KHANH HOA PROVINCIAL PEOPLE'S COMMITTEE

PROVINCIAL PROJECT MANAGEMENT UNIT

TERMS OF REFERENCE

FOR

DETAILED ENGINEERING DESIGN

Subproject: Improving and Upgrading Cam Ranh and Suoi Dau Irrigation Systems in Khanh Hoa Province

Project: Water Efficiency Improvement in Drought-Affected Provinces

NHA TRANG, October 2019

LIST OF ABBREVIATIONS

ADB	The Asian Development Bank
ADF	The Asian Development Fund
ARP	Agriculture Restructure Policy
CMD	Construction Management Department
CPMU	Central Project Management Unit
CPO	Central Project Office
DARD	Department of Agriculture and Rural Development
DED	Detailed Engineering Design
DMF	Design and Monitor Framework
DWR	Directorate of Water Resources
EA	Executing Agency
EMP	Environmental Management Plan
GoV	Government of The Socialist Republic of Vietnam
HVCs	High-Value Crops
IA	Implimenting Agency
IMC	Irrigation Management Company
MARD	Ministry of Agriculture and Rural Development
MoF	Ministry of Finance
MPI	Ministry of Planning and Investment
O&M	Operation & Maintenance
PAM	Project Administration Manual
PPC	Provincial People's Committee
PPMU	Provincial Project Management Unit
PPTA	Project Preparatory Technical Assistance
RP	Resettlement Plan
SBV	State Bank of Vietnam
SCADA	Supervisory Control And Data Acquisition
TA	Technical Assistance
ToR	Terms of Reference
USD	United States Dollar
WEIDAP	Water Efficiency Improvement in Drought-Affected Provinces Project

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1 PROJECT BACKGROUND

- The Project name in Vietnamese: "Nâng cao hiệu quả sử dụng nước cho các tỉnh bị ảnh hưởng bởi hạn hán" (WEIDAP/ADB8).

- The Project name in English: "Water Efficiency Improvement in Drought-Affected Provinces".

- Name of the Sponsor: The Asian Development Bank (ADB).

- Executing Agency: Khanh Hoa PPC.

- Effectiveness Date: 26 June 2019.

- Implementation Period: From June 2019 to 31 December 2025.

1.1 Overview

The Water Efficiency Improvement in Drought-Affected Provinces Project integrates climate-resilient agricultural practices through a transformational shift in irrigation modernization, including (i) strengthening irrigation management to improve climate resilience, (ii) modernizing irrigation infrastructure, and (iii) supporting efficient on-farm water management practices. Specifically, the Project will modernize eight irrigation systems respectively eight Subprojects: Tra Tan, Du Du, Thanh Son - Phuoc Nhon, Nhon Hai - Thanh Hai, Suoi Dau and Cam Ranh, Dak Lak, Cu Jut, and Dak Mil in five drought-affected provinces: Binh Thuan, Dak Lak, Dak Nong, Khanh Hoa, and Ninh Thuan. The modernized systems will enhance the provinces' ability to manage climate variability, improve the water productivity of agriculture, and increase incomes by supporting farmers in growing high-value crops (HVCs) such as coffee, peppers, grapes, apples, dragon fruits, and mangoes.

1.2 Rationale

In Viet Nam, more than half of the irrigation systems operate below their potential capacity mainly because of the poor condition of the asset base. Inadequate and deferred maintenance is a leading cause of premature deterioration of irrigation infrastructure.

The southern central coastal and central highlands regions of Viet Nam are particularly vulnerable to climate change. A climate vulnerability assessment carried out for the project indicated that changes in precipitation will result in hotter and wetter wet seasons and hotter and drier dry seasons. The ENSO-induced drought in 2014−2016 was the most severe in 40 years. About 60,000 hectares of agricultural land in the central highlands was affected to varying degrees, including permanent loss of perennial crops such as coffee and pepper. The impact is most severe on smallholder farmers who rely on rainfed surface water sources for irrigation.

Water scarcity and economic factors have prompted farmers in the south central coastal and central highlands regions to grow HVCs that can withstand longer dry spells and are more suited to the changing agroecological environment. Notably, an increasing number of farmers are also adopting on-farm micro-irrigation practices such as drip or sprinkler systems. They do so primarily to reduce input costs, including labor, electricity (mainly for pumping of water), and fertilizer. Irrigation systems supporting HVCs and micro irrigation must be sufficiently robust to support the desired level of service, and flexible (able to irrigate only when required), reliable (able to deliver water at a specified flow rate and duration), and accessible (with a point of delivery within 1 kilometer of the farm gate). However, many irrigation existing systems were originally designed for rice and are inappropriate for HVCs.

To address the issue, the Project will combine an innovative solution of pressurized piped irrigation systems with high level technology that meets the level of service required by farmers growing HVCs. These will function like domestic water supply systems and provide water on demand through a system of hydrants and control valves, thereby giving farmers greater flexibility to control the amount and duration of irrigation. Piped distribution systems also allow operators to control and measure water more effectively and apply volumetric water charges. These are necessary conditions to improve efficiency and sustainability, particularly in the operation and maintenance (O&M) of systems, including through

third-party service contracts. Finally, piped systems are more resilient to extreme weather conditions and require less maintenance, making them more efficient and cost-effective in the long-term.

The uptake of on-farm micro-irrigation practices by farmers in the project areas is supporting a local micro-irrigation solutions industry. However, farmers lack awareness of and extension services to help them optimize micro-irrigation options and adopt good practices, including fertigation methods. The project will also strengthen the capacity of farmers to use and operate micro-irrigation techniques aimed at improving on-farm water productivity. Once the irrigation systems are fully operational, incremental production of HVCs such as dragon fruit, coffee, black pepper and mangoes are expected to boost incomes in the targeted provinces.

The Project aligns with key government policies, strategies, and laws, including (i) the government's agriculture restructuring plan; (ii) the Ministry of Agriculture and Rural Development strategy that calls for adopting advanced and water-saving irrigation techniques and technologies on 500,000 ha of upland crops by 2020 to improve productivity, decrease irrigation water use, and increase household incomes; (iii) the national climate change strategy; and (iv) the Law on Water Resources Engineering (2017), which allows for water pricing for irrigation services.

1.3 Impact and Outcome

The Project is aligned with the following impact: climate resilience and water water productivity in agriculture improved.

The Project will have the following outcome: climate-resilient and modernized irrigation systems in five provinces established.

1.4 Outputs

Output 1: Irrigation management services strengthened

This output will support policy and institutional development measures to

improve climate resilience of agriculture by strengthening irrigation management while taking social and gender dimensions in all relevant activities into consideration. Specifically, the Project will (i) install irrigation water allocation and delivery services, including (a) surface and groundwater assessments, (b) an irrigation water-sharing and allocation framework, and (c) a real-time decision support system for farmers to optimize crop water application; and (ii) improve maintenance of irrigation systems, including (a) developing an asset inventory and management database for each irrigation system supported by the project, (b) developing a systematic asset maintenance schedule with a rigorous approach to funding based on asset condition assessments, (c) developing a water charge pricing framework, and (d) assessing options for engaging third parties in O&M of irrigation systems.

Output 2: Modern irrigation infrastructure developed

This output will modernize eight irrigation subprojects in the five provinces to provide water on-demand to farmers cultivating HVCs, reducing their vulnerability to climate change. The underlying principle of all systems is to provide a higher level of service - more flexible, reliable, and accessible supply of water to farmers than they currently receive. The infrastructure works include three broad categories: (i) pressurized pipe systems that connect canals or reservoirs with supply hydrants located in reasonable proximity to farmers' fields (enabling direct connection with a hose), with basic supervisory control and data acquisition systems to facilitate operations and monitoring of system flows; (ii) main system modernization, including canal lining, control structures, storage, and installation of flow control and measurement devices with remote monitoring; and (iii) new and improved weirs to replace temporary weirs constructed by farmers to provide storage from which farmers can pump to irrigate HVCs. Other works include upgrading culverts and farm roads to improve management of irrigation systems.

Output 3: Efficient on-farm water management practices adopted This output will focus on improving on-farm water productivity in the subproject

command areas to improve climate change resilience. Water productivity assessments conducted under output 1 will help determine suitable norms for different crops under different agroecological conditions. Based on this information, farmers will receive training and advisory services to improve on-farm water management to cope with climate variability. The service providers will consult with and provide technical advice to male and female farmers to identify and develop appropriate micro-irrigation systems that meet their individual requirements. Farmers will also be linked with private sector suppliers and provided O&M training on micro-irrigation systems.

2 INTRODUCTION TO CAM RANH - SUOI DAU SUBPROJECT

2.1 General information

- The full subproject name: Improving and Upgrading Cam Ranh and Suoi Dau Irrigation Systems in Khanh Hoa Province.
- Name of the Sponsor: The Asian Development Bank (ADB).
- Executing Agency: Khanh Hoa Provincial People's Committee.
- Implementing Agency: Khanh Hoa Department of Agriculture and Rural Development.
- Representative of the Implementing Agency: Khanh Hoa Provincial Project Management Unit.
- Implementation duration: From 26 June 2019 to 31 December 2025.

The Cam Ranh - Suoi Dau Subproject comprises two discrete areas serving both HVCs and rice lower downstream in the irrigation area. The irrigation area consists of 9 communes: Suoi Cat, Suoi Tan, Cam Tan, Cam Hoa, Cam Hai Tay, Cam Hiep Bac, Cam Duc, Cam Hiep Nam, Cam Thanh Bac in Cam Lam District, Khanh Hoa Province.

The Subproject is intended to improve water resource delivery to farmers in a sustainable manner that will promote higher level incomes amongst beneficiary farmers with land in the command area, legitimizing the current practice of extraction directly from the main canals where possible and providing a high level of irrigation service using surface water to

areas that currently are mostly dependent upon groundwater sources. The rehabilitation of the existing canal networks will provide reliable water that allows farmers to pump directly from the main canal using their own small pumps and 60 millimeters (mm) pipes, while larger pump - piped systems will be built to supply areas more distant from the main canal.

