PAKISTAN ENGINEERING SERVICES (PVT.) LTD.

Engineering Solutions — Since 1973

Champions in Development

Ref: PM/KP-RIISP/04/01/2026

Date: 18th February 2026

To,

Project Director,

PIU, KP-RIISP, Irrigation, GoKP,

House No. 18, BB-1, Park Road,

University Town, Peshawar.

Project: **COMPREHENSIVE MASTER PLAN FOR INTEGRATED IRRIGATION INFRA-STRUCTURE DEVELOPMENT & WATER RESOURCE MANAGEMENT PLAN IN MERGED DISTRICTS/SUB-DIVISIONS WITH FEASIBILITY STUDIES, DETAILED DESIGNS AND CONSTRUCTION SUPERVISION OF HIGH PRIORITY SCHEMES**

Subject: **Submission of Final Updated Inception Report**

Reference: **Your Office Letter No. 112/PD/KPRIISP, dated: 06/02/2026**

Dear Sir,

In context of the subject cited above, this office acknowledges receipt of the comments made on the submitted Inception Report by the World Bank.

In this regard, we are pleased to submit herewith the 05 copies of Final Updated Inception Report, which has been revised in accordance with the directions and observations made by the World Bank, received vide your office letter under reference.

All comments have been carefully reviewed and duly incorporated, in line with the approved ToRs and scope of consultancy services. The comments along with the Consultant's responses / compliance status are enclosed herewith for onwards submission to World Bank please.

Thanking you and assuring you of our best services and cooperation at all times, we remain.

Yours truly,

[Project Manager]

M/S Pakistan Engineering Services Pvt. Ltd.

In association with M/S Champions in Development

Enclosed: Annotated Replies to the Comments made on Inception Report

Copy to:

1. Procurement Specialist, PIU Irrigation KPRIISP.
2. Finance Management Specialist, PIU Irrigation KPRIISP.

Office of the Project Director,
Khyber Pakhtunkhwa Rural Investment
& Institutional Support Project, Peshawar
Diary No. 154
Office No. PD-KPRIISP
Dated. 19/02/2026

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ANNOTATED REPLIES TO THE COMMENTS MADE BY THE WORLD BANK ON THE INCEPTION REPORT OF KPRIISP-IRRIGATION COMPONENT

Sr. No.	Page / Section Number	Comments by The World Bank	Responses by the Consultants
1	Overall Report	The Consultants should include minutes of meetings with key stakeholders during inception phase, particularly meetings with PIU (P&DD), PIU (KPID), and the World Bank	The relevant minutes of meeting are attached as Annexure-C at the end of the Inception Report.
2	Section 1.2	Alignment with various available policies, strategies and acts should be briefly described. In addition, alignment with the KP River Protection Ordinance, KP IWRM Policy, Climate Change Policy, Climate Change Action Plan should be briefly discussed	Section 2.9 on page 2-15 is added in the report to briefly describing the strategic approach of how the master plan will be aligned with National and Provincial policies and frameworks such as KP-Integrated Water Resources Management (IWRM), KP Rivers Protection Ordinance 2002, Pakistan's National Climate Change Policy, Nationally Determined Contribution (NDC) and National Adaptation Plan (NAP).
3	Section 1.3	Implementation is under Task D of the D&S contract agreement, and may need to be excluded	It was included to describe the overall objective of the entire project and to provide context. A comprehensive section on Task-D has been included as Chapter-6.
4	Section 1.3	The key objectives should include climate inclusive detailed design (considering build back better criteria)	Noted for compliance & incorporated at page no. 1-2.
5	Section 1.3	The key objectives should include social safeguard compliance as well	Noted for compliance & incorporated at page no. 1-2.
6	Section 1.3	The D&S may include all Objectives as per signed agreement.	Needful Done. Incorporated at page no. 1-2.
7	Section 1.6	Are satellite offices at Khyber and Mohmand are needed/justified? For South and North Waziristan, the field office will be at DI Khan, which is far away from the sites compared to travel to Khyber and Mohmand from Peshawar.	The provision of satellite offices is included in the Consultancy Contract Agreement and the Consultants have planned to establish sub-offices in the close proximity of those MDs which have relatively better security conditions and ease of access for frequent site visits and supervision.

8	Section 2.1, Task A (Development of Master Plan)	The D&S shall include all available studies and their summaries in the relevant paragraphs. There are few water assessment studies and management plans and may provide baseline for the current study and master plan.	Two important studies are identified: "Technical studies of Water Resources in FATA" published by IUCN Pakistan, SDC, and FATA Environment Cell and "Water Balance: Achieving Sustainable Development through a Water Assessment and Management Plan, The Case of Federally Administered Tribal Areas, Pakistan" published by Asian Development Bank. These studies would be thoroughly reviewed, and their findings would be incorporated into the current master plan as mentioned on Page 2-4.
9	Section 2.1	Define short, medium and long-term master planning	As per page no. 38 of the contract agreement, short medium and long-terms master planning is defined as follows: 1) Short – Less than 10 years 2) Medium – 10-20 years 3) Long-term – 25 years The same has been incorporated in the Inception Report at pages 1-5 & 2-1.
10	Section 2.1	Hydro-climate stations and their data timelines need to be described. Also what will be temporal resolution of each data?	The Daily data of the following hydroclimatic stations shall be used in the project: 1). Peshawar Rainfall Station (1990-2024)* 2). Kohat Rainfall Station (1990-2024) 3). Lower Dir Rainfall Station (1990-2024)* 4). Tank Rainfall Station (1990-2024)* 5). DI Khan (1990-2024)* 6). Bannu Rainfall Station (1990-2024)* 7). Fort Lockhart Rainfall Station (1990-2024)* 8). Kurram River flow (Last 30 years)* 9). Daraban River flow (Last 30 years)* 10). Tank Zam River flow (Last 30 years)* 11). Gomal River flow (Last 30 years)* 12). Tochi River flow (Last 30 years)* 13). Kaithu River (Last 30 years)*

			*Missing Data; The Consultant is currently acquiring this data and modelling will be carried out using the consistent time series data. The table citing the data requirement is incorporated in the Inception Report on Page 2-2.
11	Section 2.1	Kindly provide a summary of data, timeseries, resolution, sources and their potential use.	Summary of available and required data is presented under Sr. No 10 and 12. The use of data is discussed below; **Daily Precipitation Data:** It shall be used for rainfall trend analysis, rainfall frequency analysis, hydrological modelling, design flood estimation in case of missing discharge data, flood mapping etc **Daily Streamflow Data:** Shall be used for streamflow trend analysis, flood frequency analysis, flood plain analysis and flood risk mapping. **Satellite and Remote Sensing Data:** Digital Elevation Models (30 and 12.5m) to be used for catchment delineation and finer resolution for hydraulic modelling. Daily Precipitation data available online shall be used in addition to gauge station data, wherever needed. Also, Satellite Sentinel-2 10m imagery shall be used to develop land use land cover classification. The same explanation has been added on Page 2-1.
12	Section 2.1	Kindly include other data required from open sources, such as precipitation, temperature, land-use, soil, satellite images etc.	**Precipitation** The commonly open-source datasets available are CHIRPS, PERSIANN & ERA-5. The Consultants will use ERA-5 as it is the most recommended dataset available online. **Land Use Land Cover**

			Sentinel-2 10m Resolution shall be used. **Digital Elevation Model** SRTM is the most reliable DEM imagery out of ASTER, NASA & ALOS PALSAR which shall be used for hydrological study. **Soil Data** FAO Soil Maps shall be used. **Climate Change Data** Coupled Model Intercomparison Project Phase-6 (CMIP-6) climate projections, and/or bias-corrected and statistically downscaled CMIP-6+ datasets shall be utilized. The same has been incorporated on Page 2-2.
13	Section 2.3	Kindly provide details of use of topographic data acquisition and use. Will this data be used in design, hydraulic modelling, demarcation of encroachments???	The allocated cost of conducting soil investigation, tests, procurement of satellite imageries etc has been included in the contract for a total cost of Rs. 20 million. It is pertinent to mention here that this cost is covered in the contract as a non-competitive bid item which was fixed by the Procuring Entity during Bidding Stage. The cost of procuring high resolution DEM and satellite imagery for an area of 505 sq. km (strip survey requirement evaluated from GIS for main rivers in the project area) @ Rs. 40,000 per sq. km (approved in the contract agreement) amounts to Rs. 20.2 million. It is noteworthy to mention here that this Rs. 20.2 million cost shall be dealt as an additional cost to the fixed provision of Rs. 20 million already defined at the Bidding Stage as the provision of Rs. 20 million does not cover the entire scope of “conducting soil investigation, tests, procurement of satellite imageries etc”. At this instance, it is being brought into the notice of entire stakeholders that approval for additional cost under this head shall be required.

			The same has been incorporated on page 2-6.
14	Section 2.4	Kindly provide a map and details of flow and sediments gauging stations and their respective operational timelines.	The study area has the following rivers on which gauge stations have been established by SWHP WAPDA with the following coordinates: 1). Kurram River at Thal (33°21’22’’N, 70°32’45’’E) 2). Daraban River at Zam Tower (31°44'59.53"N, 70°13'22.78"E) 3). Tank Zam River at Jandola (32°18'26.28"N, 70°10'36.12"E) 4). Gomal River at Gomal Barrage (32° 9'4.32"N, 70° 4'49.26"E) 5). Tochi River at Tangi Post (32°56’07’’N, 70°22’25’’E) 6). Kaitu River at Spinwam (33°10’10’’N, 70°24’03’’E) The data for above mentioned stations shall be required for the last 30 years. Details & map depicting the above referred stations has been incorporated in the Inception Report at Pages 2-8 & 2-9.
15	Section 2.4	Kindly provide methodology for ungauged area/rivers/basins in the project area	For ungauged areas/rivers/basins within the districts identified for master planning, standard hydrological regionalization and indirect assessment techniques shall be utilized. This will include delineation of catchments using DEM and GIS tools, regional analysis using nearby gauged basins with similar physiographic and climatic characteristics and application of rainfall–runoff relationships. Long-term rainfall data from available meteorological stations, satellite-based precipitation products, and land use/soil characteristics will be used to estimate runoff through empirical and conceptual hydrological models. Flood estimation will be carried out using regional flood frequency methods and unit hydrograph approaches, with results cross-

			checked through rational and empirical formulae. The methodology will be refined and validated during subsequent study stages as additional data and field verification become available. The same has been incorporated at page no. 2-10 of the Inception Report.
16	Section 2.5	Kindly provide detailed methodology about climate change assessment and use, such as which GCMs/RCMs will be used, how these will be selected, how downscaling and bias correction will be carried out, which datasets will be used for bias-correction, which scenarios will be selected?	Five (05) CMIP-6 GCMs shall be selected to represent the range of projected climate response over the region including the following: 1). Performance in Pakistan 2). Representation of Hot, Cold, Wet, Dry and Average climate response Climate change scenarios i.e., SSP1-2.6 – Low emission scenario, SSP2-4.5 – Intermediate stabilization scenario, SSP5-8.5 – High emission (worst-case) scenario shall be analysed. Since station density in the Merged Districts is sparse, ERA5 reanalysis data shall be used as the reference dataset for bias correction. Bias correction of GCM historical simulations shall be carried out using Quantile Mapping (QM) technique The bias-corrected GCM outputs shall be statistically downscaled to 25 km spatial resolution over the project area. The same has been incorporated at page no. 2-11 of the Inception Report.
17	Section 2.6	This section is stating that groundwater will be monitored. Kindly elaborate. Is this part of the scope of master planning?	Groundwater monitoring is not a part of the scope of master planning. However, this is an extremely important aspect of the overall water resources management. Therefore, it is suggested to be included in the TORs of the consultant. Based on the Institute of Applied Geo Sciences study

			conducted in 2014-2016, it was concluded that 15,129 tube wells are used for groundwater extraction in KP, however, such an extensive quantum cannot be covered under the scope of current study. The sample size has therefore been fixed at 1000 readings in total which constitutes roughly 125 sample sizes from each merged district. The study shall require 2 years to complete. Additional Cost for inclusion of key/non-key staff & direct costs shall amount to Rs. 550.264 million including taxations (Estimate is attached as Annexure-1). The same has been incorporated on page 2-12.
18	Section 2.7	This section states about groundwater balance and argues that this is not part of the D&S ToRs. Section 2.6 and 2.7 are contradictory and requires clarity.	Elucidated vide reply to comment at Sr. No. 17.
19	Section 2.8	This section is briefly describing about master planning, and requires elaboration considering the PC-I and Scope of the study. In addition, how overall water resources will be assessed, perennial flows, gauged and ungauged flows, civil channels, and modelling will be carried out??	The overall water resources will be assessed at various levels as discussed below: 1). At Basin / Catchment Scale: Watershed analysis, Runoff generation and water availability based on precipitation and surface runoff. GIS, HEC-HMS or ARC-SWAT or any other feasible runoff model will be employed 2). At River/ Stream Scale: Perennial and seasonal flows will be assessed using gauge data. Sedimentation study will also be carried out using regional approach by collecting sediment data from WAPDA or relevant authority that maintains the study river. For ungauged streams, hydrological models will be developed based on catchment area, precipitation, land use and soil classification. Where necessary and hydrologically feasible, regional methods for runoff generation will also be used. Calibration and validation of the model will also be carried out.

			3). Civil Channels: Field survey shall be carried out to draw cross sections as well as longitudinal profiles of the channels. Their existing conditions including that of existing structures like culverts, drops, weirs shall be hydraulically assessed. 4). Water Balance Studies: Furthermore, water balance studies as per TORs shall be conducted considering surface flows only, as groundwater assessment is not included in the approved TORs. The analysis will include rainfall–runoff modelling, catchment characteristics, seasonal variability, evapotranspiration losses and peak discharge estimation using appropriate hydrological methods. Industrial surface runoff in Bajaur and Mohmand, particularly from marble processing units contributing sediment laden flows, shall also be incorporated into discharge and sediment load assessments. The same has been incorporated on page 2-13.
20	Section 2.8	Per scope of work the D&S need to include details about flood modelling, high water limits, encroachment estimation, hydraulic modelling and its data requirement need to be included in the inception report.	Addressed as requested on page 2-14.
21	Section 2.8	Kindly elaborate the prioritization criteria, whether multi-criteria analysis will be carried out or other methods?	During the master planning stage, a comprehensive list of both new and existing schemes will be identified. This will include, but not limited to, check dams, flood protection works, rehabilitation of damaged works, irrigation channels and water storage reservoirs. At the master planning stage, the exercise will focus on identification, documentation & ranking of potential schemes for prioritization. The final selection of schemes for implementation shall be carried out by the PIU, Steering Committee & World Bank, based on strategic needs, sectoral importance and policy considerations. Upon approval from the competent

			forum, the shortlisted schemes will be forwarded by the consultants for detailed engineering design, preparation of PC-I and subsequently construction supervision under Task-D of the project. The same has been added on page 2-14.
22	Section 2.8	How many priority-sub-projects will be selected per District?	The number of schemes will be identified in consultation with the PIU, Steering Committee & World Bank.
23	Section 3	Kindly provide the numbers and nature of sub-projects to be designed in each district, as various sub-projects may altogether be different from simple to complex infrastructure. Also provide justification of the provided methodology for detailed design.	The type and number of schemes will be identified in consultation with the PIU, Steering Committee & World Bank.
24	Task C-IIAMS	Kindly provide details of types of interventions to be included in the IIAMS.	A detailed elaborated methodology is provided in Chapter-4 of the updated version of the inception report.
25	Task C-IIAMS	Kindly provide the details of visits and conditional assessment, how many interventions will be visited for example?	A detailed elaborated methodology is provided in Chapter-4 of the updated version of the inception report.
26	Task C-IIAMS	Kindly annex the tools for field visits, data details, and conditional analysis with the Inception Report	A detailed elaborated methodology is provided in Chapter-4 of the updated version of the inception report.
27	Annexure B	Kindly include schedules of all activities/tasks.	Needful done. Annexure-B has been updated as desired.
28	Overall Report	Kindly provide details of staff, staff manning schedule, equipment and tools to be utilized in the overall study	Needful done. Incorporated as Annexure-D at the end of the Inception Report.
29	Overall Report	Kindly provide details of any changes in the overall project planning, staffing and or any needs for the study improvement, which were not in the original scope of the project. Include the needs, financial requirements and time allocation for any such activity.	The following changes and additions have been incorporated in the overall project planning based on emerging needs and client directions, which were not part of the original scope of work: **Climate Change Study:** This component was not included in the original TORs. A climate change expert shall be hired as Key Staff with 6 man-months for which additional cost of Rs. 5.60 million shall be required.

			Groundwater Study: The groundwater monitoring is not a part of the scope of master planning. However, this is an extremely important aspect of the overall water resources management. Therefore, it is suggested to be included in the TORs of the consultant. Additional Cost for inclusion of key/non-key staff & direct costs shall amount to Rs. 550.264 million including taxations for a period of 2 years (Estimate is attached as Annexure-1). **Data Acquisition:** Procurement of hydrological and meteorological data from the Meteorological Department and SWHP WAPDA was not included in the contract agreement and is now required to support reliable analyses and design, for an additional cost of about Rs. 19.475 million. (Estimate is attached as Annexure-2) Total additional cost required = Rs. 575.339 million

FINAL
UPDATED

GOVERNMENT OF KHYBER PAKHTUNKHWA

PROJECT DIRECTOR
PIU KPRIISP
IRRIGATION DEPARTMENT
PESHAWAR

COMPREHENSIVE MASTER PLAN FOR INTEGRATED IRRIGATION INFRA-STRUCTURE DEVELOPMENT & WATER RESOURCE MANAGEMENT PLAN IN MERGED DISTRICTS/SUB-DIVISIONS WITH FEASIBILITY STUDIES, DETAILED DESIGNS AND CONSTRUCTION SUPERVISION OF HIGH PRIORITY SCHEMES

PK-PID GOKP-397515-CS-QCBS-II

LOAN/CREDIT NO. IDA-73480

DELIVERABLE NO. 1: INCEPTION REPORT

FEBRUARY 2026

PAKISTAN ENGINEERING SERVICES
Engineering Solutions Since 1973

Champions in Development

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ANNEXURES

LIST OF FIGURES

LIST OF ABBREVIATIONS

a.m.s.l	Above mean sea level
WB	World Bank
IDA	International Development Association
ADP	Annual Development Program
KP	Khyber Pakhtunkhwa
RIISP	Rural Investment and Institutional Support Project
TOR	Terms Of Reference
FATA	Federally Administered Tribal Area
AF	Acre-Feet
BOQ	Bill of Quantity
CCA	Culturable Command Area
cfs	Cubic feet per second
CSA	Consultancy Services Agreement
Dia	Diameter
E.L	Elevation
EIRR	Internal Rate of Return
FIRR	Financial Internal Rate of Return
Ft	Feet
GCA	Gross Command Area
i/c	Including

PIU	Project Implementation Unit
ID	Irrigation Department
IIAMS	Integrated Irrigation Asset Management System
MD	Merged Districts
FR	Frontier Region
TSD	Tribal Sub Division
km	Kilometer
Ltd	Limited
m	Meter
M/S	Messers
RCC	Reinforced Cement Concrete
RD	Running Distance
Rs	Rupees
Sq	Square

INCEPTION REPORT

CHAPTER 1

INTRODUCTION

1. INTRODUCTION

1.1. CONSULTANCY SERVICES

Consultancy Contract Agreement was signed on 29th December 2025, between Project Director, PIU KP-RIISP Irrigation Department, Government of Khyber Pakhtunkhwa, Peshawar and M/S Pakistan Engineering Services (PES) Pvt. Ltd. in association with M/S Champions in Development. The consultancy is financed by the International Development Association (IDA) under Credit No. 73480 and is being implemented in accordance with World Bank procurement and consultancy guidelines. The assignment aims to establish a comprehensive master plan for integrated irrigation infrastructure development and water resource management in the Merged Districts and Tribal Sub-Divisions of Khyber Pakhtunkhwa, undertake feasibility studies and detailed designs of high priority schemes, develop an Integrated Irrigation Asset Management System for Merged Districts (IIAMS-MDs), and provide construction supervision services.

This in hand Inception Report is the 1st deliverable outlined under *Appendix-A Sr. No. 1 "Expected Outputs and Deliverables"* of the Consultancy Contract Agreement. Inception Report presents the Consultant's detailed understanding of the assignment, interpretation of the Terms of Reference, proposed methodologies for each task, institutional and management arrangements, staffing plan, quality assurance mechanisms, risk mitigation measures, and a comprehensive work plan. The Inception Report serves as the baseline document for implementation of the consultancy services and provides a common framework for coordination between the Consultant, PIU and the World Bank. The primary objective of the Inception Report is identification of all the essential requirements that are necessary for the completion of in-hand project.

1.2. PROJECT CONTEXT AND SECTOR OVERVIEW

The irrigation and water resources sector in the Merged Districts is under-developed and fragmented. Existing irrigation systems are predominantly small-scale and community managed, often lacking proper design, control structures, and maintenance mechanisms. Surface water resources are largely untapped due to absence of storage and conveyance infrastructure, while groundwater development

remains limited and unregulated. Flooding poses a recurrent threat to lives, livelihoods, and infrastructure. Seasonal torrents and hill streams frequently damage irrigation channels, roads and settlements. At the same time, water scarcity during dry periods severely constrains agricultural production. These contrasting challenges underscore the need for integrated planning that simultaneously addresses irrigation development, flood management, watershed protection, and climate adaptation. The project aligns with the objectives of KP-RIISP, Provincial Irrigation Policy, the Tribal Decade Strategy (2020–2030) and the World Bank's Country Partnership Framework, which emphasizes institutional strengthening, improved service delivery and climate resilience in lagging regions.

1.3. OBJECTIVES AND SCOPE OF THE ASSIGNMENT

The overall objective of the assignment is to support the Irrigation Department, Government of Khyber Pakhtunkhwa in planning, designing and implementing sustainable, efficient and climate resilient irrigation and water resource infrastructure in the Merged Districts and Tribal Sub-Divisions. The specific objectives are to:

- Evaluation of water resources potential and preparation of Master Plans for Eight (08) Districts and Six (06) Tribal Sub-Divisions.
- Identification and prioritization of schemes for Feasibility Studies.
- Preparation of Detailed Designs of the feasible schemes along with bidding documents and their environmental assessments.
- Achieve a climate-inclusive detailed design, incorporating resilience and sustainability measures in line with the Build Back Better (BBB) criteria.
- Ensure full compliance with social safeguard requirements, including stakeholder engagement, equitable access and protection of vulnerable communities affected by the project.
- Development of Integrated Irrigation Assets Management System (IIAMS).
- Implementation of the identified / approved schemes in consultations with World Bank / PIU to be executed in Task-D.

