

TERMS OF REFERENCE FOR CONSULTANTS

A. Background

1. The Asian Development Bank (ADB) is supporting the Government of Bihar for the modernization of the Ara irrigation system which is part of the of the larger Sone canal system.

1. Sone Canal System

2. The Sone canal system was constructed in the 1870s, extending over a cultivable command area (CCA) of 560,000 hectares (ha) on both banks of the Sone River. From 1968, the system was extended with the construction of the Indrapuri barrage and high-level canal systems to cover a total CCA of 699,000 ha. The proposed project covers the Ara canal system, 202,000 ha CCA, including the link canal from the barrage (10 kilometers [km] of which is currently being lined), the Ara main canal (84.5 km), the Dumaon branch canal (64 km), the Bihiya branch canal (50 km), and associated distributaries and minors. The total length of the canal system is about 700 km. Gated cross and head regulators allow control of flow along the canal system; however, there are about 2,000 small, un-gated offtakes, many of which offtake directly from the main and branch canals. Seepage losses are high from the unlined canals, while structures are in rather poor condition.

3. Surface water resources are limited. Under the Bansagar Agreement, the allocation based on 75% dependable yields for Bihar is 9,559.5 million cubic meters (MCM) or 7.75 million acre-feet (MAF). The 75% dependable supply for the Ara canal system is assessed as 2,220 MCM, (1.8 MAF), which is equivalent to just 1.1 meters (m) over the command area. The average annual flow volume is about 45,858 MCM. However, the supply is erratic, and canal supply varies between months and/or years from 20 to 40 cubic meters per second (m³/s).

4. Soil textures are light, and soils adjoining the main rivers Ganga and Sone consist of sandy loam, loamy sand and sand, whereas, further away they consist of silty sand to sandy silt. The soils in general are fine textured away from the main rivers.

5. The irrigation water use efficiency is low, estimated at just 35% for the Ara canal system. There is severe head-tail inequity of supply, and many farmers in mid-tail areas, as well as where vegetables are cropped, use private, diesel shallow tube wells (STWs) to supplement canal supply. The aquifer is generally good, comprising sandy-silt with clay lenses. The shallow aquifer, typically 12–40 m depth range, shows significant arsenic concentrations in STWs over the tail one-third of the command area, nearer the Ganges River. There is a drastic decline in arsenic concentration below 40 m. There are pockets of salinity in the shallow aquifer. During pre-monsoon, the depth to the water table is > 8 m over one-third of the command area, > 5 m over most of the area, but post-monsoon, it rises to within 2–5 m over most of the command area.

6. The Ara canal system is managed by the Bihar Water Resources Department (BWRD), by the superintending engineer (SE) for the Sone Canal Circle in Ara, with two divisions headed by EE for Sone Canal Division, Ara and EE for Sone Canal Division in Bikramganj. Water users' associations (WUAs) have been formed and registered and now manage distributary canal systems, including operation, minor maintenance and collection of irrigation service charges over about a quarter of the command area. The WUAs are empowered to collect irrigation water charges at ₹220 per ha for *kharif*²¹ crop season and ₹188 per ha for *rabi*²² crop season, of which

²¹ Kharif = monsoon season, which lasts between June and October.

²² rabi = the dry [winter] cropping season, which lasts between November and March.

70% is retained by them and 30% deposited with BWRD. However, collection rates of the irrigation service charge from WUAs are about 50%. The irrigation water charges are fixed by BWRD.

7. The major crops grown in the command area are paddy in *kharif* and wheat in *rabi*. Yields are good near the canal due to good supply of water and with farmers applying recommended doses of fertilizers. However, in drought years or where water supply is poor, yields drop by 50% or more. Gram and oilseed/mustard is grown where irrigation supply is less assured. Areas of vegetables and herbs/mint are grown as well as sugarcane.

2. Proposed Project

8. The proposed project will address head-tail inequity and inadequate and erratic supply of canal water, particularly in drought years, through modernization of the canal system, adoption of conjunctive use supply with deep tube wells (DTWs), and buried pressure pipe distribution for smaller flows, together with improvement of management systems and arrangements.

9. The project outcome will be: higher irrigation water use efficiency, agricultural productivity and climate resilience in the Ara canal system achieved. Project outputs are: (i) Ara canal system irrigation infrastructure modernized; (ii) more efficient and sustainable management, operation and maintenance in the Ara canal system established; and (iii) farmers' capacity for on-farm water productivity improvement enhanced.

10. Engineering modernization works are expected to comprise the following:

- (i) **Canal prism re-sectioning and selected lining.** It may not be possible economically to line all main, branch and distributary canals. In which case criteria need to be developed.
- (ii) **Balancing Storage** along the main and two branch canals.
- (iii) **Flow regulatory/control structures:** the many small slide gates may be problematic for the supervisory control and data acquisition (SCADA) system, and these may be replaced with larger gates. Incorporation of spill/duck bill sections may be considered.
- (iv) **Un-gated direct offtakes:** there are many ungated direct offtakes which may be gated under the project. There remains significant risk that head-end farmers will still take too much water. One option may be to replace ungated direct offtakes from main and branch canals with pressure pipe systems.
- (v) **Flow measurement:** rating curves may be used to calibrate gated drop structures, but this may be complicated and often inaccurate. Providing dedicated measurement (flume) structures shall be considered.
- (vi) **Conveyance/safety structures:** escapes, culverts, and bridges need to be rehabilitated as required.
- (vii) **Inspection roads** are in quite good condition and no paving under the project is proposed.

11. A water management and SCADA system are proposed for the Ara main canal, Dumraon branch and Bihiya branch, i.e., to heads of distributary offtakes.

12. Water distribution from canal to farmers fields may either comprise: (i) field channels, or (ii) pressure pipes systems. The project will not support lining of field channels. For pressure pipes, options shall be considered:

- (i) **Low pressure – open systems.** Use of thin-walled uPVC pipes (pressure rating of 350 kilopascals [3.5 bars]) with residual head of 1–5 m. There is a need to repump for micro-irrigation (sprinkler/drip) and on-farm storage tanks are required.

- (ii) **Medium pressure – closed systems.** Use of thick-walled uPVC pipes (600 kilopascals [6.0 bars]) with residual head of 25–30 m. No need to re-pressure and no on-farm storage tanks required.
- (iii) **Hydrant type and size:** e.g.: for farmers, 0.1 m polyethylene hose connection; or for micro-irrigation connection.
- (iv) **Scheme size and irrigation rotation,** for example: (i) small size covers 40 ha in 1 *chak* with 8 hydrants, all flow of about 40 liters per second (l/s) to one hydrant in turn, flow measurement and charging at pump house; (ii) larger size covers 200–400 ha in 5–10 *chaks*, with 40–80 hydrants all supplied at once but with just 5 l/s, flow measurement at hydrant.
- (v) **Storage.** If pumping from larger canals, use may be made of canal storage to balance pumped demand and supply.

