KINGDOM OF CAMBODIA
MINISTRY OF INDUSTRY AND HANDICRAFT (MIH)

PREPARATORY SURVEY ON THE PROJECT FOR EXPANSION OF WATER SUPPLY SYSTEMS IN PURSAT

FINAL REPORT

DECEMBER 2019

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

CTI ENGINEERING INTERNATIONAL CO., LTD.
WATER AND SEWER BUREAU, CITY OF KITAKYUSHU
TEC INTERNATIONAL CO., LTD.

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EXCHANGE RATE (based on the average exchange rate April,2019)

USD 1 = JPY 111.21

PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey and entrust the survey to Consortium consist of CTI Engineering International Co., Ltd., Water and Sewer Bureau, City of Kitakyushu and TEC International Co., Ltd.

The survey team held a series of discussions with the officials concerned of the Royal Government of Cambodia and conducted field investigations. As a result of further studies in Japan, the present report was finalized.

I hope that this report will contribute to the promotion of the project and to the enhancement of friendly relations between our two countries.

Finally, I wish to express my sincere appreciation to the officials concerned of the Royal Government of Cambodia for their close cooperation extended to the survey team.

December,2019

MEGUMI MUTO
Director General,
Global Environment Department
Japan International Cooperation Agency

Summary

1. Overview of the Kingdom of Cambodia

(1) Natural Conditions

The Kingdom of Cambodia (hereinafter referred to as Cambodia) is located on the Indochinese peninsula, bordering Thailand in the northwest, Laos in the northwest and Vietnam in the southeast. Cambodia has a total population of 15.76 million (2016, Cambodia Ministry of Planning Statistics Bureau) and land area of 181,035 km^2. In Cambodia, the Tonle Sap River originating from the Tonle Sap Lake which is the largest freshwater lake on the Indochinese Peninsula, and the Mekong River originating in the Tibetan Plateau, are the two largest rivers. These two major rivers join in the capital Phnom Penh. Most of the land consists of plains, but there are mountain ranges in the northeast, northern and northeast of Cambodia. In addition, the northern and northeastern border with Vietnam and Laos are covered with deep forests and become treasures of wildlife and virgin forests. The climate of Cambodia belongs to a tropical monsoon climatic zone, and the rainy season and dry season are divided clearly. Generally, the former is from May to October and the latter is from November to April. The average annual amount of rainfall from 1996 to 2015 is 1,410mm, and the biggest annual amount of rainfall in this period is 1,876mm in 2008.

(2) Socio Economic Conditions

The economy of Cambodia has been showing a high growth rate since the new government starts under the new constitution in 1993 after the end of the civil war. Agriculture, manufacturing industry, construction industry and service industry in Cambodia were particularly excellent from 2004 to 2007 and its economic growth rate exceeded 10% continuously for four consecutive years. Although the manufacturing industry and construction industry fell to negative economic growth in 2009 and the economic growth rate suddenly slowed down to 0.1% due to the Lehman Shock, the economic growth rate recovered afterward and showed the high rate more than 7% for seven consecutive years from 2011 to 2017. Sectoral factors that brought economic growth of Cambodia in recent years are regarded as the sewn product export to North American in the manufacturing industry, the construction rushes of condominium or resort facility in the construction industry and the growth of tourism and retail sales in the service industry. According to the prospect of IMF in April 2018, the economic growth rate of Cambodia will be 6.9% in 2018 and 6.8% in 2019. The prospect of National Bank of Cambodia in December 2017 is also 6.9% in 2018. Based on the general view, about 7 % of high economic growth rate seems to be continued for the meanwhile.

On the other hand, the poverty ratio in Cambodia is still high. Although the ratio of 53.2% in 2004 was improved to 20.5% in 2011, the poverty reduction is important issue in Cambodia.