1.4. PROJECT LOCATION

The Project area is situated on border with Afghanistan towards West, Baluchistan Province towards South, Chitral towards North, Lower Dir, Malakand, Charsadda, Peshawar, Kohat, Bannu and DI Khan towards East. The District Headquarters of the

Project Area are linked together internally through metaled roads right from Khar Bajaur to Wana South Waziristan. Besides, each area of the Project can also be accessed from Peshawar initially through metaled all weather roads followed by narrow difficult tracks and even walkways.

Figure - 1: Project Area

The aforementioned target investments shall broadly cover the eight (08) newly merged districts and six (06) Frontier Regions/Tribal Sub Divisions (TSDs). The following is the list of target areas:

Newly Merged Districts	**Newly merged Frontiers Regions/Tribal Sub Divisions (TSD)**
Bajaur	FR Peshawar/TSD Peshawar
Mohmand	FR Kohat/TSD

Khyber	FR Bannu/TSD Bannu
Orakzai	FR Lakki/TSD Lakki,
Kurram	FR DI Khan/TSD DI Khan
North Waziristan	FR Tank/TSD Tank.
Upper South Waziristan	
Lower South Waziristan	

The above enlisted districts were previously known as Federally Administered Tribal Area (FATA) governed under Frontier Crimes Regulation and Local Jirga System as laws of the land. Now these areas stand merged in Khyber Pakhtunkhwa Province as a result of the 25th Constitutional Amendments passed by the Parliament and the entire prevailing laws of the Government have been extended. Prior to merger, the area of erstwhile FATA was divided in seven (7) Agencies each headed by a Political Agent as Administrative Head. The Agencies are now named as Districts and each District is headed by the Deputy Commissioner as Administrative Head like other Districts of the Province. Each FRs/Tribal Sub Division has been included in the nearest Tribal District for Administrative Purposes.

1.5. SCOPE OF SERVICES AND TOR COMPLIANCE

The scope of services is structured into three interrelated tasks for Tasks A, B & C (Master Planning, Detailed Design & IIAMS-MDs), as defined in the Terms of Reference.

- Task-A covers preparation of integrated irrigation infrastructure and water resource management master plans.
- Task-B includes feasibility studies, detailed designs, and preparation of procurement documents for priority schemes.
- Task-C focuses on development of a digital Integrated Irrigation Asset Management System for Merged Areas (IIAMS-MDs).
- Task-D shall focus on Construction of schemes recommended by the PIU, World Bank & Steering Committee.

The Consultant will ensure full compliance with all TOR requirements, World Bank guidelines, and applicable national laws and regulations.

A brief description of each task is provided hereunder:

TASK-A: DEVELOPMENT OF A MASTER PLAN

Master planning will be undertaken using an integrated basin and sub-basin approach to ensure holistic management of surface water, groundwater and flood flows. The methodology includes collection and analysis of hydrological, meteorological and topographical data from relevant sources, including Irrigation Department records, WAPDA, PMD, SUPARCO, and satellite imagery. Water balance models will be developed to assess current and future water availability under different climate scenarios. Irrigation demand will be estimated based on existing and proposed cropping patterns, command areas, and irrigation efficiencies. Existing irrigation and flood protection assets will be inventoried and mapped using GIS and field verification. Based on these analyses, potential interventions will be identified, including new irrigation schemes, rehabilitation and modernization of existing systems, flood protection works, and watershed management measures. Investment options will be prioritized using multi-criteria analysis considering technical feasibility, economic viability, social benefits, environmental sustainability and climate resilience. The master plans will define short (Less than 10 years), medium (10-20 years) and long term (25 years) investment programs with indicative costs and implementation schedules.

TASK-B: PREPARATION OF DETAILED DESIGNS AND BIDDING DOCUMENTS

Feasibility studies will be carried out for priority schemes identified under Task A. These studies will include detailed technical assessments, hydrological and hydraulic analyses, geotechnical investigations, command area development planning, and evaluation of alternative design options. Field surveys, including topographic, geotechnical, and hydrometric investigations, will be undertaken as required. Economic and financial analyses will be conducted in accordance with World Bank guidelines, including estimation of economic internal rate of return (EIRR), net present value (NPV) and financial sustainability. Environmental and social assessments will be carried out in compliance with the World Bank Environmental and Social Framework, including preparation of ESIA, ESMP, Resettlement Action Plans, and other safeguard instruments as applicable. Detailed engineering designs will be prepared to construction-ready level, including drawings, technical specifications, bill of quantities, cost estimates, and bidding documents using World Bank Standard Procurement Documents.

TASK-C: INTEGRATED IRRIGATION ASSET MANAGEMENT SYSTEM FOR MERGED DISTRICTS (IIAMS-MDs)

The Integrated Irrigation Asset Management System (IIAMS) for the Merged Districts will be developed as a GIS enabled digital platform to support systematic inventory, monitoring, planning, and management of irrigation assets. The system will include modules for asset registration, condition assessment, maintenance planning, budgeting and reporting. The IIAMS will be designed to integrate spatial and non-spatial data and support evidence-based decision making. Data standards, security protocols, and user access controls will be established. Capacity building and training programs will be implemented to ensure effective adoption and long-term sustainability of the system within the Irrigation Department.

TASK-D: CONSTRUCTION SUPERVISION

Task-D shall commence after one year of signing of the Consultancy Contract Agreement subsequent to the completion to Master Planning and Detailed Design phase. The construction supervision shall include the projects/schemes recommended by the PIU, World Bank & Steering Committee, which were identified during Master Planning stage.

1.6. SEQUENCE OF ACTIVITIES

- The establishment of Main Office in Peshawar is the priority of consultants and upon mobilization, the Consultants have established the main project office in University Town Peshawar, with entire office facilities, equipment and support staff. The office facility is equipped with the transport & other allied working tools mandatory for smooth running of office facilities. It is worth mentioning here that, satellite offices & sub-offices at appropriate/suitable locations in the project area or the proximity shall also be established as per specific need of staff and duration.
- The provision of satellite offices is included in the Consultancy Contract Agreement and the Consultants have planned to establish sub-offices in the close proximity of those MDs which have relatively better security conditions and ease of access for frequent site visits and supervision. For South and North Waziristan, the field office has been proposed at D.I. Khan despite the longer travel distance, primarily due to comparatively worse security conditions. Establishing offices in South and North Waziristan which although will be closer to the sites; poses safety and operational

risks & therefore, D.I. Khan provides a safer base for staff deployment and controlled access to project areas. Provision of equipment and human resources at the main office interlinked with the field teams would thus be established as shown in the figure below:

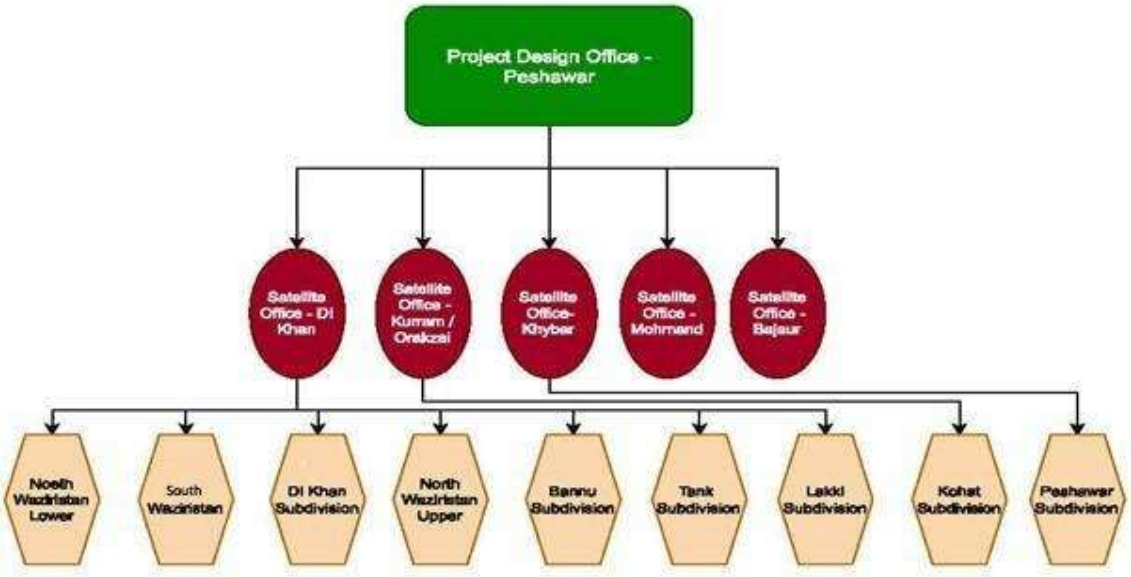


Figure 2. Location of project offices

- The objective of the in-hand consultancy assignment would be understanding the TORs for necessary outcomes and readiness for physical execution of the project. The consultants are well aware of the facts that preparation of a Comprehensive Master plan, selection of the most feasible scheme, working out estimated quantities, costing of quantities/activities, bid drawings, specifications of work, contracts packaging, bidding documents as per KPPRA/PEC, WB Guidelines, PC-I inclusive of the ADC Component, technical sanction of project, and LARP documents are pre-requisites for moving ahead towards the project implementation. The consultants also recognize the fact that the completion period for the deliverables is quite tight requiring robust staff movement, effective resource management, effective monitoring and equipment provision.
- After completion of the desk studies and fixing the milestones, the team of experts along with necessary survey equipment shall be mobilized for the topographic survey. Upon receipt of the requisite survey and data, work on master planning shall be initiated. The field data shall be compiled and processed in the office. While moving forward, more focus shall be made on the survey data needed for master

planning followed by detailed design and subsequent procurement for construction supervision.

- Once the surveys and other relevant data is in hand, accordingly, the planning and design experts with allied staff can move forward for a continuous output to fulfill the deliverable requirements of the assignment, as per TOR.
- After the submission of this Inception Report, the rest of the deliverables shall follow in the prescribed period and requirements as outlined in the Consultancy Contract Agreement.

Task wise activities that shall be part of the entire course of study are highlighted in the upcoming chapters.

CHAPTER 2

TASK-A:
DEVELOPMENT OF A MASTER PLAN

2. TASK-A: DEVELOPMENT OF A MASTER PLAN

2.1. MOBILIZATION AND DATA COLLECTION

The establishment of Main Office in Peshawar is the priority of consultants and upon mobilization, the Consultants have established the main project office in University Town Peshawar, with entire office facilities, equipment and support staff. The office facility is equipped with the transport & other allied working tools mandatory for smooth running of office facilities. It is worth mentioning here that, satellite offices & sub-offices at appropriate/suitable locations in the project area or the proximity shall also be established as per specific need of staff and duration. The Project Manager is stationed in Peshawar on permanent basis, with his entire design team for project-based design & computation activities. Satellite offices & sub-offices at appropriate/suitable locations in the project area or the proximity shall also be established as per specific need of staff and duration. After establishment of office facilities, the Consultants have mobilized key and support staff to work on the assignment, wherein, specialists / experts in various fields are engaged for collection of useful data for the master planning of the target areas and prepare the guidelines to establish the future line of action.

The comprehensive master planning for short (Less than 10 years), medium (10-20 years) and long term (25 years) warrants meticulous attention to the collection of relevant data such as historical and recent satellite imageries of the targeted areas, surveys, meteorological data, and available reports for subsequent analysis, to identify the potential water resources in the project areas. The major activities but not limited to the following shall be carried out for effective execution of the scope of work highlighted under Task-A to achieve the intended targets.

- Collection of meteorological data / reports, surveys and investigations relevant to the target areas. During the study, both open-source and observed/ gauge data shall be utilized. The details of each dataset are discussed below:
    - Daily Precipitation Data shall be used for rainfall trend analysis, rainfall frequency analysis, hydrological modelling, design flood estimation in case of missing discharge data, flood mapping etc.

- Daily Streamflow Data shall be used for streamflow trend analysis, flood frequency analysis, flood plain analysis and flood risk mapping.
- For Satellite and Remote Sensing Data, Digital Elevation Models (30 and 12.5m) to be used for catchment delineation and finer resolution for hydraulic modelling.

Open-Source Data:

In case of non-availability of gauge station data, open-source data shall be acquired and used for working in addition to gauge data. The open-source data that might be used includes but is not limited to:

- For Precipitation, the commonly open-source datasets available are CHIRPS, PERSIANN & ERA-5. The Consultants will use ERA-5 as it is the most reliable dataset available online.
- Sentinel-2 10m Resolution shall be utilized for Land Use Land Cover
- SRTM is the most reliable DEM imagery out of ASTER, NASA & ALOS PALSAR which shall be used for hydrological study.
- FAO Soil Maps shall be used for Soil data.
- Coupled Model Intercomparison Project Phase-6 (CMIP-6) climate projections, and/or bias-corrected and statistically downscaled CMIP-6+ datasets shall be utilized for climate change analysis.

Observed / Gauged Data:

Hydro-meteorological data shall be acquired for hydrological and hydraulic assessment of project areas. The data shall be collected from MET Department, SWHP and WAPDA. The required data is tabulated as follows:

Table 1: Details of Hydro-meteorological Stations in Study Area

Sr.No	Gauge Station	Source	Data Type	Temporal Scale	Duration
1	Peshawar*	MET	Rainfall/ Temperature	Daily	1990-2024

2	Kohat	MET	Rainfall/ Temperature	Daily	1990-2024
3	Lower Dir*	MET	Rainfall/ Temperature	Daily	1990-2024
4	Tank*	WAPDA	Rainfall/ Temperature	Daily	1990-2024
5	Fort Lockhart*	WAPDA	Rainfall/ Temperature	Daily	1990-2024
6	DI Khan*	MET	Rainfall/ Temperature	Daily	1990-2024
7	Bannu*	MET	Rainfall/ Temperature	Daily	1990-2024
8	Kurram River*	SWHP/WAPDA	Discharge/ Sediment	Daily	Last 30 years
9	Daraban Zam*	SWHP/WAPDA	Discharge/ Sediment	Daily	Last 30 years
10	Tank Zam River*	SWHP/WAPDA	Discharge/ Sediment	Daily	Last 30 years
11	Gomal River*	SWHP/WAPDA	Discharge/ Sediment	Daily	Last 30 years
12	Tochi River*	SWHP/WAPDA	Discharge/ Sediment	Daily	Last 30 years
13	Kaithu River*	SWHP/WAPDA	Discharge/ Sediment	Daily	Last 30 years

*Missing Data: The Consultant is currently acquiring this data.

- Assessment of surface and groundwater potential in the target areas.
- Identification of major rivers and streams and tributaries in the target areas.
- Identification of existing facilities in the target areas including flood protection works and other infrastructure.
- Identification of the potential water sector projects along the rivers, streams and tributaries.
- Efficient water resource management.

One of the foremost requirements upon mobilization would be to initiate the collection of all existing / available data, study the GT sheets and other survey reports, satellite imageries, all available technical, environmental, socio-economic data as well as other studies prospective planning previously conducted and any other reports / documents relevant to the project areas. It is expected that the client shall provide full cooperation to the Consultants to have access to the available relevant data/reports. The reports, documents and data to be acquired would include but not limited to the following.

- Information / inventory of the existing water resource infrastructures in the target areas.
- Pre-feasibility / feasibility or design studies (if any).
- Prospective planning report of FATA.
- Available Meteorological data of the target's areas.
- Available Hydrological & Sedimentation data.
- Survey of Pakistan maps / GT sheets of the target areas.
- Available Geological observations and studies.
- Socio-economic survey reports.
- Environmental study reports.
- Water uses of the rivers / streams.

Previously conducted studies would be thoroughly reviewed, and their findings would be incorporated into the current master plan. Especially, the "Technical studies of Water Resources in FATA" published by IUCN Pakistan, SDC, and FATA Environment Cell and Water Balance: Achieving Sustainable Development through a Water Assessment and Management Plan-The Case of Federally Administered Tribal Areas, Pakistan published by Asian Development Bank. The first study covered hydrological assessments, watershed characterization, preliminary identification of potential

irrigation and water supply schemes, and evaluation of existing water infrastructure. The study highlighted key challenges including seasonal variability, limited storage capacity, flash flood dynamics, groundwater depletion in localized areas, and institutional constraints. Its findings and baseline datasets serve as an important technical reference for the present Master Plan, offering foundational hydrological information, identified development potential, and strategic recommendations to guide sustainable water resources planning in the merged districts of Khyber Pakhtunkhwa. The second study developed a comprehensive water balance framework to assess the availability, demand, and sustainability of water resources in the region. It quantified surface and groundwater resources, evaluated sectoral water demands (including irrigation, domestic, and livestock uses), and analyzed seasonal and spatial variability. The study identified existing and projected supply–demand gaps, highlighted inefficiencies in water utilization, and emphasized the need for integrated water resources management (IWRM), improved storage, demand management, and institutional strengthening. Its analytical approach and water accounting methodology provide a valuable technical foundation and strategic direction for the preparation of the present Master Plan for the merged districts of Khyber Pakhtunkhwa.

2.1.1. Review of Collected Data / Documents

Previous reports / studies already carried out by different agencies will be reviewed and different aspects in terms of design approach, hydrological, geological and geotechnical aspects shall be planned in view of the climate change scenario and its long-term future impacts will be ascertained, as well as type of potential project adaptable to the existing environment will also be highlighted. A comprehensive review of the previous related studies in the target areas shall be undertaken to learn lessons and not replicate any mistakes made in the past.

2.1.2. Study of Available Maps

The data and maps of the 8 NMAs and 6 FRs will be collected to properly plan the activities and focus on the potential areas. These maps may include GT sheets from Survey of Pakistan, general maps of the area (most of them are already available with this office), satellite imageries and digital terrain / digital elevation models. The location of the existing and potential sites will be marked on the sheets for subsequent

assessment. Their accessibility will be marked from roads and the national database i.e., Survey of Pakistan approved benchmarks (BMs).

2.2. IDENTIFICATION OF POTENTIAL SITES

The river and stream network shall be developed using computer aided tools such as GIS and Global Mapper. This will enable to demarcate the major rivers/streams, tributaries and their boundaries along with its origination, either local or international. These maps shall be carefully studied in conjunction with the GT sheets already acquired from the Survey of Pakistan. The watershed areas shall be developed at technically suitable locations for in-depth evaluation during the master planning. This exercise will help to identify the potential sites for subsequent evaluation. The collected maps shall also be used to make inventory of the existing facilities that may require rehabilitation. The existing structures will be re-assessed from design point of view in wake of climate change scenario.

2.3. TOPOGRAPHIC SURVEY

At the Task-A stage, the need for a detailed topographic survey shall be carefully planned and executed using advanced GIS based techniques. This initial survey requirement is critical for capturing the spatial characteristics of the project area, including terrain features, elevation contours, watercourses, existing infrastructure, and other site-specific conditions. By integrating GIS technology, the survey will provide high accuracy, georeferenced data that can be analyzed efficiently to support preliminary assessments, feasibility studies, and alignment selection. Furthermore, this Task-A level survey will serve as the foundational dataset for the comprehensive surveys to be carried out at the Task-B stage during detailed design. Establishing this initial topographic framework ensures that subsequent detailed investigations are more focused, cost-effective, and aligned with the latest engineering standards, ultimately facilitating climate-resilient and optimized infrastructure planning.

The allocated cost of conducting soil investigation, tests, procurement of satellite imageries etc has been included in the contract for a total cost of Rs. 20 million. It is pertinent to mention here that this cost is covered in the contract as a non-competitive bid item which was fixed by the Procuring Entity during Bidding Stage.

The cost of procuring high resolution DEM and satellite imagery for an area of 505 sq. km (strip survey requirement evaluated from GIS for main rivers in the project area)

@ Rs. 40,000 per sq. km (approved in the contract agreement) amounts to Rs. 20.2 million. It is noteworthy to mention here that this Rs. 20.2 million cost shall be dealt as an additional cost to the fixed provision of Rs. 20 million already defined at the Bidding Stage, as the provision of Rs. 20 million does not cover the entire scope of "conducting soil investigation, tests, procurement of satellite imageries etc". At this instance, it is being brought into the notice of entire stakeholders that approval for additional cost under this head shall be required.

2.4. HYDROLOGY AND SEDIMENTATION

Hydrological study plays a pivotal role in any water resource development project and its importance needs over-emphasis due to ever changing climatic conditions across the globe. The initial step would be to collect the hydro-meteorological data comprising, river and streams flows, rainfall, temperature, evaporation and other relevant climatic data for the project areas. Every effort shall be made to collect the maximum available data to have at least 40 years of healthy data series including historical and recent data covering major historical unprecedented flood events. The collected data shall be meticulously analyzed in context of the potentially identified sites for infrastructure planning and development to support irrigation and flood control. The analysis shall include the pattern and time of availability of stream flows and flood magnitudes at the potential sites along the major rivers / streams and tributaries. The hydrological series thus developed and subsequent analysis would reflect variations in stream flows available throughout the year in contrast to the demand for agricultural land for water resource development projects. During the course of hydrological assessment, existing structures shall also be considered to ensure that the relative allocated share of water may not be disturbed with the addition / intervention of new schemes. Additionally, for dam sites, and particularly where master planning of flood protection works is required, statistical analysis of the related historic meteorological data and discharge data of the rivers and streams shall be carried out. To estimate the peak flows against different return periods, flood frequency analysis shall be conducted at the target areas requiring flood control and mitigation. The list is rivers in the study area is presented below along with their coordinates.