13. Criteria for selection of areas for installation of pressure pipe systems shall be developed, for example: (i) to replace direct offtakes, (ii) near urban areas, and (iii) in areas where STWs are extensively used (tail-end areas). The proportion of field channels and buried pipes may be decided following farmer consultations and studies. A preliminary suggestion is for 30% pressurized pipe.

14. Conjunctive use is proposed to balance shortage of canal supplies, and shall be firmed up by water balance and groundwater studies. It is envisaged that tube wells shall feed directly into pressure pipe systems.

15. On-farm works including precision land levelling and drip-sprinkler systems are implemented by the Department of Agriculture (DoA), On-farm Water Management (OFWM). Various government initiatives exist. The project will consider mechanisms to support take up of measures for efficient on-farm distribution and application.

16. Other engineering components include electrification and solar power and metering and irrigation service charging for both gravity and pressure pipe areas.

17. Two design–build–operate (DBO) contracts are currently envisaged for the: (i) water management and SCADA system, and (ii) pressure pipe systems including irrigation charge collection.

18. Capacity development, training support requirements for WUAs and BWRD staff for efficient management, operation and maintenance (MOM) of the modernized system will be required. BWRD facilities will also be upgraded including buildings, transportation, IT and other equipment.

19. Agriculture support will be required to ensure high water productivity throughout the command area, along with crop diversification.

B. Scope of Services

20. In December 2016, the Government of Bihar approached the Asian Development bank (ADB) for funding support. ADB visited Bihar in March 2017 and concluded that the modernization envisaged by BWRD was limited, with focus on lining. Subsequently in October 2017, BWRD recruited Tractebel Engineering Private Limited under a lump sum contract to prepare a modernization plan for the Ara canal system, leading to and including preparation of the detailed project report (DPR). The revised project scope proposed a more comprehensive modernization approach. ADB however observed that too much focus was still given to conveyance efficiency

and not enough to distribution and on-farm efficiencies. The project concept was therefore expanded to include for a balance of engineering works including conjunctive use and pressure pipes for smaller flows, measures for improved MOM, and agriculture support.

21. The proposed transaction technical assistance (TRTA) will supplement the ongoing Tractebel Engineering Private Limited (TEPL) to cover the expanded scope of the project. The TRTA will: (i) develop feasibility design of the proposed Ara Canal Water Productivity Improvement Project (ACWPIP); (ii) review the technical and economic viability of ACWPIP; (iii) evaluate safeguard requirements and prepare associated approval documents and implementation plans; (iv) prepare advance detailed design and bidding documents for 30% of the works, expected to be the main and branch canals prism resectioning and lining; (v) prepare DBO contracts for the management of the SCADA system and also for the pressure pipe systems; (vi) prepare consulting package(s) for detailed design, construction supervision and project implementation support; (vii) assist in preparation of loan documentation, and (viii) support implementation start-up.

22. Concerning technical feasibility for the expanded scope for the ACWPIP, the TRTA is required for the following:

- (i) **Expanded studies:** water distribution, water balance and groundwater investigations and modelling.
- (ii) **Additional surveys, consultations and awareness:** checking quality of topographic and structure surveys carried out by a third party, tube well and pumping survey, agro-socioeconomic survey, stakeholder consultations and awareness, resettlement survey.
- (iii) **Additional engineering design:** review canal system design including for balancing storage and dedicated flow measurement structures, design of pressure pipe systems over at least 10,000 ha, firm up electric and solar power plans and costs, and firm up scope of the SCADA system.
- (iv) **Institutional strengthening requirements** and arrangements for MOM and involvement of private sector as well as water user associations.

C. Major Outputs and Activities

23. The major outputs and activities are summarized below. The TRTA team is expected to be mobilized in July 2018.

Table 1: Summary of Major Outputs and Activities

Major Outputs	Delivery Dates	Key Activities with Milestones
1. Feasibility design, technical and economic feasibility and safeguards	December 2018	1.1 Expanded studies and groundwater modelling 1.2 Additional surveys including tube well pumping survey. 1.3 Additional stakeholder consultations and awareness 1.4 Additional engineering design including balancing storage, dedicated flow measurement structure, pressurized pumping systems, electric and solar energy, and SCADA 1.6 Institutions and management, operation and maintenance 1.6 Technical and economic feasibility 1.7 Safeguards assessment and plans

Major Outputs	Delivery Dates	Key Activities with Milestones
		1.8 Sector policy, institutional and legal gap analysis and proposals for amendments.
2. Advanced design for 30% of works with bidding documents, and DBO bidding documents for SCADA and pressurized pumping systems	2.1 September 2018	2.1 Advanced design for main and branch canals prism resectioning and lining, and bidding documents
	2.2 February 2019	2.2 DBO bidding documents for SCADA system
	2.3 February 2019	2.3 DBO bidding documents for pressure pumping systems
3. Consulting packages terms of reference, loan documents and implementation start-up	3.1 October 2018	3.1 Consulting package(s) for detailed design of remaining works, construction supervision and project implementation support
	3.2 December 2018	3.2 Assist in preparation of loan documentation
	3.3 December 2018	3.3 Support implementation start-up

D. Consulting Services Inputs

24. The TRTA will be implemented over a period of 13 months from fielding consultants which is estimated to be in July 2018. Given the current status of the ongoing TEPL study, and noting that topographic survey of canals has been completed by a third party, a total of 126 person-months of consulting services is needed, of which 31 person-months will be individually recruited international consultants and 95 person-months national consultants recruited through TEPL, to cover the revised and expanded scope of project preparation work, and to include for detailed design for 30% (by value) of the ensuing loan amount. Out of 25 national consultants, 3 are new positions that are not currently included in the ongoing contract between BWRD and TEPL. The consultant requirements are shown in Table 2.

Table 2: Summary of Consulting Services Requirement

	Positions	Remarks	Person-Months Required
	International (financed by ADB)		
1	Irrigation Engineer/Team Leader	individually recruited	8.5
2	Junior Engineer (Water Resources)	international consultants	7.0
3	Hydrogeologist		1.5
4	SCADA Specialist		1.0
5	Economist		3.5
6	Social Development Expert (Resettlement, Social Analysis and Gender)		3.5
7	Procurement Specialist (DBO)		3.0
8	Pipe Transient Flow specialist		1.0
9	Financial Management Specialist		2.0
	Sub-total		31.0
	National (financed by Bihar Government)		
1	National Team Leader/ Irrigation Engineer	TEPL contracted staff with extended inputs	6.0
2	Hydraulic Expert		4.5
3	Canal Structures/ Structural Engineer		4.0
4	Hydromechanical/ Gates Expert		2.0
5	Agriculture Expert/ Agronomist		4.0
6	Environment Specialist		3.0
7	Social Development Expert (Resettlement and Gender)		4.0

	Positions	Remarks	Person-Months Required
8	Water Users' Association/Institutional Specialist		2.5
9	Economist		3.0
10	GIS Expert		2.0
11	Solar Energy Expert		1.5
12	Costing Expert		1.5
13	Support Engineers		29.0
14	CAD Draftsman		18.0
15	GW Expert – Modeller		4.0
16	Electrical Specialist	New staff to be recruited	2.0
17	Resettlement Officer		4.0
	Sub-total		95.0
	Total		126.0

Source: Asian Development Bank estimates.