2. Background of the Project

After the improvement of drinking water supply system in Phnom Penh by the Royal Government of Cambodia (RGC), the government keeps improving the system in the provincial cities in Cambodia by expanding the accomplishment of water supply system in Phnom Penh. JICA has supported the government in the progress through Technical Cooperation, Grant Aid and ODA Loan.

"The Master Plan of Greater Phnom Penh Water Supply in the Kingdom of Cambodia" was formulated by the support of JICA in 1993 after the civil war. Based on the master plan, the drinking WTP and distribution water pipe network were constructed through Japanese Grant Aid. Strengthening of management, operation and maintenance for the water supply system progressed through the technical cooperation with Water and Sewer Bureau, City of Kitakyushu and so on.

Synergistic effect with other donor's supports made Phnom Penh Water Supply Authority (PPWSA) as one of the best water supply corporations in Asia: 90% of water supply coverage ratio, 8% of water loss rate and 24-hour water supply in 2006. Meanwhile, the water supply coverage ratio in the provincial cities of Cambodia was at 35% in 2005.

The target for water supply ratio in urban areas of provincial cities to be 100% by 2025 is disseminated in MIH, and RGC is proceeding with the expansion of water supply facilities in provincial cities.

As a result, it is possible to operate water supply system fairly: however, the water supply coverage ratio of the provincial cities is low now because of their low production capacity. For example, Pursat City which has approximately 100,000 people in the administrative area of the Waterworks(WWs) can now supply water to approximately 36,000 people only (in 2015). In the same manner, Svay Rieng City can supply water to approximately 15,000 people only (in2015) against approximately 100,000 people. Therefore, the water supply coverage ratio is approximately 38% in Pursat City and approximately 16% in Svay Rieng City. Since both cities aim at 100% water supply coverage ratio by 2025, the expansion of the water supply system is an urgent issue.

Under these circumstances, RGC made an official request in Aug. 2016 to the Government of Japan (GOJ) for "The Project for Expansion of Water Supply System in Pursat and Svay Rieng City in the Kingdom of Cambodia" (hereinafter referred to as "this project") under the Japanese grant aid to improve water supply services in Pursat City and Svay Rieng City. (The official request letter was submitted in June 2017).

According to the discussion results with Cambodian officials during the field survey, which was conducted from June to September in 2017, both sides agreed as follows:

（1） The preparation will start for grant aid scheme on the expansion of water supply system in Pursat City based on the request.

（2） As for Svay Rieng City, since the stability of water resource is required to be reviewed, the project for Svay Rieng City will be implemented separately from this project.

Based on the above background, this project aims to improve access rate to safe water, provide stable water supply service and improve the quality of life of residents by constructing intake facilities, conveyance pipes, WTP, transmission pipes and distribution pipe network in Pursat City.

3. Results of the Preparatory Survey and Scope of the Project

(1) Results of the Preparatory

The Japan International Cooperation Agency (JICA) dispatched the Preparatory Survey Team (The Team) to Cambodia over five times in total as follows based on the above-mentioned background.

The first field work: From June 11, 2017 to July 23, 2017
The second field work: From August 10, 2017 to September 4, 2017
The third field work: From June 24, 2018 to June 30, 2018
The first field work for change of design:
From February 10, 2019 to February 16, 2019
The second field work for change of design:
From March 14, 2019 to April 12, 2019

The team conducted the measuring survey, geological survey and water quality survey in addition to the survey on the present conditions of the existing water supply facilities and social condition in Pursat City and Svay Rieng City. The preparatory survey consists of appropriate outline design as a grant aid, formulating project implementation plan and project cost estimation after confirming the request contents from the Cambodian side and evaluating the validity of the project scale. As a result, it is agreed with Cambodian side that the new water purification plant of 6,600m^3/day will be constructed by this project to improve water supply coverage ratio for the population in the urban area to 86.1% and 67.9% in the controlled area of the WWs in the Pursat City.