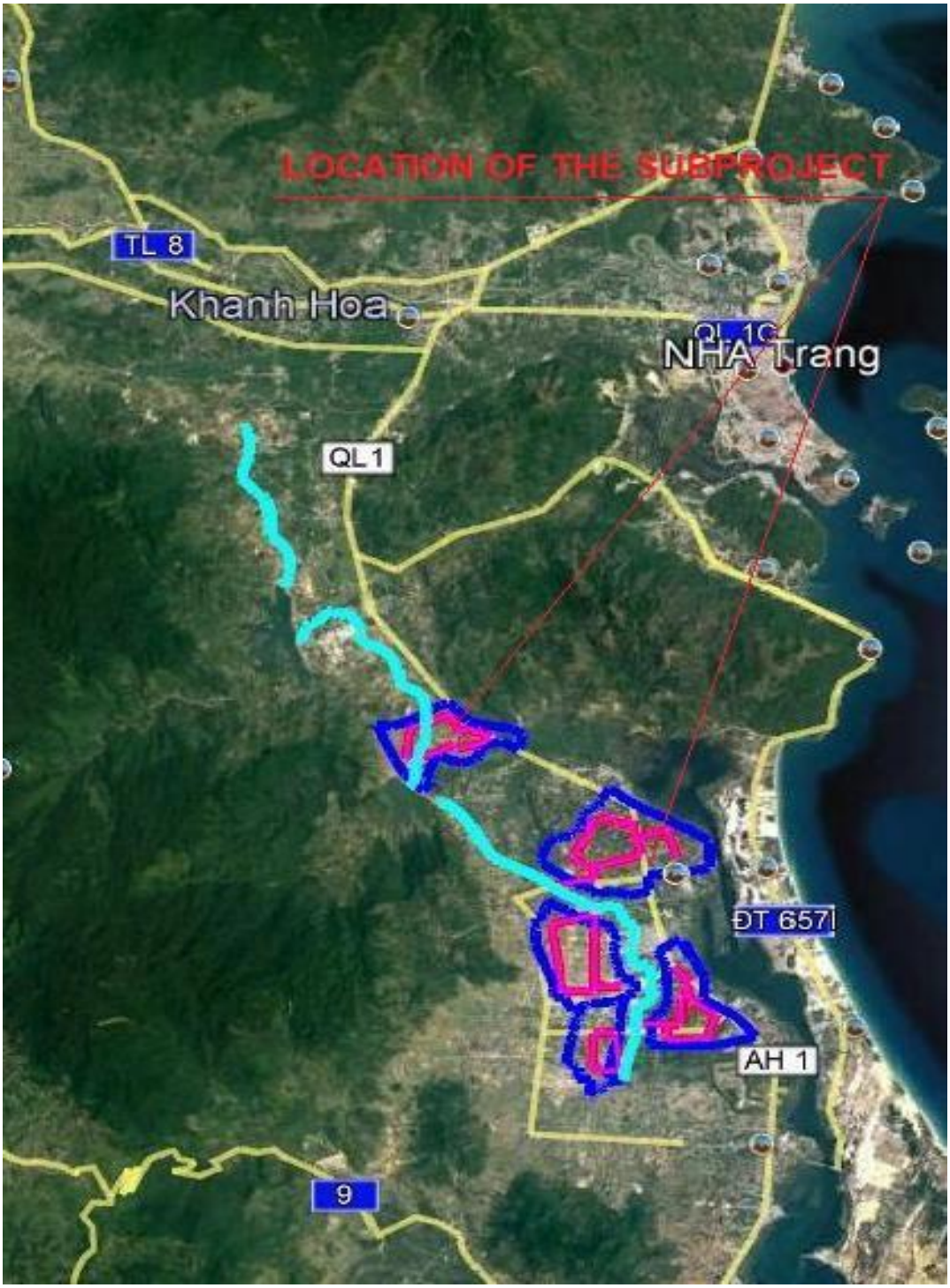
The subproject comprises the two separate Cam Ranh and Suoi Dau irrigation systems supplied from the existing Suoi Dau and Cam Ranh reservoirs providing surface water for mango orchards and rice cropping. The Suoi Dau irrigation system will supply 1,000 ha of mangos, 592 ha of miscellaneous crops and 1,200 ha of rice while the Cam Ranh irrigation system will supply 3,000 ha of mangos and 270 ha of rice.

Modernization will line main canals, support direct pumping by farmers from these canals for mangos, and build five new ring main pumped pipe systems to irrigate mango orchards more than 0.5 kilometer (km) and up to 5 km from the main canal. Rice areas, mostly in the tail of the system, will continue to be supplied by gravity canal flow. No works are proposed for secondary canals, as direct pumping from the main canals, and the new pipe systems, meaning they will have little function in the future and none for high-value (mango) cropping. Flows at the ends of the main canals supplying rice areas will be closely monitored and inform releases from the storage reservoirs. Proving balancing storage, particularly at the tails of the main canals, would eliminate losses/excess flow to rice areas, due to differences between supply and demand.

In drought years, it is expected that rice supply may be reduced or cut with priority given to the mango farms, as was practiced in the recent drought. Farmers with wells may also revert to pumping groundwater. Crop area planned shall be informed by the water level in the dam reservoir at key times of the year, particularly just prior to the dry season.

The five new ring main pumped pipe systems will comprise pumping stations located along the main canals supplying ring main piped systems.

Hydrants at 50-100 meter (m) intervals will command land either side of the pipelines. For each piped system, pressures and flows at key points shall be monitored, the pumps shall turn on/off according to pressures in the pipeline. Alarm systems shall be installed in case of pipe leakage or burst.



2.2 Technical works proposed at the approved Feasibility Study level designs

The Feasibility Study for Cam Ranh - Suoi Dau Subproject was approved by Khanh Hoa Provincial People's Committee at the Decision No. 1807/QĐ-UBND on June 22, 2018. The Subproject consists of the two separate Cam Ranh and Suoi Dau irrigation systems supplied from the existing Suoi Dau and Cam Ranh reservoirs. Both combine rehabilitation of existing gravity canal systems and construction of the five new ring main pumped pipe systems. The existing gravity canal systems will supply rice and mango areas and the new pumped pipe systems will supply established and expanded mango areas.

The Suoi Dau system will supply 1,000 ha of mango, 592 ha of miscellaneous crops and 1,200 ha of rice while the Cam Ranh system will supply 3,000 ha of mango and 270 ha of rice.

Crop water requirements for mango and rice have been estimated at 0.98 l/s/ha and 1.39 l/s/ha. Details of the calculations are presented in Supplementary Appendix 1 (Design Principles for Subprojects).

2.2.1 Gravity Canal Systems

For the design duties, the maximum required design diversion discharges are 3.23 m3/s (Suoi Dau) and 3.64 m3/s (Cam Ranh).

However, the Suoi Dau north (4.4 km) and south (8.73 km) main canals were originally designed for 1.0 m3/s and 5.2 m3/s and Cam Ranh north (1.5 km) and south (18.3 km) main canals for about 0.9 m3/s and 3.1 m3/s respectively. The existing main canals have more discharge capacity than required.

The existing main canals are trapezoidal, 80 mm thick concrete lined, except for some buried flume sections. The Cam Ranh north main canal has been abandoned and the area is now supplied by the Suoi Dau south main canal. The Cam Ranh south main canal conveyance losses are

currently very high as the lining is in poor condition and 8.1 km passes through sandy soils.

The Subproject will demolish 15.3 km of concrete trapezoidal lining and replace it with reinforced concrete flume sections with 150 mm thick walls and with a reinforced concrete cover slab 100 mm thick. Design discharges will also be reduced in line with proposed crop areas. Although bridges are in reasonableby good condition, many of them (about 30) would have to be demolished and replaced to fit the new flume canal section. Details are summarized in Table 1. No works will be done for the 59 secondary and smaller canals, other than to provide new turnout gates.

Table 1: Summary of Canal Structures

Length of Main Canal (m)	Length to be Rehabilitated (m)	Turnouts	Checks	Structures, No.		Overflow Spillways	Inverted Siphons
				Siphons/ Aqueducts	Bridges		
Suoi Dau North Canal							
4,397 Flume for first 429 m, then trapezoidal	3,968 (KM 0.429 to KM 4.397)	15 (missing/ damaged gates)	1 (missing/ damaged gates)	3	12	2	10
				Mostly in reasonable/ good condition. If flume section adopted bridges would have to be replaced			
Suoi Dau South Canal							
8,734 Flume for 1,465 m & trapezoidal for 7,269	3,300 (KM 4.268 to KM 7.568)	17 (missing/ damaged gates)	5 (missing/ damaged gates)	6	23	2	17
				Mostly in reasonable/ good condition. If flume section adopted 12 bridges would have to be replaced			
Cam Ranh South Canal							
18,300 Trapezoidal (8.07 km passes through sands)	8,083 (KM 0 to KM 8.835)	27 (missing/ damaged gates)	1 (missing/ damaged gates)	7	12	4	4
				Mostly in reasonable/ good condition. If flume section adopted 12 bridges would have to be replaced			
TOTAL	**15,351**	**59**	**7**	**16**	**47**	**8**	**31**

2.2.2 Ring main pumped pipe systems

The Subproject will build five new ring main pumped pipe systems with pumping stations and ring main distribution pipelines to meet the adopted level of irrigation service. The proposed ring main pumped pipe system layouts are shown in Appendix 1. The associated level of service is presented in Table 2.

Table 2: Levels of Service to Mango Areas

Subsystem		Access to Water (ha)			
Type	**Name**	**< 250 m**	**Inter**	**> 500 m**	**Total**
Canal Systems	SD	117	141	337	595
	CR	241	248	950	1,439
	Total	**358**	**389**	**1,287**	**2,034**
Canal	**%**	**18**	**19**	**63**	**100**
Piped Systems	SD	223	135	47	405
	CR1	213	184	163	560
	CR2	257	191	52	500
	CR3	173	91	40	304
	CR4	97	67	33	197
	Total	**963**	**668**	**335**	**1,966**
Piped	**%**	**49**	**34**	**17**	**100**
Total	**ha**	**1,321**	**1,057**	**1,622**	**4,000**
Total	**%**	**33**	**26**	**41**	**100**

The five new ring main pumped pipe systems involve 38.45 km of pipes, ranging in nominal diameter from 75 mm to 450 mm, to supply 1,966 ha of mangos at an average pipe density of 19.6 m/ha. The mango area to be served by the piped system (1,966 ha) will have a much higher level of service than the mango area served only by the canal system (2,034 ha) (shown in Table 3). Access to water will be:

- Within 250 m for 963 ha (49%), between 250 m and 500 m for 668 ha (34%) and beyond 500 m for 335 ha (17%) in the mango area served by the pumped pipe system; and
- Within 250 m for 358 ha (18%), between 250 m and 500 m for 389 ha (19%) and beyond 500 m for 1,287 ha in the mango area to be supplied directly from main canals.