E. Implementation Arrangements

25. BWRD will be the implementing agency for the TRTA and the project director will support and direct the overall implementation of the TRTA. Consultancy support will be provided in two ways:

- (i) Recruitment of international consultants through direct recruitment of individual consultants by ADB.
- (ii) Recruitment of national consultants through contract variation with increase in contract amount of TEPL-India who are already contracted by the Government of Bihar to prepare a modernization plan for the Ara canal system, leading to and including preparation of the DPR.

26. Consultants will be mobilized in a staggered and intermittent manner starting July 2018. Initial focus will be on surveys and studies, including a groundwater model and pumping survey, as well as on detailed design for 30% of works, comprising prism reprofiling and lining of the main and branch canals, to be completed by September 2018. Feasibility study and safeguards will be completed by December 2018. Consulting packages terms of reference, loan documentation and start-up support will continue to July 2019.

F. TRTA Deliverables

27. The deliverables will be the joint responsibility of BWRD, international, national consultants as described below. The draft deliverables and briefing reports will be prepared and issued to BWRD and ADB as required.

Table 3: Reports and other Technical Deliverables

SN	Report/Deliverable	Due Date (months from start)
1	Monthly Reports Monthly reports should be concise and include details of consultants deployed, reports submitted, list of activities and status, bottlenecks, and mitigation plans.	1–9
2	Inception Report – Development Intent and Stakeholder Engagement <ul style="list-style-type: none"> • Summary of proposed modernization works, with focus on engineering work and survey • Scope of studies and surveys • Preliminary plan for agriculture and irrigation management • Plan for stakeholder engagement – consultations and awareness 	1
3	Technical Reports/ Working Papers <ul style="list-style-type: none"> • Water Balance, Groundwater Modelling, Conjunctive Use and TW design • Tube wells and pumping survey findings (summary) • Agro-socioeconomic survey findings (summary) • Canal system design including design parameters (discharge statement, lining, design criteria, etc.) • Pressure pipe systems and metering: design and options including design criteria • Electric and solar energy recommendations • Management and SCADA system • Institutional development – capacity development and training • Agriculture support plan • Sector policy, institutional and legal gap analysis and proposal for amendments 	2 – 6
4	Bidding documents for advance works <ul style="list-style-type: none"> • Designs and Drawings • Quantities • Bidding documents 	2
5	Design–build–operate–management contracts <ul style="list-style-type: none"> • Management and SCADA system • Pressure pipe systems 	6
6	Feasibility Study Report <ul style="list-style-type: none"> • Technical feasibility • Economic feasibility • Environment and social safeguards and gender 	6
7	Terms of reference for consultancy package(s) for detailed design, construction supervision and project implementation	3

Table 4: Deliverables required for ADB Project Approval/Loan Processing

SN	Deliverable	Expert Responsible	Due Date (months from start)
1	Draft RRP	team leader	6
2	Sector Assessment (Summary)	team leader/ water users' association specialist	6
3	Country Economic Indicators	economist	6
4	Project Administration Manual	All experts – team leader to lead	7
5	Poverty and Social Assessment (PSA)	social expert/ resettlement/gender	6
6	Summary Poverty Reduction and Social Strategy (SPRSS) (Executive Summary to the PSA)	social expert/ resettlement/gender	6
7	Gender Equality and Social Inclusion (GESI) Plan (Attachment to the PSA)	social expert/ resettlement/gender	6
8	Safeguard Categorization Checklists (Involuntary Resettlement, Indigenous Peoples and Environment)	social expert/ resettlement/gender/ environment specialist	6
9	Resettlement Plan	social expert/ resettlement/gender	6
10	DBO Resettlement Framework for tertiary system	social expert/ resettlement/gender	6
11	Sample DBO Resettlement Plan	social expert/ resettlement/gender	6
12	Indigenous Peoples Plan (if required)	social expert/ resettlement/gender	6
13	Stakeholder Communications Strategy	social expert/ resettlement/gender	6
14	Initial Environmental Examination	environment specialist	6
15	Risk Assessment and Risk Management Plan	team leader	6
16	Financial Capacity Management Assessment	financial management specialist	6
17	Financial and economic analysis	economist	6
18	Contribution to the ADB results Framework	team leader	6
19	Development Coordination	procurement specialist	8
20	Climate change: project adaptation action report	team leader	6
21	Procurement Assessment	procurement specialist	6

G. Terms of Reference for International Consultants

28. **Irrigation Specialist/Team Leader** (international, 8.5 person-months). The specialist will preferably have a master's degree in Irrigation Engineering (or equivalent) and 15 years of experience in undertaking similar projects with canal and pipe systems, and preferably experience of leading ADB project preparation teams and of working in India. As team leader, the specialist will work with the team and be responsible for, among others:

- (i) Overall management of the TRTA team;
- (ii) Managing relationships with the government and ADB;
- (iii) Conducting quality control of outputs from the PPTA team members;
- (iv) Advising on overall sequencing of the investment project;
- (v) Preparing various documentation required for loan processing
- (vi) Compiling inception, interim and final reports;

- (vii) Facilitating and supporting ADB missions;
29. As an irrigation specialist the main task of the expert, among other will include:
- (i) Reviewing the quality TEPL concept paper report and additional studies, identifies gaps and requirement for improvement.
 - (iii) Reviewing Ara canal's water balance considering future water availability and demand taking into account various cropping patterns and water allocation strategies, different micro irrigation options, and climate change;
 - (iv) Finalizing strategies for Ara canal system modernization, presenting options to BWRD and ADB, and developing preferred option to feasibility design level;
 - (v) Planning and oversight of required studies and surveys, as well as design activities including canal and various pressure pipe systems;
 - (vi) Assessing the current drainage in the scheme and preparing outline requirements for additional drainage if required.
 - (vii) Providing state of the art inputs on all necessary associated designs, specifications and provisions for both civil works and DBO contracts;
 - (viii) Preparing the terms of reference for consultancy for detailed design of remaining works, construction supervision of works and project implementation support;
 - (ix) Support preparation of technical specification of bidding documents for 30% civil works construction contracts and DBO contracts.
 - (x) Assisting BWRD in evaluating bid submissions for the implementation DBO contracts;
 - (xi) Undertake a sector policy, institutional and legal gap analysis and identify amendments required to ensure compliance with project proposed approach and activities (e.g. DBO, water service tariff, etc.)
30. **Junior Engineer (Water Resources)** (international, 7.0 person-months). The specialist will have preferably a post-graduate civil engineering degree (or equivalent) and 5 years of experience in undertaking similar projects, and preferably have experience of working in the region. Experience in canal and pressure pipe system design is highly desirable. The specialist's responsibilities will include:
- (i) Support for required studies and surveys, including water balance, tube well pumping and resettlement surveys; and
 - (ii) Support design activities including canal and various pressure pipe systems.
31. **Hydrogeologist** (international, 1.5 person-months). The specialist will have preferably a masters' degree in Earth Sciences, or equivalent and 15 years of experience in assessing, modelling, and developing groundwater resources, preferably with working experience of the Ganges Plains. The specialist will be responsible for the assessment of recharge and sustainable groundwater use in the Ara command area and advise on the spacing/locations of tube wells for conjunctive use as well as on tube well design. The specialist will:
- (i) Review existing geological and hydrogeological information and groundwater studies relating to hydrogeology;
 - (ii) Review existing geological and hydrogeological information and groundwater studies relating to hydrogeology;
 - (iii) Check the conditions in the field to assess typical yields from tube wells, water quality and possible issues;
 - (iv) Define the requirements for a groundwater model to assess sustainable levels of groundwater withdrawals;
 - (v) Work with the national groundwater modeler to implement the groundwater studies including the development of a groundwater model;

- (vi) Assess the current recharge to the aquifer and identify the contribution from irrigation;
- (vii) Assess water quality of groundwater – both shallow and deep aquifers, including hazards for irrigation from salinity, arsenic and so on; and
- (viii) Advise on a development strategy for conjunctive surface and groundwater management.

