turbulences in the planetary boundary layer (PBL) taken into account. It belongs to the second generation of dispersion models in which Gaussian formulations are used for stable conditions, and for unstable situations a semi-empirical approach is adopted.

The air dispersion modelling input data consisted of meteorological data, detailed information on the physical environment terrain features and details of all emission points on-site. Using this input data, the model predicts ambient ground level concentrations beyond the site boundary for each hour of the modelled meteorological years. The model post-processes the data to identify the location and concentration of the worst-case ground level concentrations. The flow chart of the AERMOD modeling system is given in Figure 2.1.

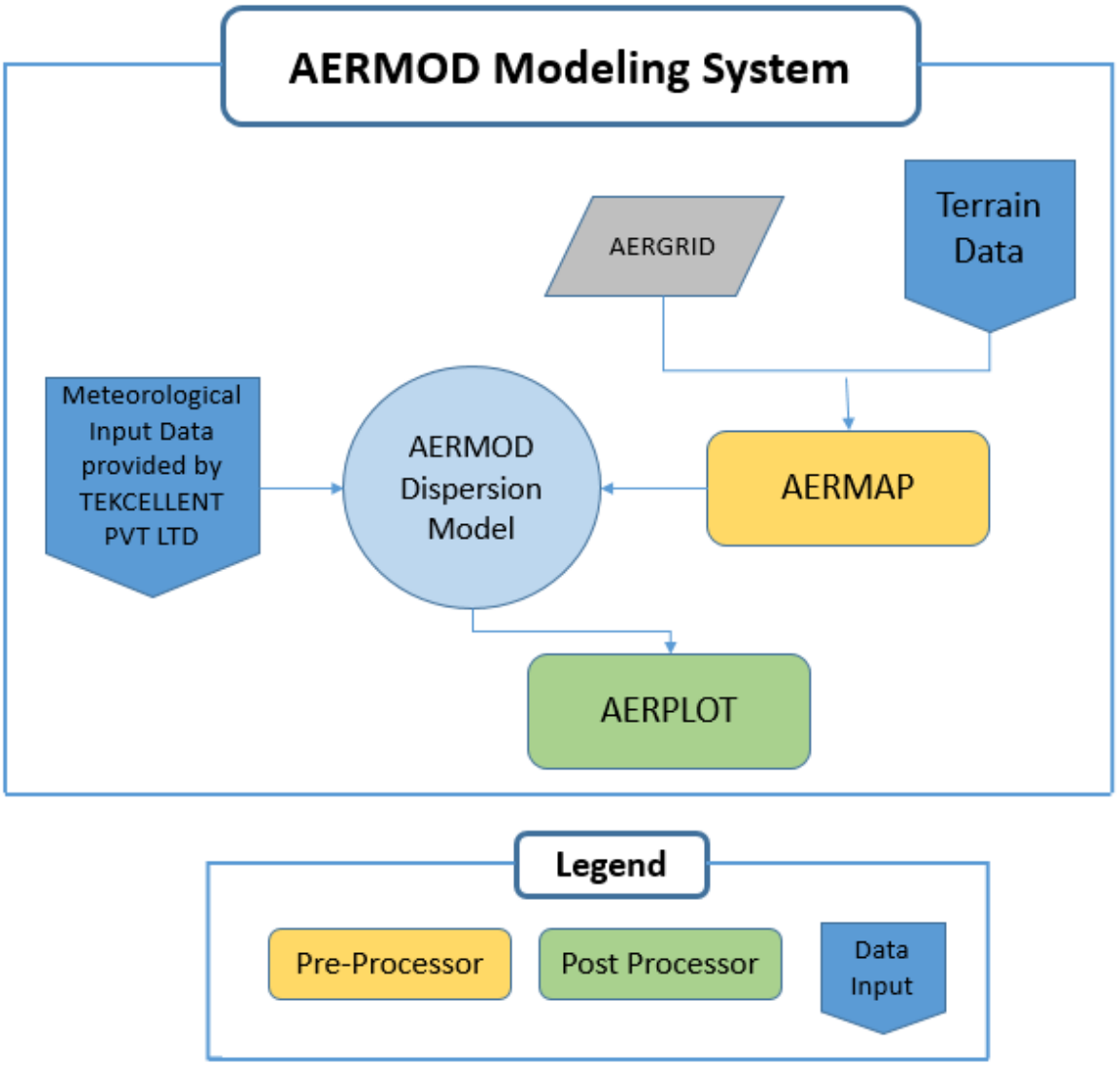

Figure 2.1: AERMOD Modeling System flow diagram

In this study, the dispersion of CO, SO2, NO2, and TSP are estimated. Following three types of data sets were used:

1. Plant Emission Data
2. Meteorological Data (both Surface & Upper air)
3. Baseline background concentration data of pollutants

Stack design parameters & emissions data and baseline background data are given in tables 2.1, 2.2 & 2.3 respectively as provided by TEKCELLENT Pvt (Ltd).

Table 2.1: Emission Characteristics of Boiler Stack for Normal Scenario

Required Parameters – Boiler	Unit	Values
Number of Boilers to be operated at a time and number of hours	-	1 @ 24 hrs
Fuel to be used in Boilers	-	70% lignite coal and 30% Rice Husk
Number of Boiler Stacks	-	2
Stack Diameter	meter	1.5
Stack Height	meter	30
Stack Gas Velocity	m/sec	22
Flue Gases Temperature	°C	150
Expected Emission Rate (Particulate Matter, TSP)	g/sec	≤ 0.5
Expected Emission Rate (SO2)	g/sec	6.25
Expected Emission Rate (NO2)	g/sec	3.75
Expected Emission Rate (CO)	g/sec	0.9375
Expected Emission Rate (Total VOCs)	g/sec	0.15

Table 2.2: Emission Characteristics of Boiler Stack for Extreme Scenario

Required Parameters - Boiler	Unit	Values
Number of Boilers to be operated at a time and number of hours	-	1 @ 24 hrs
Fuel to be used in Boilers	-	100% lignite coal
Number of Boiler Stacks	-	2
Stack Diameter	meter	1.5
Stack Height	meter	30
Stack Gas Velocity	m/sec	22
Flue Gases Temperature	°C	150
Expected Emission Rate (Particulate Matter, TSP)	g/sec	0.5
Expected Emission Rate (SO2)	g/sec	8.125
Expected Emission Rate (NO2)	g/sec	4.375
Expected Emission Rate (CO)	g/sec	1.0
Expected Emission Rate (Total VOCs)	g/sec	0.15

Table 2.3: Baseline Ambient Air Quality Data in/Around Proposed Tyre Manufacturing Plant at Gharo, Sindh

Parameter	Unit	Duration	Average Concentration	SEQS Limit
Carbon Monoxide (CO)	mg/m^3	8 Hours	0.66	**5.0**
Sulfur Dioxide (SO_2)	$\mu g/m^3$	24 Hours	28.90	**120**
Nitrogen Oxide (NO_2)	$\mu g/m^3$	24 Hours	28.10	**80**
Particulate Matter (TSP)	$\mu g/m^3$	24 Hours	85.13	**500**

A brief description of other datasets that are required to run an AERMOD simulation is given in the following sub-sections.