Table 3: Summary of Piped System Designs

Pipe Ø	Piped System

(mm)	Unit	SD	CR1	CR2	CR3	CR4
75	m	963	0	0	0	0
110	m	481	1,539	1,216	512	464
160	m	1,444	736	441	512	929
200	m	963	529	499	2,501	464
250	m	1,926	1,010	1,720	2,883	1,393
315	m	1,444	2,144	1,496	547	1,857
355	m	0	1,264	1,995	0	0
400	m	0	399	998	866	201
450	m	75	1,734	308	0	0
Length	**m**	**7,296**	**9,355**	**8,673**	**7,821**	**5,308**
Area	**ha**	**405**	**560**	**500**	**304**	**197**
Density	**m/ha**	**10.0**	**16.7**	**17.3**	**25.7**	**26.9**

Three centrifugal electric pumps are proposed for each pumped pipe system, one being standby. Pump houses shall be provided for pump security, and to house control and monitoring systems. Three-phase electric connections shall be provided, complete with transformers, switches, lightning arrestors and so on. General arrangement drawings of the pump houses, together with intake and small pumping reservoir, have been prepared in Appendix 1.

Consistent with the modern level of service standards, the Subproject will equip the five piped systems with 385 standard hydrant-manifolds, each with a 5 l/s design discharge. Therefore, the total design discharge of the 385 hydrant-manifolds is 385 hydrant-manifolds (HMs) x 5 l/s/HM = 1,925 l/s, which is the same as the total design discharge of the five pumped pipe irrigation systems serving 1,966 ha x 0.98 l/s/ha for mango = 1,927 l/s.

The unit cost of simple PVC hydrant-manifolds is about $435 (80 mm diameter) or $320 (63 mm). Therefore, the maximum total cost of 385 hydrant-manifolds will be $167,475, which is only $85 per ha over the service area of 1,966 ha. The average spacing of HMs will be 100 m. Each HM will serve about six households.

Water meters would be installed at manifolds so that farmers become more aware of the volume of water they each use and subsequently pay for same. These meters could be cheap (mechanical) meters read manually. An alternative could be to install pre-paid meters/ smart water meters, though the high cost of these would limit them to hydrant flows.

Those farmers wishing to use high-pressure application technologies, drip or sprinkler, may need to re-pressurize at the off-take point to raise the level of the head as required (at the individual cost of the farmer).

2.2.3 SCADA system

The basic SCADA system would facilitate efficient operations by the irrigation management company (IMC) and/or private operator responsible for the pipe systems and the canal systems.

For the canal systems, water levels shall be monitored remotely in the tail of the main canals, in the sumps where water is pumped into the five pump systems, and also possibly at the seven check structures using both pressure and ultrasonic sensors. This dual measurement safeguards against equipment errors with an alarm sounding if readings are different. The levels would be relayed to a control office over the cellular network or Universal Mobile Telecommunication (UMTS) or the latest mobile technology, stored on a computer, and used to adjust flow releases to the main canals from the reservoirs.

Manual gate adjustment is proposed under the Subproject, though gate actuators for remote operation could be fitted later.

To measure flows, water level gauges could be installed in flume structures located at the head of each main canal with data also transmitted to the control office.

For the five pumped pipe systems, devices would be installed so that pump operations are linked to pipeline pressures. Also, devices could be installed to ensure against pipe fracture during pump start-up or shutdown. This function may be performed by gradual opening/closure of valves. Control valves would be installed at the pump stations, and possibly at a

few key locations in the pipe systems to allow pipe branches to be isolated for maintenance, in the case of pipe leak/burst. Operations would also be monitored, and in the event of problems, including pipeline fracture or leaks, the pumps would automatically shut down. Pipe flows could be metered using clamp-on ultrasonic digital meters fixed around the pipes at the pump stations. These operate by battery. Meters will also be installed at each hydrant. Data will be transmitted over the UMTS/ the latest communication technology and stored on a computer at the control office.
In addition to the above, meters would be installed at manifolds so that farmers become more aware of the volume of water they each use and subsequently pay for same. These meters could be cheap (mechanical) meters read manually. An alternative could be to install pre-paid meters/ smart water meters, though the high cost of these would limit them to hydrant flows.

With the five pumping stations, there is a clear need for good scheme operation and maintenance. Such arrangements require some management oversight and an emergency response mechanism in the event of pressure failure. Operational requirements are needed to operate and maintain pumps and respond to burst pipes or failed valves, and may best be undertaken by a private operator under a public-private-partnership (PPP) whereby the operator would collect a service fee from beneficiary farmers.

2.3 Total investment cost and funding sources

2.3.1 Total investment amount

According to the memorandum of March 2016, the Subproject shall provide financial support for investment items from key works to irrigation management transfer points of WUGs, cost components supported by the Subproject. The investment includes:

- Costs for site clearance and compensation are paid to:

+ Compensation for long-term land acquisition of pumping stations and pipelines;

+ Compensation for temporary land acquisition during construction;

+ Compensation for assets on land including infrastructure, houses, trees, crops, etc.;

+ Support resettlement, fixed cultivation, stable production and daily life;

+ Costs for making compensation, support and resettlement plans, fixed cultivation;

- Cost of implementing clearance and compensation. Construction costs are paid for construction preparation costs (clearing, clearing the ground); construction of construction items (solidifying degraded canal sections, pumping stations and water pipelines), construction of camps and temporary works for construction.

- Equipment costs are paid for water level gauges, pipelines, pumps and control devices, transformer stations for pumping stations.

- Project management costs paid for the organization of managing the implementation of project management jobs from the project preparation phase and project implementation to the completion and acceptance of the project, putting the work into utilization.

- The consulting costs will cover the preparation phase and the project implementation phase, including the cost of survey, design, phase verification, monitoring and verification.

- Other costs to pay for detection and destruction of bombs, mines and explosive objects; construction insurance; construction deformation monitoring; audit, verification and approval of investment capital settlement; fees and charges as prescribed.

- Contingency cost includes volume and contingency provisions during construction.

Table 4: Total approved investment

No.	CONTENT	Million VND		USD		
		Loan	Counterpart fund	Value After Tax	Loan	Counterpart fund
I	**COMPONENT 2:**	**334.991,000**	**75.109,000**	**18.046.019**	**14.732.580**	**3.313.439**
I.1	Cost of site clearance and compensation		16.700,000	738.938		738.938

No.	CONTENT	Million VND		USD		
		Loan	Counterpart fund	Value After Tax	Loan	Counterpart fund
I.2	Cost of construction	239.676,241	23.967,624	11.665.658	10.605.143	1.060.514
I.3	Cost of equipment	32.450,068	3.245,007	1.579.428	1.435.844	143.584
I.4	Cost of project management		4.849,291	214.570		214.570
I.5	Cost of construction consultancy	12.671,215	7.473,891	891.376	560.673	330.703
I.6	Other costs	16.636,786	7.618,713	1.073.252	736.141	337.111
I.7	Contingency cost	33.556,464	2.434,536	1.492.522	1.394.779	97.743
I.8	Loan interest		8.820,185	390.274		390.274
II	**COMPONENT 3:**	**1.636,364**	**163,636**	**79.646**	**72.405**	**7.241**
III	**SHARE ACTIVITY FOR 5 PROVINCES**	**6.961,673**	**2.538,327**	**420.354**	**308.039**	**112.315**
	TOTAL	**343.589,000**	**77.811,000**	**18.546.020**	**15.113.024**	**3.432.990**

2.3.2 Funding sources

- The Loan from the Asian Development Fund by The Asian Development Bank (ADB);
- Counterpart fund by the Government of Vietnam as the budget fund at the local province (Khanh Hoa province).

As for the loan:

Total loan amount (ADB) is 15.113 million USD, equivalent to 343.59 billion VND;

In which:

+ Central budget allocates 50% of the total loan, equivalent to 371.53 billion VND, about 7.60 million USD;
+ Local budget re-lends 50% of the total loan, equivalent to 371.53 billion VND, about 7.60 million USD.

As for counterpart fund:

- The counterpart fund is 77.812 billion VND, equivalent to 3.443 million USD.

3 OBJECTIVES, SCOPE AND TASKS OF CONSULTING SERVICES

3.1 Objectives

Objectives of consulting services are to prepare the Detailed Engineering Design for upgrading and modernizing the Cam Ranh and Suoi Dau irigation systems based upon the WEIDAP Guidelines for Detailed Engineering Design, and in order for facilitating O&M, climate resilience and water productivity in agriculture improved, Irrigation management services strengthened (Output 1) and Efficient on-farm water management practices adopted (Output 3).

The recruitments of consulting services to prepare the Detailed Engineering Design for irrigation modernization systems by other four drought-affected provinces are also expected

3.2 Scope of consulting services

The Scope of Consulting Services consists of, but not limited to the following:

- Studying further and Identifying, Proposing modifications/ options/solutions for improving the feasibility study level designs.
- Carrying out necessary surveys.
- Preparing the detailed engineering design documents for the Subproject.
- Supporting the Khanh Hoa PPMU in the process of submission and explanation of examinations and evaluation comments.
- Attending the study tour in Australia to visit the systems in the Riverland region of South Australia where the policy and institutional framework has been established, to increase water use efficiency in agriculture and developed pressure piping systems

and/or water-saving irrigation technologies to be installed in the system.

- Organizing design workshops to report design options and consult the experts.
- Cooperating closely with the project implementation support consultants, if recruited/ appointed in time.
- Regularly reporting the work progress to the Khanh Hoa PPMU.
- Providing the oversight of the detailed engineering design authors' right, etc.

3.3 Specific Tasks of the Detailed Engineering Design

* ***Overall requirements***: The Detailed Engineering Design shall be aligned with those in the approved Feasibility Study and shall observe the current design standards/ regulations. Specifically, designs of pressured pipe systems shall/ should observe the design standard: Water supply - Distribution pipeline system and facilities (TCXDVN 33:2006).

During the implementation process, the consultants must comply with the recommended standard frameworks for surveys and designs as listed in the Appendix 2.

The specific tasks of the Detailed Engineering Design include, but not limited to the following:

3.3.1 Making the outlines for additional surveys and the detailed engineering design

Before conducting the detailed engineering design, the consultants must prepare and submit outlines for additional surveys and detailed engineering design to the PPMU.

The outlines shall be based on the feasibility study report.

3.3.2 Studying further and Identifying, proposing modifications/ options/ solutions for improving the feasibility study level designs

- Construction sites and solutions: Construction sites and solutions were proposed during the feasibility study phase. At the detailed engineering design, when the basic documents are collected, more detailed and full surveys will be needed for confirming the optimization of the selected locations and solutions. In case of any changes in the feasibility study phase, there must be a valid argument. Also, basic documents/ data from the surveys and designed works must allow to ensure determining sufficient volume components.
- For the pumped pipe systems, the pumped pipe system service (command) areas shall be further refined to ensure that only HVCs (mangos) areas are included.

Other design improvements building on the feasibility study level designs are presented in the following appropriate sections. propose additional survey tasks

3.3.3 Evaluating the current available documents to propose additional necessary data collection and survey activities

- At the detailed engineering design, additional hydro-meteorological data collection, topographic and geological surveys, hydrogeological works and other data will be required. All work must comply with relevant technical standards, regulations and norms.
- Additional data collections shall be hydro-meteorological, hydraulic, hydrogeological and other data.
- The purpose of construction survey work aims to provide topographic, geological, meteorological and hydrological documents for the design of the technical design phase of construction of pumping stations and primary irrigation.