(2) Scope of the Project

1) Construction of Water Supply Facilities

The water supply facilities that will be constructed are as follows:

Intake and Raw Water Transmission Facilities

Item			Structure and Scale
Large	Middle	Small	
Intake Facility 7,260m^3/day	Sedimentation pond 7,260m^3/day , 1-pond	Sedimentation pond (Circular Elevated Tank)	Reinforced Concrete Circular Elevated Tank Size: Tank Diameter 7.0m Height: 19.7m onGL Depth: 4.0m Equipped facility: Crane (0.5 ton) for Maintenance, Inlet Pipe, Outlet Pipe, Drainage Pipe and Water Gauge
	Intake pump facility	Intake Pipe and Pump room	Rectangular reinforced concrete structure with basement room First floor (under beam): B7.50m x L14.00m x H3.10m (measuring between center of walls) Basement room (under beam): B7.50m x L6.00m x H1.5m (measuring between center of walls) Equipped facility: incoming panel, control panels, valve control panel, auxiliary machine panel, emergency generator, intake pump (5.04m^3/m, 34m, 45kW x 2sets), pipe laying for intake and outlet side, crane (3t) for maintenance and floor drain pumps
		Personnel office	Rectangular reinforced concrete structure with basement room Size: B6.00m x L6.00m x H2.40m (measuring under beam between center of walls) Equipped facility: power board and instrumentation board
	Temporary works	Earth Coffer Dam	Earth Coffer Dam and Large Sand Bag H=4m L=60m
Conveyance Facility	Conveyance Pipe	Under the Road	Ductile cast iron pipe (DIP), Diameter 350mm, L=8.3km
		Bridge-piggybacked pipe	Steel pipe(SP), Diameter 350mm, 4 sites

Water Treatment Plant

Item	New Pursat WTP: 6,600m^3/day	
	Structure and Scale	Qty
Receiving Well	Reinforced Concrete Structure Internal Dimension: Width1.50m×Length3.90m×Depth4.70m Volume (V): 27.5m3, Retention Time (T): 5.5min (Criteria: ≧1.5min)	1 Basin
Mixing Well	Reinforced Concrete Structure Methods to utilize the energy of water flow itself Internal Dimension: Width1.50m×Length1.50m×Depth4.12m Volume (V): 9.27m3, Retention Time (T): 1.83min (Criteria: 1＜T＜5min)	1 Basin
Flocculation Basin	Reinforced Concrete Structure Slow Mixing Method: Up-and-Down Roundabout Type (zigzag flow) Number of Stage: 5 Stages Internal Dimension per Basin: Width7.00m×Length3.65m×Average Effective Water Depth3.76m (Height	2 Basins

Item	New Pursat WTP: 6,600m^3/day	
	Structure and Scale	Qty
Sedimentation Basin	Reinforced Concrete Structure Horizontal Flow Sedimentation Type Supernatant Water Collecting System: Collecting Trough + Submerged Orifice Internal Dimension per Basin: Width7.00m×Length20.00m×Average Water Depth4.40m Surface Loading: Q/A=18.0mm/min (Criteria:15-30mm/min) Mean Velocity (V): 0.08m/min (Criteria: 0.40m/min or below)	2 Basins
Rapid Sand Filter (Reference) *	Reinforced Concrete Structure Type: Self-Balancing Type Internal Dimension: Width2.50m×Length6.00m Filter Sand Thickness: 1.0m Underdrain System: Perforated Block Filtration Rate (V): 121m/day (Criteria: 120-150m/day) Backwash Method: Air Wash + Water Wash	4 Basins
Service Reservoir	Reinforced Concrete Structure using Flat Slab Structure Effective Volume per Basin (V): 1,152m^3(576m^3×2Basins) Effective Water Depth (H): 4.00m (Criteria:3-6m) Retention Time (T): 8.4hours (Set from daily-water demand fluctuation) Internal Dimension: Width12.00m×Length24.00m×Depth4.00m	2 Basins
Drainage Basin	Reinforced Concrete Structure Volume (V): 228.8m^3(114.4m^3×2Basins) Internal Dimension per Basin: Width4.00m×Length11.00m×Effective Water Depth2.60m (Height5.60m)	2 Basins
Drying Bed	Reinforced Concrete Structure Effective Area (A):536.8m^2 (Area per bed: Width11.0m×Length12.2m ＝	4 Beds
Chemical Feeding Facilities (in Chemical Building)	Coagulant: Polyaluminum Chloride (PAC) Acid and Alkali Agents: Lime Chlorine Agents: Calcium Hypochlorite (Bleached Powder)	1 Unit
Power Generator Equipment (in Chemical Building)	Capacity: Long Running Type 350KVA Type: Low Noise Cubicle Type	1 Unit
Chemical Building	Reinforced Concrete Structure, 3Storey Building, Total Floor Area (A):425.8m^2 (Usage) Ground Floor: Workshop, Storage, Emergency Generator Room, Toilet Chemical Carry-in Room (1-3 Fl. Open Ceiling) 1st Floor: Waste Solution Reservoir, Chemical Injection 2nd Floor: Chemical Dissolving Tank Room	1 Unit
Administration Building	Reinforced Concrete Structure, 1 Story Building, Total Floor Area (A): 266.7m^2 (Usage) Ground Floor: Office Room, Meeting Room, Monitoring Room, Laboratory, Toilet	1 Unit