32. **SCADA Specialist** (international, 1.0 person-month). The specialist will have a preferably post-graduate Mechanical Engineering degree (or equivalent) and 5 years of experience in SCADA systems for similar projects. The specialist will be responsible for firming up the requirements for a water management and SCADA system for the main and branch canals, as well as monitoring water used for pressurized pumping systems, and command area information. The specialist's responsibilities will include:

- (i) In consultation with others, define the objectives for the water management and SCADA system (e.g., for improved equitable and timely water distribution, for volumetric metering and irrigation charges for pressure pipe systems, and for monitoring of crops and crop stress, etc.).
- (ii) Define the scope of the system including: (a) data monitoring (canal system and command area) – remote sensing/GIS and direct measurement of water levels, flows, gates positions, rainfall, soil moisture, and crops; (b) decision support system software; (c) automation of gates; (d) Power supply requirement and options, for example mains plus backup solar; and (e) data communication options, for example cellular-mobile phone network.
- (iii) Prepare specifications and quantities and work with the procurement specialist to prepare bidding documents for a DBO contract.

33. **Economist** (international, 3.5 person-months). The specialist will have preferably a post-graduate degree in Economics, or equivalent with 15 years of professional experience in undertaking economic assessments, preferably within the irrigation, agriculture and water resources management sectors. The specialist will also have financial assurance experience, which ideally will include relevant prior ADB experience, preferably in the same country and sector. The specialist should have good understanding of public financial management and international best practices in accounting and auditing. Responsibilities will include:

- (i) Undertaking a detailed economic analysis in accordance with ADB's Guidelines for the Economic Analysis of Projects (2017);
- (ii) Identifying the economic risks associated with the project and undertaking a sensitivity and risk analysis;
- (iii) Undertaking financial sustainability analysis of the Project
- (iv) Preparing the costing of the project
- (v) Preparing and managing all necessary sub-contracts for collection of necessary survey data from the field, government or other institutions, for example farm budgets, "cost of cultivation" survey or other regular data collection;
- (vi) Undertaking either cross-sectional analysis with control for selection/placement bias (e.g. Propensity Score Matching, endogenous switching regression, etc.) or panel analysis using fixed effects models (the methodology of the analysis will be agreed with ADB prior to initiating the analyses);
- (vii) Characterizing baseline input-output characteristics for agricultural production at system and sub-system levels from household survey data for each major season of production;

- (viii) Identifying current and future seasonal cropping patterns in the Ara canal system command areas from household survey and and/or secondary sources at the system and sub-system levels;
- (ix) Undertaking an econometric analysis that effectively isolates the effect of irrigation development from covariates, including factors conditioning program placement and farmer participation, so as to rigorously predict the effects of irrigation modernization on cropping intensity, yields and variable production costs (methods may include Propensity Score Matching, endogenous switching regressions, instrumental variables or other control function approaches);
- (x) Calculating the conversion factors for translating financial prices into economic prices;
- (xi) Applying parameters on cropping patterns, baseline input-output characteristics, and expected "treatment" effects of irrigation to calculate output market supply shifts and consequences for producer, consumer and labor in explicit economic surplus analyses for major crops;
- (xii) Compiling the detailed costing of the project, collecting component-wise detailed costs from other experts, and contribute to project packaging. The consultant will follow the guidance set out in the ADB's Financial Due Diligence Note (2009) and Note on Preparation and Presentation of Cost Estimates (2008, revised 2010) and will prepare project cost estimates using excel for each main project cost item including base costs, physical contingencies, price contingencies, and financial charges during implementation. Base costs are expressed in domestic currency and on real price basis. Base costs also distinguish between foreign exchange and local currency components, as well as recurrent and investment costs, and separate identification of taxes included within cost components. Project costs would also include estimates of resettlement costs, if applicable;
- (xiii) Applying the project's costing and economic surplus estimates in economic rate of return analysis;
- (xiv) Undertaking sensitivity and switching value analysis on the parameters estimated and key assumptions/risks underpinning the rate of return calculations; and,
- (xv) Undertaking a distribution analysis between different groups, calculating poverty impact ratio and analyzing project impact on farmers' incomes (farm budget analysis)
- (xvi) Application of economic efficiency principles to the selection of subproject alternatives", as consideration of project alternatives is an area of economic analysis under ADB's Guidelines.
- (xvii) Preparing draft and final reports detailing the above tasks and outputs.
- (xviii) Preparing the investment program costing and a financial analysis of the project following the guidance set out in the ADB's Financial Due Diligence Note (2009) and Note on Preparation and Presentation of Cost Estimates (2008, revised 2014)
- (xix) Preparing projections of future incremental costs, assess whether the implementing agencies will have funding to cover long-term costs as needed to ensure investment program sustainability, and identify actions needed to ensure investment program financial sustainability as conditions; and
- (xx) Preparing a disbursement schedule including S-curve for projections of contract awards and disbursements, and standard cost estimates tables (by expenditure category, by financier, by Output, and by Year).
- (xxi) Preparing a project financing plan taking to account of any prospective cofinancing and assess veracity of proposed counterpart funding.
- (xxii) Co-developing with BWRD the projected cash flow statements for a 10-year period including projected revenue and costs.

- (xxiii) Assisting in developing the project financial covenants, if necessary – in particular, actions needed to ensure project sustainability should be identified covering operating performance, liquidity and debt serviceability.