Re-using the surface and altitude control that has been implemented during the FS phase to deploy the entire measurement areas. The control of the surface at class IV, grade 2, coordinate system VN2000, the control

of the height of class IV - Hon Dau (Hai Phong) in accordance with current standards.

- The detailed engineering design will reuse the available topographic maps, including:

+ Topographic map in scale of 1/500 with 0.5m contour line in the area of headworks, and the management office;

+ Topographic map in scale of 1/1000 with 1.0m contour line in the area of pipeline systems;

- For topographic map of the roads for management and pipeline system, the FS phase has not yet implemented. So, in the detailed engineering design, it will be necessary to measure the topographic map of 1/1000 with 1.0 m contour line.

- For longitudinal sections, cross-section of construction items that have not been implemented in the period phase of the sub-project, they will be measured in the detailed technical design.

- Positioning the center of the works, monitoring benchmarks, and land clearance boundaries that have not been implemented in the period phase of the sub-project, they will be measured in the detailed technical design.

The consultant shall base on the quantity and quality of meteorological, topographic and geological documents surveyed, and others in the previous period to ***propose additional survey tasks*** in accordance with the accuracy requirements of documents in detailed construction engineering design stage.

3.3.4 Identifying survey components and quantities and conducting topographic surveys

a. Data collection

- The work of collecting data is an important task which help the consultant have enough data to analyze and calculate in order to provide reasonable solutions when conducting surveys and technical design of construction details and construction works:

- Data to be collected in the period of detailed engineering design include:

+ Topographic maps of all kinds of structure (pipelines, pumping stations, water storage tanks, canals and main pipelines).

+ Documents on control points (coordinates, altitudes, benchmarks).

+ Other relevant survey materials.

b. Identifying quantity of all topographic survey work items

- Horizontal control network: The horizontal control network in this phase is only built for measuring scale of 1/1000 with 1.0m contour line at the locations of material yards.
- Technical leveling: The technical leveling is guided from the traverse network - grade 1 set up in the previous phase to the station points for the measurement of the topographic section of the construction items.
- Topography of material yards at the scale of 1/1000 and contour line h = 1.0 m. The location of material yards handed over in the field by the geological survey team leader, the areas for earth embankment and the works must be surveyed to determine the area and boundaries of crops.
- Topography of benefit area:

  + Detailed engineering design consulting unit reviews and updates the survey data on the position map, the map shows the pipeline, irrigation canal and combined with the longitudinal and cross-section measurement data in the period serves the detailed design work.

  + Proposing proposals if necessary.

- Measuring longitudinal sections: Measuring scope includes the system carrying water from the reservoir to the station, power lines, main pipelines, irrigation pipeline and the roads for management.
- Measuring cross sections: Cross-section measurement range includes the system carrying water from the reservoir to the station, the main pipeline, irrigation pipeline and the the roads for management.
- Positioning the center of the works: Installation of work items includes the beginning and the end points and the turning points.
- Determination of the boundary of land clearance: The benchmark system is to determine the boundary of land clearance. It is necessary to

define the boundary of the system carrying water from the reservoir to the station, pumping station, power line, feeder pipeline, main pipeline, irrigation pipeline and the roads for management and for site clearance, make compensation fund.

- Ground accuracy determined by accuracy of grade 2.
- Height accuracy determined according to technical leveling.
- Benchmark size is 10x10x60cm concrete column with name and code number.

3.3.5 Identifying survey components and quantities and conducting geological surveys

c. Collecting documents

- The existing documents of the items are only guaranteed to be evaluated at the locations with boreholes and excavation surveys. The distance and the number of survey positions does not guarantee the assessment for the entire route. During this phase, additional surveys are needed at the locations of pumping stations, water storage tanks, discharge pipelines, main pipelines irrigation pipelines and the roads for management.

d. Identifying quantity of geological survey items.

❖ Digging the survey pit

- Excavation work is to determine stratigraphy, soil layer depth and take soil and rock sampling.

- The distance between excavated pits in the centerline of the pipeline is usually from 50 m to 75 m (at each of the abutments of the pressure pipe, manholes should have at least one survey pit) with a depth lower than the foundation expected process from 1m to 2m (or in medium weathered rock zone from 1 m to 2 m).

- The distance between excavated pits in the centerline of the road is 500 m. The depth of the surveyed pits must be deeper than the foundation expected from 2m to 3m.

- For mountainous canals with a flow of Q ≥ 0.5m3/s, the distance of boreholes along the centerline of the canal is 100m to 200m/hole. The depth of boreholes, pit and pierced through the centerline of the

canal should be lower than the canal bottom from 2m to 5m. In case the canal bottom is in soft and weak layer, the survey depth must pass that layer from 1m to 2m. If the weak soft layer is too thick, the survey depth must be greater than 2b (b is the width of the canal bank bottom) and greater than 1.5h (h is the height of the canal).

❖ Drilling work

- Drilling work is to determine stratigraphy, soil layer depth and take soil and rock sampling.
- The depth of boreholes must pass the foundation level of the works from 3 m to 10 m and greater than 1.5B (with B as the foundation width).
- In case of encountering soft soil layer, there must be at least 1 hole to pass through soft soil layer and into a good soil layer below that not less than 2 m. In all cases, the depth of borehole does not exceed 15 times of S (with S as the depth of foundation buried from its bottom elevation). In case of encountering ancient alluvial layer, the depth of borehole must be deep into this layer of 5 m to 7 m.In case of encountering rock, this value is from 3 m to 5 m.
- Drilling work is arranged at pumping stations, water storage tanks. The F/S phase was surveyed with each location of 1 to 2 drill holes. In this phase, boreholes should be arranged at positions not yet surveyed.

❖ Surveying at material yard

Each material yard is expected to dig 3 pits. Each pit has a distance of 200m each and 4m deep. It is expected that each area will survey 01 material yard. The digging volume is as 7 areas x 3 pits/ area x 4m = 84m.

❖ Standard penetration test (SPT)

- SPT testing aims to serve the calculation of the soil bearing capacity, to check the status and structure of soil at the site, to be carried out in top soil and strong weathering rock layers.

- This testing is performed in the boreholes at the pumping station and water storage tank locations.
- Pursuant to TCVN 8477: 2010 - 7.3.3.6 In-room and outdoor tests - Standard Penetration test (SPT) in the remaining soil layers under the works. At each soil layer there are no less than 05 SPT values. Expected to have 3 layers of soil and volume of 15 times.

❖ Testing sample with 9 criteria

- The testing sample with 9 criteria is to provide physical and mechanical parameter to serve the calculation of the stability of the works.
- Samples are taken in boreholes and pit. Samples to be taken must be representative of the entire stratum of the survey.
- Based on TCVN 8477: 2010 - 7.3.4. Main waterways: canal routes, tunnels (tunnels), water pipelines and river bank protection embankments, 7.3.4.3 Water tunnel, water pipeline, pressure pipe and 7.3.5 Other works: Hydroelectric power plants, power distribution stations, management office, road serving for construction and electric lines. Testing soil samples from 6 to 10 samples each.

❖ Testing rock samples

- The purpose is to determine the compressive resistance intensity of rock samples in natural state and saturated state.
- Samples are taken in boreholes at pumping station and water storage tank locations. It is expected to have 1 weathered rock layer / 1 hole, 1 sample for each hole.
- Total rock samples is 2 samples.

❖ Testing to determine standard compaction criteria, soil properties of material yards

- Samples are taken at material yard locations. The sample is non-intact. Serving the earthworks at the lower elevations than the required elevation, each material yard is expected to have 1 usable

layer of soil, each layer will take 3 compaction samples, 3 prepared samples. Survey quantity is as follows:

- Standard compaction model: 24 samples
- Preparation testing: 24 samples.

3.3.6 Participate in Study Tour in Australia

- A study tour will be held after recruiting Consultants for all subprojects.
- The study tour aims at learning about modern irrigation systems in the Riverland Region of South Australia. The study tour will be sponsored by the Australian Water Partnership (AWP).
- After the study tour, the Consultants shall prepare and submit the PPMU a report on findings, experiences/ lessons learned and proposals that can be applied in the detailed engineering design for the Irrigation Systems of the Cam Ranh - Suoi Dau Subproject.

3.3.7 Preparing the detailed engineering design

Overall requirements for the detailed engineering design:

- Checking and repairing structural items, design criteria and design standards of approved items in the FS;
- Confirming the optimization of the tasks and measures of items identified in the FS;
- Carrying out additional design work to improve the technical works that are determined to be feasible: In case of need to adjust and supplement the tasks and structural measures of the project, it is necessary to recalculate and redefine requests for items in order to have explanations for such adjustments and additions;
- For the proposed technical solutions, it is necessary to study and find solutions to treat the ground in accordance with the geological conditions, select the size of the structure and measures according to the principle of making the best use of the local materials and easy construction;
- Designing and accurately arranging the layout of the main items, including pumping stations, power stations, low voltage lines, intake sump tanks, push pipes and discharge tanks, canals, input items, pipelines and

related items according to the landscape architecture planning for works and in line with the road system, in the subproject area;

- Reviewing the location selections of items in the previous phase in the subproject areas to select the optimal locations;

+ Basis of choice: Characteristics of categories, natural and social conditions, management requirements...

+ Selecting places to design;

+ The overall layout of items according to each location's options;

+ Possibility of land acquisition and resettlement (if any);

+ Determining the basic size of items;

+ Calculation and analysis to select the optimal category positions.

- Selecting and approving on the best technical plan: Technical plans will be presented and approved by the relevant authorities as prescribed, then the detailed engineering design will be carried out. Based on the approved basic design in the preparation of the Feasibility Study Report, adjustments and additions to the project's structural tasks and measures (if any) and the optimal structural location select and give the main part of the pumping station: Based on the approved items in the step of preparing the feasibility study report, adjustments and supplements to the tasks and structural measures of the project (if yes) and the optimal category position is selected, to calculate and select the optimal size and item of the works, item details and categories and items and select the optimal solution for foundation treatment.

- Checking to correct the ratio and basic dimensions of the structures, calculate the stability of the structures.

- Calculating the stability of items of pumping stations, suction tanks, propellers, roads and other auxiliary facilities.

3.3.7.1 Checking required hydrological and irrigation calculations

- Checking and evaluating the calculation data in the phase of preparing the FS report.

- Irrigation calculations are carried out for engineering items, pumping stations, hydraulic pressure pipes and dams, canal systems and related

items to determine/confirm the size of items as well as to evaluate options/technical solutions to improve/modify FS level design.