Note: * As stated in 2-2-2-5-(3)-4), since the specification and structure of rapid sand filter is based on bidder's proposal, the description on the above table is for reference.
Source: JICA Survey Team

Distribution Facility

Item	Structure and Scale	Qty
Service Reservoir (inside new (WTP)	Reinforced concrete (RC) Structure, Rectangle, 2 Reservoirs Effective Capacity: V=1,100 m^3×2 Effective depth: H=3.80 m Water Level: HWL+17.20m、LWL+13.40m Foundation: Direct Foundation	1 set
Distribution Pump Facilities (inside new WTP)	Horizontal Volute Pump 3.5m^3/min H=55m 75kW Inverter Equipment	3 Pumps (1 standby)
Distribution Mains	DCIP Straight Pipe: T type, Thrust Blocking: Retainer Gland φ400mm L= 0.1km / φ350mm L= 5.8km / φ300mm L= 1.4km	7.3km
	HDPE φ250mm L= 5.4km / φ200mm L= 11.2km / φ150mm L= 10.3km / φ100mm L= 16.5km / φ 80mm L= 7.7km / φ 50mm L= 23.1km	74.2km
	Water Main Bridge SP (corrosion prevention coating) φ 80mm one place	1 Places
	Bridge-piggybacked Water Main SP (corrosion prevention coating) φ300mm 3 place / φ250mm 4 places / φ200mm 8 places / φ150mm 10 places / φ100mm 6 places / φ 80mm 8 places / φ 50mm 1 place	40 Places
Monitoring equipment of water distribution	2 flowmeters (1 each inside and outside WTP) 3 water pressure gauges (outside WTP)	1 LS

Note: Pipe length of water main bridges and the bridge-piggybacked water mains shall be included in the length of ductile cast iron pipes and high density polyethylene pipes.

2) Procurement of Equipment

To achieve adequate water treatment and conduct sound operation and maintenance of the new water supply facilities and to promote service connections for the low-income household, the following equipment will be procured under Japanese grant aid:

Item	Equipment /Material	Specifications	Qty
Equipment for Water Quality Analysis	Water Quality Instruments	Jar Tester, Distillation apparatus, Turbidity Meter, pH Meter, Residual Chlorine Analyzer, Electric Conductivity Meter, Water Bath (for COD), Microscope	1 set
	Absorptiometer	For multi-item water quality measurement(including reagents) Measurement Range：320-1100nm	1 set
	Uninterruptible Power System (UPS)	Output Capacity: 3kVA	1 set
	Microbiological Analysis Apparatus	Filtration Equipment, Bacteria Incubator, Autoclaved Sterilizer, Test Filter, Petri dish, Agar Culture medium, etc.	1 set