34. Social Development Expert (Resettlement, Social Analysis and Gender) (international, 3.5 person-month). The specialist will have a post-graduate degree in social sciences (or similar) and a minimum of 10 years of relevant work experience, with at least 5 years working as a social development/gender specialist for a project funded by ADB, World Bank, JICA or equivalent. The Social Development Specialist will assume primary responsibility for assisting and guiding the National Social Development Expert in the preparation of all required social documents. The Social Development Specialist will guarantee the credibility and quality of social assessments and outputs prepared for the project, consistent with international standards and best practice. Specific tasks include but are not limited to the following:

- (i) Conduct sensitization training workshops on ADB safeguard and social development requirements with the executing agent staff. Familiarize the Implementing agent staff ADB social policy and required documents with respect to; gender, stakeholder communications, poverty and social assessments and safeguards. Ensure that project engineers working on the technical project design participate. Conduct interviews, focus groups, or other meetings with stakeholders to confirm their needs, demands, capacities, constraints, and willingness to participate in the project.
- (ii) Undertake poverty and social assessment. Prepare profiles of the proposed client/beneficiary groups and subgroups, and other groups likely to be affected by the project, and identify institutions and service/user group structures already existing in the proposed project area(s). Assist the National Social Development Expert with the preparation, analysis and write up of all social assessments, checklists and the formation of plans and frameworks to comply with ADB requirements. Outputs include:
 - (a) Safeguard categorization: Indigenous peoples and involuntary resettlement
 - (b) Resettlement Plans, Frameworks and Due Diligence
 - (c) Indigenous Peoples Plan (if required)
 - (d) The Poverty and Social Assessment (PSA)
 - (e) The Summary Poverty Reduction and Social Assessment (SPRSS)
 - (f) Gender Equality and Social Inclusion Plan (GESI)
 - (g) Stakeholder Communications Strategy
 - (h) Establishment of a Grievance Redress Mechanism (in coordination with the Environment specialist)
- (iii) Undertake final review of all outputs before submitting to ADB.
- (iv) Prepare piggy-back technical assistance if the social safeguards and social dimensions of the project need other source of funding.
- (v) Assist the National Social Development Expert in processing the project: (a) seeking approval for social safeguards' categorizations; (b) addressing social safeguards' concerns and social dimensions' concerns raised by other department/division as a result from inter-department circulation, (c) preparing write up for the report and recommendation of the President to the Board, project administration manual, and terms of reference (TORs) for project implementation (for example, arrangements should be in place for an external expert to advise the borrower on compliance and verify internal monitoring findings for IR), and (d) process the piggy back assistant in coordination with the project team leaders.

35. **Procurement Specialist (DBO)** (international, 3.0 person-months). The specialist will hold preferably a graduate degree in a relevant discipline (e.g., Procurement, Engineering, Law, Management or Business) and preferably have at least 5 years of experience in procurement practices in Asia, with a background in the implementation of development projects. Good experience in preparing and managing turnkey contract (DBO, turnkey) using FIDIC Gold Book or equivalent is necessary. Experience in the area of procurement of civil works and goods following ADB's Procurement Guidelines (2015, as amended from time to time), undertaking country procurement assessments, and national procurement reform programs will be a strong advantage. Likewise, good experience with preparing and managing turnkey contracts will be taken as an advantage. The specialist will report to the TRTA team leader and responsibilities will include:

- (i) Reviewing options and advising on the proposed turnkey/ DBO contract for design and construction of all/ part of the Ara irrigation system, particularly those where expertise for O&M is required such as the management and SCADA system, and the pressure pipe systems. Also prepare, with others, schedules, costs, specialist requirements including the methodologies for technical and financial assessment of bid, and any associated risks and how to manage them;
- (ii) Prepare master bidding documents for different types of contracts under the project, including an RFP for selection of implementation consultant, DBO contracts and large civil works packages in line with the ADB procurement guidelines and requirements of the government
- (iii) Assisting BWRD and ADB with contracting actions, and supporting BWRD in evaluating bid documents.

36. **Pipe Transient Flow Specialist** (international, 1.0 person-month). The specialist will have preferably a suitable post-graduate qualification in civil engineering (or similar) and 10 years of applicable experience. Ideally the specialist will have profound knowledge of pipeline surge analysis and modeling and designing of pressurized piped systems. The specialist's responsibilities will include:

- (i) Reviewing the pressure pipe system designs, particularly the closed medium pressure pipe systems, to check for surge/ water hammer and advising on necessary measures and suitable pressure and flow control devices as well as devices for flow metering.
- (ii) As appropriate modelling a few typical pressure pipe design designs/ layout arrangements, to assess impacts of water hammer and advise on appropriate pipe design parameters, specifications, and costs.

37. **Financial Management Specialist** (international, 2.0 person-month). The expert will have a degree in accounting, finance, or a related field, and will have a recognized professional accountancy qualification.

38. The expert should have at least 15 years (international consultant) [8 years (national consultant)] experience, including in financial due diligence (FDD).

39. The expert will conduct FDD in accordance with ADB's requirements.¹ Relevant guidance is available at <http://www.adb.org/projects/operations/financial-management-resources>. The FDD will include:

- (i) Conducting a financial management assessment of the executing and implementing agencies, including (a) assessing whether previous financial management assessments have been conducted by ADB or other agencies and, if so, reviewing the results and ascertaining whether these can be used as input,

- (b) assessing capacity for planning and budgeting, management and financial accounting, reporting, auditing, internal controls, and information systems (c) reviewing proposed disbursement and funds-flow arrangements, and (d) concluding on the financial management risk rating and identifying and confirming measures for addressing identified deficiencies;
- (ii) Supporting the preparation and agreement of cost estimates and a financing plan, which are based on verifiable data and are sufficient to support project implementation;
- (iii) Preparing financial projections and conducting financial analyses of the executing and implementing agencies, and incremental recurrent costs, to determine financial sustainability, and reviewing proposed cost-recovery and tariff policies, including affordability;
- (iv) Conducting financial evaluations (financial cost-benefit analyses) including sensitivity analyses of project components that have a cost-recovery objective;
- (v) Where significant risks are identified to project financial sustainability or viability, proposing relevant financial performance indicators to be incorporated in financial covenants; and
- (vi) Assessing and reaching agreement on financial reporting, auditing and public disclosure arrangements for the project, and, as appropriate, identifying and agreeing arrangements for receiving financial statements from executing and/or implementing agencies.

H. Terms of Reference for National Consultants

40. **National Team Leader/ Irrigation Engineer** (national, 6.0 person-months). The specialist will have preferably a post-graduate qualification in civil engineering, agricultural sciences, irrigation (or similar), with at least 15 years of experience in preparing and implementing irrigation projects. Preferably the specialist will have previously co-led international donor-funded development projects. The specialist will support the Team Leader with overall management duties of the team, help lead the feasibility study and design process, and liaise with the BWRD and project stakeholders. The main tasks of the specialist will be:

- (i) Support the team leader in managing the overall assignment, in maintaining close coordination with BWRD and be responsible for the national consultants' outputs.
- (ii) Collect and compile all relevant studies and data.
- (iii) Support the timely submission of the deliverables.
- (iv) Support feasibility studies and surveys required, including TW pumping surveys, groundwater studies and stakeholder discussions.
- (v) Support technical studies and design work required for feasibility, for the canal system and pressure pipe systems as well as management and SCADA system.
- (vi) Support detailed design for 30% of the works, expected to focus on canal re-sectioning and design, and review drawings, cost estimates and specifications.

41. **Hydraulic Expert** (national, 4.5 person-months). The specialist will have preferably a post-graduate qualification in civil engineering (or similar), with at least 10 years of experience in designing hydraulic structures. Experience with pressure piped systems would be an advantage. The main tasks of the specialist will be:

- (i) Preparing hydraulic design of the canal system, including hydraulic design of canal structures including gated cross and head regulators, balancing storage reservoirs, and so on.
- (ii) Preparing hydraulic design of pressure pipe systems.