Table 2: Names and Locations of Streamflow Stations in Study Area

Sr.No	Rivers	Gauge Station	Location	Duration
1	Kurram River	Thal	33°21’22’’N, 70°32’45’’E	Last 30 years
2	Daraban Zam	Zam Tower	31°44'59.53"N, 70°13'22.78"E	Last 30 years
3	Tank Zam River	Jandola	32°18'26.28"N, 70°10'36.12"E	Last 30 years
4	Gomal River	Gomal Barrage	32° 9'4.32"N, 70° 4'49.26"E	Last 30 years
5	Tochi River	Tangi Post	32°56’07’’N, 70°22’25’’E	Last 30 years
6	Kaithu River	Spinwam	33°10’10’’N, 70°24’03’’E	Last 30 years

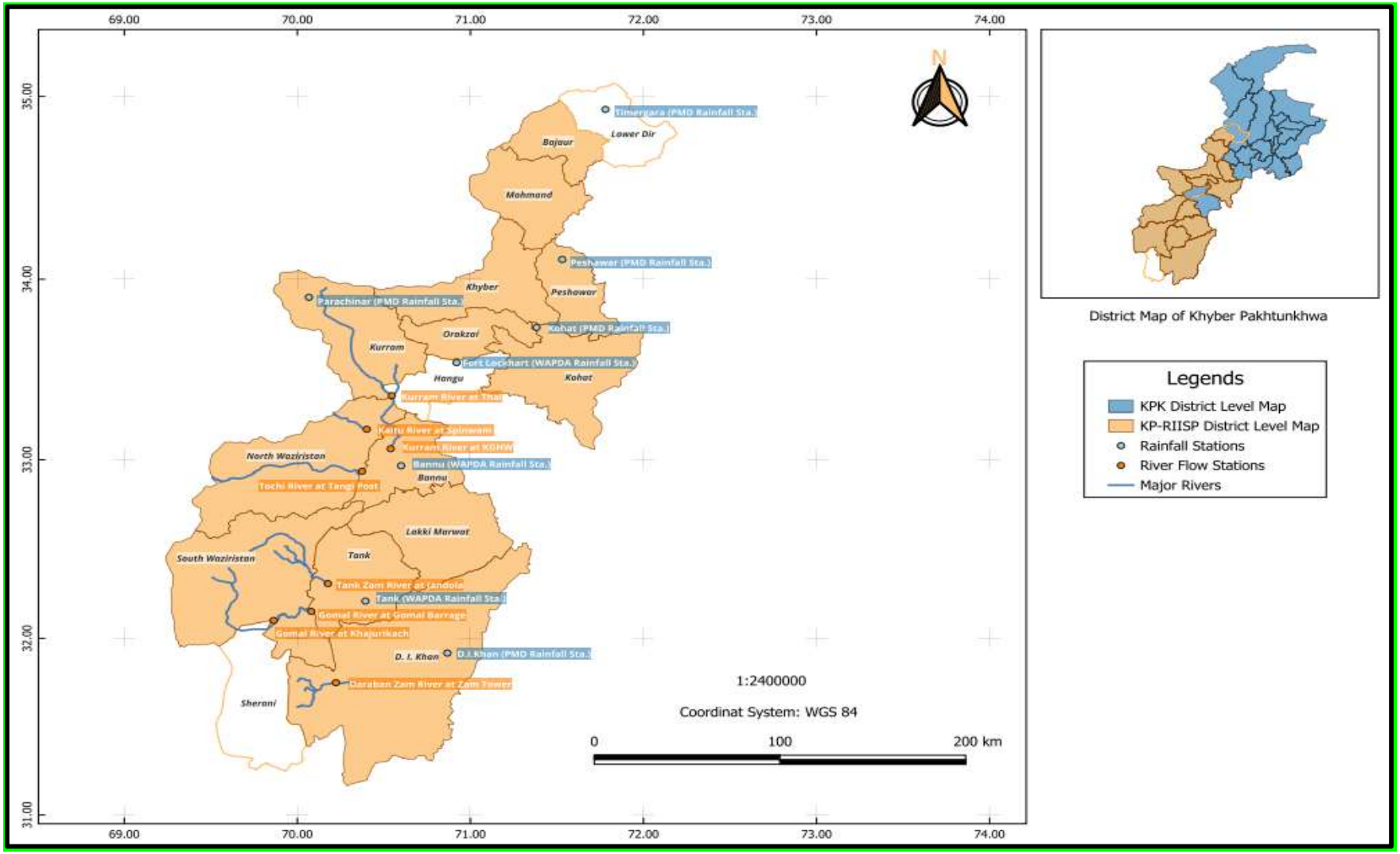


Figure 3. Locations of rainfall and river flow stations

The study of the nature and quantity of the sediment inflow along the rivers and streams / tributaries will also be carried out to determine the sediment load and deposition behavior. This aspect is grossly important to highlight the anticipated life of the infrastructure development and measures to be taken up for more than a decade of master planning of infrastructure development in the target areas. To achieve the objective, sediment data of the major rivers / streams in the target areas shall be collected from the concerned departments to ascertain the sediment inflow rate at the particular potential site.

Flood frequency analysis is generally carried out by using different theoretical probability distributions such as Gumbel, Weibull, General Extreme Value-I and Log Pearson (LP) Type III. USWRC has standardized that LP-III method should be used for flood frequency analysis for US conditions. However, no method is standardized for Pakistan conditions and various methods have been used in the past in Pakistan for different projects/conditions. Given the site conditions, a suitable method shall be adopted by excluding the high outlier values.

While deriving the flood magnitudes against different return periods or PAE%, a more conservative approach shall be adopted in the context of the current and anticipated trend of the climate change scenario to build climate change resilient structures. The estimated flood magnitudes shall be adopted to prepare the water surface profiles and inundation maps for flood management and sizing of the proposed protection structures. The analysis shall be carried out in HEC-RAS by developing the river cross sections along the vulnerable reaches identified through previously available data or utilizing the GIS tools and survey coupled with the availability of discharges estimated through hydrological assessments. The flood inundation maps shall be used to mark the critical boundaries of the major rivers and streams to avoid encroachment in the identified waterways.

For ungauged areas/rivers/basins within the districts identified for master planning, standard hydrological regionalization and indirect assessment techniques shall be utilized. This will include delineation of catchments using DEM and GIS tools, regional analysis using nearby gauged basins with similar physiographic and climatic characteristics and application of rainfall–runoff relationships. Long-term rainfall data from available meteorological stations, satellite-based precipitation products and land use/soil characteristics will be used to estimate runoff through empirical and

conceptual hydrological models. Flood estimation will be carried out using regional flood frequency methods and unit hydrograph approaches, with results cross-checked through rational and empirical formulae. The methodology will be refined and validated during subsequent study stages as additional data and field verification become available.

2.5. CLIMATE CHANGE IMPACT STUDY

The hydrological appraisals for the identified potential sites shall be integrated with the current and long-term climate change impact scenarios so that to ensure climate change resilient designs. For the purpose, in-house expertise shall be utilized.

Five (05) CMIP-6 GCMs shall be selected to represent the range of projected climate response over the region including the following:

1). Performance in Pakistan

2). Representation of Hot, Cold, Wet, Dry and Average climate response

Climate change scenarios i.e. SSP1-2.6 – Low emission scenario, SSP2-4.5 – Intermediate stabilization scenario & SSP5-8.5 – High emission (worst-case) scenario shall be analyzed.

Since station density in the Merged Districts is sparse, ERA5 reanalysis data shall be used as the reference dataset for bias correction. Bias correction of GCM historical simulations shall be carried out using Quantile Mapping (QM) technique. The bias-corrected GCM outputs shall be statistically downscaled to 25 km spatial resolution over the project area.

2.6. SUB-SURFACE HYDROLOGY

During the site visits to the identified potential sites in the target areas, there will be a need to analyze the groundwater situation keeping in view the various number of tube-wells and other groundwater depleting entity & water recharge facilities of the area to develop a water balance sheet in specific zones for prospective planning. The selected sites will be properly studied by using groundwater-calibrated models. The impacts and behavior of the aquifers after the construction of the reservoirs will also be investigated by hydrological modeling. It is noteworthy to mention here that groundwater monitoring is not a part of the scope of master planning. However, this is an extremely important aspect of the overall water resources management. Therefore,

it is suggested to be included in the TORs of the consultants as an additional scope of work.

2.7. GROUND WATER STUDY AND ASSESSMENT

The consultants will undertake a comprehensive assessment of groundwater conditions as part of the master planning. This will include evaluation of aquifer characteristics, estimation of recharge abstraction balance, analysis of seasonal groundwater level fluctuations, and assessment of the sustainability of existing and proposed groundwater withdrawals. In addition, water quality assessments will be carried out to determine the suitability of surface and groundwater for irrigation and other intended uses. Based on the assessed availability of water resources, a water budgeting and demand supply needs assessment will be prepared at scheme and basin/sub-basin levels to support informed planning and prioritization of interventions for sustainable water resource management.

Groundwater monitoring is not a part of the scope of master planning. However, this is an extremely important aspect of the overall water resources management. Therefore, it is suggested to be included in the TORs of the consultant. Based on The Institute of Applied Geo Sciences, it was concluded that 15,129 tube wells are used for groundwater extraction in KP, however, such an extensive quantum cannot be covered under the scope of current study. The sample size has therefore been fixed at 1000 readings in total which constitutes roughly 125 sample sizes from each merged district. The study shall require 2 years to complete. Additional Cost for inclusion of key/non-key staff & direct costs shall amount to Rs. 550.264 million including taxations.

2.8. MASTER PLANNING

The aforementioned activities shall enable the consultants to identify the potential sites from the target areas based on the in-depth study of collected maps, imageries, topographic surveys, and detailed hydrological data assessments and to prepare a list of inventories for the water resource development, comprising different projects including storage/check dams, weirs, irrigation canals (gravity and lift irrigation), infiltration galleries, tube wells, deep observation wells and flood protection/mitigation structures. These projects shall be categorized based on existing and newly identified categories and sequenced with due consideration to the type, relative importance

potential outcomes, and demands of the locals or the area. The master planning of the target areas shall cover the comprehensive details about the available water resources in the target areas and long-term (25 years) planning to develop those potential sites. As per requirement of medium to long term (10-25 years) of prospective master planning, high-priority projects shall be considered immediately for the collection of geological and geotechnical investigation data/soil investigations for subsequent preparation of feasibility and subsequent detailed design studies during the second phase under Task-B.

The overall water resources will be assessed at various levels as discussed below:

1). At Basin/ Catchment Scale: Watershed analysis, Runoff generation and water availability based on precipitation and surface runoff. GIS, HEC-HMS or ARC-SWAT or any other feasible runoff model will be employed

2). At River/ Stream Scale: Perennial and seasonal flows will be assessed using gauge data. Sedimentation study will also be carried out using regional approach by collecting sediment data from WAPDA or relevant authority that maintains the study river.

For ungauged streams, hydrological models shall be developed based on catchment area, precipitation, land use and soil classification. Where necessary and hydrologically feasible, regional methods for runoff generation shall also be used. Calibration and validation of the model shall also be carried out.

3). Civil Channels: Field survey shall be carried out to draw cross sections as well as longitudinal profiles of the channels. Their existing conditions including that of existing structures like culverts, drops, weirs shall be hydraulically assessed.

4). Water Balance Studies: Furthermore, water balance studies as per TORs shall be conducted considering surface flows only, as groundwater assessment is not included in the approved TORs. The analysis will include rainfall–runoff modelling, catchment characteristics, seasonal variability, evapotranspiration losses and peak discharge estimation using appropriate hydrological methods. Industrial surface runoff in Bajaur and Mohmand, particularly from marble processing units contributing sediment laden flows, shall also be incorporated into discharge and sediment load assessments.

Flood modelling shall be carried out using HEC-RAS 1D/2D modelling capabilities. Various return period floods shall be simulated as required in TORs. Design discharges for flood modelling shall be derived from rainfall/ flood frequency analysis using statistical software like HEC-SSP. For ungauged catchments or where long-term discharge data is not available, rainfall-runoff models shall be developed using HEC-HMS or ARCSWAT. Calibration and validation of the model shall also be carried out by comparing model results with historic floods using flood marks or satellite flood imageries or community-reported flood levels. Sensitivity analysis of Manning's roughness shall also be carried out as it is one of the most critical parameters in hydraulic modelling directly affecting flow depths and velocities.

High Water limits shall be determined from HEC-RAS model out puts for various return periods. Flood inundation maps shall be generated and exported to GIS for better visualization and categorization of water depths. Based on these maps, encroachments along the rivers or flood plains will be assessed by overlying the same maps on high resolution satellite imagery of the study area. Land Use map shall also be overlayed to quantify the class of land i.e., agricultural, settled or other, that comes under inundation. This working shall support identification of vulnerable areas and mitigation planning.

The hydraulic modelling of rivers shall be carried out using High resolution DEM or accurate river cross-sections that shall also incorporate existing structures like bridges, culverts, embankments etc. The simulation result will show the hydraulic capacity and performance of existing structures during flood events.

During the master planning stage, a comprehensive list of both new and existing schemes will be identified. This will include, but not limited to, check dams, flood protection works, rehabilitation of damaged works, irrigation channels and water storage reservoirs. At the master planning stage, the exercise will focus on identification, documentation & ranking of potential schemes for prioritization. The final selection of schemes for implementation shall be carried out by the PIU, Steering Committee & World Bank, based on strategic needs, sectoral importance and policy considerations. Upon approval from the competent forum, the shortlisted schemes will be forwarded by the consultants for detailed engineering design, preparation of PC-I and subsequently construction supervision under Task-D of the project.

2.9. ALIGNMENT WITH NATIONAL AND PROVINCIAL POLICIES

The Master Plan for the merged districts will be fully aligned with relevant national and provincial laws, policies, and climate change frameworks to ensure legal compliance, policy coherence, sustainability, and access to development financing. Alignment will be achieved through an integrated planning approach that embeds the principles of Integrated Water Resources Management (IWRM), climate resilience, ecosystem protection, and inclusive governance into all planning, design and implementation processes.

At the provincial level, the master plan will operationalize the KP IWRM Policy/Strategy by adopting basin-based planning, conjunctive surface-groundwater management, cross-sector coordination (water, agriculture, energy, urban development, environment), data-driven decision-making, and participatory governance mechanisms. River corridor planning and infrastructure development will be aligned with the KP Rivers Protection Ordinance (2002) and its amendments by enforcing river buffer zones, regulating encroachments, protecting floodplains, and integrating ecological flow requirements and pollution control measures into project designs. Climate resilience measures will be harmonized with the KP Climate Change Policy, ensuring climate-risk screening of all water infrastructure, integration of nature-based solutions, and climate-smart water management practices in irrigation.

At the national level, the master plan will be aligned with Pakistan's National Climate Change Policy, Nationally Determined Contribution (NDC) and National Adaptation Plan (NAP) by embedding climate adaptation and mitigation objectives into water sector investments. This includes flood and drought risk reduction, climate-resilient storage systems, water efficiency improvements, etc. Sectoral strategies will support Pakistan's adaptation priorities in the agriculture-water nexus, disaster risk management, natural capital protection, and community resilience as defined in the NAP.

For the merged districts, special emphasis will be placed on equity, institutional strengthening, and post-merger governance integration by aligning traditional water management systems with formal regulatory frameworks, strengthening local institutions, and ensuring community participation in planning and monitoring. The

master plan will mainstream social inclusion, gender sensitivity, and community-based management to ensure equitable access to water resources and services.

Institutionally, alignment will be ensured through coordinated implementation frameworks linking provincial departments (Irrigation, LG&RDD, Environment, Agriculture, Energy, PDMA), federal agencies, and local governments, supported by harmonized monitoring indicators, shared data platforms, and unified regulatory procedures. All proposed projects will undergo policy-compliance screening, climate-risk assessment, and environmental safeguards alignment at the planning stage.

Through this integrated alignment approach, the master plan will function as a policy-compliant, climate-resilient, and investment-ready framework, enabling sustainable water security, disaster resilience, ecosystem protection, and socio-economic development in Khyber Pakhtunkhwa, with targeted transformation of the merged districts into resilient, water-secure regions.

2.10. OUTCOMES OF TASK-A

In the light of collected data such as satellite imageries, survey maps, geology and geotechnical investigations and meticulous hydrological appraisal of the potential identified sites, a preliminary design of each project shall be carried out. Based on the basic design of each project's component identified in the target areas in context of the project objectives, a tentative cost estimate shall also be prepared along with tentative implementation schedule based on the type and scale of the project. Every effort shall be made to present an optimal investment strategy for the identified potential sites.

The viability of the each identified potential project selected from the target areas shall be determined considering the technical and socio-environmental appraisal and shall be put forward for investment according to the priority list.

The master planning report for each of the targeted merged areas shall consist of the parameters considered for the selected potential sites such as the availability of water, flood hazard potential, irrigation potential, and suitability of site conditions. Given the security reasons in the NMAs, the order of priority in the master planning criteria shall be established from low-risk areas to high-risk and the same criteria shall be followed for detailed design and construction supervision of the potential sites in the respective areas. The identified sites under each district based on the relative potential sequence

and priority in the context of the efficient utilization of the water resource shall be submitted in the form of interim master planning report to the steering committee for approval and go ahead for subsequent detailed design and construction supervision. The district-wise reports shall be combined in a single report / master plan of merged areas for final submission.

Sr. No.	Deliverables	Objective of the Report	Tentative Delivery from Contract Signing
1	Inception Report	The report shall cover the proposed line of action to carry out the master planning of the target areas	01 Month
2	Master Plan for Bajaur	-do-	03 Months
3	Master Plan for Mohmand and TSD Peshawar	-do-	04 Months
4	Master Plan for Khyber	-do-	05 Months
5	Master Plan for Orakzai and TSD Kohat	-do-	06 Months
6	Master Plan for Kurram, NW & TSD Bannu & TSD Lakki Marwat	-do-	08 Months
7	Master Plan for SW (Upper & Lower) with TSD Tank & DI Khan	-do-	09 Months
8	Final Master Plan for Merged Areas	-do-	12 Months

CHAPTER 3

TASK-B: PREPARATION OF DETAILED DESIGNS AND BIDDING DOCUMENTS

3. TASK-B: PREPARATION OF DETAILED DESIGNS AND BIDDING DOCUMENTS

3.1. GENERAL

The objective of Task-B is to carry out the detailed engineering design of both new and existing schemes. The nature of sub-projects may vary from simple to complex and will include check dams, flood protection works, rehabilitation of damaged structures, irrigation channels and water storage reservoirs. There may also be existing projects under the NMAs that are currently non-operational due to flood damage or other reasons, yet have available designs. In such cases, the consultants shall propose a rehabilitation strategy after conducting a design review of the existing designs, ensuring alignment with the latest design criteria and the principles of climate resilient infrastructure development. Accordingly, design requirements will range from straightforward rehabilitation works to detailed hydraulic, hydrological, geotechnical and structural designs. Furthermore, the exercise will focus on identification and documentation of potential schemes rather than detailed prioritization through multi-criteria analysis. The prioritization of schemes shall be carried out by the Steering Committee based on available funding, inter-district balance, strategic needs, sectoral importance and policy considerations. Upon approval from the competent forum, the shortlisted schemes will be taken forward by the consultants for detailed engineering design, preparation of PC-I and subsequently construction supervision under Task-D of the project.

The major activities to be carried out for the detailed design studies are described hereunder.

3.2. SITE VISITS

The teams of experts having diversified hands-on experience of the multiple disciplines shall be mobilized to the approved sites of the target areas. The team shall visit the sites and evaluate the on-ground scenarios and perform preliminary data collection, particularly the critical aspects requiring special attention. During the physical walk over survey, appraisal of the preliminary proposed type of structure and relative suitability of the site shall also be evaluated. All the relevant data required for the scope of detailed design study shall be collected from the sites for subsequent

analysis and detailed design studies. The line of action for the additional topographic surveys and field investigations shall be formulated during the site visits and subsequent desk study.

3.3. TOPOGRAPHIC SURVEY

The survey work for the master planning of the target areas to identify the potential water resources and effective flood management is an essential part of the study and is required to be given priority. Topography is the first important parameter for the selection of any potential site for assessment and its technical viability. However, for the scope of master planning, considering the limited time for completion of the works under Task-A, spread in 8 NMAs, fast-track solutions utilizing cutting-edge technology shall be considered for preliminary survey works. To achieve the objective, high-resolution (0.5 m) stereo satellite imagery with GCPs and or advanced aerial photogrammetry technique shall be adopted to acquire the required survey data from the target areas. This will not only save precious time but will also enable to carry out the infrastructure identification, planning, and development of flood management schemes.

3.3.1. Survey of Pakistan (SOP) Maps/Topo Sheets

Survey of Pakistan (SOP) Maps / Topo sheets on 1:250,000 and 1:50,000 scales for the sites shall be collected and initially utilized for obtaining topographic information for preliminary reconnaissance survey.

The Map information shall also be supplemented by the field surveys. The initial planning for survey is essential as other studies and investigations depends on the availability of accurate topographic maps of the area showing all essential existing features.

3.3.2. Topographic Survey Methodology

The existing ground data shall be acquired using GPS / GNSS in RTK mode and Total Station. All linear features shall be captured in line form, buildings in ST Zone and area features in close polyline / polygon format. The isolated non-dimensional features shall be capture in point format. The captured data will be processed with 3-D geometry (x,y,z).

The teams that shall be mobilized for topographic survey are given below:

- Monuments Fixing Team
- GPS Survey Team
- Traverse Survey Team
- Topographic and Cross Section Survey Team

The survey methodology shall include:

- Establishment of permanent reference markers along the existing carriageways.
- Traverse survey, horizontal and vertical control.
- Details of all features both natural and manmade.

3.3.3. Units of Measurement

All dimensions and levels shall be in SI units. The site survey shall be accomplished according to the International Standards. The linear measurement units used in survey and mapping work shall be in meters, and the angular measurement in degrees, minutes and seconds of arc.

3.3.4. Scale Used

Scales used in preparation of the topographic sheets shall be 1:2000 in linear dimension and 1:1000 for plotting elevations a.m.s.l on the drawings.

3.3.5. Survey Equipment

The instruments which shall be used for topographic survey are listed below;

- STONEX RTK GNSS-933
- SOKIA IM 102
- DJI Mavic Air 2S

3.3.6. Establishment of Survey Control Points

Before the start of survey work, vertical and horizontal control points shall be established in the project area. For vertical control, GPS shall be used to establish survey reference points in the project area. The horizontal control points shall be set

up by triangulation, traversing or GPS, depending upon the site conditions at different locations.

Permanent benchmarks (as per SOP specifications / standard) shall be established at conspicuous points, particularly near critical nature sites. In addition, temporary benchmarks shall be installed at important and known locations, duly recorded with all the three coordinates.

The survey shall be carried out by a team of experienced surveyors under the supervision of field engineer. The extent and requirement for the survey shall be planned, scheduled, and directed to meet the needs of hydrologists and design engineers for the current scope of study.