2.1.1 Meteorology Data

The meteorological data required by the dispersion model is wind speed, wind direction, Pasquill-Gifford stability category, boundary layer height and ambient temperature. The stability category and boundary layer height are used to characterize the turbulence within, and the height of the lower levels of the atmosphere. Extremely unstable conditions can cause plume looping and elevated concentrations close to the stack. Under stable conditions elevated concentrations can occur due to the emissions being trapped below the boundary layer. Neutral conditions, characterized by cloudy skies and strong winds, are most favorable for dispersion due to the mechanical mixing of the lower atmosphere. The wind direction determines the direction in which the plume is blown, and for a particular stability, higher wind speeds will result in reduced plume rise so causing the plume to reach ground level closer to the stack with elevated emission concentrations. The boundary layer height determines the total vertical distance over which the plume may spread. The model has been run for each pollutant using six years of meteorological data

(2018 – 2023) obtained by AERMOD Ready WRF-MMIF model from Lakes Environment Software. The meteorological wind-roses for the six years are presented in Figure 2.2. Dominant wind direction was from the WSW direction

2.1.2 Building Downwash

Air streams blowing across buildings can become disrupted, with turbulent eddies occurring downwind in the building wake. If an emission point is sufficiently close to a building, then the plume may become entrained in the turbulent eddies of the building wake. This entrainment can cause plume downwash resulting in elevated emission concentrations close to the emission point. The stacks modeled are not subject to downwash and, as a result, no direction specific building dimensions were calculated. The AERMOD model interprets the influence zone of each building for a given wind direction using the Building Profile Input Program (BPIP).

2.1.3 Receptors

The model was set up to examine the impact of emissions on the area surrounding the site using a series of receptors. A receptor is a location at which the model will calculate maximum process contributions. A Cartesian co-ordinate receptor grid system was established with the site at its center. A 10km x 10km grid with receptors at 500 meters spacing was created with the development site at its center (see Figure 1.1).

2.1.4 Terrain Data

A terrain height for each of the receptors on the grid was input to the model in order to accurately represent the changing elevations of the surrounding landscape. Digitized terrain data was incorporated into the model using a Digital Elevation Model (DEM) file and the AERMAP function of the AERMOD model. For the purpose, Shuttle Radar Topography Mission (SRTM) DEM of 1 Arc-Second (~30 meter) has been used in this study.

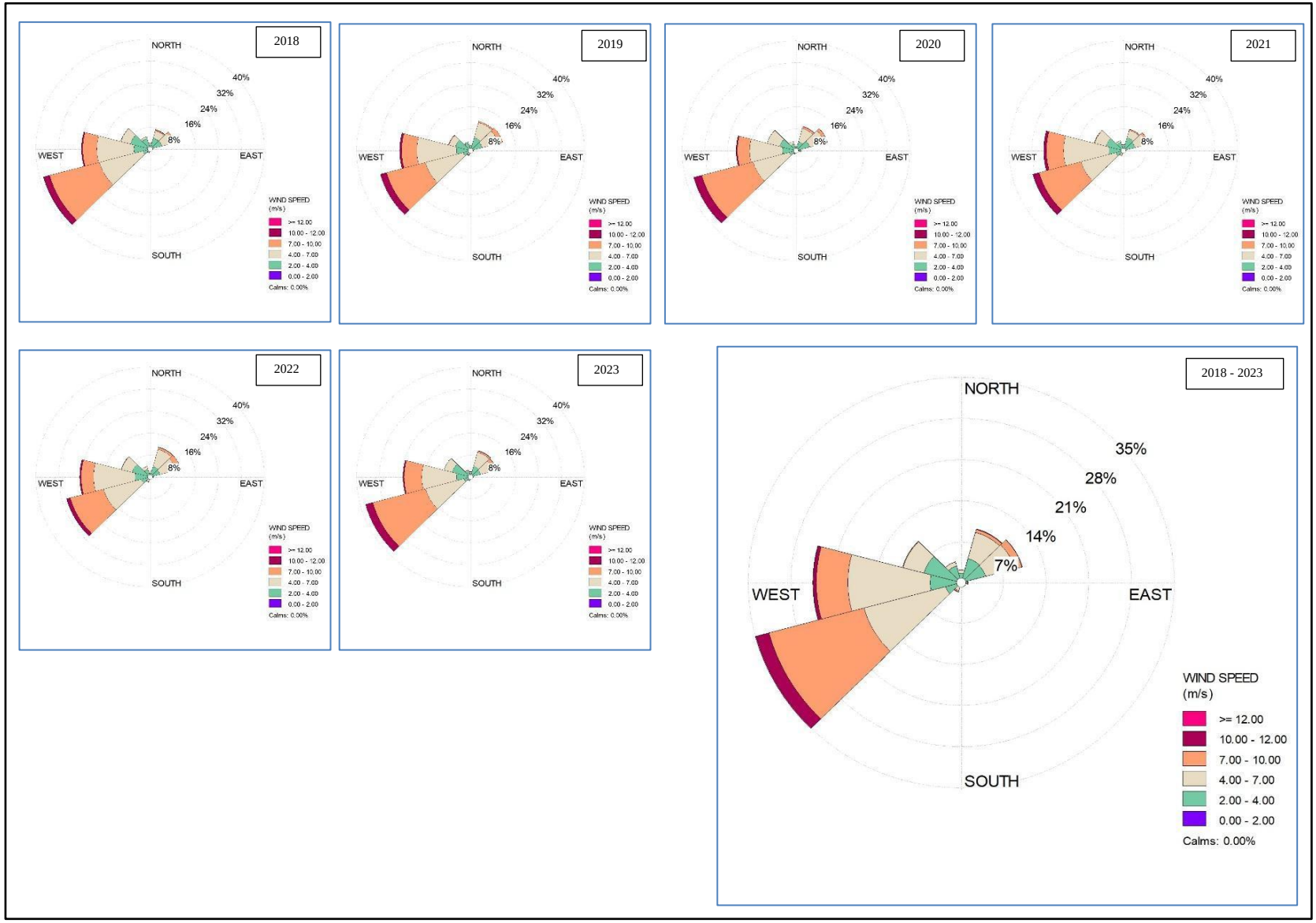

Figure 2.2: Meteorological Wind roses for six years (2018 – 2023)

2.1.5 Method

The model approach is being used to compare the model predictions plus the relevant background concentrations with Sindh Environmental Quality Standards (SEQS). Model predictions are being made using meteorological data for a 6 year period (2018-2023). Predictions are being made at a number of points (receptors) that comprised grids of 10km x 10km with spacing of 500 m. Model predictions also considered the terrain around the facility by using terrain heights for all receptors and SRTM DEM has been used for the purpose.

2.2 AIR DISPERSION MODELING SCENARIOS

The assessment that is being carried out for the Environmental Impact Statement (EIS) of Tyre manufacturing plant which will have two (02) boilers, of which only one (01) will be operational at all times. The chimney outlet diameter of each boiler is 1.5 meters; however, the two boilers will not be operated together simultaneously, as one will remain as a backup to be operated only when the other is off/close for maintenance. There are two scenarios for the plant operation:

(i) **Normal Case Scenario** – in which 70% lignite coal and 30% Rice Husk will be used as fuel (refer table 2.1 for emission characteristics of boiler stack)

(ii) **Extreme Case Scenario** – in which 100% lignite coal will be used as fuel (refer table 2.2 for emission characteristics of boiler stack)

There are four parameters (CO, NO2, SO2, TSP) for which the impact has been assessed. For each parameter, impact of emission rates with each scenario has been assessed. In this way, there are 09 simulations (see table 2.4) in total have been performed to assess the overall impact of the pollutants around the site.