- The design flows for Suoi Dau pumped pipe system based on 0.98 l/s/ha, for Cam Ranh pumped systems based on 0.94 l/s/ha for mangos. The required capacity may be reassessed/ confirmed at the detailed engineering design.

3.3.7.2 Requirements for hydraulic work calculations of pressurized pipeline systems

- Hydraulic diagram and software for hydraulic calculations: Calculation of hydraulic works of focal points; calculating hydraulic piping hydraulic by EPANET or WaterGEMS software unless other is approved.
- Outputs of hydraulic problems: Determination of size and elevation of intake pump tank, pipeline, push pipe; determine the size of the irrigation pipe.

3.3.7.3 Detailed Engineering Design Requirements for Main Canals

- A cheaper alternative would be for the existing trapezoidal sections to be improved by: (i) repair of broken sections, and (ii) use of concrete protected liner to seal the canal. The canals should not be covered except in built up areas, or where necessary to prevent sediment ingress. For the trapezoidal option, if the existing canal section is too big, it should not be reduced. The existing section may just be repaired and a new liner constructed to minimize seepage. As farmers prefer to pump and irrigate mango in the early morning and evening, an overlarge canal would also provide buffer storage which would be helpful in balancing supply and demand.
- Reconsider the feasibility study recommendation to demolish all the trapezoidal concrete lined sections and replace with new reinforced concrete flume sections. This is expensive, requires that bridges are also demolished and replaced, and probably unnecessary where the existing lining is in good condition. Use of geotextile liners protected with

concrete shall be considered. Overlarge sections that are retained provide useful buffer storage against pumped abstractions.

3.3.7.4 Detailed Engineering Design Requirements for Pressurized Pipe Systems

- The design flows for for Suoi Dau pumped pipe system based on 0.98 l/s/ha, for Cam Ranh pumped systems based on 0.94 l/s/ha with adjustments for desirable flexibility, and likely farmer takes up (willingness to connect and pay for water). The required capacity shall be reassessed/ confirmed at the detailed engineering design.
- The proposed intake and pumping arrangements are rather more expensive than necessary, as well as taking up considerable land with building for stores and an office. Adopting a slightly more modest layout and design may be considered. Also, cost saving may accrue if a single pumping station/ intake serves two pumped pipe schemes.
- Adoption of centrifugal pumps and/ or variable flow (VFD) pumps shall be considered.
- The service areas and pipeline layouts should be checked/further assessed to improve the inequities in the distances from farmers field-to-pipe hydrants inherent in the present pipe system designs/ The pumped pipe system service (command) areas and layouts should be further assessed and refined to ensure that they address inequities in standard of service. Also, and more importantly, efforts to address the inequities between supply level of service between mango areas served by the main canals and mango areas served by the new pumped ring main systems should be made. This may require further to the command areas and numbers of the pump-pipe systems.
- Cost effective hydrant - manifolds designs shall be adopted so that hydrant flows are $\pm$5 l/s for a range of residual heads at the design flow with metering and flow control devices. Direct fuse connections are envisaged between the main HDPE pipeline and the off taking pipe. Adequate protection against tampering shall be considered.

- Water meters shall be installed at manifolds so that farmers become more aware of the volume of water they each use and subsequently pay for same. These meters could be cheap (mechanical) meters read manually. An alternative could be to install pre-paid meters/ smart water meters, though the high cost of these would limit them to hydrant flows.
- The requirement for valves shall be firmed up at detailed engineering design, and will include air valves at intervals/ high points along the pipelines, washout valves at gully crossings, and flow control valves to allow parts of the pipeline to be isolated. For each (ring) pressurized pipe system a header tank may be located at the highest point along the pipeline. In case of no positions high enough for constructing header tanks, there shall be technical and economic arguments/ evaluations for other options, including direct pumping into pipelines with pumping controlled by pressure sensors in the pipelines.

3.3.7.5 Detailed Engineering Design Requirements for SCADA Systems

- The SCADA system shall allow remote monitoring of water levels, pressures, flows at appropriate points in the two reservoir, in the intakes to the pumping stations, on open canal systems, in the main pipeline leading from the pumping stations, at all/ selected hydrants. Pumping stations shall also be monitored and controlled. The operation of the pumps shall be linked to pipe pressures.
- The SCADA system shall link the pumping stations, monitoring stations at the fields, the water measurement system and the central control office via the Internet and the 5G universal mobile telecommunication system (UMTS) or the latest mobile technology. The central office shall be located, rehabilitated and equipped as required with server/ computer/ devices/ Internet/ UMTS connections, software, databases and so on.

At the detailed engineering design, the consultants shall consider further:

(i) The transmission of data/ coded signals from sensors – loggers/ remote terminal units (RTUs) to central control offices and vice versa

should use the Internet and the 5G universal mobile telecommunication system or the latest mobile technology;

(ii) Real time SCADA and applications of Internet of Things (IoT) technology shall be considered;

(iii) The Websocket protocol/ technology shall be applied for real time SCADA systems;

(iv) SQL Server and ArcGIS databases will be very useful for control and management as well as maintenance of pressure pipe systems, etc.

3.3.7.6 Electricity supplied to the pumping stations

Requirements for electrical designs:

- It is necessary to calculate the power load of the project (pumping station, manager), the load for the construction work (the whole construction site) as a basis for asking the power source and connection point, and working with the Electricity Company. Local to locate the connection point, voltage level and the length of the power line to operate the project management and provide electricity for construction.
- A suspended or on-ground substation will be located in the area of management and operation. The capacity of the station must be calculated to ensure the operation of the pumping station.
- Connection: The connection point is taken at the local medium voltage line passing through the pump station area and there must be an approved connection dossier. Medium voltage 22 kV transmission line will be built from the connection point to the substation
- Designing and calculating the main items and set up premises and records of power supply lines for the work of pumping stations, including traverse lines and substations.
- Electrical works provide necessary three-phase power to each pumping station need more accurate design and costing
- Low voltage system design including main electrical connection diagram; Engine control, measurement and protection diagrams to open and close pumping stations, diagrams of monitoring and communication systems, lightning protection systems and grounding systems.

3.3.7.7 Requirements for roads

a) Requirements for roads

- Determining the cross section for the road according to rural road standards - design requirements: TCVN10380-2014.
- Surveying to review the current status of the road to serve the design requirements based on the following principles:

+ The road must meet favorable connection with existing roads and construction items, serving for project management and operation.

+ Considering to make full use of the existing road and construction road to upgrade and expand to meet the design requirements before new construction.

+ Taking advantage of the available local materials (or on-site materials) into the road and structure.

- Regarding the roadbed compaction level, permissible settlement of the road bed must comply with current standards.
- Crossroads at intersections and crossroads need to be arranged with curved radius in accordance with the standard to ensure visibility for vehicles to run.
- Signaging pile system, road markings, protective guardrails, and metal structure detailed drawings (if any).

For access roads, at least to reach of the pumping stations, shall be designed and costed.

- The main canal banks are largely unpaved sandy tracks. Inspection/ patrols would benefit from a paved road along one side of main canals. These may be funded if less is spent on canal lining.

3.3.7.8 Requirements for design of construction organization and construction method

- Optimal method of exploiting and transporting construction materials.
- Method of construction of main works;
- Construction quality control measures;
- Fire and explosion prevention, and labor safety;

- Environmental protection during construction;
- Transportation inside and outside the construction site;
- Auxiliary facilities (factories, camps ...) and systems to provide electricity, water, and communications for construction and on-site activities;
- Total construction ground general construction progress;
- Provide main materials and equipment for the project;
- Navigation diagrams and construction by year;
- Measures to prevent flow (specifications and volume of materials;
- Construction method of structure;
- Planning and using construction materials;
- Other necessary drawings.

3.3.7.9 Requirements for cost estimates

The consultants will study the basic construction unit prices in the locality, the norms of basic construction costs, the current regime and policies of the state and the province in terms of capital construction, make a summary table of volumes and a detailed forecast, and cost estimates for the works and the total cost of the subproject.

3.3.7.10 Requirements for the preparation of operation and maintenance guidelines

In order to develop processes for operation, management, exploitation, maintenance and protection of buildings, including:

- Instructions on O&M;
- Detailed scope of protection and management;
- Details of the item and architecture of the project to serve the operation and protection management of the project;
- Details of the monitoring and control network;
- Details of the communication system;
- The exact number and quantity of equipment and construction operation management system.

3.3.7.11 Requirements for updating the resettlement plan

Based on the resettlement plan, it is required to set up in the project investment phase, the consultants will update minor changes in the pipeline and canal design during the detailed design process, so that the plan is re- implemented. Settlement must be updated in accordance with technical amendments.

3.3.7.12 Requirements for updating the environmental management plan (EMP)

Items and contents of the EMP of the Subproject must be in accordance with Annex 2.10 in Circular No.27/2015/TT-BTNMT dated on 29/05/2015 issued by the Minister of Natural Resources and Environment on environmental assessment, strategies, environmental impact assessments and environmental protection plans. The main content is as follows:

- Measures and plans to minimize negative impacts on the environment during the preparation phase (if any) and the project construction phase, including:
- Minimize negative impacts on the surface water environment (if any)
- Minimize negative impacts on groundwater environment (if any);
- Minimize negative impacts on the air environment (if any);
- Minimize bad impacts due to noise and vibration (if any);
- Minimize negative impacts on the community (if any);
- Collection, temporary storage, transportation and disposal of waste;
- Minimize other negative impacts (if any).
- Planning to build environmental protection items for the operation phase -of the project (if any), including:
- Wastewater treatment works; Water treatment factory; Waste treatment works;
- Projects for storing and treating ordinary solid wastes and hazardous wastes;

- Plan for construction and installation of other environmental protection projects: The content of construction plans and installation of environmental protection works for the operation phase of the project must clearly show the expected construction time, installation and finishing.
- Environmental monitoring program during the construction phase of the project: The content of the environmental monitoring program should clearly state the monitoring position, monitoring frequency, monitoring parameters and technical standards and regulationsapplied to assess environmental sample quality with approved sampling locations in environmental impact assessment reports.

3.3.8 Advising comments and adjusting the detailed engineering design

- Organizing technical design workshops and advising comments/ suggestions/ recommendations with all related parties including consultants, PPMUs, PPC's representatives, experts, operation and maintenance units, local authorities, representatives of Subproject stakeholders, and the appraisal/ verification consultants, etc.
- Preparing a report on explaining the comments of related parties in the Design Workshop and adjusting the Detailed Engineering Design according to the comments/ suggestions and recommendations.
- The consultant will present the DED in a meeting before submitting the DED to the PPC.

3.3.9 Presenting the content of the Detailed Engineering Design in the meeting held by the PPC

- After receiving appraisal comments of the agencies, the PPC will hold a meeting to discuss about the DED. During the meeting, the Consultants will present about DED, explain the comments.