3.4. GEOLOGICAL & GEOTECHNICAL FIELD INVESTIGATIONS

One of the most important factors among many others for successful and sustainable water resource infrastructure development is to have sufficient quantum of field investigations and data collection on the existing geology and geological structure at the project site. Geological and geotechnical field investigations are a prerequisite for safe and economical design, and it is also helpful in layout of the major and important project components. Therefore, in view of the type of structure proposed at a specific site from the target areas, requirements for the geology and geotechnical field investigations shall be formulated for execution. The investigations shall be carried out maintaining the highest standards and quality control. The field investigations shall consist of but not limited to the surface geological mapping of the target areas and necessary borehole drillings at the proposed critical locations, in-situ testing including permeability and water pressure test, FDTs, CPT /SPT and test pitting, and collection of suitable soil and rock samples for laboratory testing. In addition to the drilling, construction material sources shall be identified in the vicinity of the proposed sites. Logs of the boreholes/ test pits shall be prepared during the execution of the field investigations and the work shall be supervised by an experienced geologist. The Core boxes shall be prepared and preserved during the investigations. The collected data shall be utilized to obtain useful engineering properties of the existing soils and construction materials anticipated to be used during the construction stage. The data shall be carefully collected and analyzed during the design phase of the projects.

3.4.1. Topography and Geomorphology

The site-specific topography and geomorphology shall be assessed during site visits and made part of detailed design reports.

3.4.2. Stratigraphy and Lithology

The general stratigraphic sequence prevailing in the project area shall be made part of detailed design studies.

3.4.3. Geotechnical Investigation Plan

Surface geological mapping and demarcation of orientation and trend of the outcrops is an important factor to be considered in the design. Therefore, scanline survey, and identification of detailed geological features prevailing at the site shall be carried out. For the purpose, topographic survey map of the site shall be used and rock contacts and all the major and minor geological features shall be noted and marked on the map. For the mapping, sufficient area upstream and downstream shall be considered.

3.4.4. Geophysical Survey

Geophysical Survey using electrical resistivity technique is one of the suitable methods to delineate the subsurface lithology at the sites which enables the designers to plan the subsurface borehole drillings at suitable locations to achieve the maximum information of the prevailing lithology with a limited available resource. An accurate interpretation of the tomographs is an essential tool to predict the subsurface bed rock depth at point of interest. Furthermore, it is used to ascertain any subsurface anomaly/ unseen geological feature which may be overlooked in the drilling program due to limitation of providing the localized information only.

The survey shall be conducted with Mangusta AmbroGeo or other instruments with 24 or more electrodes keeping a uniform inter-electrode spacing of 5 m. Geophysical Data shall be acquired with Dipole-Dipole and Wenner-Schlumberger arrays. Best compatible software RES2DINV shall be used to invert the raw data into 2D images for the illustration of sub-surface conditions.

3.4.5. Borehole Drilling

In the light of findings and recommendations of the ERT study, a comprehensive geotechnical investigation plan shall be prepared to be executed. The major concern

and point of interest would be to ascertain the sound bed rock in the nullah bed for foundation that would be confirmed through drilling.

The distribution of boreholes shall be proposed keeping in view the structure type aspects suited with the prevailing topography and to have maximum outcome in terms of subsurface information of the sound rock. In situ testing including water pressure test and permeability test shall be conducted in each borehole to take information about rock properties. Borehole logging of each drilled borehole shall be carried out incorporating, macro and micro details of the encountered strata, results of the permeability tests, core recovery and RQD%.

Identification of suitable borrow areas for construction materials and collection of adequate samples of each source material shall also be the part of the investigation plan. During the field investigations, sampling of the suitable construction material and rock coring will be carried out for subsequent laboratory testing.

3.4.6. Construction Materials

The identification of suitable construction materials shall be carried out parallel to the results of borehole drillings. The general construction materials include Cement and Fine/Coarse aggregates which can be obtained from the site, whereas cement can be procured from the nearby cement factories, other related structures such as outlet and canal lining etc. specifically require the following construction materials and their availability is discussed below.

- Suitable type of cement is to be purchased and transported from nearest factory to the site.
- Fine aggregate i.e., sand is to be located in the vicinity of the site during the field investigation to be used as fine aggregate after testing.
- Excavated material from stream bed and abutments can be used as coarse aggregate after its proper distribution according to size and type of material gained during excavation.
- Suitable water for construction can be used from available flow after confirming its quality.

- The suitability of the available and to be transported materials shall be confirmed after appropriate investigation, laboratory testing, and comparison of requirement and available quantity.

3.5. DETAILED DESIGN OF PROJECT COMPONENTS

3.5.1. Check Dams

Check dams are small barriers constructed across streams or gullies to control runoff, reduce erosion, enhance groundwater recharge, and provide water for irrigation and livestock. They are usually constructed using RCC, masonry, gabion or earthfill depending on local availability and site conditions.

Design Considerations:

1. **Site Selection:**
   - Preferable locations with narrow gorges or gentle slopes.
   - Geologically stable foundation to resist sliding and overturning.
   - Avoid locations prone to excessive sediment deposition or flash floods.
2. **Hydrological Design:**
   - **Peak runoff estimation:** Using rational method or unit hydrograph.
   - Sediment load estimation for storage capacity.
3. **Structural Design:**
   - Type: RCC, masonry, gabion, or earthfill.
   - Spillway design to pass peak flood safely.
   - Safety against sliding:
4. **Design Standards:**
   - ICOLD Guidelines for small dams
   - WAPDA / Pakistan Water & Power Development standards
   - FAO Manual for Check Dams
5. **Environmental & Social Considerations:**
   - Impact on downstream water users
   - Fish passage where required
   - Community involvement in maintenance

3.5.2. Flood Protection Works

Flood protection works include embankments, levees, revetments and channel improvements to protect settlements, agricultural lands, and infrastructure from flood hazards.

Design Considerations:

1. **Hydrological Assessment:**
   - Flood frequency analysis using Gumbel or Log-Pearson Type III distribution.
2. **Structural Design:**
   - Embankment stability (slope, height, freeboard).
3. **Risk Mitigation:**
   - Design for 1:50 to 1:100 year flood events**.**
   - Provision of spillways, culverts, and drainage paths.
4. **Standards:**
   - WAPDA flood protection design manuals
   - ICOLD recommendations
   - FEMA / international flood risk design guidelines
5. **Maintenance:**
   - Periodic inspection of embankments and drains.
   - Vegetation management to prevent erosion.

3.5.3. Rehabilitation of Damaged Structures

Rehabilitation aims to restore structural integrity and operational efficiency of damaged hydraulic or irrigation structures, including small dams, weirs and canals. A list of damaged infrastructure in NMDs, FRs & TSDs has been provided by the Employer which shall be taken into consideration during master planning stage.

Design Considerations:

1. **Assessment of Existing Structure:**

- Visual inspection for cracks, erosion, spalling, or seepage.
- Material testing (concrete, masonry, steel) to determine residual strength.
- Geotechnical evaluation of foundations.

2. **Design Interventions:**

- Strengthening: jacketing, grouting, and fiber reinforcement.
- Retrofitting for seismic and hydrological safety.
- Reconstruction using modern materials compliant with design standards.

3. **Structural Checks:**

- Flexural and shear capacity of repaired elements.

4. **Standards:**

- WAPDA structural rehabilitation manuals
- ACI / Eurocode for structural design
- Local seismic codes for retrofitting

3.5.4. Irrigation Channels

3.5.4.1. Hydraulic Design Criteria

Being successfully used for the design of fixed boundary open canals over decades, Manning formula i.e. $V = 1.486/n\ (R^{2/3}\ S^{1/2})$ where V = mean velocity of flow in ft/sec. R = hydraulic radius in feet and S = hydraulic slope. Hydraulic "R" = A/P where "A" = cross sectional area of flow (ft^2) and "P" = wetted perimeter of canal in feet has been used for hydraulic section of the canal. After knowing the flow velocity, discharge has been worked out by using continuity equation i.e. "Q" = AV. The full supply depth, bed width, side slope and bed slope of canal shall be adjusted in a way to give the required discharge. Other requirements are as per site conditions, the following guidelines are considered while fixing the canal geometrics:

The bed slope shall be adjusted to the existing ground slope so that to avoid excessive cutting/filling. Generally, it should lie within 0.1 to 0.05 percent, silting will take place if the canal slope is kept less than 0.05% while erosion would take place when it becomes more than 0.1%. Similarly, while fixing the slope, area to be irrigated is considered as by increasing the slope, the velocity could be increased to obtain lesser cross section but the command area is likely to be lost.

3.5.4.2. Design Analogy

Survey and Mapping

Strip survey sheets along the canal length shall be prepared & the irrigation canal alignment and its appurtenant structures shall be marked on these topographic survey sheets. These survey sheets shall be comprehensive in details as all towns, houses, roads; mosques shall be marked for ease of canal alignment.

Canal Alignment

The alignment shall be marked on topographical map to command maximum area to provide minimum cross drainage structures for economical design. The cross sections of cross drainage work and structures shall also be conceived from the topographic survey sheets. The alignment shall be laid along the contour avoiding excessive cutting and filling. The alignments of the water courses shall be proposed to run cross contours on ridges to provide better command to fields on terraces, therefore, nominal minimum curves shall be provided at turning points with a radius of 10 times the top width.

Engineering and Revenue Chakbandi

The selection of Chakbandi, or the division of land for irrigation purposes in canal systems, involves multiple factors to ensure equitable and efficient water distribution. Topography plays a critical role, as the elevation, slope, and terrain of the land influence how water is distributed and absorbed. The canal's water availability and distribution capacity are key, with areas farther from the canal requiring careful planning to ensure sufficient water reaches those regions. Additionally, the types of crops grown and their specific water needs must be taken into account, grouping together areas with similar crop patterns to optimize irrigation efficiency. Soil type and fertility also impact how water is absorbed and utilized, with fertile lands potentially requiring more water. Existing infrastructure, such as canals and drainage systems,

must be considered to ensure that the Chakbandi design works within the limits of the current system or only requires minimal adjustments. Land ownership and farm sizes are also important, as larger plots may need more complex systems for water distribution, while smaller holdings require simpler solutions. Social equity is a vital factor, aiming to provide fair access to water, especially for marginalized or small-scale farmers. The system must also minimize water loss due to seepage, evaporation, or runoff, which requires efficient channels and infrastructure. Hydrological studies, such as rainfall patterns and water table data, are used to assess the ability of the system to handle water fluctuations. Finally, operational and maintenance considerations are factored in to ensure the long-term sustainability and cost-effectiveness of the irrigation system.

Typically, a single Chakbandi is designed to irrigate an area ranging from 25 to 125 acres, depending on the local context, water availability, and land characteristics. However, the maximum area that can be irrigated by a single Chakbandi varies based on these factors. In areas with better water flow and infrastructure, larger areas may be irrigated efficiently, while in regions where water availability is limited, smaller areas might be preferred to ensure better control and distribution of water.

Revenue Chakbandi shall be prepared with focus on the administrative and legal aspects of land division. It shall aim to align with the revenue records and the ownership structure of the land, taking into account the legal boundaries and revenue assessments of each plot. The division is based on ownership patterns, revenue assessment records, and the size of land holdings. The focus is on formalizing land ownership in relation to water distribution. The revenue department or local government typically handles revenue Chakbandi, ensuring the legal recognition of land holdings and the distribution of water based on ownership rights.

Capacity/Draw-off Statement of Irrigation Outlets

Draw off statement of the outlets of irrigation channels shall be prepared to highlight the withdrawals for the irrigation outlets. Based on total available CCA and design discharge, water allowance shall be fixed for the canal and discharge requirement at each outlet shall be evaluated. Losses due to friction, bends and evaporation shall be duly considered to ensure water availability in the canal.

Design Discharge

Design discharges of irrigation canal shall be perused from the outlets provided at offtake point.

Longitudinal Slope

The longitudinal bed slope of the irrigation canal shall be primarily based on the fact that the canal shall maintain a self-cleaning velocity and minimum maintenance cost. Flatter slopes reduce the velocity of flow and may cause the silting of the channel over time and steep slope may reduce the potential command area.

Manning's "n" Coefficient

The canal shall be designed with Manning's "n" by selecting the co- according to the canal conditions. Lined Canals deteriorate with age and their flow capacity gradually decreases as the lining becomes increasingly rough.

Design Section

The canal section shall be designed based on the topography of the area. For hilly terrain prone to sliding, rectangular section shall be provided, for plain lands trapezoidal section shall be adopted and for tail reaches with discharge less than 7 cusecs, parabolic sections shall be designed.

Design Velocities

The velocities in the canal will be a resultant of hydraulic parameters such as bed slope, shape of cross section and the type of lining, adopted for the canal depending on the flow conditions in each canal reach, the flow velocities may fall below non-silting velocities.

Side Slopes

The side slope in trapezoidal section shall be designed as 1:1 whereas rectangular section shall be designed with vertical side walls of concrete.

Freeboard

Due to sedimentation, miss operation, rainfall, rougher friction factor or ice cover the water rises above the full supply depth designed for a given discharge. To cater for such rise additional depth, freeboard is provided. Generally, for the canal in mountainous terrain having steep topography with a tendency of precipitation and rain

water to ingress into the canal through hill torrents, a freeboard of 1.0-2.00 ft is recommended to be provided.

Canal Outlets

Four types of outlets shall be used in the canal system depending upon site suitability:

1. Proportional Dividers
2. Open Flume Outlets (OF)
3. AOSM Outlet
4. Pipe Outlet.

Proportional Dividers (Bifurcators or trifurcators) are used wherever practicable, in general where the off taking discharge is not less than 10% of the primary canal flow. Where adequate drop is not available, traditional "Adjustable Proportional Modules – APM" is preferred. In the pipe/barrel outlet, the discharge is a function of the working head. These are used for direct outlets from the canals for chaks.

Proportional Dividers (Bifurcators/ Trifurcators)

Proportional dividers are Crump weirs with splitter walls arranged to divide the flow in proportion to the CCA served by each offtake and the downstream parent canal. The Discharge – Head relationship is:

$$Q = CLH^{3/2}$$

Where;

Q = discharge in cumec or cfs.

L = length of weir crest between centres of splitter walls in m or ft.

H = total head over crest in m or ft.

C = 2.0 (metric units), 3.6 (fps units)

The minimum width of any offtake may be 0.15 m (0.5 ft) in a few cases. The width of offtake channel is adjusted as a function of the length of weir crest. Proportional dividers are used where the smallest off taking discharge is not less than 10% of the parent canal. However, the off taking width is more important even if the off taking discharge is less than 10% of the parent canal flow.

For modular operation, the head loss is generally 0.3 H.

Open Flume Outlets (OF)

Open Flume acts as a smooth weir with long throat constriction to control the section within the parallel throat for minimum to maximum flows. The discharge is given by the formula:

$$Q = c.b.H^{3/2}$$

Where;

Q = discharge in cumec / cfs.

b = width of throat in m/ ft.

H = head above crest in m/ ft.

c = 1.66 (b < 0.1 m).

1.68 (b < 0.13 m).

1.7 (b > = 0.13 m).

The minimum practical throat width b is normally set at 0.05 m (0.2 ft).

This type of outlet is proportional with setting the crest level at 0.90 of the depth of channel. The minimum modular head required for this type of outlet is 0.2 H.

Adjustable Orifice Semi-Module (AOSM)

AOSM type of outlet is a long-throated flume with a roof block, capable of vertical adjustment, introduced into the upper end of the parallel throat. The roof block is so shaped that the jet is made to fill the exit of the orifice and jet contraction is suppressed. The precast R.C.C. structure will be used.

The discharge of this type of outlet is given by the formula: -

Q (m^3/sec) = 4.14 by H^0.5

Where;

b = width of orifice in metres

y = height of orifice in metres

H = Full head on orifice in meters

Pipe or Barrel Outlet (PBO)

In case of free flow, the outlet works as a semi module, and in submerged conditions, non-modular. The use of this type of outlet is only used where no other type of outlet can be provided due to small flows. These can be sued in existing channel outlets.

The discharge of pipe/ barrel outlet is given by the formula:

$$Q = CA(H)^{1/2}$$

Where;

Q = discharge, cfs.

A = Area of pipe, ft2.

H = FSL – Level of centre of pipe circle.

H = FSL (Canal) – FSL (W.C).

C = Coefficient of discharge which is taken as 5.0 for free fall outlet and 6.4 for submerged outlet.

Diameter of the pipes is selected in whole number of inches. In case pipe of non-availability of a particular diameter pipe in the market, the specified diameter will be made by incorporating a socket of the required size and sufficient length in it.

Canal Falls / Drops

The type of falls varies with the drop and discharge as well as the topography of the fall location. The drop proposed in project is either step drop or vertical fall. Step drops are suitable for 150 mm fall and are normally provided without specific energy dissipation arrangement. Whereas, vertical falls are suitable for drops upto 1.5 m (5 ft) where the energy of the flow is dissipated by means of impact and sudden deflection of velocity from vertical to horizontal. A water cushion is provided at the toe of the drop, so as to reduce impact of the falling jet and thus to prevent downstream scour. The water cushion is provided by keeping floor level of the fall lower than the downstream channel bed. Size of the cistern is designed as following:

Depth of cistern below the downstream channel bed level = 1/4 or minimum ½ Ef2.

Length of cistern = 5 (H.HL)1/2 or minimum 4 to 6 times the depth of cistern.

Where

Ef2 = Height of total energy line downstream, above the bed level.

H = Head of water over crest including velocity head

HL = Drop of total energy line in the fall

The discharge is calculated by the formula:

$Q = C.B.H^{3/2}$

Where

Q = Discharge in cumec or cfs.

C = Constant equal to 1.7 (metric units) or 3.0 (fps units).

B = Width of crest in m or feet.

H = Height of upstream total energy line above crest level, in m or ft.

Canal Escape/ Side Spill

Two types of escapes are proposed for the irrigation system.

a) Gated Escape

b) Weir Escape or Side Spill Weir

Gated escapes will be proposed at least one at a suitable location preferably where frequent spill may be anticipated in case of emergency. The crests of escapes would be kept on the main canal bed level to drain off the canal completely for emergent maintenance purposes.

Side spills would be provided upstream of the siphons to release excess water in case of partial blockage of barrel or accumulation of large floating materials at siphon inlet. Gated escapes are designed for peak design discharge at that section, and side spills are designed for 15-20% flow of the canal at that particular section with freeboard of the lining still remaining surplus. Design concept of gated weirs is the same as that of a regulator and side spill is that of a free overflow weir.

3.6. SOIL, WATER AND AGRICULTURAL DATA

Optimum utilization of every drop of available water is becoming increasingly important with the ever-increasing population to meet their food and fiber needs. Knowledge of

soils suitability for irrigation in any water development project is a pre-requisite. High costs of such projects necessitate the evaluation of soil qualities for crop production. More efficient use of land and water is the key to the national needs. In the Khyber Pakhtunkhwa Province, where good agricultural land is a limiting factor and where rain water is wasted by flowing over steep slopes water resource management projects are very necessary.

3.6.1. Objectives of Soil Study

- Carry out soil survey and mapping of soils in the field.
- Collection of representative soil samples for laboratory investigations
- Preparation of soil map
- Evaluation of the soils for irrigation
- Preparation of a land capability map and working out extent under different land capability classes
- Preparation of crop suitability ratings keeping in view soils, climate and water availability
- Classification of surface and ground water for irrigation.

3.6.2. Methodology

To achieve the objectives as mentioned above, following course of action will be undertaken:

Keeping in view the physiographic variability, about 15 sites would be needed in case to a maximum depth of 1.5m. These sites would generate about 75-100 soil samples each. These samples would be checked in the field from morphological aspect. Besides, pH and $CaCo_3$ will be tested in the field. Model soil profiles will be sampled. About 8-10 soil samples from the site will be brought to Testing Laboratory for the following investigations. The laboratory analysis will provide necessary backing to the field estimations.

1.	Soil Texture	2.	ECe
3.	pH	4.	Ca

5.	Mg	6.	Na
7.	CO_3	8.	HCO_3
9.	SO_4	10.	Cl
11.	SAR	12	RSC

Base maps, Auger, Shawl, Kassi, Gainti, profile Knife, Thymol Blue for estimating pH in the field, HCL 10% for estimating percentage of $CaCo_3$, spot plate, wash bottle, compass, camera etc. would be used during field work.

A proforma has been developed for land evaluation survey which will be filled in the field and all such proformas will form part of the feasibility report. From these proformas information will be summarized in the form of a table which has been designed and attached at the end of this section for reference.

Nutritional status of the soils will also be evaluated by analyzing OM, N, P and K. The morphological, physical, chemical and nutritional characteristics of the soils will be presented in tables. Formats of all such tables have been developed and placed herein.

Land capability class will be assessed based on the above field and laboratory investigations. There from a generalized land capability map will be prepared for the command area.

Statistics of different land capability classes will be computed. Natural vegetation, soil slope, terracing, graveliness and present land use will be noted in the field. Based on the overall exercise crop suitability ratings will be worked out.

Water samples will be collected for determining water quality for agriculture purpose. A proforma has been prepared for physical observation of the water sample to be collected for laboratory analysis which is placed as Annexure-II.

It is proposed that 03 water samples would be collected, one sample would pertain to the nullah water (surface water) another to the ground water of a tube well if installed (deep groundwater) and the third from an open well/hand pump if available (shallow ground water).

For agricultural purpose, the required determinations will be done at an appropriate Laboratory. These determinations would include but not limited to the;

EC, pH, Ca, Mg, Na, CO_3, HCO_3 SO_4, Cl, SAR and RSC

The results of all these determinations will be annexed in the feasibility report along with the guidelines for the explanation of irrigation water quality terminology.

3.6.3. Summary of Activities

Summary of activities to be carried out during the soil study are given in the table below:

Sr. No.	Activity Description
1.	Topographic map (1:50,000) will be used for planning field traverses.
2.	About 15-20 observation points will be augured to about 1.5m depth in the culturable command area (CCA) of the site.
3.	All the profile descriptions will be recorded on a pre-designed proforma.
4.	Representative profiles will be sampled for laboratory analysis. It is expected that about 8-10 soil samples will be collected from site.
5.	Physical properties, chemical properties and nutritional status of the soils will be estimated in the laboratory.
6.	Potential of the soils will be assessed on the basis of information gathered and land capability map will be produced.
7.	Arial extent of all the land capability classes/subclasses will be calculated.
8.	Present land use of the area will be described.
9.	Crop suitability of various soils will be assessed.
10.	About 3 water samples from site pertaining to surface, deep and shallow ground water will be collected and got analyzed in the laboratory for irrigation suitability as well as for drinking purpose.