Table 2.4 : Number of Simulations for different scenarios

S. No.	Simulation ID	Simulation Condition		
		Pollutant Short Name	Avg Time	Modeling Scenario
1	CO_1hr_Nor	CO	1 hr	Normal
2	CO_1hr_Extr			Extreme
3	CO_8hr_Nor		8 hr	Normal
4	CO_8hr_Extr			Extreme
5	NO2_24hr_Nor	NO2	24 hr	Normal
6	NO2_24hr_Extr			Extreme
7	SO2_24hr_Nor	SO2	24 hr	Normal
8	SO2_24hr_Extr			Extreme
9	TSP_24hr_Extr	TSP	24 hr	Extreme

SECTION 3

3.0 Results and Discussion

AERMOD was executed to estimate the impact zones of the dispersion of pollution emissions from proposed tyre manufacturing plant at Gharo, Thatta. Estimated modeling results are discussed in the following sections for each pollutants (CO, NO2, SO2, TSP) separately.

3.1 Carbon Monoxide (CO)

3.1.1 Normal Case Scenario for CO

Estimated modeling results for the average maximum concentrations of CO for 1-hr & 8-hr were 0.6647 mg/m^3 & 0.6642 mg/m^3 respectively for normal case scenario. Predicted cumulative ground level concentrations (1-hr & 8-hrs avg) depicted that the emissions of CO from the Tyre manufacturing plant are within the permissible limits of SEQS for CO and will have insignificant impact on ambient air quality of surrounding areas.

The other details of analysis are given in Table 3.1. The concentration maps for 1-hr and 8-hr are shown in Figure 3.1 & 3.2 respectively.

Table 3.1: Maximum Average Concentrations (1st Highest) of CO (mg/m^3) for tyre manufacturing plant, Gharo (Normal Case)

Pollutant	AERMOD Model Results				
	Scenario	Avg. Period	Peak Value (mg/m^3)	UTM	
				East (m)	North (m)
CO	Normal case	1-HR	0.6647	357845.50	2733904.77
		8-HR	0.6642	357845.50	2733904.77

Spatial Distribution of CO for 1-hours (Normal Scenario)

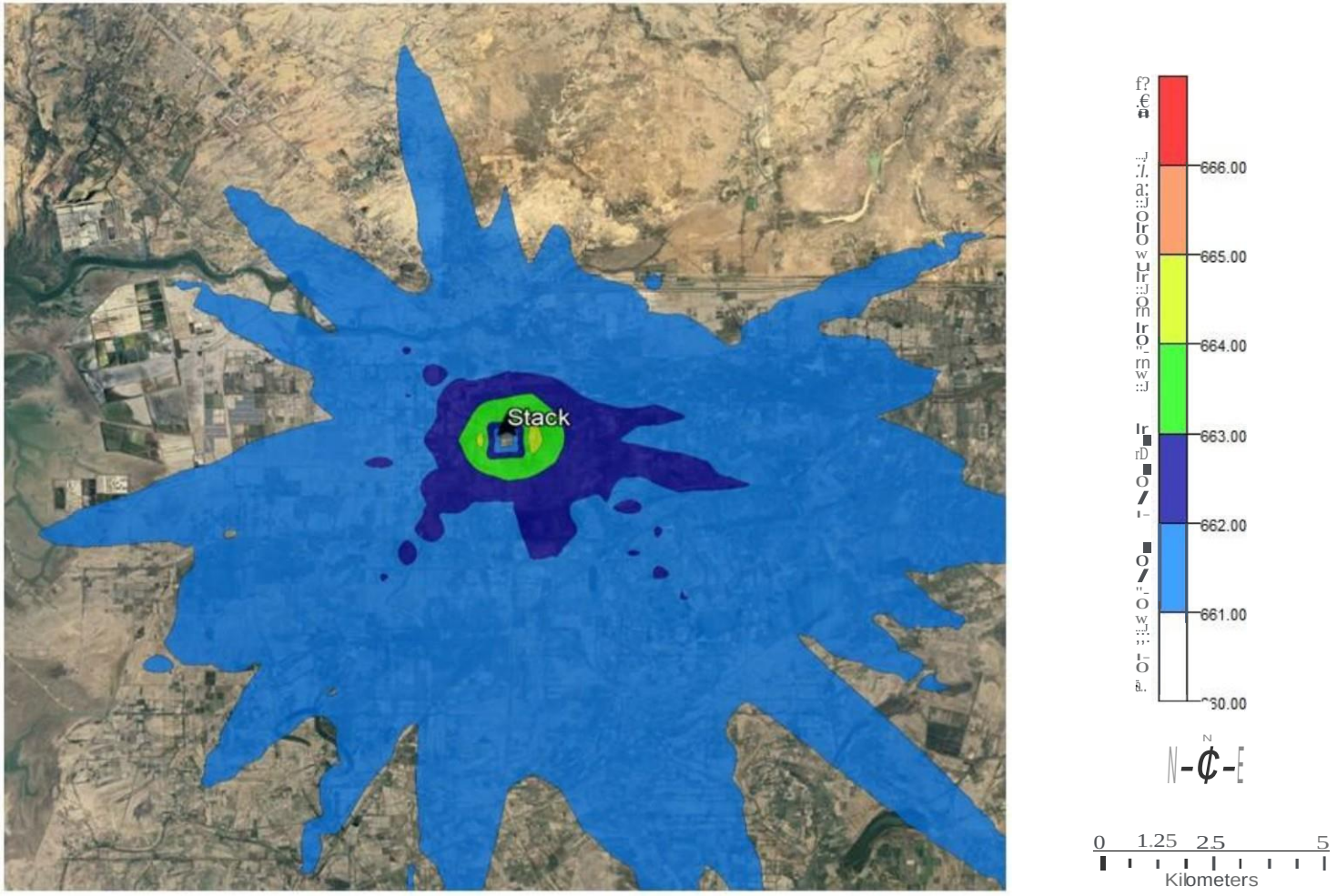

Figure 3.1 : Spatial Distribution of CO (1st Highest) concentration for 1-hr average (Normal Scenario)

Spatial Distribution of CO for 8-hours (Normal Scenario)