- (iii) Supporting the Team leader/ Irrigation Engineer to prepare design guidelines/ criteria and also standardized spreadsheets for hydraulic design of structures and pressure pipe systems.
- (iv) Providing guidance to support engineers, including use of standard design tools/ spreadsheets, and preparation of standard/ typical drawings for hydraulic structures and bills of quantities.

42. **Canal Structures/ Structural Engineer** (national, 4.0 person-months). The specialist will have preferably a post-graduate qualification in civil engineering (or similar) with 10 years of experience in designing reinforced concrete structures. The main tasks of the specialist will be:

- (i) Preparing structural design of the canal and pressure pipe system structures, including gated cross and head regulators, bridges, culverts, pump houses and so on.
- (ii) Preparing of standard drawings for structural elements, including retaining walls, piers, breast walls, culverts, bridge decks, and bridge hand railing.
- (iii) Preparing of typical drawings for key structures that may be used to firm up quantities, particularly for concrete, steel, shuttering, etc., and including: (a) cross and head regulators, (b) flow measurement structures, (c) pump houses and so on.
- (iv) Supporting the irrigation engineer/ team leader to prepare design guidelines/ criteria/specifications and also standardized spreadsheets for design of structures and pressure pipe systems. This to include advice on concrete classes and steel reinforcement requirement in accordance with relevant standards.
- (v) Providing guidance to support engineers, including use of standard design tools/ spreadsheets, and preparation of standard drawings for hydraulic structures and bills of quantities.

43. **Hydromechanical/Gates Expert** (national, 2.0 person-months). The specialist will have preferably a post-graduate qualification in mechanical engineering (or similar), with at least 5 years of experience in designing gated structures. Experience with pumping equipment will be an advantage. The main tasks of the specialist will be:

- (i) Preparing of standard drawings for gates for canal structures, including radial and vertical lift gates of various sizes.
- (ii) Supporting the team leader/irrigation engineer to prepare design guidelines/ criteria/specifications. This to include specifications for gates, lifting arrangements, gate seals, electric energy/motor requirements to automation, and so on.
- (iii) Providing advice on pumps and steel pipework associated with the pressure pipe systems and the balancing storage reservoirs.

44. **Agriculture Expert/Agronomist** (national, 4.0 person-months). The specialist will preferably have a post-graduate qualification in Agronomy (or similar) with relevant experience in agro-economics. The specialist will have preferably 10 years of experience in agro-economics/agronomy. The specialist should have experience in the development of irrigated agriculture projects, economic value chains and market-based crop production analysis. The specialist should have experience working in multi-disciplinary teams. The specialist's main tasks include:

- (i) Providing detailed assessment of current cropping systems and farmers' farming strategies in Ara command area and recommending opportunities for improving on-field water management and crop production, and crop diversification;
- (ii) Supporting the international staff in determining crop water requirements with/ without project and carrying out water balance for the command area.

- (iii) Supporting the economist and others by gathering necessary data on cropping and farm budgets. Also collect "crop cut" yield data and correlation with water supply/ location/ distance from canal as appropriate.
- (iv) Working with others to designing and carryout out an agro-economic social survey.
- (v) Engaging in a series of stakeholder consultations along with other team members with various farmer groups including WUAs.
- (vi) Consult relevant government agencies (Department of Agriculture and others) and with relevant private sector firms/ operators engaged in agriculture value chains (input suppliers, buyers, processors, financial, extension and other service providers) to identify key constraints and opportunities to enhance agriculture value addition and strengthen the engagement of farmers in value chains.
- (vii) Based on the above, identify strategies to raise agricultural productivity across the whole Ara command, by targeting interventions related to inputs, extension services, finance, technology and knowledge solutions, marketing and so on.
- (viii) Preparing an agriculture modernization support plan for the project detailing support activities, concerned institutions/ parties, implementation arrangements and cost.

45. **Environment Specialist** (national, 3.0 person-months). The specialist will have preferably a master's degree in Environmental Sciences or equivalent and 8 years of experience in preparing environmental impact assessments (EIAs) or initial environmental examination (IEE) for donor agencies including ADB. Experience with ecology, agriculture, climate change and environmental assessments will be appreciated. The specialist will be responsible for preparing the environmental assessment study for the ACWPIP Project by undertaking necessary surveys for baseline information, analyzing potential environmental impacts and preparing environmental management plan (EMP), conducting public consultation with affected people and creating a grievance redress mechanism. He will assist BWRD to prepare an IEE report for the project. The IEE report should be prepared in accordance with ADB's Safeguard Policy Statement, 2009 (SPS). To fulfill with the requirements described in ADB SPS, the following are shall be carried out:

- (i) Consult with the technical team to confirm the project design and activities, proposed location of project activities and obtain the details of the project activities that will be assessed for this study.
- (ii) Perform the scoping activities to identify the potential environmental impacts and environmental parameters/indicators that will affected by the project design and activities.
- (iii) Gather data in the project areas that cover water resources, geophysical environment, climatic condition and climate change scenarios, ecological environment, and social-economic conditions. Confirm availability of all secondary data parameters identified at the scoping stage are available.
- (iv) Identify the potential impacts from the project to and from the environment. It is essential to assess the impacts of project activities and designs to other components of the project.
- (v) Assess institutional arrangement to implement proposed mitigation measures and arrangement for handling grievance from affected people.
- (vi) Consult with the Department of Environment and Forest and Ministry of Environment, Forest and Climate Change (MoEFCC) for the compliance of the project activities and design to environmental and forest standards.
- (vii) Prepare the EMP matrix to show, activities that caused impacts, potential impacts, proposed mitigation measures, and who will implement mitigation measures and

who will monitor the implementation, proposed cost to implement mitigation measures.

- (viii) Discuss with BWRD the proposed environmental management and propose a grievance redress mechanism, and get a principle agreement for all proposed mitigation measures from BWRD.
- (ix) Translate the agreed EMP matrix into local language as the materials to be distributed during public consultation.
- (x) Conduct public consultations to ensure the proposed project including the potential environmental impacts, the location of the impacts and the persons affected by the impacts are clearly explained to affected people.
- (xi) Ensure that all concerns from the participants are addressed and discuss with BWRD any potential issues raised during public consultation.
- (xii) IEE report will be prepared in compliance with the ADB SPS and the Government(s) of India and Bihar requirements.
- (xiii) Establish a Grievance Redress Mechanism in coordination with the Social Development and Gender Experts

46. **Social Development Expert (Resettlement and Gender)** (national, 4.0 person-months).