3.7. ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT STUDIES

The framework for the environmental and social studies will be considered as provided by operational policies and guidelines of EPA, WB, ADB and other international organizations having relevancy with the current scope of work. The studies will be supervised by senior environmental and social development specialists, with fieldwork

undertaken by experts in soils, ecology and biodiversity, fisheries, agriculture, land use & water rights, sociology, public health and archaeology etc.

Following will be the broader framework of our methodology for conducting EIA. The initial aim will be to complete a situational analysis of the bio-physical and social environment of the identified potential sites from the target areas.

3.7.1. Baseline Surveys

All the available published information regarding the proposed projects and data (if available) will be collected and reviewed. Consultant's team will hold discussions with the stakeholders and visit the potential sites. All relevant departments/organizations such as Survey of Pakistan, WAPDA, Revenue, Agriculture, Statistical Bureau, Irrigation, Forestry, NGOs and wildlife etc. will be approached by the Consultants for their support and provision of relevant documents. Consultants will conduct Project Beneficiary Survey and women issue survey for environmental and social impact assessment.

3.7.2. Development of Questionnaires/Interviewing Guides

Separate interviewing schedules for the specific project affectees will be prepared. A draft will be prepared on gender issues, village concerns regarding the project activities and other point of interest. These interviewing schedules /questionnaires and guides will be tested in the field and will be updated by making necessary adjustment as per field requirements. Data will be analyzed scientifically on the predetermined formats. This whole process will be completed at desk.

3.7.3. Social Impact Assessment

Participatory Rapid Appraisal (PRA) will be applied to understand the phenomenon with respect to various aspects of proposed sites especially in terms of how and in which ways local population will be eased. This will also make local people acquainted with the project activities.

The systematic study of basic socio-economic characteristics will be conducted which will include but not limited to number, age composition, religious affiliations, occupational classification, local status, income level, family type, family size, educational attainment, literacy rate and employment status. The selected areas will

be positively correlated with attitudinal formation, behavior, performance for a development activity.

3.7.4. Physical Environment

- **Land Use**

Detailed quantitative analysis of the land use in the target areas under the influence of the potential sites will be analyzed.

- **Climate**

Data on rainfall/precipitation, temperature, relative humidity, the river flows and evaporation will be collected; climatic diagrams will be constructed to establish and quantify the likely climatic effects for each potential site. Climatological data will be provided by the project's hydrologist and interpreted in terms of soil and water conditions and agricultural production.

- **Water Quantity**

In the case of storage dams, the fluctuation in the flow regime can affect downstream ecology and water-consuming practices. Therefore, downstream impacts due to controlled releases from the potential dam sites will be assessed and minimum downstream flows will be determined for conservation of aquatic life, flora and socio-economic activities.

- **Water Quality**

Water quality may be affected during the construction and operation phases of the proposed projects. Water quality parameters to be covered will include relevant Physio-Chemical constituents as per NEQS.

- **Biotic and Chemical Remains**

All the potential project sites that may potentially be exposed to contamination by organic/inorganic materials such as: trees and shrubs; remains of human activities; vehicle repair shops; storages of fertilizers and pesticides; animal waste disposals and cemeteries will be investigated. During construction, some of these objects might have to be removed in order to avoid negative impacts on water quality.

- **Mineral Resources**

Geological data available at the Geological Survey of Pakistan and other sources will be appraised to identify locations, sizes and types of mineral resources. The

information available from the consultant's geological team will also be incorporated. Current and future exploitable mineral resources in project impact areas, particularly areas subject to pounding will be identified.

- **Hydrology, Limnology and Sedimentation**

Hydrological data will be provided by the project's hydrologist and interpreted in terms of river ecology, water supply to settlements and cropland, especially downstream. The quality of the inflow will be important for the limnology and sedimentation in the reservoir.

Water samples will be collected under different flow regimes and analyzed for water chemistry and sediment load. Estimates of the existing and future rates of sediment transport and its effects will be addressed in the engineering feasibility studies. The results will be available to the EIA team, which will consider the impacts of buildup of deposits on aquatic ecology.

3.7.5. Biological Environment

- **Wildlife, Plants, Animals, Fish and Habitats**

An inventory will be carried out of wildlife, plants, animals, and their habitats in the impact areas. The study will be focused on endangered animals, their biodiversity and habitats that could be potentially threatened by the activities for the proposed projects. From international point of view due to their Trans boundary migration, water birds are important. The analysis will be focused on diversity features of species, most important habitat types, population, and degree of preservation, current threats and habitat conditions. Focus will be made on migratory birds if any migration takes place in the project sites from the target areas.

- **Downstream Ecology**

Reservoir impounding in case of dam construction will have impacts on downstream ecological objects such as Habitats and wetlands. Available data and information on potentially affected downstream, natural conditions, plant, habitats of animal species, natural preservation status and current threats will be studied and incorporated in the master planning. Assessment will also include minimum release of water for ecological purposes.

3.7.6. Social Environment

- **Community Consultation Programme**

Adequate information and community participation can reduce much of the fear and uncertainty associated with the project. The purpose of community Consultation program will be; to ensure that all concerned stakeholders have adequate input to project planning & design and that the project will be well-received by them. Thus, in addition to the usual government liaison, the Consultants will propose an adequate program of consulting the public during the EIA. The purpose of the program will be to inform all interested parties about the proposed project and solicit their views about it.

- **Archaeological/ Cultural Heritage**

The assessment area for heritage and archaeological resources will encompass lands influenced by the implementation of the projects. The evaluation of archaeological and heritage resources will be done through a desktop review/field visits of existing data (checking record of Archaeological Department, review of mapping for indicator of the likelihood for occurrence of archaeological resources, consultation and fieldwork.

- **Community Structure, Social Inter-Relations and Vulnerable Groups**

The investigation will include study for each settlement to cover: ethnic and tribal situation including influential; community organizations and identification of vulnerable groups which may include women, landless farmers and shepherds etc.

- **Gender Issues**

Gender sensitivity analysis is the systematic study to assess the differences in social roles played by male and female in the project implementation and completion. Women constitute about half of the population of the country. They play an important role in the socioeconomic activities and participate in the daily household earnings. A gender survey will be carried out to study the woman's role in socioeconomic life and to examine various issues faced by the women of the project area. For this survey, a pre-structured questionnaire will be used and direct Consultation with the permission of community/family head will be conducted by acquiring services of highly qualified gender specialist/Social and Poverty Specialist.

- **Socio-Economic Survey**

To find out socio-economic status in the project area, a socio-economic survey will be conducted with participation of representatives of affectees. The survey will be used to collect information on demography, infrastructure, livelihood & cultural values and the likely changes that may occur due to project interventions.

The socio-economic assessment will also consider likely scale of the workforce for the project, its housing, and the way in which economic benefits to the local population can be maximized thereby minimizing social problems.

- **Agriculture**

Agriculture is one of the dominant economic activities since generations. Data will be collected regarding cropped area, crop pattern, fruit and other trees. Information regarding agricultural related other income generating activities and local market will also be collected and analyzed.

- **Fishery and Other Economic Activities**

Investigation will include assessment of other economic activities such as fishery, poultry farming, transportation services, vehicle repairing, trade and others. In particular, fishery may can become one of the new sources of income for the population in context of the storage dams.

- **Health Facilities**

Existing infrastructure for health facilities will also be examined.

- **Infrastructure**

The transportation facilities including bridges across the river, roads, telecommunication and water supply infrastructure in the area will be analyzed and mapped.

- **Quantification of Social Benefits**

Social benefits emanating from project activities such as education, health, transport, water supply, sanitation and drainage facilities available to local population will also be quantified during the data collection phase of study.

3.7.7. Predictions of Impacts and Mitigation

- **Prediction of Environmental Effects**

Predictions of positive and negative environmental effects will be made regarding the nature, magnitude, duration, frequency, geographic extent and reversibility. The

significance of these environmental effects will also be determined. The definition of significance of positive and negative environmental effects will be clearly stated in using quantifiable reference to the magnitude, geographical extent, duration, frequency, reversibility and ecological context that are likely to be affected by the project to meet the needs of the present and those of the future. Significance of impacts will be determined in the context of project-specific and cumulative environmental effects and after taking into account the implementation of appropriate mitigation/optimization measures.

- **Mitigation Measures**

The EIA will describe general and specific measures that are technically and economically feasible to implement, in order to optimize positive effects and mitigate any negative environmental effects of the proposed projects.

3.7.8. Environment and Social Management Plan (ESMP)

The Environmental and Social Management Plan (ESMP) constitutes a critical component of the project's sustainable development framework, ensuring that all environmental and social impacts are systematically identified, assessed, and mitigated throughout the project lifecycle. At the inception stage, the consultants shall initiate a thorough baseline assessment encompassing physical, ecological, and socio-economic conditions within the project influence area. This will include field surveys, stakeholder consultations, review of secondary data, and GIS-based mapping to identify sensitive receptors and potential impact zones. Based on this assessment, the consultants will develop an ESMP that outlines specific mitigation, monitoring, and reporting measures aligned with national environmental regulations, World Bank safeguards, and climate-resilient infrastructure principles. The ESMP will define roles and responsibilities for implementation, establish environmental and social monitoring indicators, and propose a clear grievance redress mechanism for affected communities. During the subsequent project stages, including design refinement and construction, the consultants will ensure that the ESMP is integrated into project planning, with adaptive measures incorporated to address evolving environmental or social risks. Regular monitoring, compliance reporting, and engagement with stakeholders will ensure that the project achieves its objectives in a sustainable, socially responsible, and environmentally sound manner. It will be designed to address the potential environmental impacts identified during

environmental assessment of the project through devising a proper mechanism for implementation of mitigation and enhancement measures. It will describe actions for managing (i.e. avoiding or mitigating) of each identified impact, required budget institutions/personnel responsible for carrying out those actions, capacity development, training of personnel and cost estimates.

3.7.9. Environmental Monitoring and Evaluation System

An Environmental Monitoring and Evaluation (M&E) System will be designed to enable early detection and response to any unexpected environmental impacts or emergencies during and after the construction activities. The organizational setup for M&E will also be devised. To provide support to M&E, a Management Information System may also be considered.

3.7.10. Resettlement Action Plan (RAP)

On the basis of analysis of data collected through surveys and public Consultation, social and resettlement issues, if any, will be determined. Mitigation measures will be identified vis-à-vis suggesting the mitigation actions and offices / agencies responsible to undertake these measures. As per Pakistan Resettlement Ordinance 2001, ADB and World Bank guidelines on Resettlement, a Resettlement Action Plan (RP) is to be developed in case the number of relocated persons exceeds 200. In case the number of relocated persons is less than 200, a Short Resettlement Plan will be needed. Similarly in case, the resettlement issues are negligible, a Resettlement Framework (RF) will be developed to take care of the resettlement issues.

3.7.11. Field Proforma

Following information will be covered in the proforma for data collection during site visit.

1. Name of the Project
2. Stream Name
3. Tehsil and District Name
4. Population Upstream and Downstream of Site
    - Village Names
    - Populations

- Tribes

5. Groundwater

- Depth
- Quality (Saline or sweet etc.)

6. Climate

- Met. Data from Nearest Met Station

7. Biological Environment

- Flora and Fauna
- Agriculture
- Crops
- Vegetables
- Fruits
- Livestock
- Fisheries

8. Economy

- Employment Classes
- Occupations
- Income

9. Civic Amenities

- Housing (Class, Pucca, Kutcha Houses)
- Water Supply and Sanitation
- Health (Hospitals, Clinics, Dispensaries)
- Education (Schools)

10. Culture

- Archaeological Sites
- Mosques
- Education of Women

11. Assets Submergence

- Submergence of Total Land Area (Acres)
- Private Land
- State Owned Land
- Area required for construction (cost/acre):

- Irrigated
- Rainfed
- Wasteland
- Residential Area (Cost/Acre)
- Name of villages
- No. of Houses (Cost/House)
- Population (No. of People Displaced and Needing Resettlement)
- No. of Trees to be removed

12. Archaeological Sites

- Shrines
- Mosques

13. Infrastructure

- Existing nearest major road required for project construction and equipment transportation

14. Using PRA method for Interviews of Locals

- The team led by environmentalist will collect data on environmental, biological and socio-economic aspects of the project area including scoping sessions with the locals.

3.8. AGRICULTURE STUDIES

The agriculture studies and estimation of crop water requirements for the feasibility studies of command area development project will be carried out.

The command area to be developed is presently partially irrigated with below subsistence level rainfed agriculture. Most of the land is abandoned and lying barren for want of irrigation water.

The increased water availability with the construction of various projects will enormously increase cropping intensity and productivity in the currently un-irrigated parts of the command area. Due to timely and regulated water supplies, there will be substantial improvement in agriculture production. The lining of watercourses and canal will improve irrigation efficiency on one hand and reduce incidence of water logging on the other.

3.8.1. Introduction

There will be appreciable socio-economic development with implementation of the project. However, without project, the existing agriculture situation will remain unchanged. The assessment of current agricultural production and the future agriculture development with project conditions will be carried out and will be explained under the following three conditions.

- Present Agriculture
- Future Agriculture without Project
- Future Agriculture with Project

3.8.2. Present Agriculture

Agriculture development status of any area is evaluated by its land use, cropping pattern, intensities and level of crop yields. Information on these parameters will be obtained from the published and recorded data for relevant districts, if available. The agriculture institutions in the area will be consulted and relevant literature will be collected. Department of Revenue, Agriculture and Irrigation will be contacted and data on land use and cropping pattern and intensities will be collected.

3.8.3. Data Collection

After the commencement of command area development studies, the following data will be collected. These data will be utilized to establish the existing agriculture situation in the command area of the proposed site and will serve as the basis for making the future projections of cropping intensity and crop yields.

- Area, production and yield of major crops for Khyber Pakhtunkhwa by Districts. Major crops include Wheat, Maize, Sorghum, Millets, Tobacco, Sugarcane, Orchards, Rapeseed and Mustard.
- For irrigated area, production and yield of all crops for last five years will be collected.
- Area, production and yield of all crops for last five years will be collected for un-irrigated area.

3.8.4. Agronomic Field Survey

The command area to be brought under irrigation will be identified. The agricultural data will be collected pertaining to command area and the adjoining cultivated areas from the primary and secondary sources.

For obtaining primary data on existing agriculture, a well-designed farmer questionnaire will be filled regarding cropping patterns, crop yields, crop inputs and cultural practices in the project areas. Five farmers from the command area of the project will be randomly selected. Sample farmers will be contacted and interviewed by consultants. However, additional primary data will be collected for reconfirmations of certain facts and figures through personal communications and discussion with the agriculture specialists in the Project area.

Land use Statistics

Land use data are required to examine the existing agriculture development status in the project area. These data also provide information regarding the future potential for land development. Land use statistics for proposed command area of the project will be collected from the records of concerned Revenue Department. The data from the Soil Studies will also be incorporated to finalize the land use statistics.

Farm Size

The farm size has a major impact on the agriculture development of an area, because large farms have comparatively higher absorptive capacity for development than smaller farms. Therefore, data collection and appraisal regarding farm sizes and their distribution in the command areas is necessary to evolve a practicable strategy which suits the socio-economic conditions of the farming community in the area. The published data regarding farm structure for the command area will be obtained from the latest Agriculture Census Report.

The number of farms by the size of the farm for the proposed command areas will be computed. Farms will be classified into four categories i.e., I, less than 5 acres, II, 5 to 12.5 acres, III, 12.5 to 25 acres and IV above 25 acres. The percentage of number of farms and the farm area in each category will be computed and discussed.

Existing Cropping Pattern and Intensities

The cropping pattern and intensities of an area are an index of its agriculture development status. Therefore, to compare the existing cropping pattern and intensities in the command area, data on area under different crops will be obtained from the concerned Revenue Office and the Department of Irrigation.

Where the secondary data is not available an agronomic survey will be conducted by the Consultants to appraise the present agriculture in these areas.

Crop Yields and Production

The data on crop yields for an area is required to multiply with the cropped area to compute crop production. The published data from the Agriculture Statistics Khyber Pakhtunkhwa will be supplemented with primary data collected through agronomic field survey and consultation with the local Agriculture Officer.

The average crop yields are extremely low due to inadequate and erratic rainfall in the un-irrigated parts of the command areas. The yield level is below expectations in the irrigated command. The existing yield will be computed from the published and primary information collected through the agronomic field survey.

The average yields of the crops grown in the relevant District will be computed from the yield of un-irrigated and irrigated areas published in the latest available Agricultural Statistics Khyber Pakhtunkhwa, these yields will be rationalized through agronomic field survey by consultants and discussion with the local Agriculture Officer and the concerned Statistical Officer, Crop Reporting Services of the Department of Agriculture.

Farm Inputs

An agronomic survey will be conducted to obtain information regarding the use of inputs in the proposed command area of the project. The other inputs such as seed rates, tillage and labour use for the command area will be determined.

Information on use of inputs in the irrigated areas will be obtained through the agronomic survey and tested with available agriculture literature on crop production. The use of inputs/acre for existing agriculture conditions and future agriculture will be determined.

Agriculture Extension

The agricultural extension services are inadequately available in the area. However, the existing facilities in the project area will be identified and reported in the feasibility report for the project.

3.8.5. Agriculture Development "Without" Project

The present condition of inadequate and erratic rainfall resulting in low yields and crop failures is not going to improve without provision of regular irrigation supply. Technology may slightly improve yield level but that is not in the scope of this project. However, it is expected that the existing level of farming and production would continue. Therefore, the existing cropped area; yield, production and inputs will be assumed under "without" Project conditions for project evaluation.

3.8.6. Future Agriculture Development "With" Project

As earlier discussed, there are un-irrigated and may be irrigated sub-commands in command areas of the project. The provision of irrigation water will transform the rainfed below subsistence level farming into sustainable productive agriculture. This will also bring socio-economic changes and prosperity in the area. Improvement of water availability will reactivate the farmers and large extent of abandoned cultivable land will be cropped. This will result in increased production and consequently the farm income. The Improvement in irrigation efficiency will enhance production, through improved irrigation system in the command area.

The allocation of volume of water for irrigation and the resultant improvement in the cropping pattern, intensities and productivity in the proposed command area will be evaluated.

Proposed Cropping Pattern and Intensities

With the provision of irrigation water, there will be improvement in cropping pattern and increase in cropping intensities of the currently un-irrigated area. Keeping in view the water availability, the crop water requirements, the irrigation efficiency, the agro-climate, soil crop suitability and socio-economic conditions in the project area, a suitable cropping pattern will be established.

The cropping pattern will be similar to what is already being grown in or in the neighborhood of the project area. It is expected that the local agriculture extension

network would be reinforced to facilitate the transition from rainfed to irrigated agriculture technology.

Although, there may be un-irrigated farming still it may take quite some time to convert the rainfed un-even farms into irrigable-levelled fields connected with the water distribution system. It is expected that the area development to achieve the ultimate intensity will be completed in 3 years after the commencement of this project.

Crop Yields

The yield projections for the project command area will be made keeping in view the availability of irrigation, water, current irrigated crop yields in the district, the yields projected in other projects and findings of the agronomic field survey by consultants. The yield potential reported by the Agricultural research institute in the project area and in the neighborhood and technical publications literature of the Department of Agriculture, Khyber Pakhtunkhwa will also be taken into consideration. Technical and agriculture factors affecting annual growth rate and yield development will be considered in projecting the yields. The yield projections will be based on the following basic assumptions.

- Findings of the soil survey, whether the command area soils possess production potential for the proposed crops or not.
- Adequate and regular irrigation water supplies would be available to meet the crop water requirement in full.
- Agro-climatic conditions are suitable for successful growing and producing potential yields.
- Crop production technology and required inputs will be available in the area.
- The network of agricultural extension services would be strong enough for transfer of technology and making inputs timely available with ease.

Agricultural Production

The agricultural production will be estimated for “with” project conditions along development of command area.

The incremental production expected from the new area brought under irrigation with project will be estimated.

Agricultural Inputs

Use of farm inputs at the recommended rates is essential to achieve the targeted yields. The rates per acre of inputs i.e., seed, fertilizer, tillage operations, labour and plant protection will be formulated according to yield levels and recommendations of the Department of Agriculture, Khyber Pakhtunkhwa. The local agriculture extension specialists will be consulted in this regard. Agronomic field survey will also be conducted to obtain primary information regarding yields per acre and inputs used by the farmers in the project area. Following major inputs will be dealt in detail.

i. Seeds and Planting Material

Infestation free pure seed of improved varieties is necessary to achieve optimum productivity. The use of recommended seed rates is also very important to establish the desired plant population in the field. The Department of Agriculture will be contacted to obtain the recommended seed rates to incorporate in the crop budget and estimate the total requirements.

ii. Fertilizers

Chemical fertilizer is the most effective input to increase crop yields and production. Its application at the right time and with optimum combination of required nutrients is essential to obtain target production. To maintain the proper percentage of organic matter in the soil, farm yard manure (FYM) especially for vegetables and orchard crops is also necessary. It provides micronutrients that are lacking in the commercially available NPK fertilizers. FYM also improves CN ratio in the soil and enhances water-holding capacity of soil. Rates of FYM per acre will be collected from agriculture department.

iii. Chemical Fertilizers - NPK

Chemical fertilizers are indispensable for achieving productivity potential of a crop. Nitrogen (N) is part of Chlorophyll molecule, amino acids, proteins, nucleic acids and pigments. Normal metabolic process can only continue in the presence of an optimum level of nitrogen. Leaves, being metabolically most active contain the highest level of Nitrogen followed by roots, stem and fruit. Nitrogen is most needed during the blooming period to mobilize the process of flower opening, fruit setting and fruit development.

Addition of Nitrogen enhances vegetative growth and deficiency leads to low production, stunted growth and small yellow leaves.

Phosphorous (P) is a major essential plant nutrient and is extremely important in plant metabolism. Phosphorous level is higher in seed and lower in leaves and roots. It stimulates root growth and early maturity. It improves quality of produce and offers disease resistance and prevents lodging in cereals. Deficiency of Phosphorous causes reduction in plant growth and ultimately yields especially those of cereals crops.

Potassium (K) is considered essential in photosynthesis, sugar translocation, Nitrogen metabolism and protein synthesis, enzyme activation, stomata movement, water relation and promotion of growth of meristematic tissue. Potassium is known as quality element and high level of K improves the physical quality and nutritional value of grains, fruit vegetables and forages. K develops resistance to crop pests and diseases.

The recommended doses of elemental Nitrogen, Phosphorus and Potassium will be collected from various sources of literature. Special consideration will be given to the recommendations by the Department of Agriculture, Khyber Pakhtunkhwa.