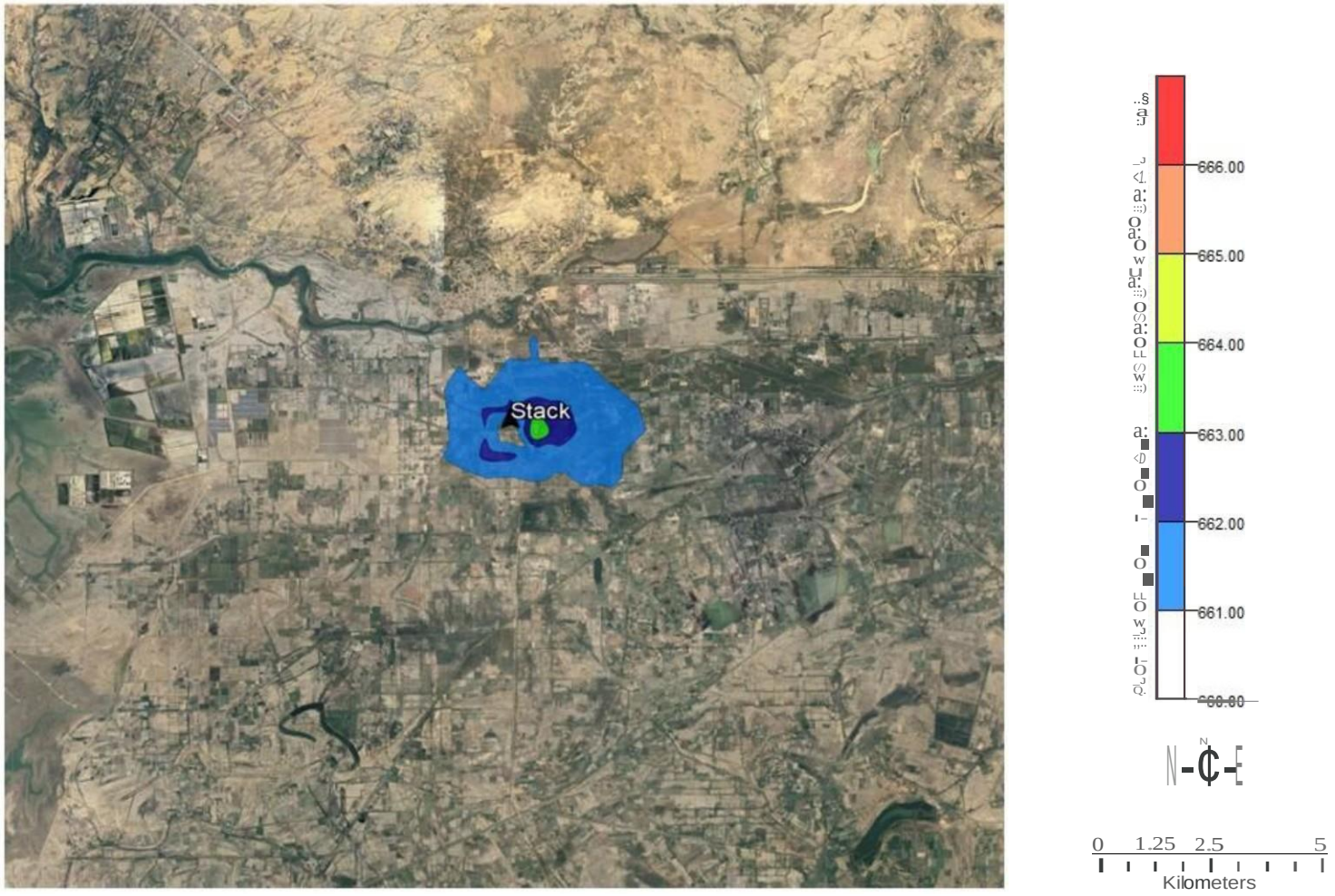

Figure 3.2: Spatial Distribution of CO (1st Highest) concentration for 8-hr average (Normal Scenario)

3.1.2 Extreme Case Scenario for CO

Estimated modeling results for the average maximum concentrations of CO for 1-hr & 8-hr were 0.6651 mg/m^3 & 0.6644 mg/m^3 respectively for extreme case scenario. Predicted cumulative ground level concentrations (1-hr & 8-hrs avg) depicted that the emissions of CO from the Tyre manufacturing plant are within the permissible limits of SEQS for CO and will have insignificant impact on ambient air quality of surrounding areas.

The other details of analysis are given in Table 3.2. The concentration maps for 1-hr and 8-hr are shown in Figure 3.3 & 3.4 respectively.

Table 3.2 : Maximum Average Concentrations (1st Highest) of CO (mg/m^3) for tyre manufacturing plant, Gharo (Extreme Case)

Pollutant	AERMOD Model Results				
	Scenario	Avg. Period	Peak Value (mg/m^3)	UTM	
				East (m)	North (m)
CO	Extreme case	1-HR	0.6651	357845.50	2733904.77
		8-HR	0.6644	357845.50	2733904.77

Spatial Distribution of CO for 1-hours {Extreme Scenario)

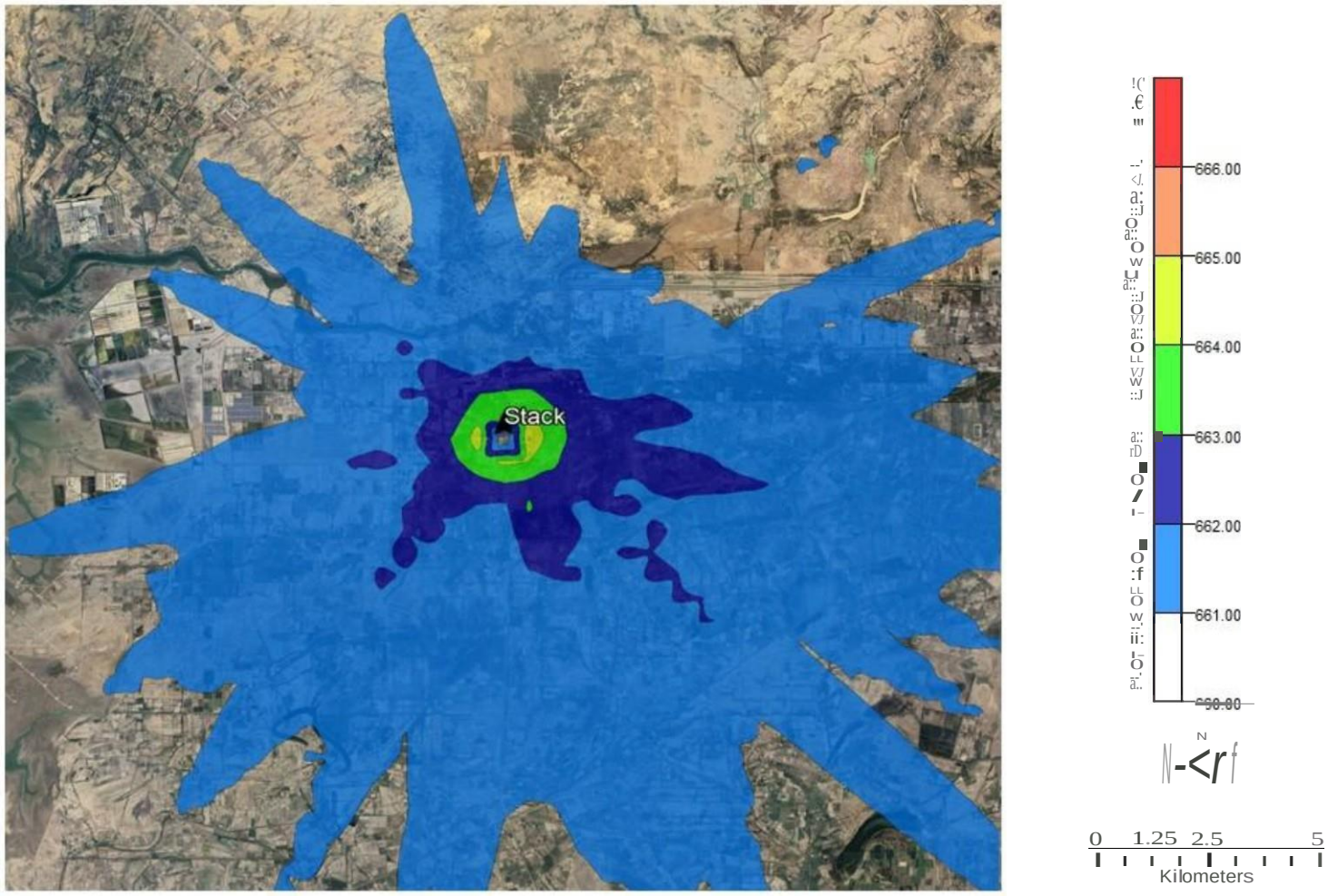

Figure 3.3: Spatial Distribution of CO (1st Highest) concentration for 1-hr average (Extreme Scenario)

Spatial Distribution of CO for 8-hours {Extreme Scenario)