Item	Equipment /Material	Specifications	Qty
	Continuous Measurement Water Quality Analyzer	Analyzer that continuously measures the turbidity of treated water. Measurement Range: 0-100NTU(Turbidity), 0-3mg/L (Residual Chlorine)	1 set
	Reagents	pH Standard Solution, BTB reagent, DPD reagent, etc.	1 set
	Glassware	Beaker, Measuring Flask, Pipette, burette, etc.	1 set
	Laboratory Table	Central Laboratory Table (including reagent shelf, socket outlet, piping and wiring), Side Laboratory Table, Sink	1 set
	Other	Storage Shelf, Refrigerator, Desk/Chair	1 set
Tools for Mechanical Equipment	Clamp Power Meter	Voltage Range: AC600V Current Range: AC600mA-AC 1000mA (or above)	1 set
	Vibration Checker	Acceleration: 0.02-200m/s^2、Velocity:0.3-1,000mm/s Displacement: 0.02-100mm	1 set
	Mechanical Torque Wrench	Measurement Range:50-300Nm	1 set
	Portable Ultrasonic Flow meter	Measurement Range of Pipe Diameter:13-600mm	1 set
	Sieve Shaking Machine	Effective Diameter: 0.8mm-1.0mm	1 set
	Butt Fusion Machine for PE	Φ63-280mm	1 set
Accounting System Equipment	SUMS System	Computer×3 (for billing, accounting and casher, 1 PC for 1 software), UPS×1, Printer×1, SUMS Software (Full License x 2, Light License x 1) Software of full license includes “Billing “and “Accounting”. Software of light license includes “Casher”. Since each software of “Billing”, “Accounting”, “Casher” is operated by separated PC, three (3) PC will be required.	1 set
Service connection installations	Water Supply Equipment	Per 1 set ・ snap taps with saddle for DN350mm~OD63mm) ・ HDPE water supply pipe (25mm) 30m ・ Water meter (15mm, Tangential flow impeller type, Single-jet, Class C) ・ Stopcock (15mm) ・ Attachment (joint, coupling, etc.)	257 sets

3) Technical Assistance (Soft Component)

Training in the following 3 items will be provided under the technical assistance (soft component) of this project.

- Operation and maintenance of water treatment facilities
- Operation and maintenance of water transmission and distribution facilities
- Production management (Water supply facility management)

4. Implementation Plan and Cost Estimation

(1) Implementation Plan

The implementation plan of this project was formulated as the multiple year project considering its construction contents and construction period. The detailed design will be carried out in the first year and construction works including procurement of equipment and materials from the next year. The construction period is 6.5 months for detailed design, 3.5 months for bidding and contract period, and 25 months for construction works and procurement.

(2) Approximate Project Cost

Total expense of Cambodian side is approximately 669,825USD. The expense items are ground leveling for intake facility and drinking WTP, UXO survey, environmental monitoring survey, information and communication, electric power lead-in to new intake plant and new drinking WTP, bank arrangement, house connection works using procured equipment for poverty households and so on.

5. Project Evaluation

(1) Relevance of the Project

Beneficiary of the Project

Water supply to the residents in Pursat City is expanded by this project. The water supply coverage ratio of approximately 37.8% in 2018 in the controlled area of the WWs will increase to 67.9% in the target year:2025. The ratio in the urban area advocated by MIH becomes 86.1%. Approximately, 39,864 people will benefit.

Urgency of the Project

Although the Pursat City has an existing water supply system, the expansion of the system becomes the urgent matter for the further improvement of the water supply coverage ratio because the ratio remained approximately 37.8% in 2018.

Consistency with National Strategic Development Plan

Based on NSDP (National Strategic Development Plan, December 2017), MIH aims to work out 100% of the water supply coverage ratio in the urban area by 2025 by covering 90% with pipe water supply system and remaining 10% with other water supply system. This aim can be almost accomplished in the urban area within the administrative area of the WWs by this project.