The total requirements of Nitrogen, Phosphorous and Potassium (N-P-K) along years of project development for the proposed command areas will be computed.

iv. Plant Protection

The plant protection measures are essential to save the crops from the damage of insects and pests, particularly those crops that are easily susceptible, like vegetables and orchards. Provision of adequate and timely spraying is necessary for achieving target production. With the increased use of fertilizers, the crops are likely to become succulent and more susceptible to insects and pests. The population of insects and pests would increase considerably due to favorable environments for their multiplication. Cultural practices like crop rotations, adjustment of sowing time, use of healthy seed and resistant varieties can go a long way in minimizing the crop losses from insects/pests and diseases. Undoubtedly, the application of pesticides to control insects/pests is the most effective remedial measure. As such, the percent of cropped area to be covered with plant protection measures by development years, proportionate to production potential will be estimated.

v. Tillage and Labor Requirements

The number of ploughing and plankings for preparatory tillage and seedbed preparation of various crops “with” project by the years of development will be estimated. These tillage operations would be based on the Agronomic field survey and consultations with the concerned officers of the Agriculture Department.

The labor requirements in terms of man-days for various farm operations such as sowing, fertilizer application, watering, harvesting and threshing etc will be based on the Agronomic field survey and discussions with the personnel of the Agriculture Department and professional experience.

Labor requirements per acre for each crop in the command area will be worked out.

3.8.7. Crop Water Requirements

Climatic data from the nearest Meteorological station of the project area is required to compute crop water requirements. The data has been collected and shall be updated to the recent available years. Daily Maximum, Minimum Temperatures and Precipitation for the last 30 years will be adopted. The other climatic parameters i.e., Relative Humidity, Sunshine hours and Wind Speed required for computation of crop water requirements will be used from Meteorological station near the proposed dam site.

Background

In early 1970’s, FAO developed a practical procedure to estimate crop water requirements, which has become a widely accepted standard, in particular for irrigation studies. Since the publication of the methodology as FAO Irrigation and Drainage Paper No. 24, new concepts and advances in research have revealed shortcomings in the methodology and made a review and revision necessary.

A consultation of experts organized by FAO, recommended the adoption of Penman-Monteith combination method as a new standard for reference evapotranspiration and advised on procedures for calculation of the various parameters.

The FAO Penman-Monteith method has been developed by defining the reference crop as a hypothetical crop with an assumed height of 0.12 m having a surface resistance of 70 s m-1 and an albedo of 0.23, closely resembling the evaporation of an exclusive surface of green grass of uniform height, actively growing and adequately

watered, which overcomes shortcomings of the previous FAO Penman method and provides values more consistent with actual crop water use data worldwide.

The FAO Penman-Monteith equation is recommended as the standard method for estimating reference crop evapotranspiration. The new method has proved to have a global validity as a standardized reference for grass evapotranspiration and has found recognition both by the International Commission for Irrigation and Drainage and by the World Meteorological Organization.

Revised procedures have been developed by FAO in cooperation with an international working group of high-level experts to estimate Crop Evapotranspiration based on Penman-Monteith approach.

i. Penman Monteith Approach

Penman Montieth Computer Programme “CROPWAT” will be used to compute reference evapotranspiration (ETo) from the climatic data of the concerned stations. The daily, monthly and annual ETo values will be worked out. The maximum potential evapotranspiration and minimum potential evapotranspiration will be determined. The total annual ETo will be estimated. The monthly ETos will be divided into 10-day periods using graph for smooth rising and falling temperatures and evapotranspiration.

ii. Crop Consumptive Use

Crop consumptive use, is defined as the depth of water needed to meet the water losses through evapotranspiration (ETc) of disease-free crop growing in large fields under non-restricting soil conditions including soil water, fertility and achieving full production potential under the given environment”. ET crop will be computed by multiplying ETo with crop coefficient (Kc).

iii. Growing Season of Different Crops

Crop evapotranspiration varies with the types of crops and the climatic conditions, i.e., rainfall, wind speed, humidity, temperature and sun shine hours etc. In order to estimate crop water requirements, type of crops, time of sowing, harvesting and the length of growing period is essential. The data about the sowing and harvesting of different crops will be collected from publications of the Department of Agriculture, Khyber Pakhtunkhwa and verified with field visit and interviews with farmers in the project command area.

iv. Crop Coefficient

The effect of crop characteristics on crop water requirement is given by the crop coefficient (Kc), which represents the relationship between the reference (ETo) and crop evapotranspiration (Etc). The crop evapotranspiration is defined as;

ETc = Kc x ETo.

The crop coefficients of the proposed crops to be grown in the Project area will be adopted from F.A.O. Paper 24 and Paper 56. The 10-day periods crop coefficient will be developed for different crops in the Project area.

v. Effective Rainfall

Effective rainfall is that portion of rainfall, which directly meets the crop water requirements and will be calculated by the formula of United States Bureau of Reclamation using “CROPWAT” Computer Program developed by FAO. The effective precipitation for different months will be computed. It may be noted that because of low rainfall the percentage of affectivity is very high. The breakdown of monthly rainfall into 10-day periods will be listed.

vi. Net Consumptive Use

The net consumptive is the depth of irrigation water, exclusive of effective rainfall; carry over soil moisture etc. required consumptively for crop production. It is the quantity of irrigation water required to bring the soil moisture level in the effective root zone to the field capacity. The net consumptive use in Project irrigation scheme will be the total consumptive use (mm) reduced by effective rainfall (mm).

Project Areas & Proposed Cropping Patterns

The strategy of agriculture development, proposed cropping pattern and intensities, the crop water requirement and gross irrigation requirements for the command area will be worked out.

Keeping in view the agro-ecology, soil suitability, the existing cropping pattern and intensities in and around the project area, value of crops, the quantum of water availability with project will be matched with crop water requirements to evolve a suitable cropping pattern & intensity for future agriculture development in the area.

Net Irrigation Requirement for the Project

The net consumptive use of each crop at the proposed intensity in acre-feet will be worked out. The volume of irrigation water required at head works depends on the efficiency of irrigation system in the Project area.

Irrigation Efficiencies

Not all the water diverted at the source reaches the crop root zone for consumptive use by the crops. There are several types of water losses on the way from head works to crop root zone affecting the efficiency of the Irrigation system. It is proposed that canals and water courses are to be lined. Therefore, based on technical consultations with irrigation experts, information from similar projects in the neighborhood, FAO Papers No. 24 and personal experience the conveyance efficiencies will be determined.

Field Application Efficiency for irrigated area of command will be determined. Field application efficiencies in the currently un-irrigated areas due to different soil types and greater extent of light soils would be different. Therefore, based on technical consultations with the Project Soil Scientist and FAO Bulletin # 42, FAO Papers No. 24 and information from similar projects in the neighborhood, field application efficiencies will be computed and then multiplied with the conveyance applications to arrive at the irrigation efficiency for the area.

Gross Irrigation Requirement

To meet net consumptive use requirements of the crops at the root zone, provision for the losses of water on the way is made to determine the volume of water required at the Head Works.

The gross irrigation requirements for the Project at source are computed as follows.

$$\text{Gross Irrigation Requirement} = \frac{\text{Net Crop Water Requirement}}{\text{Project Irrigation Efficiency}}$$

The gross irrigation requirements will be worked out with the related irrigation efficiency. The gross irrigation requirements for monthly and 10-day periods for the proposed dam project will be worked out with the related irrigation efficiency.

3.9. FORMULATION OF DETAILED ENGINEERING DESIGN

The already conceived preliminary designs during the master planning of the projects shall be optimized based on the detailed investigations and fine tuning in the other relevant aspects such as topographic surveys, hydrological studies and laboratory testing etc. The detailed design of the proposed projects shall be based on the latest design standards such as USBR USACE, ASTM and supported with detailed computation utilizing modern tools and software techniques. The layouts and detailed cross sections of the project features shall be prepared according to the design in the form of detailed engineering drawings.

3.10. FABRICATION OF DETAILED DESIGN DRAWINGS

As part of the detailed design study, detailed engineering drawings shall be prepared for each project component of the specific proposed/existing project from each target areas under the present assignment. The necessary drawings shall comprise, layout plans, profiles and detailed cross section along with all the essential details.

3.11. COST ESTIMATES

Once the detailed engineering drawings are completed, quantities of the construction materials shall be estimated utilizing the prepared drawings and cost estimates shall be developed though detailed bill of quantities of each project component of the project. The cost estimates of the project shall be based on the latest prevailing MRS and presented in a proper engineering format. If rates for certain components are not available in the schedule, these shall be determined on the basis of current market rate for which proper rate analysis shall be carried out. Rates for the pipes etc. components will be based on the manufacturers' rates. The project cost estimate shall comprise, the cost of individual project components, land acquisition, and physical as well as price contingency. In addition to the cost of the project components, cost estimates for the annual operation and maintenance (O&M) of facilities to be constructed under the project shall also be prepared outlining the budgetary requirements, as well as the necessary manpower and resources for effective O&M of the project.

The overall project cost estimate will include civil works and the following costs mentioned below:

- Pre-construction engineering for final design and construction supervision, etc.;
- The administrative and legal costs of the Sponsors during implementation of the project;
- Land acquisition and resettlement payments; and
- Costs for environmental impact mitigation measures.
- Cost for web based electronic live monitoring system on the construction site For the purposes of economic evaluation, we will add allowances for physical contingencies to the total estimated cost at an appropriate percentage for civil works and equipment. Financial (price) contingencies will be estimated separately.

3.12. ECONOMIC AND FINANCIAL ANALYSIS

The consultant's methodology for economic and financial analysis of the scheme will be based on the following approach as under:

3.12.1. Economic Evaluation

Economic evaluation will be carried out to identify and quantify benefits, in efficiency prices to estimate real value to the provincial economy resulting from investment/capital expenditure on the project.

The economic justification of the project will be assessed in the framework of efficiency criteria of public investment using discounted cash flow techniques. Economic indices like Net Present Value (NPV), Benefit Cost Ratio (B/C Ratio) and Economic Internal Rate of Return (EIRR) will be worked out to assess the economic viability of proposed investment. It will be carried out as follows:

- Determination of economic prices for use in project inputs and outputs;
- Derivation of economic costs;
- Determination of economic benefits;
- Computation of EIRR, NPV & B/C Ratio;
- Sensitivity Analysis by varying assumptions like cost overrun, decrease in benefits or both occurring simultaneously; and
- Appropriate adjustment of costs and benefits to reflect the scarcity/ abundance of inputs and output, i.e., the resource cost to the economy.

3.12.2. Cost Benefit Ratio

Project benefits of the proposed projects or its alternative layout will comprise irrigation benefits. Irrigation benefits will be estimated on the basis of crop yields.

3.12.3. Net Present Value

Economic indicator such as EIRR, B/C Ratios and NPV at various discount rates will be computed to establish economic viability of the project.

3.12.4. Economic Parameters

The Consultants will take into account the following primary parameters required for undertaking the optimization studies and will establish the Economic viability of the selected project layout.

- Price Datum
- Currency
- Units of Measurement
- Exchange Rate
- Discount Rate
- Inflation Rate
- Basis of Economic Cost Estimation
- Value of Standard Conversion Factor (SCF)
- Specific conversion factor
- Pricing of Tradable
- Valuing Non-Tradable
- Valuing land
- Long Run Marginal cost
- Consumer Surplus Benefits
- Economic life

3.12.5. Financial Evaluation

For the financial appraisal of the Project, financial analysis will be carried out computing the similar indicator described in the section for economic analysis (FIRR, B/C Ratios and NPV) representing the economic costs and benefits in financial terms.

In addition, the financial analysis will be supplemented by computing the cash inflow outflow of the project.

The financial evaluation of a project will be undertaken to assess its financial viability i.e. earnings to pay off its financial obligation, repayment of loan, O & M cost, replacement cost and profitability over its useful life. For this purpose, annual costs will be streamlined against annual benefits / income over its useful life. The financial analysis will be carried out to identify and quantify costs and benefits to estimate real return of the project resulting from its capital investment. In other words, the cost and benefits will be assessed at nominal market price.

Justification of the project will be established by showing its profitability in terms of excess benefits / revenues over costs by using discounted cash flow stream over the project life. The projected stream of benefits over its useful life will be compared with stream of costs by bringing the two on a uniform basis through process of discounting. For this purpose, analysis requires:

- Estimation of financial cost of the project which includes escalation and Interest during Construction (IDC), if required. Other taxes and duties if any should also be included in the Base Cost. Costs reflect the scarcity / abundance value of inputs and output;
- O & M cost of the project;
- Estimation of various kind of project benefits which will be obtained during the life of the project;
- Calculation of Financial Internal Rate of Return (FIRR) and B/C Ratio;
- Financial Sensitivity Analysis;
- Cash Flow Statement and Pay Back Period etc.;
- Calculation of Unit Costs i.e. Cost per Acre Foot of water, Cost per Cropped Acre and Cost per KWh generated; and
- Recovery of cost from beneficiaries.

3.12.6. Financial Parameters

The comparison of alternative layouts, selection of the optimum project configuration and economic rate of return will be made in economic prices representing true cost to the economy. The selected project layout will be examined from the financial perspective as a standalone entity.

To establish the financial obligations, the recommended project layout will be evaluated in terms of financial implications. This is important because the assessment and quantification of both costs and benefits is different in financial prices which include custom tariffs, excise duties, sales tax etc. Moreover, the costs will be split into local and foreign components and the later expressed in Pak Rs according to the, the official exchange rate. The following parameters will be taken into account by the Consultants:

- Cost allocation;
- Source of financing;
- Terms of financing,
- Repayment period;
- Payment of interest on loans;
- Escalation;
- Depreciation;
- Interest during Construction.

3.13. DETAILED ENGINEERING DESIGN REPORT

All the above-mentioned studies and designs for the approved sites will be incorporated in a comprehensive Detailed Engineering Design Report and submitted to the client.

This will include all the collected data, appraisals and subsequent studies along with layout plans of the project components and land acquisition, profiles, cross section of all the project components. The cost estimate / detailed bill of quantities based on the detailed engineering drawings and subsequent economic and financial viability of the project shall also be made part of the design report. The report shall also cover the detailed aspects of the Environment and Social Management Framework including EMP, SMP, RAP as outlined in the respective section.

3.14. PREPARATION OF BIDDING DOCUMENTS

After the BOQ or the engineers' estimate shall be updated as per detailed design study, the Consultants will prepare the bidding documents including instruction to bidders, bid data and the specifications for the BOQ items which will be made

according to the standard specifications as are available in the American code and ASI & USBR codes. However, it is expected that some items will require special specifications which will be prepared by the Consultant's own experts. The general condition of the Contract shall be prepared as per guidelines of World Bank, FIDIC and KPPRA regulations. Special conditions of the Contract will be drafted in the light of special features relating to the Project.

3.15. PREPARATION OF BIDDING DRAWINGS

In order to facilitate the construction work, the bid drawings will be prepared which will indicate construction details such as concrete outline, reinforcement details, micro detailing and stage construction of various structures.

3.16. PREPARATION OF PC-I PROFORMA

During the design of various structures, itemized quantities for each of the component structures will be computed and a detailed BOQ will be prepared. Two nos. PC-I proformas shall be prepared (1. For priority schemes approved by the Steering Committee in District Bajaur, Mohmand & Khyber with TSD Peshawar & 2. For priority schemes approved by Steering Committee in District Orakzai, Kurram, North, South (Upper & Lower) Waziristan with adjoining TSDs) and submitted incorporating the estimated cost and economic viability of the project on the standard planning commission format or as agreed with the client.

3.17. OUTCOMES OF TASK-B

S. No.	Deliverable	Months from Contract Signing
1	Draft engineering design of priority schemes approved by the Steering Committee in District Bajaur, Mohmand & Khyber with TSD Peshawar	7th Month
2	Final Detailed Design Report for Sr. No. 1	8th Month
3	PC-Is & Bidding Documents (BOQs, Specifications and Tender Drawings) for Sr. No. 1	9th Month

4	Draft engineering design of priority schemes approved by Steering Committee in District Orakzai, Kurram, North, South (Upper & Lower) Waziristan with adjoining TSDs	10th Month
5	Final Detailed Design Report for Sr. No. 4	11th Month
6	PC-Is & Bidding Documents (BOQs, Specifications and Tender Drawings) for Sr. No. 4	12th Month

CHAPTER 4

TASK-C: INTEGRATED IRRIGATION ASSET MANAGEMENT SYSTEM FOR MERGED AREAS (IIAMS-MDs)

4. TASK-C: INTEGRATED IRRIGATION ASSET MANAGEMENT SYSTEM FOR MERGED AREAS (IIAMS-MDs)

4.1. GENERAL

The Integrated Irrigation Asset Management System for Merged Districts (IIAMS-MDs) will be designed to provide a comprehensive, technology-driven solution for the inventory, management, and visualization of irrigation assets. Our approach leverages modern web technologies, GIS integration, and mobile data collection to ensure accurate, real-time management of water resources. The system will be developed through a structured lifecycle ensuring data integrity, system scalability, and robust security. The aim is to not only digitize existing records but to establish a dynamic framework that supports future planning and prevents duplication of efforts. This initiative not only focuses on efficient information management but also seeks to enhance the capacity of the Irrigation Department for improved planning and the prevention of duplication of efforts.

The overall implementation workflow of the development of the IIAMS-MD's is shown in the following figure.

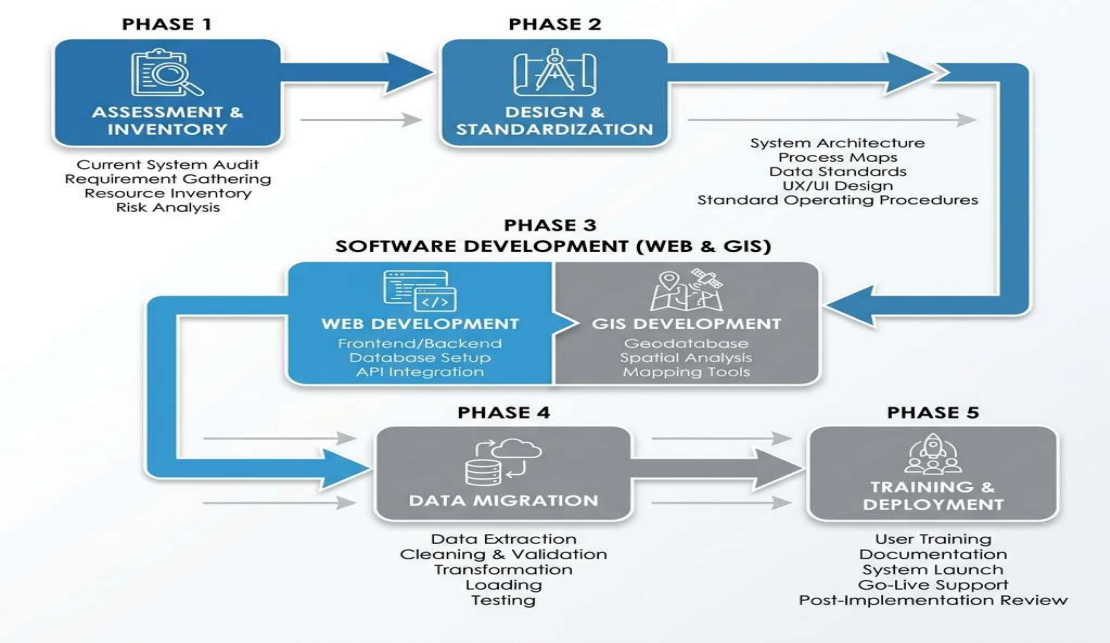


Figure 4. Implementation Workflow of IIAMS-MD's

4.2. ASSESSMENT INVENTORY ASSESSMENT

A thorough assessment of the existing inventory of irrigation assets, capturing essential details such as location, type, capacity, and condition will be carried out. This will include, but not limited to check dams, flood protection works, irrigation channels and water storage reservoirs. A rigorous field survey strategy will be deployed to assess irrigation assets. Detailed attributes including GPS coordinates, physical condition (functional/non-functional), capacity (cusecs), and type (channel, weir, flood protection works, small dam, etc.) will be recorded. Mobile-based data collection forms will be utilized to ensure data accuracy at the source.

4.3. DATA STANDARDIZATION

A standardized framework will be developed for organizing and categorizing irrigation asset data to ensure consistency in data formats, nomenclature, and key attributes to facilitate seamless integration into the digital system.

4.4. DIGITAL PLATFORM DEVELOPMENT

The core of the IIAMS-MD's development is the Digital Platform. It will be a web-based, user-friendly interface allowing authorized personnel to view, update, and manage irrigation asset information. Key features of the platform will be easy data input, retrieval, and update by authorized personnel.

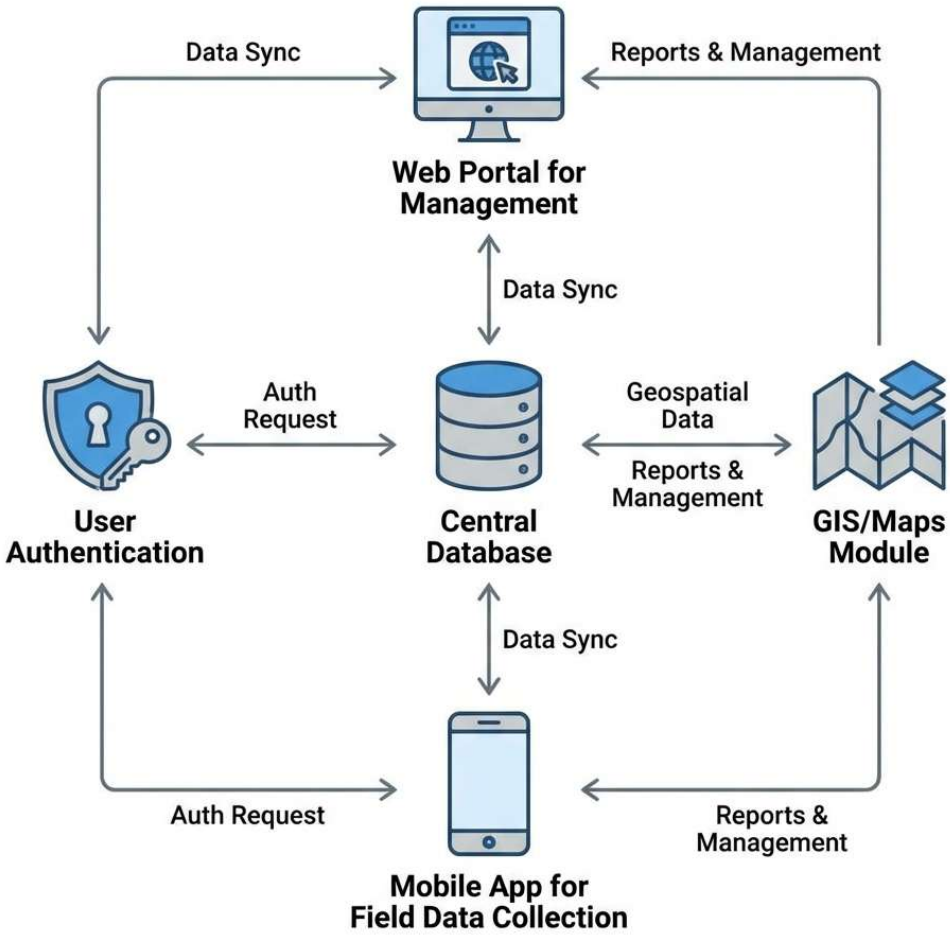


Figure 5. High-Level System Architecture

Key features will include:

- Unified Dashboard: Real-time overview of asset status.