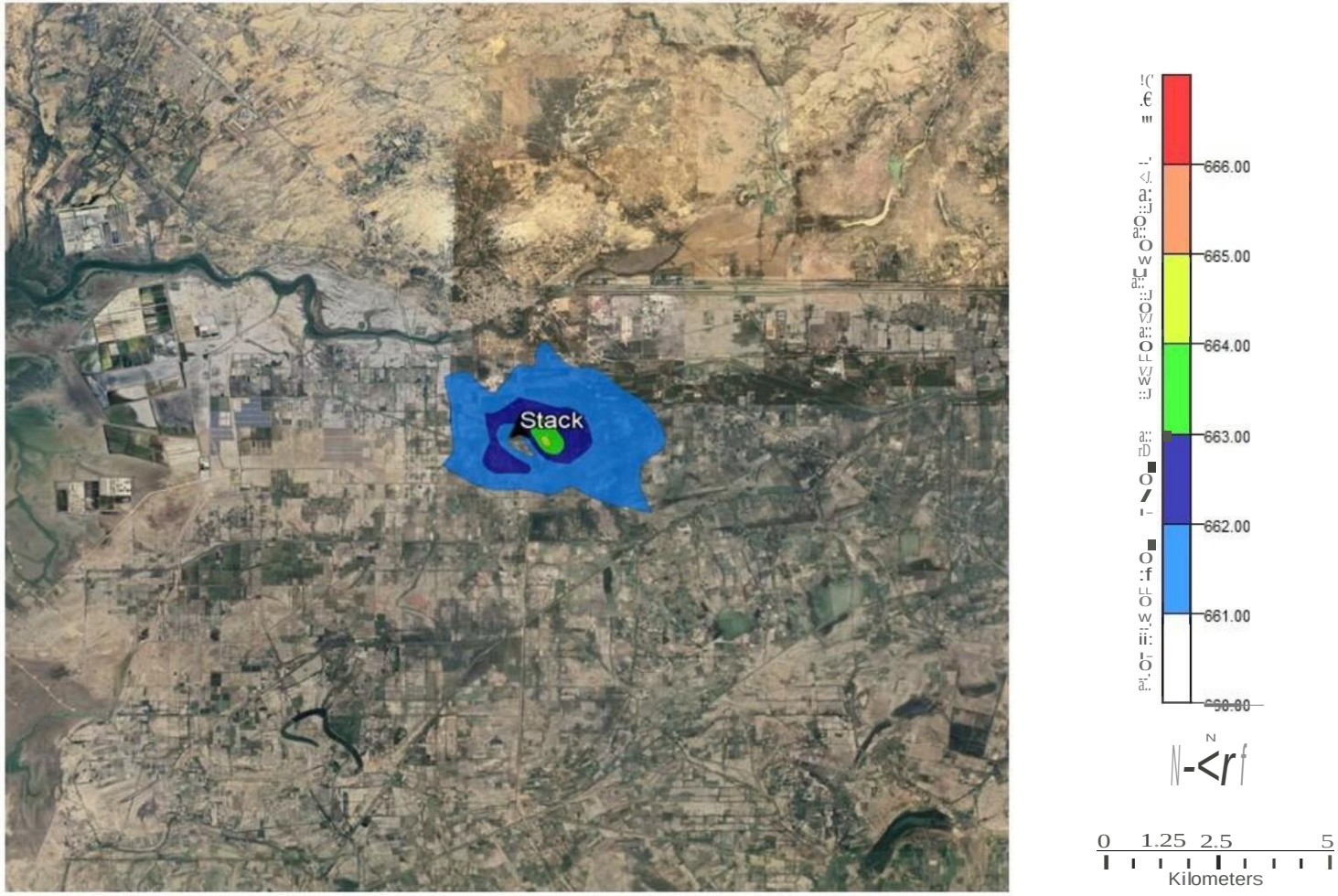

Figure 3.4: Spatial Distribution of CO (1st Highest) concentration for 8-hr average (Extreme Scenario)

3.2 Oxides of Nitrogen (NO2)

3.2.1 Normal Case Scenario for NO2

Estimated modeling results for the average maximum concentrations of NO2 for 24-hr is 39.22 µg/m^3 for normal case scenario. Predicted cumulative ground level concentrations (24-hrs avg) depicted that the emissions of NO2 from the Tyre manufacturing plant are within the permissible limits of SEQS for NO2 and will have insignificant impact on ambient air quality of surrounding areas.

The other details of analysis are given in Table 3.3. The concentration map for 24-hr is shown in Figure 3.5.

Table 3.3 : Maximum Average Concentrations (1st Highest) of NO2 (µg/m^3) for tyre manufacturing plant, Gharo (Normal Case)

Pollutant	AERMOD Model Results				
	Scenario	Avg. Period	Peak Value (µg/m^3)	UTM	
				East (m)	North (m)
NO2	Normal case	24-HR	39.22	357845.50	2733904.77

Spatial Distribution of N02 for 24 hours (Normal Scenario)