The specialist shall have a post-graduate qualification in social sciences (or similar) and a minimum of 10 years of relevant work experience, with at least one year working as social development/gender specialist for a project funded by ADB, World Bank, JICA or equivalent. The specialist will prepare all required social documents, ensuring compliance with ADB SPS and the Government of India requirements. Specific responsibilities of the specialist include the following:

- (i) Conduct a desktop review of safeguard policy and requirements pertaining to ADB's social safeguards and the Indian Government requirements; involuntary resettlement and indigenous peoples. See for example: ADB SPS, ADB's Involuntary Resettlement Sourcebook, ADB's Handbook on Poverty and Social Analysis and relevant Government of India legal and policy frameworks pertaining to involuntary resettlement.
- (ii) Attend training on ADB's social development procedures and required documents, to be provided by the International Social Development Expert.
- (iii) Compile the following outputs in coordination with the International Social Development Expert, who will assist with the design and review of outputs:
 - (a) Safeguard categorization: Indigenous peoples and involuntary resettlement
 - (b) Resettlement Plans, Frameworks and Due Diligence
 - (c) Indigenous Peoples Plan (if required)
 - (d) The Poverty and Social Assessment (PSA)
 - (e) The Summary Poverty Reduction and Social Assessment (SPRSS)
 - (f) Gender Equality and Social Inclusion Plan (GESI)
 - (g) Stakeholder Communications Strategy
 - (h) Establishment of a Grievance Redress Mechanism (in coordination with the Environment specialist)
- (iv) Screen and categorize the project in terms of IR and IP by using the categorization checklists. This will involve identifying all project activities generating IR or IP impacts.
- (v) Develop a resettlement plan based on a full census of the project affected families based on the preliminary project design. The resettlement plan should closely follow the template provided in ADB SPS and include measures to restore livelihoods and quality of life. Note that the RP will be updated following detailed design during the implementation.

- (vi) Develop a DBO Resettlement Framework and Sample Plan
- (vii) Identify permanent and temporary socioeconomic impacts as a result of land acquisition, changes in land use, or restrictions of access to assets and common property resources.
 - (a) Carefully assess and provide best estimate on impact to land assets and non-land assets for titleholders and non-titleholders.
 - (b) Assess risks and opportunities for affected people.
 - (c) Identify strategies and options to restore livelihoods and quality of life.
 - (d) Define categories of impact and eligibility of affected persons for compensation and prepare a draft entitlement matrix covering compensation for all lost assets and income, and assistance to achieve full replacement costs for lost assets, income, and livelihoods. Assess whether the compensation standards for all types of assets, crops, and trees are based on replacement value and discuss in detail the valuation methodology used. Entitlement matrix should be prepared in accordance to government policies and ADB SPS.
 - (e) Prepare and carry out a consultation plan and a format for documenting meaningful consultation with affected people, listing events, people consulted, documents disclosed, and timing of disclosure in accordance with ADB Public Communications Policy (2011) and summarizing the issues raised, agreed actions, and improvements resulting from the consultation. Assess stakeholders' concerns and consider possible changes in the project design to minimize resettlement impacts.
 - (f) Identify management, consultation, and dispute resolution mechanisms for the resettlement plan.
 - (g) Make arrangements for monitoring and evaluation of resettlement activities.
- (viii) Undertake due diligence on project sections where land was previously acquired to ensure full compliance with Government regulations. Prepare due diligence report and/or corrective action plan, if needed.
- (ix) Prepare a Poverty and Social Assessment (PSA) based on a representative sample of the population in the project area. Discuss template and design for the plan with the International Social Development Expert and ADB personnel. Information should be gathered based on primary and secondary data sources. Qualitative and quantitative research methods are appropriate, surveys, targeted interviews and focus groups should also be held with key informants from marginalized groups (scheduled castes, women etc.) to supplement the existing database. The SPRSS is a template that must be used as the executive summary of the PSA. Note that the GESI is an appendix to the PSA. Ensure that all data is sex disaggregated.
- (x) Design a Stakeholder Communications Plan by seeking guidance from the ADB Social Development Specialist.
- (xi) Review the organizational structure and assess the institutional capacity of executing agency to implement the resettlement plans and other social development-related measures and recommend improvements required before the start of land acquisition.

47. **Water Users' Association (WUA)/Institutional Specialist** (national, 2.5 person-months). The specialist will have preferably at least 15 years of relevant experience, and a post-graduate qualification in civil engineering, water resources management, social studies (or similar). The specialist should have experience in the development of irrigated agriculture projects

with participation of farmers. The specialist should have experience working in multidisciplinary teams. The specialist's main tasks include:

- (i) Assessing BWRD and other relevant government agencies following diagnostic analysis approach, including establishing the institutional and legal context of the project and its linkages with other national initiatives.
- (ii) Reviewing the legislative framework and institutional structure and arrangements governing the sector and recommend improvements to enhance WUAs role and agriculture value addition and the role of farmers in agriculture value chains.
- (iii) With support from the team leader, undertaking a sector analysis and assessment of Bihar's water resources and irrigated agriculture sector, including reporting on Bihar's and India's sector investment roadmap, policies and reform agenda and prepare a sector assessment including problem tree analysis and sector results framework following ADB templates.
- (iv) Consulting with farmers, WUAs and BWRD to: (a) firm up and clearly define WUAs duties and mandate for management and O&M of canal systems at distributary level and below, including for pressure pipe systems, (b) advise and firm up irrigation charging arrangements, for gravity and pressure pipe supplied areas, (c) identify likely problems and risks and determine support requirements for farmer producer organizations/WUAs, (d) identify delivery mechanism to strengthen farmer producer organizations and WUAs, including roles of public (BWRD) and private sector.
- (v) Develop the institutional framework and an institutional development/ support plan for the project.
- (vi) Develop a costed training/capacity development plan for both WUAs, BWRD and others to ensure sustainable management and O&M of the irrigation system.

48. **Economist** (national, 3.0 person-months). The specialist will have preferably a post-graduate degree in Economics and/or Finance, or equivalent, with at least 10 years of professional experience in undertaking economic assessments, preferably within the irrigation, agriculture and water resources management sectors. The specialist will support the international agricultural economist. The specialist's main tasks include:

- (i) Support for design and supervising the agro-socioeconomic field surveys, with a focus on data requirements for farm budget preparation, and processing/ checking of results and findings.
- (ii) Supporting a detailed economic analysis in accordance with ADB's Guidelines for the Economic Analysis of Projects (2017);
- (iii) Assistance in identifying the economic risks associated with the project and undertaking a sensitivity and risk analysis;
- (iv) Assist in financial sustainability analysis;
- (v) Assist in an assessment of water charges to cover O&M costs for both gravity and pressure pipe systems.

49. **GIS Expert** (national, 2.0 person-months). The specialist should have preferably at least 10 years of experience in using a geographic information system (GIS), remote sensing, and database systems. A post-graduate degree in GIS, databases, or information systems is required. The specialist's main tasks include:

- (i) Sourcing available topographical survey data or satellite data and developing digital elevation map of the Ara canal system gross command area to 2-meter contours (or better);

- (ii) Sourcing any other suitable data that are available (soils, land use, groundwater, tube wells, aquifer parameters, rainfall, cropping, etc.), that are available, and adding layers to the GIS database;
- (iii) Preparing/ obtaining cost estimates for procurement of any data from GIS/ satellite agencies as may be required.
- (iv) Advise on the technical feasibility and costs for drone surveys, including obtaining quotations.
- (v) Ensuring GIS/mapping data are available to all team members, and assisting in use and interpretation of data.
- (vi) Assisting in report preparation.