- Search & Filter: Advanced retrieval by district, tehsil, or asset type.

- Role-Based Access: Secure login for Data Entry Operators, Engineers, and Executives.

4.5. GEOSPATIAL INTEGRATION

Geospatial visualization is critical for planning. The system will integrate with a GIS engine (e.g., Leaflet/Mapbox or ArcGIS) to display assets on interactive maps. Layers

will include satellite imagery, district boundaries, and water bodies, enabling spatial analysis for decision-making.

4.6. INFORMATION SECURITY

Data security will be paramount. We will implement HTTPS encryption for data in transit and AES encryption for sensitive database fields. Regular automated backups and audit logs will be established to track all user activities and changes to critical data.

4.7. COMPATIBILITY AND SCALABILITY

The system will be built using a responsive design framework (e.g., React/Bootstrap), ensuring full compatibility across Desktops, Tablets, and Smartphones. The backend (Microservices architecture) will allow straightforward scalability for future modules.

4.8. TRAINING AND CAPACITY BUILDING

Sustainable adoption of the IIAMS-MD'S will require training and continuous capacity building. We will conduct specialized training sessions:

Executive Training: Using dashboards for decision making.

Technical Training: System administration and data management.

Field Staff Training: Using mobile apps for data collection.

Comprehensive User Manuals and Video Tutorials will be delivered as part of the specialized training package.

4.9. DATA MIGRATION

The existing data, available in the form of lists, technical reports, drawings, and supporting documentation, will be obtained in both soft (digital) and printed hard copy formats. Digital records will be reviewed, standardized, and directly migrated into the IIAMS-MDs platform after appropriate formatting, indexing, and quality checks to ensure compatibility, completeness, and data integrity.

For documents available only in hard copy, a systematic digitization process will be undertaken. This will include high-resolution scanning, optical character recognition

(OCR) where applicable, metadata tagging, and structured data extraction to convert the information into searchable and editable digital formats. The digitized records will then be validated, categorized, and integrated into the IIAMS-MDs database architecture in accordance with predefined data standards and protocols. This approach will ensure the preservation of legacy information, minimize data loss, and facilitate efficient retrieval, analysis, and long-term management within the integrated information system.

4.10. REPORTING AND ANALYSIS

Comprehensive reporting tools will be developed and integrated within the system to generate insightful analytics and decision-support reports on irrigation asset performance, maintenance requirements, and overall operational functionality. The reporting module will include customizable dashboards, automated report generation, and real-time data visualization to track key performance indicators (KPIs) such as asset condition ratings, operational efficiency, downtime, water conveyance losses, maintenance frequency, and rehabilitation needs. These reporting tools will strengthen evidence-based decision-making, enhance transparency, improve resource allocation, and support long-term planning for sustainable irrigation infrastructure management in the merged districts.

4.11. MONITORING AND EVALUATION

A comprehensive Monitoring and Evaluation (M&E) framework will be established to systematically assess the effectiveness, efficiency, and sustainability of the digital system. The framework will define clear performance indicators aligned with the system's objectives, such as data accuracy and completeness, system uptime, user adoption rates, response time, reporting efficiency, and reduction in manual processes. Baseline benchmarks will be established at the time of deployment, against which periodic performance assessments will be conducted. The M&E mechanism will include regular technical audits, system performance reviews, and compliance checks to ensure adherence to data standards, cybersecurity protocols, and operational

guidelines. Structured reporting intervals (monthly, quarterly, and annual) will be defined to track progress and identify gaps.

In parallel, a structured user feedback mechanism will be instituted to capture insights from field staff, engineers, administrators, and decision-makers. Feedback will be collected through surveys, stakeholder workshops, helpdesk logs, and periodic review meetings. This input will be systematically analyzed to identify usability issues, training needs, functional gaps, and potential system enhancements. A continuous improvement cycle will be adopted, whereby identified issues are prioritized, corrective measures are implemented, and system updates are deployed in a phased and controlled manner. This iterative approach will ensure that the digital platform remains responsive to user needs, technically robust, and aligned with the evolving requirements of irrigation asset management in the merged districts.

4.12. TECHNOLOGY STACK & TOOLS

We will utilize a modern, open-source technology stack to ensure scalability and cost-effectiveness:

- Frontend (Web): React.js / Bootstrap (for a responsive, modern Dashboard)
- Backend (API): Python (Django/FastAPI) or Node.js (for high-performance APIs)
- Database: PostgreSQL with PostGIS extension (specialized for geospatial data)
- Mobile App: Flutter (Cross-platform for Android & iOS)
- GIS / Maps: Leaflet JS / Mapbox / ArcGIS API
- DevOps & Hosting: Docker containers, CI/CD pipelines, deployed on secure Cloud/Local servers.

4.13. OUTCOMES OF TASK-C

The consultants shall prepare and submit the following as per the schedule;

Sr. No.	Description	Submission Schedule
1	Prototype of the System	After 06 Months
2	Beta Version of the System	After 08 Months
3	Final Version of the System	After 10 Months
4	Training and Capacity Building of the Users	After 12 Months

CHAPTER 5

LAW AND ORDER SITUATION

5. LAW AND ORDER SITUATION

It is pertinent to mention here that law and order situation in the project areas has remained relatively conducive in the past decade, however, recently a considerable resurgence in anti-state activities has been noticed in the past couple of years. The abnormal security conditions in the project area have restrict accessibility and free day to day movements. To tackle the ever-worsening law and order situation in the NMDs and FRs, the Consultants shall devise the following measures:

a) Careful planning shall be done while planning site visits to the project areas.

b) Most of the site visits shall be made unannounced by using the same model vehicles (low valued/ profiled) which are prevalent in the NMDs and FRs.

c) The Consultants are well aware of the fact that most topographic survey, geophysical/geotechnical investigation firms belong to the NMDs, therefore, hiring of such firms shall be prioritized instead of firms from settled/established districts of the country.

d) The Consultants have kept provision of a number of survey helpers and support staff who shall be directly hired from the project area thereby giving a sense of ownership to the local community.

e) Frequent jirgas shall be held with the elders of the local communities citing their concerns and demands for an efficient planning of the schemes.

f) The Consultants have an extensive experience of working in NMDs and FRs and past experiences have taught that working in such environments is not possible without unprecedented support of district administration and law enforcing agencies. In this connection, the Consultants shall require support from the Employer and Donors who shall aid in liaison with the district administration and Pakistan Army. This shall enable the Consultants to plan field visits efficiently by taking all the concerned agencies on-board.

In wake of the above, it is envisaged that the project timelines shall be extended beyond the designated parameters, due to uncertain law and order situation in the NMDS and FRs.

CHAPTER 6

TASK-D:

CONSTRUCTION SUPERVISION

6. TASK-D: CONSTRUCTION SUPERVISION

During this stage, the consultants shall mobilize to the site of works and shall supervise the construction activities of various components of the approved schemes by the World Bank, PIU & Steering Committee under the role of “The Engineer” or “Project Manager”. The brief methodology of the activities performed by the consultant during this phase of the project is as under:

6.1. METHODOLOGY FOR CONSTRUCTION SUPERVISION

It is to be noted that, apart from the prime objectives of project completion, progress control and contract management also includes input of the design staff for modifications during construction stage, documentation and reporting, along with reviews and approvals of execution procedures and method statements.

The construction supervision needs continuous monitoring of various aspects which can broadly be divided into three major types:

- Office Aspects
- Field Aspects
- Contractual Aspects

These three major categories can further be sub-divided into sub-activities as follows:

6.1.1. Office Aspects

i. Preparation and revision of Construction Drawings

ii. Review and evaluation of Shop Drawings along with submitted implementation schedule and construction methodology by the contract

iii. Preparation of As Built Drawings

iv. Verification of the submitted IPCs

v. Preparation of recommendation of variation orders to the client

vi. Preparation of Revised PC-I of the scheme, if required

vii. Close liaison with the client and keep record of the correspondence

viii. Submission of progress reports and other reports as required by the client

6.1.2. Field and Contractual Aspects

i. Verification of the survey in the field

ii. Checking and verification of Layout in the Field

iii. Supervising additional explorations if required

iv. Checking and approving excavated foundation, Reinforcement and Concrete work as per submitted drawings

v. Supervising Day-to-Day Work of Contractor

vi. Monitoring Quality of Civil Works

vii. Monitoring the Safety and Environmental Aspects

viii. Plan for Progress Control

ix. Verification and approval of the construction material and borrow areas

x. Verification and supervision of the field and laboratory tests

xi. Provision of guidance to the contractor and or client about the matters cropped up during the execution of the project.

xii. Preparation of punch list at the end of the project completion

xiii. Identification of defects during the defect liability period and providing assistance in rectification of the same.

6.2. OFFICE ASPECTS

6.2.1. Preparation of Construction Drawings

The tender provided to contractor will have only a tender drawing. Immediately after the Award of Contract, a detailed discussion with the contractor will be carried out to agree with the contractor in light of construction schedule, a time schedule for issuance of construction drawings for each component of the work. These drawings will include general layout of each component and drawings for excavation, concrete outline,

reinforcement, joint detail etc. These drawings will be the basis for the contractor's execution of the work.

6.2.2. Checking the Method Statement

The contractor on the basis of construction drawings will prepare Method Statement for each of the project component, in which he will provide details regarding execution and resource management procedures. These Method Statements will be both for the temporary work as well as the permanent work. The Consultant will review these Method Statements to check that the safety of the project is not compromised and the contractor has taken into account every eventuality such as seepage control, the stability of slope of excavation, the gradient of the temporary axis, safety of personnel during blasting and other aspects. The Consultant after thorough review and discussion with the contractor will approve Method Statement which will form the basis for the execution of work.

6.2.3. Review and Checking of Shop Drawings

On the basis of the construction drawings and approval of Method Statement by Consultant, the contractor will submit shop drawings for each component. These drawings will be reviewed by consultants and approved so that the various components can be executed satisfactorily.

6.2.4. Variation Orders

During the execution of the construction activities, if any new items is found necessary to be constructed which was not part of the approved engineer's estimate, or any variation in the scope of work due to any reason, the supervision consultant shall prepare after identification, design and on-site measurement of the work involved, the variation order for approval of the client before execution of the same. The cost involved for construction of any new item shall be prepared including details of the measurement and quantities.

6.2.5. Reporting Requirements

Reports of various types required by the Client are considered an important means of interaction with the Client during the implementation of the project by the Consultants. Preparation, proper reporting and review by the Client and timely action by the parties greatly contributes in improvement of quality of output, timely completion as well as

cost of the assignment. For preparation of each of the following reports, global concepts, World Bank / GOP criteria / Planning Commission formats and the Client's instructions will be kept in view. For documentation of construction and installation procedures and progress, these will be supported, in sufficient details, by photographs and video records covering the whole Project sites.

The Consultants will prepare and submit to the employer the following reports and documents:

- Monthly Progress Reports after every month
- Quarterly Progress Reports on Quarterly basis
- Mid Term Report after two years from the date of commencement of the construction supervision
- Any other report as desired by the client on agreed schedule
- Final Report on completion of the project activities.

6.3. FIELD ASPECTS

6.3.1. Checking of Layout in the Field

One of most critical aspect which will need to be carried out immediately on mobilization of contractor will be checking of the survey in the field. A joint survey will be carried out and the coordinates and ground elevation mutually agreed between Consultants and Contractor. Any variation with respect to tender drawings should be identified so that the alignment and layout of various project features can be modified in the issuance of construction drawings.

6.3.2. Layout and Survey of Various Works in the Field

Once the survey has been mutually agreed, the layout of various features of the project will be laid down so that execution of project can be carried out. In the most critical project feature, which need to be laid out will be the location of dam abutments, footprint of the dam, center line of spillway, location of irrigation conduit and alignment of irrigation canal.

6.3.3. Checking and Approving Foundation

Once the layout has been carried out in the field and the contractor will carry out excavation and preparing of foundation of various project components. The Consultant's staff will check and approve the foundation finally prepared by the contractor. This checking by the Consultant's staff will be according to specifications laid down in the contract. After approval, the contractor will be allowed to place concrete on fill material.

6.3.4. Checking and Approving Reinforcement

Once foundation is approved and dental concrete has been placed and consolidation grouting has been carried out where required, the reinforcement will be placed by contractor and engineer will check that reinforcement is placed according to drawings for their size and spacing. Consultant's staff will also check that enough cover for steel has been provided according to specifications and it has been supported strongly so that it is not displaced during execution.

6.3.5. Checking and Approving Concrete

Consultant's staff will approve the concrete mix to be used in various components of structure and check that admixtures are provided according to the Method Statement. The concrete during placement will be checked for segregation and temperature and also that enough vibration is carried out so that no honeycombing is possible. Special care will be needed for spillway structure and intake, outlet works & flood protection works.

6.3.6. Supervising Day-to-Day Work of Contractor

Consultant's staff will be required to continuously monitor contractor's work. This will need checking of form work, placement of concrete, placement of fill in the embankment, dewatering, construction of cutoff walls and adhering to the specifications in all aspects of the execution of project.

6.3.7. Monitoring Quality of Civil Works

The main objective of the Consultant's team on site is to ensure that the Project's works are built in conformity with the contractual specifications, approved drawings, standards, scheduled contract time, good engineering practices and state-of-the art execution.

During the execution of work, a laboratory will be established which will carry out Quality Control tests on concrete, steel and fill materials. The Consultants will ensure that samples are taken and proposed at regular intervals according to specifications and sent to laboratory for testing for their quality control. The field staff will coordinate with laboratory staff for the results so that quality of concrete, steel and fill material is maintained.

Other items of special concern regarding quality control and management include quality inspection procedures for removal, transport and storage of test samples, pieces of equipment, materials (reinforcement steel, soil, concrete, etc.); Quality assurance effected by the Consultants involving verification that quality control is carried out according to specifications and that the works thus built are satisfactory, in accordance with standards and specifications and fully able to perform their function. The Consultants' staff will be available to help the Contractors understand the construction specification, inspection procedures and progress reporting requirements.

6.3.8. Monitoring the Safety and Environmental Aspects

The contractor has to prepare a safety and environmental procedure which he will submit to the Consultants for approval. Once it is approved, the Consultants will ensure that both Contractor and Consultant’s staff is following safety requirements. The site staff has proper helmets and boots and temporary works are carried out according to safety requirements.

6.3.9. Plan for Progress Control

Using the same basic data as those established for project cost control, a progress chart will be maintained and updated by the Consultants. The construction programme will then be compared regularly with the progress of works and the resulting documents will be presented for appraisal during the site meetings and in the monthly and quarterly reports. Depending on the findings of the documents, recommendations will be made by the Consultants to the Employer for necessary action.

6.3.10. Completion and Final Acceptance Certificate

The Consultants will supervise jointly with the Employer's representative the acceptance tests and will prepare the Completion Certificate and the final acceptance certificate to be issued by the Employer's representative.

6.4. CONTRACTUAL ASPECTS

6.4.1. Plan for Project Cost Control

On the basis of the field survey control and quantity survey required for determination of actual quantities of work items accomplished by the Contractor the Consultants will approve or reject the quantities of materials delivered, equipment installed, and works performed by the Contractor.

In the meantime, the contractor will prepare his invoice and account to be presented to consultant for examination.

After verification (concrete, soil etc.) the Resident Engineer will identify the amounts and calculate the corresponding Contract Prices. He will then prepare the interim payment certificates and submit these to the Project manager, who will countersign the certificates before forwarding to the same to the Employer for approval.

Using the same procedure after the final inspection has been satisfactorily completed, the Consultants will prepare the final certificate including a recommendation that the Employer may make final payment.

6.4.2. Measurement of Work Quantities and Interim Payments

Generally, at three monthly intervals, measurements of work quantities will be carried out and the Employer will be kept informed of any significant changes and consequences as well as problems and their remedies. These quantity measurements will be the basis for progressive payment to the Contractors.

6.4.3. Reviewing Claims

It is a normal practice of contractors that they submit claims for variant costs in respect of any change in design or variation in quantities which may interrupt the works. The same is expected in every project. The claims submitted by the Contractor in writing, duly supported by facts with reference to the relevant Clauses of the Contract Documents will be examined by the Consultant.

The consultants will thoroughly review each claim submittal by the contractor and determine adequacy of the claim with respect to time and cost. The consultants are responsible for backup justifications of these claims prior to forwarding to the employer for the approval. After careful examination, the Consultant will report his analysis and

his recommendation to the Employer who will decide on case-to-case basis, and issue variation orders.

6.4.4. Preparation of Variation Orders

During the construction of major civil works particularly in the water resources projects, there are normally a number of instances where variation to the original design has to be adopted in special items which are not included in the original tender documents are added. Some of the items provided in the BOQ are deleted as such the number of variations to the original contract is required. The variations are normally submitted for evaluation to the Consultants by the contractor and are finalized after discussion with the contractor and then submitted to the employer.

The Consultants will also analyze the variances of construction progress from the Contractors' programme and determine the cause of the variance. From the analysis, the measures to be taken to achieve key target objectives shall be determined and recommendations made. In the event that the progress falls behind programme, appropriate modifications to programme and work method shall be developed through discussions with the Contractor for the recovery of the original programme.

The variation orders will require a thorough study and justification for the proposed variation; therefore, the Consultants will issue variation orders with the Employers consent. However, there will be certain variation order which will be within the limit of the Engineer and will be approved by the consultant. It will also be required fixing of the rates for various items.

ANNEXURES

ANNEXURE-A

TOR COMPLIANCE MATRIX

Annexure-A: TOR Compliance Matrix

TOR Reference / Clause	TOR Requirement	Consultant's Proposed Approach / Compliance Statement
Inception Report	Submission of Inception Report within 1 month of contract signing	Inception Report will be submitted within the stipulated one-month period outlining understanding of TOR, methodology, work plan, staffing, safeguards approach, and coordination arrangements with PIU and World Bank
Background & Project Context	Understanding of KP RIISP, Merged Districts context, and irrigation sector challenges	The Consultant demonstrates comprehensive understanding of KP RIISP objectives, socioeconomic conditions of Merged Districts, irrigation gaps, flood risks, and climate vulnerabilities
Overall Objective	Preparation of comprehensive master plan, feasibility, detailed design and construction supervision	The assignment will be executed through phased Tasks A–D ensuring integrated planning, design and safeguards compliance
Water Resources Assessment	Comprehensive assessment of surface and groundwater resources	Hydrological, hydrogeological, meteorological and water demand analyses will be undertaken using historical data, remote sensing, GIS and field validation
International Waterways	Identification and assessment of international waterway implications	Screening of all sub-projects for international waterways, documentation of impacts, and compliance with World Bank procedures

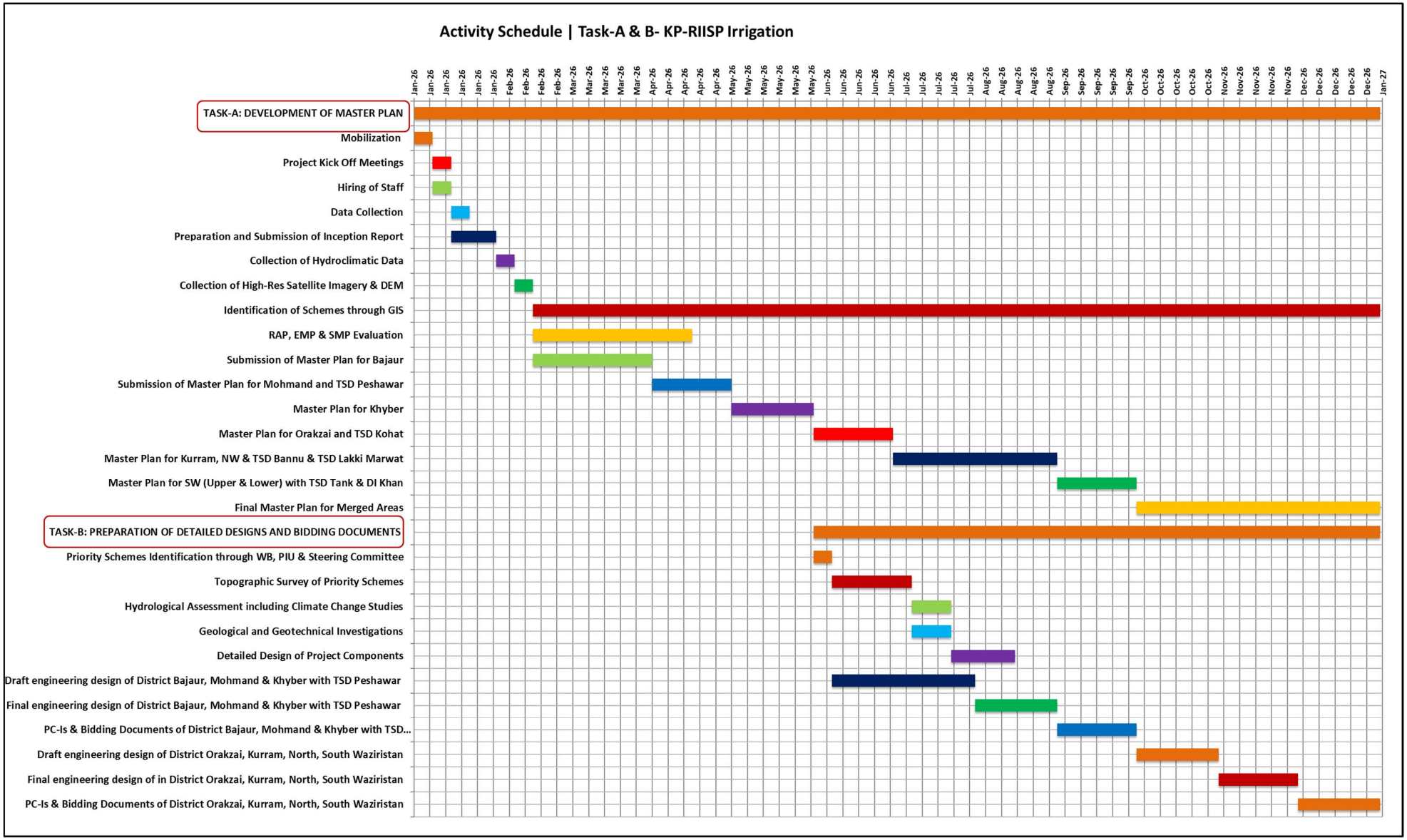
TOR Reference / Clause	TOR Requirement	Consultant's Proposed Approach / Compliance Statement
District-wise Master Plans	Preparation of district-wise master plans with sequencing	District-wise master plans will be prepared in TOR-defined sequence, reviewed by Steering Committee, and consolidated into a final MD Master Plan
Prioritization of Schemes	Identification of priority investments	Multi-criteria prioritization based on technical, economic, social, environmental, and climate resilience parameters
Task B – Detailed Design	Conduct technical, environmental and social detailed design studies	Detailed studies will be carried out for shortlisted schemes including alternatives analysis and cost estimates
Topographic Surveys	Conduct essential topographic and site investigations	GIS based survey planning at Task-A stage followed by detailed topographic and geotechnical investigations during Task-B
Detailed Designs	Preparation of detailed designs suitable for bidding	Designs will comply with international standards and World Bank requirements, incorporating climate resilience
Bidding Documents	Preparation of BOQs, drawings, specifications	World Bank Standard Procurement Documents will be used for preparation of bidding documents
Environmental Assessment	Preparation of EA/ESMP/EIA	Environmental assessments and ESMPs will be prepared, cleared by WB and KP-EPA, and integrated into design reports
Social Safeguards	RAP, LARP, social surveys, consultations	Social impact assessments, RAPs, and stakeholder consultations will be conducted in line with WB ESF