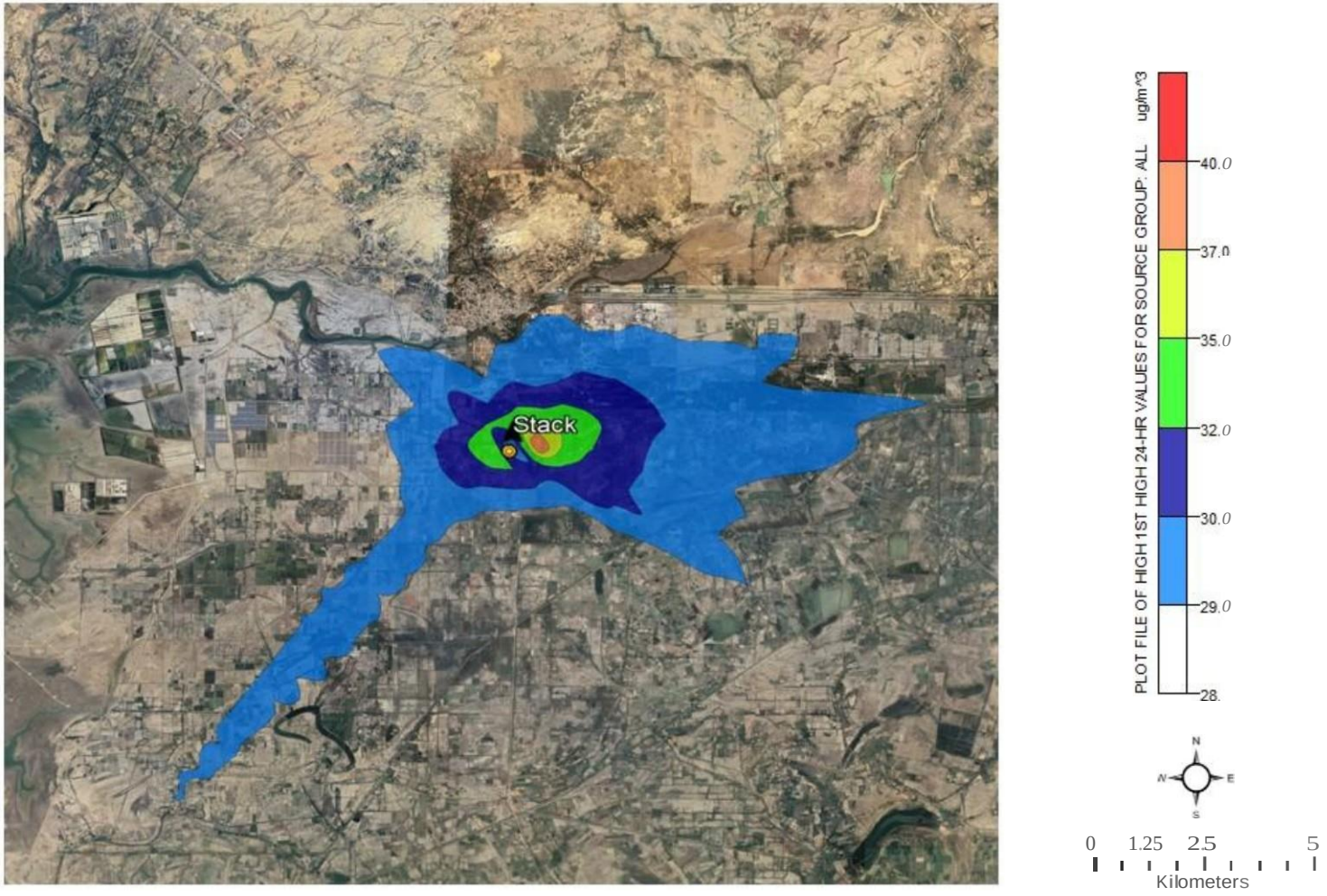

Figure 3.5 : Spatial Distribution of N02 (1st Highest) concentration for 24-hr average (Normal Scenario)

3.2.2 Extreme Case Scenario for NO2

Estimated modeling results for the average maximum concentrations of NO2 for 24-hr is 41.07 µg/m^3 for extreme case scenario. Predicted cumulative ground level concentrations (24-hrs avg) depicted that the emissions of NO2 from the Tyre manufacturing plant are within the permissible limits of SEQS for NO2 and will have insignificant impact on ambient air quality of surrounding areas.

The other details of analysis are given in Table 3.4. The concentration map for 24-hr is shown in Figure 3.6.

Table 3.4 : Maximum Average Concentrations (1st Highest) of NO2 (µg/m^3) for tyre manufacturing plant, Gharo (Extreme Case)

Pollutant	AERMOD Model Results				
	Scenario	Avg. Period	Peak Value (µg/m^3)	UTM	
				East (m)	North (m)
NO2	Extreme case	24-HR	41.07	357845.50	2733904.77

Spatial Distribution of N02 for 24 hours (Extreme Scenario)

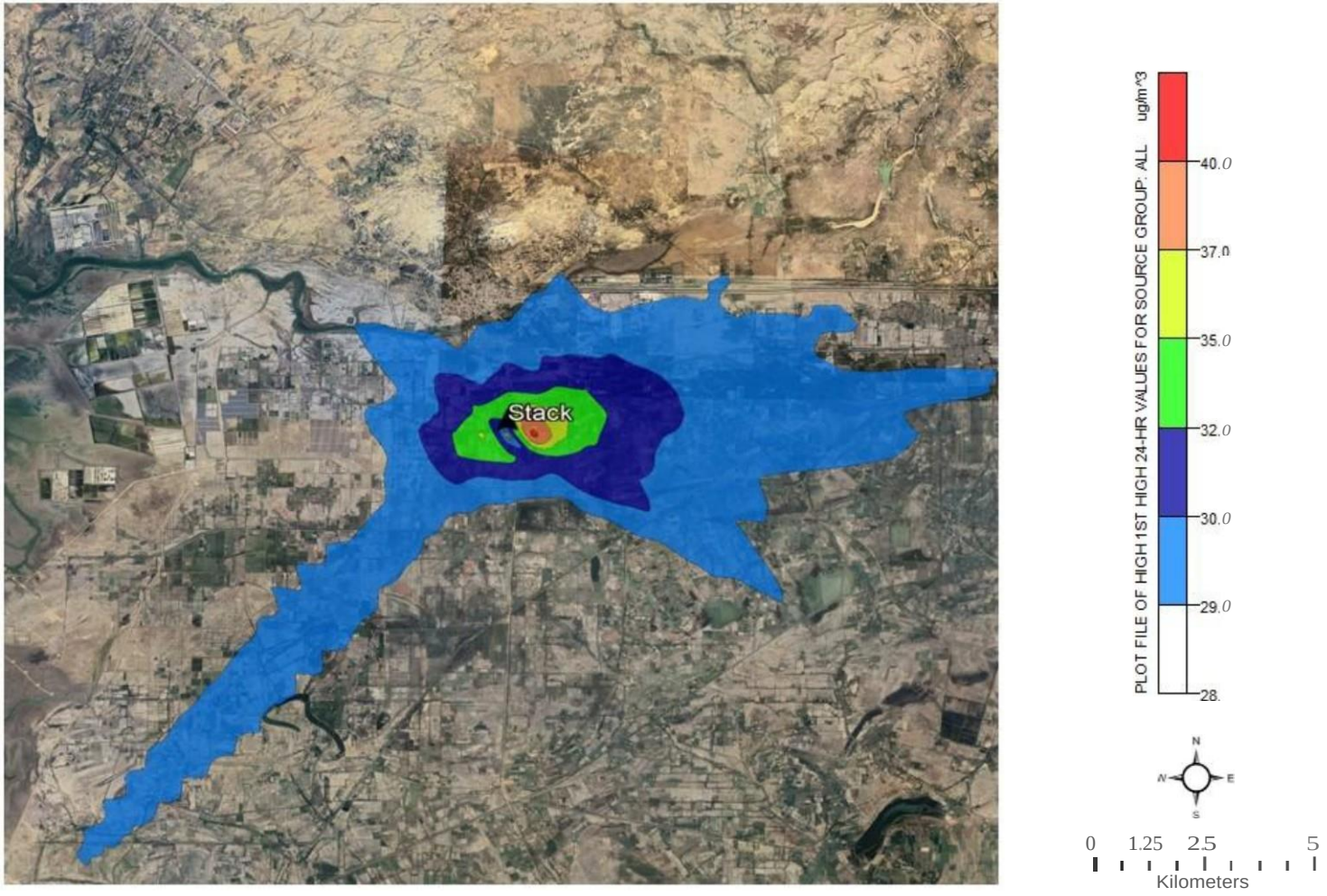

Figure 3.6 : Spatial Distribution of N02 (1st Highest) concentration for 24-hr average (Extreme Scenario)

3.3 Oxides of Sulphur (SO2)

3.3.1 Normal Case Scenario for SO2

Estimated modeling results for the average maximum concentrations of SO2 for 24-hr is 47.44 µg/m^3 for normal case scenario. Predicted cumulative ground level concentrations (24-hrs avg) depicted that the emissions of SO2 from the Tyre manufacturing plant are within the permissible limits of SEQS for SO2 and will have insignificant impact on ambient air quality of surrounding areas.

The other details of analysis are given in Table 3.4. The concentration map for 24-hr is shown in Figure 3.6.