- Adjusting/ finalizing and completing the DED according to those comments and submitting the DED dossier for the approval.

3.3.10 Requirements for the authors' right supervision of the detailed engineering design

- The consultants are responsible for providing the oversight of the authors' right according to the current regulations (Decree 46/2015/ND-CP on quality management and construction maintenance).
- Appointing the qualified specialist to supervise the authors' right during the construction process. The main tasks are as follows: responsible for explaining and clarifying construction design documents to the Investor and other contractors for management and construction in accordance with the design; modify the design for the content which is not consistent with the actual standards and conditions of the project; detect errors compared to the design, etc.

3.4 Essential Documents attached to the TOR needing to be observed and referred

3.4.1 The Guidelines for Detailed Engineering Design

The Guidelines for Detailed Engineering Design (Revised version 2019) is prepared to guide the detailed engineering design process, for use by MARD, DARDs, SPPMUs/PPMUs involved in the WEIDAP Project, and ADB, AWP, and will be included/ attached to the Terms of Reference for the procurement of services for detailed engineering designs with support from CPO/CPMU.

The Guidelines, which give the Key Design Principles for design of the Subprojects as well as specific guidance for Subprojects in each Province, shall be observed by the detailed engineering design consultants.

The Guidelines for Detailed Engineering Design can be downloaded at: http://onlinedroughtcontrol.com/FinalRevisedGuidelines4DED.pdf

3.4.2 The Subproject Report: Cam Ranh – Suoi Dau Subproject

The consultants shall also review the following report when preparing the detailed engineering designs: "Subproject Report: Cam Ranh – Suoi Dau Subproject" at https://www.adb.org/sites/default/files/linked-documents/49404-002-sd-07.pdf

This report is one of the linked documents to the ADB's Report and Recommendation to the President (RRP: VIE 49404-002) on the proposed loan, grant, and administration of grant to Viet Nam for the Water Efficiency Improvement in Drought-Affected Provinces Project.

3.4.3 The Design Principles for Subprojects

The Design Principles for Subprojects can be downloaded at: https://www.adb.org/sites/default/files/linked-documents/49404-002-sd-01.pdf

The Design Principles for Subprojects, especially the specific guidance for System Design Discharges shall be referred.

3.4.4 The Feasibility Study report

The Feasibility Study for Cam Ranh – Suoi Dau Subproject was approved by Khanh Hoa Provincial People's Committee at the Decision No. 1807/QĐ-UBND on June 22, 2018.

The design consultants shall review the Decision and the Feasibility Study Report at: http://onlinedroughtcontrol.com/KhH_PPCsFS_Dcs.pdf.

and http://onlinedroughtcontrol.com/KhanhHoaFS1.pdf.

4 IMPLEMENTATION DURATION

Consulting services for the detailed engineering design are expected to begin just after signing the contract. Contract implementation duration is 270 days (9 months). The technical proposal of the Consultant will include an action plan with expected members of the consulting team and the progress of mobilizing experts and support staff:

+ Phase 1 (From the effective date of the contract to Day 90): Researching on improving FS and geological topography, learning experience in Australia (according to the proposed plan of CPO and the Australian Water Partnership (AWP))

+ Phase 2 (Day 91 to Day 180): Carrying out the detailed design.

+ Phase 3 (Day 181 to Day 240): Organizing the Design workshop, acquiring the opinions of related parties to complete the design and submitting detailed design documents.

+ Phase 4 (Day 241 to Day 270): Coordinating with PPMU and related parties to report, explain and finalize the detailed design until it is approved.

5 REPORTING REQUIREMENTS AND TIME SCHEDULE FOR SUBMISSIONS OF DELIVERABLES

5.1 Reporting requirements

The dossiers of the detailed engineering design must be prepared in accordance with the relevant sectoral norms, standards, and other relevant regulations and procedures of the Government, and the WEIDAP Guideline for Detailed Engineering Designs.

The main report and working papers: Composition and volume of reports must complying with the National Technical Regulation on the composition, contents of the technical design dossier and detailed engineering design of hydraulic works QCVN 04-02: 2010/BNN-PTNT.

Language of the dossiers and reports: Vietnamese and English.

The Dossier shall consists of:

(i) Main report

(ii) Specific working papers:

- Topographical report: complying with the standards on topography
- Geological report: complying with the standards on geology
- Hydro-meteorological - water balance report: complying with the standards on hydro-meteorological and water balance
- Structure design report
- Mechanical design report
- Electric design report
- Report on construction organization and measures
- Report on operation and maintenance rules

(iii) Drawings

- Site geological engineering drawings: complying with the promulgated regulations on the composition and volume of geological survey in the project planning and design stages.
- Drawings of structure status
- Structure design drawings: showing the entire contents of a detailed design of structures, including the location, size, details of elements, layout of equipment, construction measures, and measures to protect the ecological environment, operation, management and maintenance of structures. The design drawings must show full and accurate details to allow the practical construction on site in accordance with the design requirements; honestly reflecting the contents of the approved basic designs; presenting clearly, scientifically and easily to understand in the prescribed format.
- Mechanical design drawings
- Electrical design drawings
- Design drawings for construction organization.

Survey files and construction design drawings:

The results of consultancy services must fully reflect the contents and components of survey dossiers and detailed technical designs according to current regulations. The design dossier must be clear, accurate, complete, qualified and approved by competent authorities.

The number of submitted documents is 09 parts in Vietnamese, including:

- Part 1: Explanation of detailed technical design;
- Part 2: Summary report;
- Part 3: Specialized reports: Hydrological and hydraulic calculation report; construction design; mechanical design; electrical design; construction organization and construction measures;
- Part 4: Topographic survey report (notes, drawings and appendices)
- Part 5: Geological survey report (explanatory notes, drawings, testings, drill samples, drilling images ...)
- Part 6: Engineering design drawings;
- Part 7: Construction cost estimates;

- Part 8: Technical guidelines on construction method;

- Part 9: Operation and maintenance procedure.

Design consultants are responsible for translating design documents into English upon request of the Investor. Do not translate the entire record but only translate the documents to serve the Sponsor's requirements and stakeholders.

Note: Attached to the USB, write the contents of detailed engineering design documents and data and original documents of construction survey documents (including all the data from the above part 1 to part 9 above).

5.2 Time schedule for submissions of the deliverables

Table 5: Progress of submitting the deliverables

	Milestone	**Content**	**Name of dossier**
Phase 1	From the effective date of the contract to Day 90	Studying further for improving the FS, Topography and surveys, Study tour in Australia	(1)Topographic survey diary (2)Topographic survey report (3)Topographic survey processed data data (4)Topographic survey drawings (5)Geological survey diary (6)Geological construction survey report (7)Geological construction survey drawings (8)Original testing documets (9)Australia Study tour report
Phase 2	Day 91 to Day 180	Carrying out the detailed engineering design	(11)Hydrological and Irrigation reports (12)Mechanical design and electricity reports (13)Construction organisation reports (14)Construction instruction explanation/note (15)Detailed engineering design – cost estimates

	Milestone	**Content**	**Name of dossier**
			design explanation/ note - *Calculating appendix* - *Prognosis appendix* (16)Technical process of O&M (17)Hydrological and Irrigation reports (18)Mechanical design and electricity reports (19)Construction organisation reports Construction instruction explanation/note (20)Construction drawings *-Hydraulic design drawings* *-Pumping and pipeline design drawings* *-Steel layout drawings* *-Mechanical and electricity design drawing* *-Construction organisation drawings*
Phase 3	Day 181 to Day 240	Organizing the Design workshops for advising , acquiring the comments of related parties to completing the design and submitting detailed design documents.	(10)Minutes of Design Workshops
Phase 4	Day 241 to Day 270	Coordinating with PPMU and related parties to report, explain and finalize the detailed design until it is approved	Completed Detailed Engineering Design Dossier

6 QUALIFICATION REQUIREMENTS FOR CONSULTING FIRMS

6.1 Qualification requirements for consulting firms

- The consulting firm must ensure its eligibility under the Vietnamese Bidding Law and the "Guidelines on the Use of Consultants by Asian Development Bank and Its Borrowers ";

- Consulting firm must ensure fair competition under the guidance in the “State-Owned Enterprises Guidance note on Procurement”;

- The consulting firm must be a company with full legal status and business registration appropriate to the scope of work; have a certificate of construction consultancy activities as prescribed;

- Consulting firm with strong financial capacity in the past 3 years (2016, 2017, 2018);

- The Consulting Company must have at least 10 years of experience in providing advisory services in the areas of project preparation, agriculture and rural development design, water resource development and irrigation water supply;

- The consulting company must have at least 5 years of experience on survey and detailed engineering design for ODA projects in the field of Agriculture and Rural Development .

- At least 02 implemented project contracts of consultancy on survey and detailed engineering design for pumping stations, pressurized water supply pipelines. Priority is given to consulting firms that have performed contracts to design pressurized water supply projects for HVCs/ agriculture funded by ODA;

- The consulting company has sent an expression of interest (EOI) and should participate in the WEIDAP Project Pre-Bid Workshop.

- If the Consultant is a joint venture, each member must meet the same requirements as for the independent consultant corresponding to the work performed.

6.2 Requirements on qualifications of key specialists

No	Expert	Quantity	Requirements on experience and capability	Duties	Duration
	Team leader	01 person	- Has a bachelor degree	Team leader will report	

No	Expert	Quantity	Requirements on experience and capability	Duties	Duration
			in irrigation construction, perferably master or higher degree; - Has a valid certificate in irrigation construction design consultancy; - At least 15 years experience in irrigation construction design consultancy; - At least 10 years experience in team leader construction design consultancy; - Has join at least 1 ODA project in position Design consultant Team leader; -Fluent in English will be an advantage.	to the PPMU and work consistently with other specialists and project implementation supporting staffs. Perform those following tasks: - Taking general responsible for managing consultant team, ensuring consultancy service's progress and quality. Reporting and clarifying contents related to sub-project consultancy services to authorized agencies, international consultancy specialist and advisors supported by ADB; - Supervising and evaluating consultant team's performance; - Assisting PPMU to cooperate with consultancy specialists from CPO, MARD and ADB during sub-project implementation and approval process.	
	Topographic expert	01 person	- Has university degree majoring in construction topoghraphic survey, preferably master or higher degree; - Has a valid certificate; - At least 10 years experience in irrigation construction topographic survey consultancy; - Has join at least 1 ODA project in Survey consultant team; - Fluent in English will be an advantage.	- Responsible for topographic survey results; Coordinate with the team leader and other specialists to carry out the topographic survey to ensure the progress and quality of consulting services; - Syntherizing the data, reporting the survey results and hand over the landmark to the PPMU; - Participating in the implementation, monitoring and evaluation of the performance of support	

No	Expert	Quantity	Requirements on experience and capability	Duties	Duration
				staff in the topographic survey of the sub-project;	
	Geologic expert	01 person	- Has university degree majoring in construction geology, preferably master or higher degree; - Has a valid certificate; - At least 10 years' experience in the field of irrigation construction geologic survey consultancy; - Has join at least 1 ODA project in Survey consultant team; - Fluent in English will be an advantage.	- Responsible for the results of engineering geological surveys; coordinate with the team leader and other specialists to carry out the geological survey to ensure the progress and quality of consulting services. - Syntherizing the data, report the survey results, analyze and clarify the experimental data. - Participating in the implementation, monitoring and evaluation of the performance of support staff in the geological survey of the sub-project;	
	Construction expert	01 person	- Has a bachelor degree in irrigation construction, perferably master or higher degree; - Has an valid certificate; - At least 10 years experience in irrigation construction design consultancy; - Has join at least 1 ODA project in Survey consultant team; -Fluent in English will be an advantage.	- Field work, in collaboration with other experts assess the status of the work, analyze relevant documents. - Coordinate with the Team leader and other experts to formulate the construction method of the works, make explanations and addendum to conduct construction instructions..	
	Hydrology, irrigation expert	01 person	Has an university degree majoring in construction hydrology or water resource management, preferably master or higher degree, and Has a valid certificate	- Taking overall responsibility for irrigation calculation results and water balance to ensure the progress and quality of consulting services.	