This project also includes supplying equipment and materials to the poor households for house connection works conducted by the Cambodian side. Therefore, the consistency with the poverty reduction which is the greatest purpose in NPDS is ensured.

Consistency with Japan's ODA Policy

According to "Rolling Plan for the Royal Government of Cambodia, July 2017", one of the important priority areas is "Promotion of Social Development" including "Program for Water Supply and Sewage System". The implementation of this project has consistency with this Japan's ODA policy.

(2) Effectiveness

About the effectiveness of this project, the following quantitative effects and a qualitative effect are expected.

Quantitative Effects

Quantitative effects by the expansion of water supply system in Pursat City are expected as shown in the table below.

No.	Indicator	Baseline Data (Year 2018)	Target (Year 2025) (3 years after completion of the new facilities)
1	Water Supply Capacity (m^3/day)	5,607	11,386
2	Served Population[1]	37,661	75,033

Note: refer to 2-2-2-1 for calculation method

Qualitative Effects

Qualitative indicators by the project are expected as follows.

- Improving living environment of the residents
- Increasing house connections for the poor household

As mentioned above, the relevance of the project is high, and both quantitative and qualitative effects by the project are expected.

[1] If the population growth in the water supply area undergoes predictably, the water supply coverage ratio: approximately 37.8 % in the controlled area of Water Works in 2018 will be 67.9% and 86.1% in its urban area in 2025.

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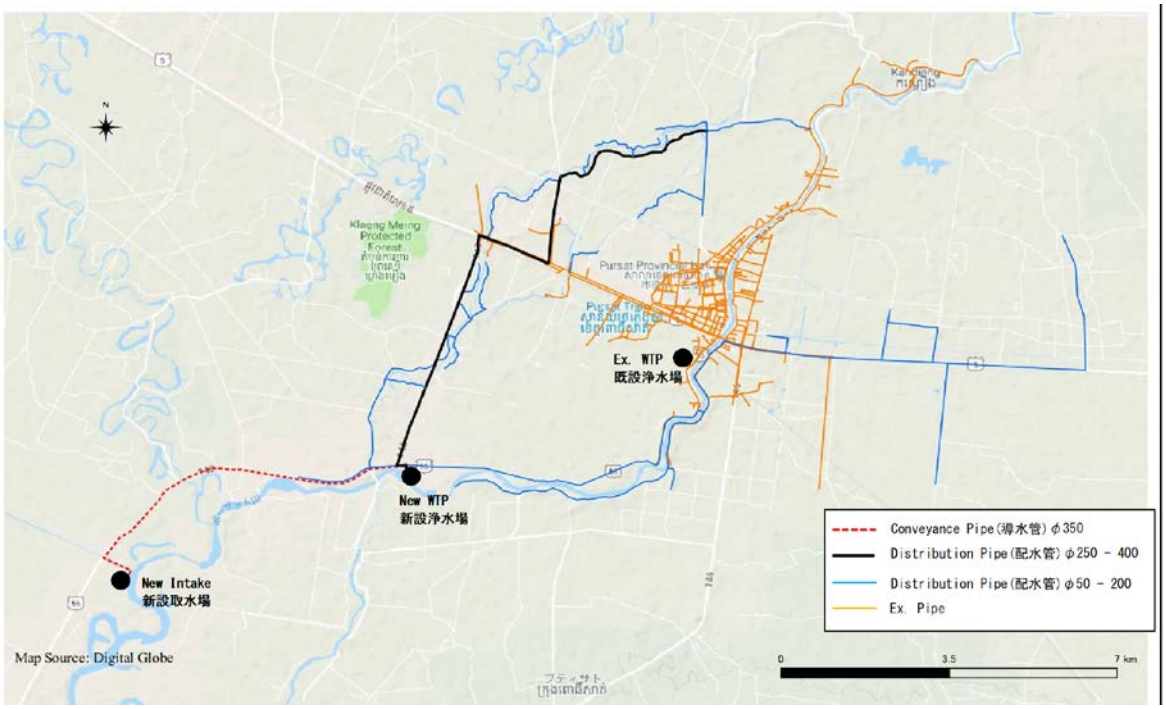
Location Map