Table 3.4 : Maximum Average Concentrations (1st Highest) of SO2 (µg/m^3) for tyre manufacturing plant, Gharo (Normal Case)

Pollutant	AERMOD Model Results				
	Scenario	Avg. Period	Peak Value (µg/m^3)	UTM	
				East (m)	North (m)
SO2	Normal case	24-HR	47.44	357845.50	2733904.77

Spatial Distribution of S02 for 24 hours (Normal Scenario)

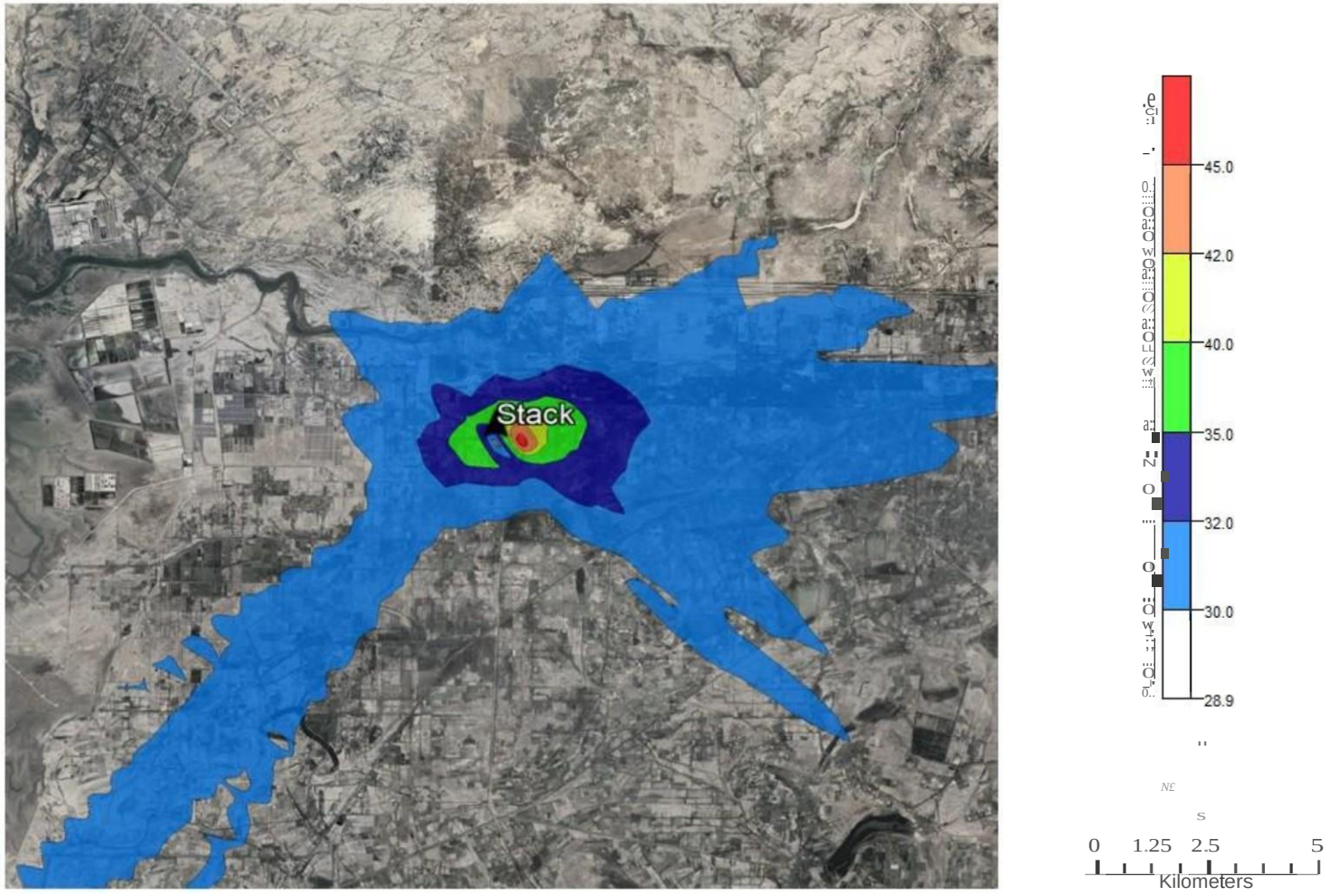

Figure 3.7: Spatial Distribution of S02 (1st Highest) concentration for 24-hr average (Normal Scenario)

3.3.2 Extreme Case Scenario for SO2

Estimated modeling results for the average maximum concentrations of SO2 for 24-hr is 51.44 µg/m^3 for extreme case scenario. Predicted cumulative ground level concentrations (24-hrs avg) depicted that the emissions of SO2 from the Tyre manufacturing plant are within the permissible limits of SEQS for SO2 and will have insignificant impact on ambient air quality of surrounding areas.

The other details of analysis are given in Table 3.5. The concentration map for 24-hr is shown in Figure 3.7.

Table 3.5 : Maximum Average Concentrations (1st Highest) of SO2 (µg/m^3) for tyre manufacturing plant, Gharo (Extreme Case)

Pollutant	AERMOD Model Results				
	Scenario	Avg. Period	Peak Value (µg/m^3)	UTM	
				East (m)	North (m)
SO2	Extreme case	24-HR	51.44	357845.50	2733904.77

Spatial Distribution of S02 for 24 hours {Extreme Scenario)

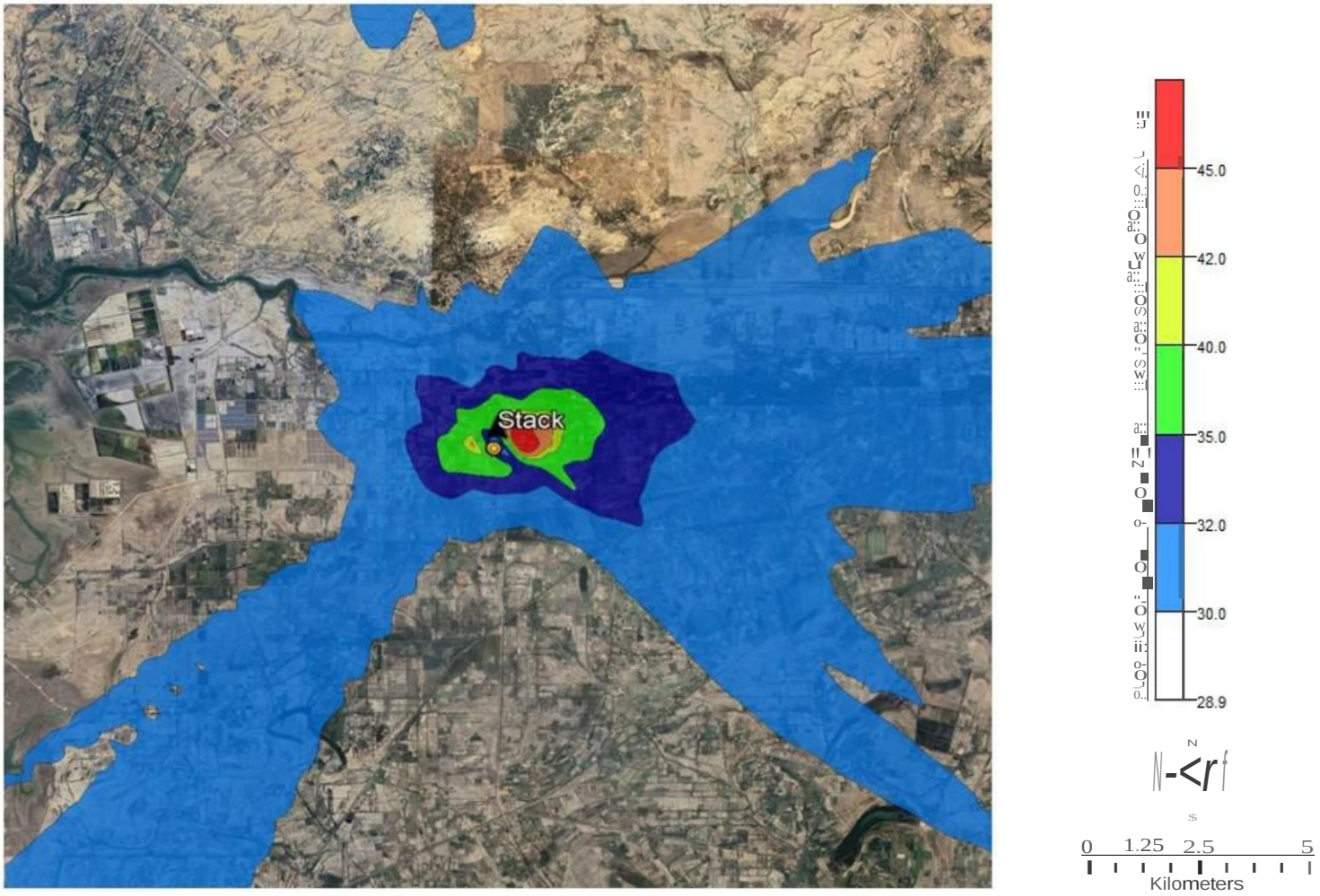

Figure 3.8: Spatial Distribution of S02 (1st Highest) concentration for 24-hr average (Extreme Scenario)