No	Expert	Quantity	Requirements on experience and capability	Duties	Duration
			at least 10 years experience in irrigation work consultancy and - Has join at least 1 ODA project in Survey consultant team; -Fluent in English will be an advantage.	- Syntherizing, reporting and clarifying the contents related to the calculation results to the team leader and authorized agencies, international consultants, advisory teams supported by ADB; - Participating in the implementation, monitoring and evaluation of the performance of the supporting staff in the construction drawing design of the subproject;	
	Hydraulic expert	1 person	Has an university degree majoring in irrigation work, preferably master or higher degree, Has a valid certificate At least 10 years experience in irrigation work consultancy; - Has join at least 1 ODA project in Survey consultant team; -Fluent in English will be an advantage.	- Taking overall responsibility for the results of hydraulic calculations, hydraulic structures, construction organization methods to ensure the progress and quality of consulting services; - Syntherizing, reporting and clarifying the contents related to the calculation results to the team leader and authorized agencies, international consultants, advisory teams supported by ADB; - Participating in the implementation, monitoring and evaluation of the performance of the support staff in the construction drawing design of the subproject;	
	Water supply expert	1 person	Has an university degree majoring in water supply, preferably master or	- Taking general responsibility for the results of the pump	

No	Expert	Quantity	Requirements on experience and capability	Duties	Duration
			higher degree, Has a valid certificate At least 10 years experience in water supply design consultancy; At least 3 implemented projects in using EPANET or WaterGEMS software; - Has join at least 1 ODA project in Survey consultant team; fluent in English will be an advantage.	station calculation, the hydraulic calculation of the pipeline, the organization of construction methods to ensure the progress and quality of consulting services. - Designing technical piping for pumping stations and pipelines. - Syntherizing, reporting and clarifing the contents related to the calculation results to the team leader and authorized agencies, international consultants, advisory teams supported by ADB; - Participating in the implementation, monitoring and evaluation of the performance of the supporting staff in the construction drawing design of the subproject;	
	Electricity/automation expert (SCADA expert)	1 person	- Has an university degree majoring in electricity, preferably master or higher degree, - Has a valid certificate - At least 10 years experience remoting electricity design consultancy for pumping station works/water supply factories; - Has join at least 1 ODA project in Survey consultant team; fluent in English will be an advantage.	- Taking overall responsibility for the results of the calculation of the electricity for the pumping station, measures to organize the construction to ensure the schedule and quality of consulting services; - Designing remoting electricity for pumping stations; - Syntherizing, reporting and clarifying the contents related to the calculation results to the team leader and authorized agencies, international consultants, advisory	

No	Expert	Quantity	Requirements on experience and capability	Duties	Duration
				teams supported by ADB; - Participating in the implementation, monitoring and evaluation of the performance of the supporting staff in the construction drawing design of the subproject;	
	Mechanic, hydraulic equipment expert	1 person	- Has an university degree majoring in Mechanic, hydraulic equipment expert, preferably master or higher degree, - Has a valid certificate - At least 10 years experience of hydraulic mechanic equipment, lines substation design consultancy; - Has join at least 1 ODA project in Survey consultant team; fluent in English will be an advantage.	- Taking overall responsibility for the results of the calculation of the structure of hydraulic mechanic devices, the scale of the substation's line in line with the objectives and tasks of the sub-project to ensure the progress and quality of consulting services. - Syntherizing, reporting and clarifying the contents related to the detailed mechanical, operating electrical design for the team leader and authorized agencies, international consultants, advisory teams approved by ADB; - Participating in the implementation, monitoring and evaluation of the performance of the supporting staff in the construction drawing design of the sub-project;	
	Economic, estimation expert	1 person	Has an university degree majoring in construction economy, preferably master or higher degree, Has a valid certificate At least 10 years experience of preparing	- Updating the policies, construction unit prices issued by the local government as a suitable basis for calculating the works construction estimate for the	

No	Expert	Quantity	Requirements on experience and capability	Duties	Duration
			work construction cost estimate; - Has join at least 1 ODA project in Survey consultant team; fluent in English will be an advantage.	subproject to ensure the progress and quality of consulting services. . - Reviewing and comparing the construction prognosis, syntherizing, reporting and clarifying the contents related to the work construction cost estimation with the team leader and the authorized agencies, international consultants, the advisory teams supported by ADB; - Participating in the implementation, monitoring and evaluation of the performance of the supporting staff in the work construction cost estimation for the sub-project;	
	Supporting staffs	At least 5 people	Having relevant university degree At least 3 years of experience in designing irrigation works, irrigation systems;	The consultant must mobilize a support team with experience in designing, drawing and collecting data. The mobilized support personnel should have expertise in hydraulic engineering.	

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Summary of specialists and their work volume

Table 6: Summarized quantity and volume of consultant work per man month

No.	Position	Quantity	Mobilized time (man month/per)	Total time of mobilization (man month)

No.	Position	Quantity	Mobilized time (man month/per)	Total time of mobilization (man month)
1	Team leader	1	9	9
2	Deputy team leader	1	9	18
3	Topographic experts	1	4,5	6
4	Geological experts	1	4,5	6
5	Hydrological , irrigation experts	1	9	6
6	Hydraulic, construction experts	1	9	6
7	Water supply experts	1	9	6
8	Electrical/ autonomation experts	1	6	6
9	Operating mechanic, electricity experts	1	6	6
10	Economic, estimation experts	1	6	6
11	Suppporting staffs	5	6	15
	Total:	**15**	**78**	**90**

7 COST ESTIMATES FOR CONSULTING SERVICES

7.1 Basis of preparing cost estimates for the consulting services

- Pursuant to Decision No. 1354/QD-BXD dated December 28, 2016 of the Ministry of Construction;
- Pursuant to Decision Circular 05/2016 / TT-BXD dated 10/3/2016 of the Ministry of Construction;
- Pursuant to the Decision No. 279 / QD-UBND dated February 7, 2014 of the People's Committee of Khanh Hoa province;

- Pursuant to Circular No. 01/2017 / TT-BXD dated 06/02/2017 of the Ministry of Construction;
- Pursuant to Decision No. 2242 / QD-UBND dated August 7, 2017 of the People's Committee of Khanh Hoa province;
- Pursuant to Decision 79/QĐ-BXD date Feb 15, 2017 of The Vietnam Ministry of Construction;
- Pursuant to on Circular 02/2015/TT-BLĐTBXH date Jan 12, 2015 of The Vietnam Ministry of Labour - Invalids and Social Affairs;

7.2 Implementation costs

Table 7: Estimations for consulting service

No.	Item	After taxation	Note
1	Topographic survey	4.062.009.492	
2	Geological survey	1.372.967.955	
3	Detailed engineering design Expenses	5.287.590.000	
	Total	**10.722.567.447**	

8 COORDINATION AND OVERSIGHT

- The Consultant must report to the PPMU on the progress of the monthly implementation, prepare the documents and attend meetings/workshops on the relevant issues as required by the Investor.
- The Consultants will coordinate with the subproject implementation advisors and other stakeholders such as CPO and ADB/ AWP. Specifically, the discussions/inspections on milestones of subproject are required (as stated in the WEIDAP guidelines). The Consultant should closely coordinate and provide necessary data, information and reports for subproject implementation advisors and other stakeholders during the implementation process. The Consultant must participate in meetings and discussions with relevant agencies at the central and local levels.
- The Consultants should work closely with community representatives (traditional and non-traditional way) to ensure the

information collection during the FS phase, and accurately assess the impacts of the subproject as well as related issues on the environmental and social protection policies.

9 IMPLEMENTATION ARRANGEMENTS

- During the implementation of the task, the Consultant will report directly to PPMU. PPMU will be responsible for providing the Consultant with the contact information of other agencies as required.
- The Consultant must organize the implementation of the subproject. All relevant estimated costs must be anticipated in the bidding document and there will be no change in the total cost when signing the contract.
- All costs related to fieldwork and data needed to meet the technical requirements of this consulting work must be fully considered in the proposal. Terrain and meteorological data and other information must be expected during the bidding process to ensure that the work is completed within the estimated total cost. For this purpose, the Consultant must estimate the corresponding workload and costs because there will be no change in the total cost of the subproject after signing the contract for any reason.

The Consultant will pay for all travel and accommodation related expenses (including field trips) for the entire consulting team during the contract period. The Consultant will also pay for all support staff (administrative, translators, office clerks, accountants) and field staff to perform the work for all data collection activities.

Technical reports and consulting products will be provided as described in the distribution section. The Investor will only accept the sub-project when subproject implementation advisors agree with the consultingproducts and ADB issues the Non Objection Letter (NOL).

10 SUPPORTS FROM THE PROVINCIAL PROJECT MANAGEMENT UNIT

10.1 Responsibilities of the Consultants

- Implementing the consultancy service in accordance with the agreed content and workload, and regulations on the application of Vietnamese and ADB standards and regulations;
- Submitting the report to the Investor within the time limit required by ToR;
- Ensuring the mobilization and arrangement of personnel, offices and transport facilities;
- Ensuring that all consulting works implemented by the Consultant are in accordance with Vietnamese law.
- Implementing and being responsible for the quality of the consulting products;
- Participating in meetings related to consulting products when the Investor requests it during the implementation process, ensuring compliance with the regulations of MARD, PMU, PPC as well as the Sponsor; based on the Decision on approval of feasibility study report of the project and the subproject to recommends the Investor to supplement the missing contents according to the Decision;
- Commitment that the Consultant will appoint a competent representative to resolve any problems at any time at the request of the Investor.
- Complying with the direction and guidance of the investor, except for guidances or requirements that are contrary to the law or are not feasible.
- The Consultant shall not disclose any confidential or proprietary information relating to the consulting work, the contract or the work activities of the Investor without prior approval of the Investor in written document.