50. **Solar Energy Expert** (national, 1.5 person-months). The specialist should have preferably at least 5 years of experience in solar power systems, planning, design and implementation. A post-graduate degree in electrical engineering (or similar) is required. The specialist will work closely with the electrical specialist. The specialist's main tasks include:

- (i) **Solar plant design.** Develop feasibility-level solar photo-voltaic power plant with generation capacity that supports at least third of the peak power requirements of the project's irrigation tube wells associated with pressure pipe systems, and also meets backup power requirements of the proposed management and SCADA system – at least for monitoring of canal water levels, gates positions, pump status and pipe flows. Consider the land requirement and work with other team members to advise on the practicality of mounting the solar systems over canal prisms/ waterways. Provide drawings and estimated cost of investment and operation and maintenance.
- (ii) **Grid connection plan.** Analyze known and likely technical and managerial issues and challenges in connecting the project's solar power plant to the national grid, particularly in regard to the grid stability and seasonal/ daily gaps and variance between the demand and supply of energy; develop plans and feasibility cost estimates to address the identified challenges and issues in grid connection; and in consultation with national grid authority (through BWRD), identify the process and steps in obtaining relevant permits for grid connection and sale of energy generated by the project's solar plant.

51. **Costing Expert** (national, 1.5 person-months). The specialist will have preferably a post-graduate qualification in civil engineering (or similar), with at least 5 years of experience in costing hydraulic structures. The main tasks of the specialist will be:

- (i) Collecting official schedule(s) of unit rates for works.
- (ii) Carrying out unit rate analysis for new work items for which approval will be required from the concerned authorities. These are likely to be for SCADA system, solar energy and electrification and pressure pipe systems.
- (iii) Preparing standard spreadsheet/data base to facilitate quantity and cost estimation for engineering works required under the project.

52. **Support Engineers** (national, 6 persons, 29.0 person-months). The specialists will have preferably a post graduate qualification in civil engineering (or similar), with at least 2 years of experience in designing engineering structures, such as hydraulic structures, pipe systems, etc. The support engineers will work as directed by the team leaders (international/national) on the following:

- (i) Assessment of water distribution along the canal system, by analysis of water levels/gate openings at key structures.
- (ii) Assessment of water balance for the Ara command area.

- (iii) Supporting groundwater modelling, for example through data entry.
- (iv) Carrying out the tube well and pumping survey in the Ara command area.
- (v) Design of the canal re-sectioning and lining works, including drawings, quantities and cost estimates. Detailed design is expected to be completed for at least the main the two branch canal systems based on long and cross section survey completed by others.
- (vi) Feasibility level design of selected hydraulic canal structures including drawings, quantities and cost estimates.
- (vii) Feasibility level design of about 10,000 ha of pressure pipe systems including drawings, quantities and cost estimates.

53. **CAD Draftsman** (national, 4 persons, 18.0 person-months). The specialists will have preferably a qualification in AutoCAD (or similar), with at least 5 years of experience in drawing preparation. Experience with irrigation/ hydraulic structures will be an advantage. The support engineers will work as directed by the team leaders (international/national) to prepare drawings for engineering works, including canal and pressure pipe systems, and in take-off of quantities.

54. **GW Expert – Modeller** (national, 4.0 person-months). The specialist will have preferably a post graduate degree in Earth Sciences (or similar), and have 10 years of experience in assessing, modelling, and developing groundwater resources, preferably with working experience of the Ganges basin/ plains. The specialist will be responsible for the assessment of proposals for the conjunctive use of surface and groundwater in the Ara project area. Specific tasks will include:

- (i) Collect and review existing geological and hydro-geological information and groundwater studies relating to hydrogeology, including aquifer parameters and groundwater fluctuations.
- (ii) Check the conditions in the field to assess typical yields from tube wells, water quality for irrigation, and including arsenic, and possible issues. This includes participation/advice for the planned tube well and pumping survey.
- (iii) Design and implement appropriate numerical groundwater model(s) to assess:
 - (a) current recharge to the aquifers and identify the contribution from irrigation, and
 - (b) likely future trends in water table for the proposed conjunctive use development.
- (iv) Prepare alternative tube well designs for a range of yields (e.g. from 30 to 60 l/s), together with drawing(s), quantities and costs. Estimate drawdown for various tube well spacings.

55. **Electrical Specialist** (national, 2.0 person-months). The specialist will have preferably a suitable post-graduate qualification in electrical engineering (or similar) and at least 10 years of applicable experience. The specialist's main tasks include:

- (i) Determination of the power requirement of the proposed engineering works, including along the main and branch canals, as well as for the pressure pipe and conjunctive use systems, and map the power requirement locations.
- (ii) Consult with electric power authorities to: (a) collect electrical data, (b) map alignments of existing high tension lines and equipment, including substations, and (c) advise on size of solar power plant(s) constructed under the project.
- (iii) Assess connectivity options, also taking into account location(s) of proposed solar plant(s) installed under the project. Options shall take into consideration: (a) effective metering arrangements for bulk supply of power, (b) reliability of supply, and (c) estimated connectivity costs, etc.

- (iv) For the preferred option, prepare feasibility level designs for: (i) High voltage system including any substations, power transmission lines, control systems, switchyards, etc., and (ii) Low voltage system including transformers, power transmission lines and arrangement at pump houses, etc. Prepare drawings, cost estimates and draft specifications;
- (v) Advise on procurement arrangements.

56. **Resettlement Officer** (national, 4.0 person-months). The specialist will have preferably at least 10 years of experience in formulating and implementing resettlement plans and indigenous peoples plans, and undertaking similar assignments, preferably financed by ADB or other multilateral agencies. The specialist will have post graduate degree in any of the social sciences. The specialist's main tasks include:

- (i) Supporting the Social Development Expert in the design and preparation of ADB social safeguard documents and the Gender Equality and Social Inclusion Plan. All project documents are to be prepared in accordance to the Government of India and Government of Bihar regulations on land acquisition and indigenous people, and also to ADB SPS;
- (ii) Designing and implementing a 100% census of affected people impacted by the project footprint based on the preliminary project design. The Officer will identify the scope of involuntary resettlement impacts, type and detail losses, and whether there are any impacts to indigenous people as described in ADB SPS;
- (iii) Reviewing the "cut-off" date policy of the ADB SPS and ensuring that households likely to experience physical and/or economical displacement are issued with identification to ensure that affected people can be differentiated from in-migrants that arrive following the announcement of the project.
- (iv) Conducting consultations with potential affected people to ensure their understanding about the potential impacts of the project on their livelihoods;
- (v) Confirming the involuntary resettlement and indigenous people categorizations of the project;
- (vi) Discussing the entitlement matrix with the Social Development Expert and BWRD;
- (vii) Supporting the Social Development Expert in preparing a resettlement plan for the project in accordance to the government's regulations on land acquisition and ADB SPS.