3.4 Particulate Matter (TSP)

3.4.1 Normal/Extreme Case Scenario for TSP

Estimated modeling results for the average maximum concentrations of TSP for 24-hr is 86.61 µg/m^3 for Normal/extreme case scenario. Predicted cumulative ground level concentrations (24-hrs avg) depicted that the emissions of TSP from the Tyre manufacturing plant are within the permissible limits of SEQS for TSP and will have insignificant impact on ambient air quality of surrounding areas.

The other details of analysis are given in Table 3.7. The concentration map for 24-hr is shown in Figure 3.9.

Table 3.7 : Maximum Average Concentrations (1st Highest) of TSP (µg/m^3) for tyre manufacturing plant, Gharo (Normal/Extreme Case)

Pollutant	AERMOD Model Results				
	Scenario	Avg. Period	Peak Value (µg/m^3)	UTM	
				East (m)	North (m)
TSP	Normal/Extreme case	24-HR	86.61	357845.50	2733904.77

Spatial Distribution of TSP for 24 hours (Normal/Extreme Scenario}

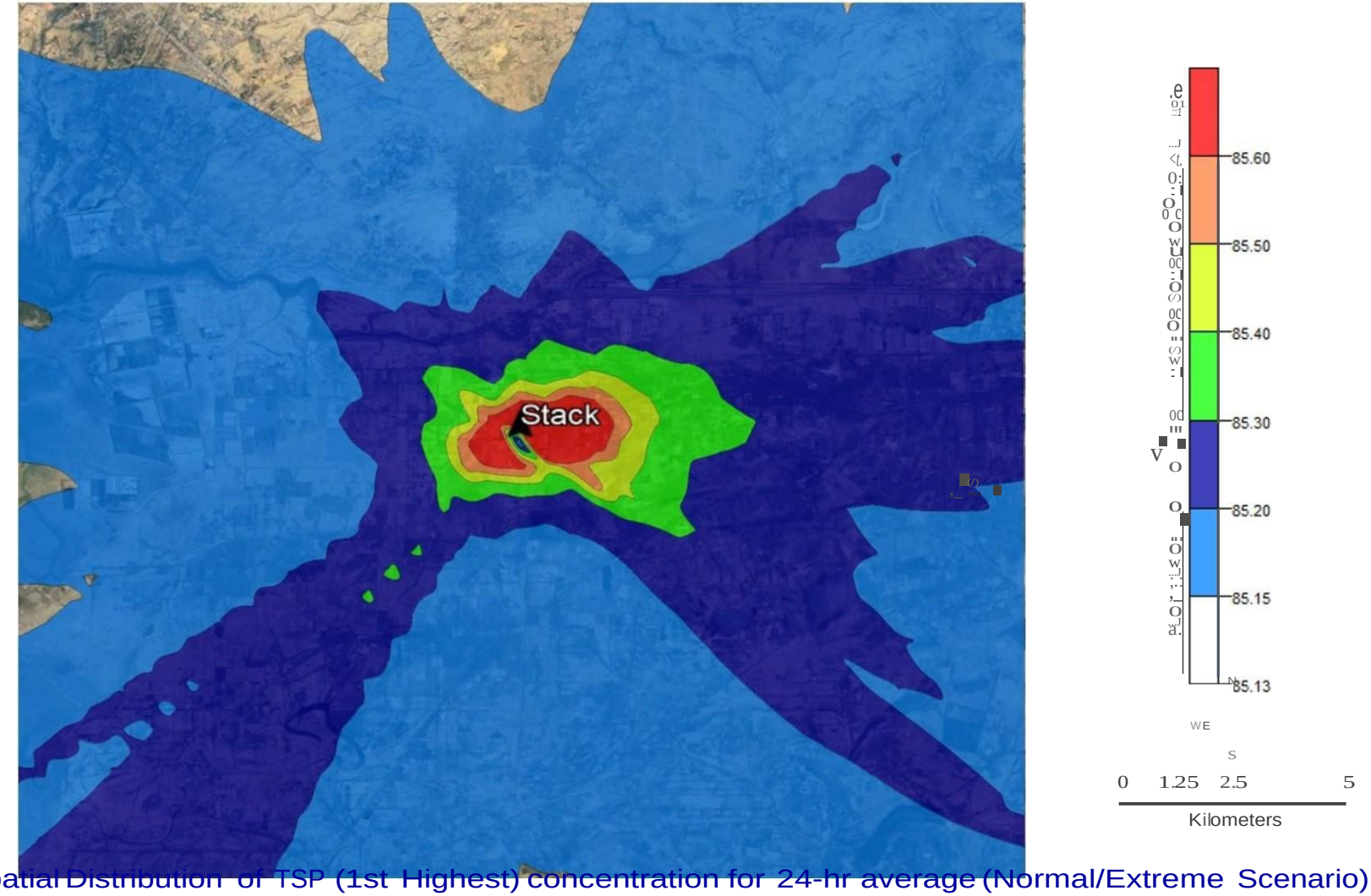

Figure 3.9: Spatial Distribution of TSP (1st Highest) concentration for 24-hr average (Normal/Extreme Scenario)

Table 3.8 : Comparision of results with WHO Guidelines & SEQS for Ambient Air Quality

Parameter	Air Dispersion Modelling (ADM) Scenarios	ADM Results	WHO Ambient Air Quality Guidelines	SEQS
SO_2 ($\mu g/m^3$)	Normal	47.44	**40** *guideline for 24Hr avg)*	120 (24 Hours)
	Extreme	51.44	**50** *(Interim target-2 for 24 Hr avg)*	
NO_2 ($\mu g/m^3$)	Normal	39.22	**25** *(guideline for 24 Hr avg)*	80 (24 Hours)
	Extreme	41.07	**50** *(Interim target-2 for 24 Hr avg)*	
CO ($\mu g/m^3$)	Normal	664.2	**4000** *(guideline for 24 Hr avg)*	5000 (8 Hours)
	Extreme	664.4	**10,000** *(guideline for 8 Hr avg)*	
TSP ($\mu g/m^3$)	Normal /Extreme	86.61	-	360 (Annual) 500 (24 Hours)

SECTION 4

4.0 Conclusion

The modelling results of the study indicate that the predicted environmental concentrations of the modelled pollutants for TSP, CO, SO_2 and NO_2 were well within the prescribed limits of SEQS for ambient air for both the scenarios (Extreme and Normal case).

While comparing with WHO Guidelines for SO2 and NO2 (normal/ extreme) modelling scenarios, results exceed from the prescribed limit of WHO guidelines whereas CO was found within the prescribed limit of WHO guidelines.