- The Consultant is responsible for searching and applying appropriate standards and regulations for the subproject. In the absence of such standards, the relevant international standards must be consulted and agreed by the Investor. Some key standards are expected to apply.

10.2 Responsibilities of the Provincial Project Management Unit

- The PPMU provides the Consultant with documents of the feasibility study and other relevant legal documents;
- Creating the best possible conditions for the Consultant to perform consulting work;
- Supporting and facilitating conditions for the Consultant to have access to the works location;
- Providing necessary documents according to the Consultant's proposal for the Consultant to perform the consulting work. The Investor is responsible for the accuracy and completeness of the documents provided;
- Reviewing the requirements and proposals of the Consultant regarding the implementation of consulting and approval work within a reasonable period of time so as not to delay the implementation of the consultancy;
- Pays for the Consultant as the contract price in accordance with the regulations;
- Answering in writing the proposals or requests of the Consultant;
- Appointing any qualified and professional individuals suitable to each job to work with the Consultant and specified in the specific decisions of the PPMU.

For Clarification of the Terms of Reference only, please contact the Khanh Hoa provincial Project Management
Address: 04 Phan Chu Trinh
City: Nha Trang
Province: Khanh Hoa
Country: Viet Nam
Telephone: 84 (058) 3 823 435 - 84 (058) 3 823 436
Email : adb8.khanhhoa@gmail.com

APPENDIXES

Appendix 1: Topographic survey volume

Appendix 2: Geological survey volume

APPENDIX 1: TOPOGRAPHIC SURVEY VOLUME

No	Description	Unit	Topographic level	Volume
A	**NORTH MAIN CANAL OF SUOI DAU RESERVOIR**			
1	**Works on the canal**			
-	Traverse line grade II	point	III	3
-	Technical leveling	km	III	1,5
-	Topographic map of work positions on the main canal in scale of 1/200; h=0,5m			
+	*Speculum spillway*	ha	III	0,3
+	*Siphon*	ha	III	0,18
-	Longitudinal section, scale of 1/200			
+	*Speculum spillway*	100m	III	1
+	*Siphon*	100m	III	0,6
-	Cross section, scale of 1/100			
+	*Speculum spillway*	100m	III	1,2
+	*Siphon*	100m	III	0,6
2	**Backfill soil extraction area**			
-	Land clearance points	point	III	4
3	**Landfill**			
-	Points of traverse line grade 2	point	III	2
-	Technical leveling	km	III	1
-	Plane chart of landfill in scale of 1/1000, h = 1m	100ha	III	0,02
-	Land clearance points	point	III	4

No	Description	Unit	Topographic level	Volume
4	**Planning centre of work routes**			
-	North main canal of Suoi Dau reservoir	point	III	12
-	Works on the canal	point	III	3
B	**SOUTH MAIN CANCAL OF SUOI DAU RESERVOIR**			
1	**Benefit area**			
-	Traverse line class IV	point	III	3
-	Traverse line grade II	point	III	16
-	Leveling grade IV	Km	III	2,43
-	Technical leveling	Km	III	4,86
-	Plane chart / topographic map of irrigation area in scale of 1/2000; h = 1,0m	100ha	III	4,86
2	**Works on the canal**			
-	Technical leveling	km	III	2,4
-	Plane chart/ topographic map of works positions on the main canal in scale of 1/200; h=0,5			
+	*Speculum spillway*	ha	III	0,45
+	*Flood spillways*	ha	III	0,36
+	*Pumping station + Management house*	ha	III	0,1
-	Longitudinal section, scale of 1/200			
+	*Speculum spillway*	100m	III	1,5
+	*Flood spillways*	100m	III	1,2

No	Description	Unit	Topographic level	Volume
+	*Pumping station + Management house*	100m	III	0,5
-	Cross section, scale of 1/100			
+	*Speculum spillway*	100m	III	1,8
+	*Flood spillways*	100m	III	2,4
+	*Pumping station + Management house*	100m	III	0,6
3	**Operation management road**			
-	Technical leveling	km	III	3,3
-	Plane chart/ topographic map of management road in scale of 1/500; h=0,5m	ha	III	-
-	Longitudinal section of operation management in scale of 1/500	100m	III	33
-	Cross section of operation management in scale of 1/100	100m	III	10,05
4	**Pipeline route**			
-	Technical leveling	km	III	7,3
-	Plane chart/ topographic map in scale of 1/500, h=0.5m	ha	III	7,3
-	Longitudinal section of pipeline in scale of 1/500		III	73
-	Cross section of pipeline in scale of 1/500		III	14,7
5	**Backfill soil extraction area**			

No	Description	Unit	Topographic level	Volume
-	Land clearance points	Point	III	6
6	**Landfill**			
-	Traverse line grade II	point	III	2
-	Technical leveling	km	III	1
-	Plane chart Landfill 1/1000, h = 1m	100ha	III	0,03
-	Land clearance point	Point	III	6
7	**Planning center of work route**			
-	South main canal of Suoi Dau reservoir	Point	III	12
-	Pipeline	Point	III	29
-	Works on the canal	Point	III	8
-	Management road	Point	III	8
C	**SOUTH MAIN CANAL OF CAM RANH RESERVOIR**			
1	**Irrigation area**			
-	Traverse line class IV	point	III	10
-	Traverse line grade II	point	III	63
-	Leveling grade IV	Km	III	9,07
-	Technical leveling	Km	III	18,13
-	Plane chart/ topographic map in irrigation area in scale of 1/2000; h = 1,0m	100ha	III	18,13
2	**Works on the canal**			
-	Technical leveling	km	III	5,7

No	Description	Unit	Topographic level	Volume
-	Plane chart/ topographic of works positions on the main canal in scale of 1/200; h=0,5			
+	*Speculum spillway*	ha	III	0,75
+	*Flood spillways*	ha	III	0,36
+	*Weir*	ha	III	0,24
+	*Pumping station + Managing house*	ha	III	0,16
-	Longitudinal section			
+	*Speculum spillway*	100m	III	2,5
+	*Flood spillways*	100m	III	2
+	*Weir*	100m	III	1,2
+	*Pumping station + Managing house*	100m	III	2
-	Cross section			
+	*Speculum spillway*	100m	III	3
+	*Flood spillways*	100m	III	2,4
+	*Weir*	100m	III	2,4
+	*Pumping station + Managing house*	100m	III	1,6
3	**Management road**			
-	Technical leveling	km	III	8,1
-	Longitudinal section of road in scale of 1/500	100m	III	81
-	Cross section of raod in scale of 1/100	100m	III	16,3
4	**Pipeline route**			

No	Description	Unit	Topographic level	Volume
-	Technical leveling	km	III	31,2
-	Topographic map in scale of 1/500, h=0.5m	ha	III	31,2
-	Longitudinal section of pipeline in scale of 1/500	100m	III	312
-	Cross section of pipeline in scale of 1/500	100m	III	62,5
5	**Backfill soil extraction area**			
-	Land clearance point	Point	III	6
6	**Landfill**			
-	Traverse line grade II	point	III	2
-	Technical leveling	km	III	1
-	Topographic map in scale of 1/1000, h = 1m Landfill	100ha	III	0,06
-	Land clearance point	point	III	8
7	**Planting center of the work route**			
-	South main canal of Cam Ranh reservoir	point	III	32
-	Pipeline	point	III	125
-	Works on the canal	point	III	19
-	Management road	point	III	16

APPENDIX 2: GEOLOGICAL SURVEY VOLUME

No	Description	Unit	Rock level	Volume
A	**NORTH MAIN CANAL OF SUOI DAU RESERVOIR**			
1	***Speculum spillway***			
1.1	Hand drilling	m		
-	Level I-III	m	I-III	27
-	Level IV-V	m	IV-V	3
1.2	Water pouring test	time		4
1.3	Original sample test	sample		8
2	***Landfill***			
2.1	Hand drilling			
-	Level I-III	m		7,5
-	Level IV-V	m		1,5
2.2	Laboratory test			
-	Standard compact sample test	sample		3
-	Prepared sample test	sample		5
B	**SOUTH MAIN CANAL OF SUOI DAU RESERVOIR**			
1	***Pump station***			
1.1	Hand drilling			
-	Level I-III	m		16,5
-	Level IV-V	m		1,5
1.2	Water pouring test	time		2
1.3	Original sample test	sample		8
2	***Speculum spillway***			
2.1	Hand drilling			
-	Level I-III	m		40,5
-	Level IV-V	m		4,5
2.2	Water pouring test	điểm		3
2.3	Original sample test	sample		10
3	***Pipeline systems***			
3.1	Hand drilling			
-	Level I-III	m		59,2
-	Level IV-V	m		14,8
3.2	Water pouring test	time		10
3.3	Original sample test	sample		16
4	***Landfill***			
4.1	Hand drilling			

No	Description	Unit	Rock level	Volume
-	Level I-III	sample		10
-	Level IV-V	sample		2
4.2	Laboratory test			
-	Standard compact sample test	sample		6
-	Prepared sample test	sample		10
5	***Operation management***			
5.1	Hand drilling			
-	Level I-III	m		4,8
-	Level IV-V	m		1,2
5.2	Original sample test	sample		4
C	**SOUTH MAIN CANAL OF CAM RANH RESERVOIR**			
1	***Pump station***			
1.1	Hand drilling			
-	Level I-III	m		38,4
-	Level IV-V	m		9,6
1.2	Water pouring test	time		8
1.3	Original sample test	sample		16
2	***Speculum spillway***			
2.1	Hand drilling			
-	Level I-III	m		67,5
-	Level IV-V	m		7,5
2.2	Water pouring test	time		5
2.3	Original sample test	sample		20
3	***Pipeline systems***			
3.1	Hand drilling			
-	Level I-III	m		224
-	Level IV-V	m		56
3.2	Water pouring test	time		12
3.3	Original sample test	sample		20
4	***Landfill***			
4.1	Hand drilling			
-	Level I-III	m		30
-	Level IV-V	m		6
4.2	Laboratory test			
-	Standard compact sample test	sample		12
-	Prepared sample test	sample		16
5	***Operation management***			
5.1	Hand drilling			

No	Description	Unit	Rock level	Volume
-	Level I-III	m		19,2
-	Level IV-V	m		4,8
5.2	Original sample test	sample		8