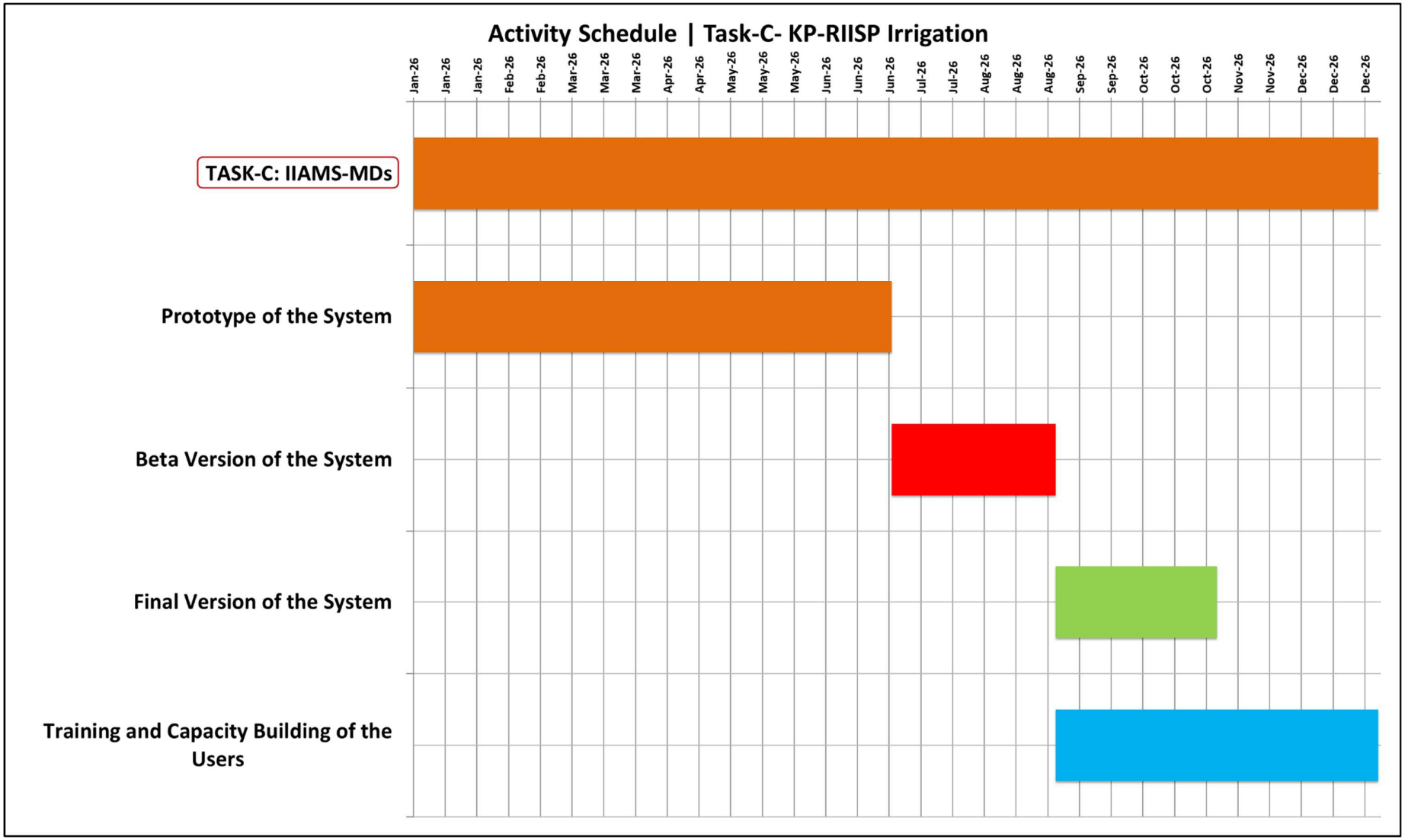
TOR Reference / Clause	TOR Requirement	Consultant's Proposed Approach / Compliance Statement
Gender Mainstreaming	Gender analysis and action plan	Gender considerations will be integrated into planning, design, and implementation stages
OHS & LMP	Preparation of OHS and Labor Management Plans	OHS and LMP will be prepared for each contract package and enforced during construction
Task C – IIAMS-MDs	Development of Integrated Irrigation Asset Management System	A GIS-enabled digital platform will be developed including asset inventory, data standardization, training and M&E
Capacity Building	Training of PIU and Irrigation staff	Structured training programs and on-the-job capacity building will be conducted
Institutional Arrangements	Coordination with PIU and stakeholders	Dedicated coordination mechanisms with PIU, Steering Committee and World Bank
Duration of Assignment	One year assignment with phased delivery	Work plan aligns with TOR timelines for Tasks A–D
Deliverables Format	Electronic and hard copies, local language summaries	All deliverables will be submitted in required formats and languages

ANNEXURE-**B**

GANTT. CHART / WORK PLAN

Activity Schedule | Task-A & B- KP-RIISP Irrigation




Activity Schedule | Task-C- KP-RIISP Irrigation
Jan-26
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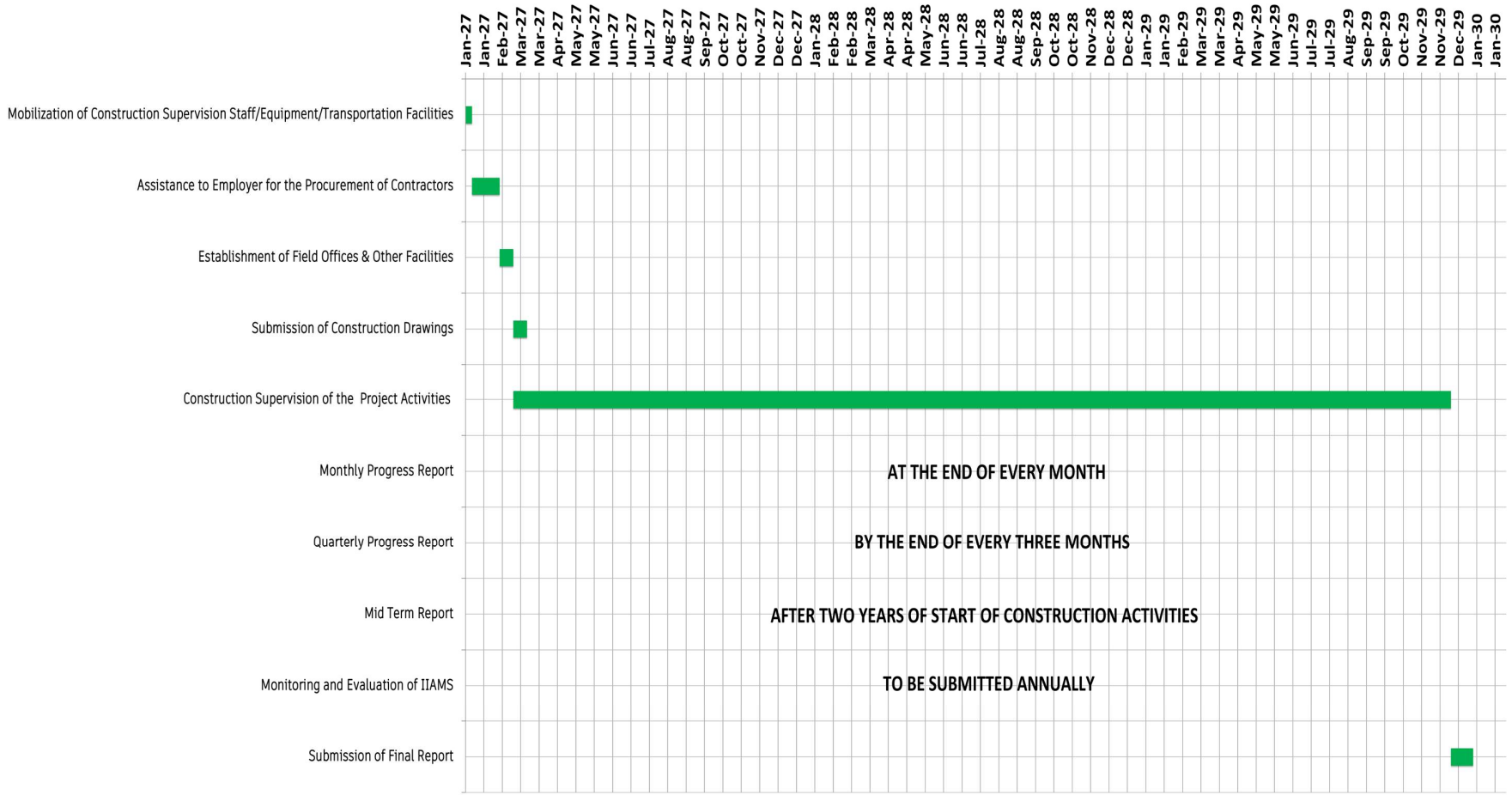
Dec-26
TASK-C: IIAMS-MDs
Prototype of the System
Beta Version of the System
Final Version of the System
Training and Capacity Building of the Users

Activity Schedule | Task-D- KP-RIISP Irrigation



ANNEXURE-C

MINUTES OF MEETING

MINUTES OF THE MEETING DATED 13-01-2026

Meeting with World Bank Team

Dated: 13th January, 2026

Time: 12:00 PM

Mode: Online

Participants:

- World Bank Task Team Leader and team Members.
- Project Director, KP-RIISP PIU Irrigation alongwith staff.

Agenda Items and Discussions:

1. The Task Team Leader opened the meeting and inquired about the updated status of Procurement of Consultants.

   The Project Director informed the participants, that the Consultancy was awarded on 26th December, 2025 and the Contract Agreement signed on 29th December, 2025. It was further shared that a meeting has been scheduled on 15th January, 2026, wherein the Consultants Key Staff have been requested to attend to initiate further activities.

2. **Submission of Inception Report:**

   The World Bank Team inquired about the submission timeline of the inception report, and requested to share the report for the comments of World Bank before the upcoming Technical Mission. The Project Director assured that the inception report would be submitted to the World Bank at the earliest.

3. **Clarification on Duplication of Schemes:**

   The Task Team Leader sought clarification regarding possible duplication of the recently approved the ADP Schemes ***"250036- Construction of Check Dams/Water Storage Reservoir, flood Protection Works and Irrigation Channels at Feasible Location in Merged Districts"*** costing of Rs. 2300.00 Million.

   The Project Director apprised the participants, that the scheme is a part of Annual Development Program and is financed by Government of Khyber Pakhtunkhwa. He further assured that there will be no duplication and the department will provide a non-duplication certificate accordingly.

   List of proposed rehabilitation flood protection works:

   The World Bank Team requested the list of proposed Rehabilitation Flood Protection Works, which were damaged recently due to heavy floods. The Project Director told the World Bank Team that the list would be shared as soon as possible.

The meeting concluded with a vote of thanks to the participants.

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PROJECT DIRECTO
Khyber Pakhtunkhwa Rural Investme
& Institutional Support Project, Pesha

ANNEXURE-D

MANNING SCHEDULE & EQUIPMENT DETAILS

Sr. #	Name	Position	Firm	Months												Man Months
				1	2	3	4	5	6	7	8	9	10	11	12	
1. Key- Experts Tasks A, B and C																
1	Dr. Zaheer Muhammad Malik	Project Manager / Team Leader	*PES*													12.0
2	Dr. Mujahid Khan	Senior Hydrologist	*PES*													6.0
3	Dr. Bazid Khan	Senior Structural Engineer	*PES*													6.0
4	Dr. Shahid Ullah	Senior Geotechnical Engineer	*PES*													6.0
5	Hashim Hanif	Procurement and Contracts Specialist	*PES*													6.0
6	Dr. Daulat Khan	Environmental Specialist	*PES*													6.0
7	Dr. Nawaz Tariq	Social and Resettlement Specialist	*PES*													6.0
8	Naeem ud Din Ahmed Khan	Senior Computer / ICT Specialist	*PES*													12.0
9	Murad Ali Kisana	GIS Specialist	*PES*													12.0

Sub-Total (1)																	**72.0**
2. Non-Key- Experts Tasks A, B and C																	
1	Abdur Rehman / Muhammad Haris / Saad Saud	Junior Engineer (Civil) (3 Nos.)	*PES*														36.0
2	Adeel Ahmed	Junior Geotech /Material Engineer	*PES*														12.0
3	Ahmed Faraz / Musanif Shah	Quantity Estimation Engineer (2 Nos.)	*PES*														24.0
4	Ali Abbas	Junior Social & Resettlement Specialist	*PES*														12.0
5	Faraz Ali	Gender Specialist	*PES*														12.0
6	Muhammad Jawad	Environmental Specialist	*PES*														6.0
7	Abdullah Hanif	Junior Procurement and contract Manager	*PES*														6.0
8	Irfan Khattak	Geologist	*PES*														9.0
Sub-Total (2)																	**117.0**
3. Technical Support Staff																	
1	Asad Awan / Mohsin Khan / Ali Sher / Khurram Shah / Qasim Ali / Hussain Awan	Health & Safety Inspectors (6 Nos.)	*PES*														72.0

2	Naveed Aslam / Usama Khan / Haris Ahmed / Abdullah Shah / Hamza Muhammad / Mujtaba Ali	Site Inspectors (6 Nos.)	*PES*													72.0
3	Qari Masaud / Asad Zaman / Sohail Khan / Sabir Ali	Surveyors (4 Nos.)	*PES*													48.0
4	Zubair Shahid / Ali Shan / Raheel Khan / Muhammad Saleem / Babar Khan / Irtaza Mir	Survey Helpers (6 Nos.)	*PES*													72.0
5	Yasir Ali / Faisal Pervaiz / Mehmood Aslam	Quantity Surveyors (3 Nos.)	*PES*													36.0
6	Ghulam Mustafa / Farooq Ali / Muhammad Nadeem	AutoCAD Operator (3 Nos.)	*PES*													36.0
7	Imran Ali / Ghafoor Khan	Computer Operators (2 Nos.)	*PES*													24.0
Sub-Total (3)																**360.0**
4. Non-Technical Office Support Staff																
1	Muhammad Hassan	Office Manager	*PES*													12.0
2	Irfan Ali / Omer Shabbir	Accountant (2 Nos.)	*PES*													24.0

3	Waris Mir	Telephone Operator	*PES*														12.0
4	Imad Khan / Irfan Ullah	Documents Controller (2 Nos.)	*PES*														24.0
5	Mir Sohail / Sharafat Khan / Muhammad Arsalan	Cook / Office Boys (3 Nos.)	*PES*														36.0
6	Shakir Ullah / Wilson Mushtaq / Ahmed Ali / Zafar Khan / Rauf Ahmed	Drivers (5 Nos.)	*PES*														60.0
7	Allah Ditta / Sameer Khan / Sikandar Iqbal / Abubakar Kamboh / Raza Ali / Ahsan Latif	Security Guards (6 Nos.)	*PES*														72.0
Sub-Total (4)																	**240.0**
Total (1 + 2 + 3 + 4)																	**789.0**

Sr. #	Name	Position	Firm	Months																																Man Months
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	
1. Key- Experts Tasks D																																						
1	Dr. Muhammad Fahim	Chief Resident Engineer (CRE) / Project Manager / Team Leader	*PES*																																			36.0
2	Dr. Mujahid Khan	Senior Hydrologist	*PES*																																			3.0
3	Dr. Bazid Khan	Senior Structural Engineer	*PES*																																			3.0
4	Dr. Shahid Ullah	Senior Geotechnical Engineer	*PES*																																			3.0
5	Hashim Hanif	Procurement and Contracts Specialist	*PES*																																			6.0
6	Dr. Daulat Khan	Environmental Specialist	*PES*																																			6.0
7	Dr. Nawaz Tariq	Social and Resettlement Specialist	*PES*																																			6.0
8	Naeem ud Din Ahmed Khan	Senior Computer / ICT Specialist	*PES*																																			3.0
9	Murad Ali Kisana	GIS Specialist	*PES*																																			3.0
10	Sareer Khan	Deputy Team Leader	*PES*																																			36.0
11	Mehmood Ahmed Khan / Muhammad Adnan Khan Khattak	Resident Engineers (2 Nos.)	*PES*																																			72.0
Sub-Total (1)																																						**177.0**

2. Non-Key- Experts Tasks D					
1	Muhammad Asim / Daud Jan / Shaheen Shah / Muhammad Younas / Muhammad Sohail / Zafar Khan / Shakir Ali / Liaqat Ali	Assistant Resident Engineers (8 Nos.)	*PES*		288.0
2	Abdur Rehman / Muhammad Haris / Saad Saud	Junior Engineer (Civil)	*PES*		36.0
3	Adeel Ahmed	Junior Geotech /Material Engineer	*PES*		12.0
4	Ahmed Faraz / Musanif Shah	Quantity Estimation Engineer (2 Nos.)	*PES*		72.0
5	Ali Abbas	Junior Social & Resettlement Specialist	*PES*		6.0
6	Faraz Ali	Gender Specialist	*PES*		6.0
7	Muhammad Jawad	Environmental Specialist	*PES*		6.0
8	Abdullah Hanif	Junior Procurement and Contract Manager	*PES*		6.0
9	Shareef Ullah	Health & Safety Inspectors	*PES*		6.0
10	Irfan Khattak	Geologist	*PES*		6.0
Sub-Total (2)					**444.0**

3. Technical Support Staff					
1	Asad Awan / Mohsin Khan / Ali Sher / Khurram Shah / Qasim Ali / Hussain Awan	Health & Safety Inspectors (6 Nos.)	*PES*		216.0
2	Naveed Aslam / Usama Khan / Haris Ahmed / Abdullah Shah / Hamza Muhammad / Mujtaba Ali	Site Inspectors (6 Nos.)	*PES*		216.0
3	Qari Masaud / Asad Zaman / Sohail Khan / Sabir Ali	Surveyors (4 Nos.)	*PES*		144.0
4	Zubair Shahid / Ali Shan / Raheel Khan / Muhammad Saleem / Babar Khan / Irtaza Mir	Survey Helpers (6 Nos.)	*PES*		216.0
5	Yasir Ali / Faisal Pervaiz / Mehmood Aslam	Quantity Surveyors (3 Nos.)	*PES*		108.0
6	Ghulam Mustafa / Farooq Ali / Muhammad Nadeem	AutoCAD Operator (3 Nos.)	*PES*		108.0
7	Imran Ali / Ghafoor Khan	Computer Operators (2 Nos.)	*PES*		72.0
			Sub-Total (3)		**1,080.0**
4. Non-Technical Office Support Staff					
1	Muhammad Hassan	Office Manager	*PES*		36.0
2	Irfan Ali / Omer Shabbir	Accountant (2 Nos.)	*PES*		72.0
3	Waris Mir	Telephone Operator	*PES*		36.0
4	Imad Khan / Irfan Ullah	Documents Controller (2 Nos.)	*PES*		72.0
5	Mir Sohail / Sharafat Khan / Muhammad Arsalan	Cook / Office Boys (3 Nos.)	*PES*		108.0
6	Shakir Ullah / Wilson Mushtaq / Ahmed Ali / Zafar Khan / Rauf Ahmed	Drivers (5 Nos.)	*PES*		180.0
7	Allah Ditta / Sameer Khan / Sikandar Iqbal / Abubakar Kamboh / Raza Ali / Ahsan Latif	Security Guards (6 Nos.)	*PES*		216.0
			Sub-Total (4)		**720.0**
			Total (1 + 2 + 3 + 4)		**2,421.0**

EQUIPMENT DETAILS

Equipment for Office		**Nos.**
a.	Desktop Computers and Accessories	9
b.	Laptops	2
c.	Photocopy Machines	2
d.	A3, A4 Scanner	1
e.	Misc Gadgets (USBs, Cables etc)	1
Furnishing of Office		
a.	Office Table	16
b.	Conference Room Table	1
c.	File Cabinets	4
d.	Side Wooden Racks	2
f.	Chairs + Sofas	51
g.	Wooden Partitions	1
i.	Inverter Air Conditioner 1.5 Tons	6
l.	Refrigerator	1
m.	Water Dispenser	1
n.	Microwave Oven	1
q.	Instant Water Geyser (Electric)	2
r.	Crockery	2
s.	Vehicles rent including POL and maintenance	3