Facility Layout in the Project Area

Perspective of Intake and Water Treatment Facilities

Existing Facilities

Photo1-1：Existing Intake (June 2017)

Photo1-2：Existing Intake Pump Facility (June 2017)

Photo1-3：Existing Intake Pump (June 2017)

Photo1-4：Existing WTP (June 2017)

Photo1-5：Existing WTP (June 2017)

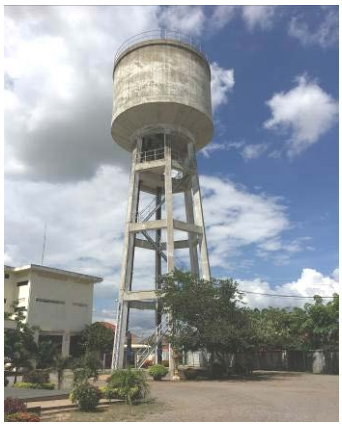


Photo1-6：Existing Elevated Water Tank (June 2017)

Planned Site for New Facilities

Photo2-1：Damnak Ampil, downstream of the new intake point (Aug. 2017)

Photo2-2：New Intake Point. The left bank of upstream from Damnak Ampil (Aug. 2017)

Photo2-3：Land for new WTP, the left bank of Pursat River (Aug. 2017)

Photo2-4：Drainage point from new WTP to Pursat River (Aug. 2017)

Situation of Similar Project

Photo3-1：Intake in Battambang (June 2017)

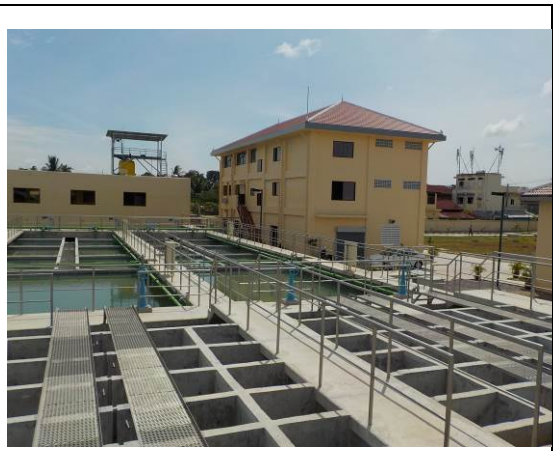


Photo2-2：WTP in Battambang (June 2017)

Situation of Water Utilization

Photo4-1：Shallow well drilled in each commune. People has not use it because of drying up (July 2017)

Photo4-2：Water pot put in each house. People store both tap water and rain water in it (July 2017)

Photo4-3：A house of a poor family. Although there is a water faucet in a house, water consumption is small. (July 2017)

Photo4-4：A private house. Pipes are installed from the roof to the water pot so that rainwater can be collected in the house on the left side (July 2017)

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ABBREVIATIONS

ADB	Asian Development Bank
ADCP	Acoustic Doppler Current Profiler
APGR	Annual Population Growth Rate
ARAP	Abbreviated Resettlement Action Plan
BM	Bench Mark
BMZ	Federal Ministry for Economic Cooperation and Development
BOD	Biochemical Oxygen Demand
CDC	Council for the Development of Cambodia
CMAC	Cambodia Mine Action Center
CMDGs	Cambodia Millennium Development Goals
CRC	Complaint Resolution Committee
DAIS	Damnak Ampil Irrigation System
DCIS	Damnak Chheukrom Irrigation System
DIH	Department of Industry and Handicraft
DIP (DCIP)	Ductile Cast Iron Pipe
DOA	Department of Agriculture
DOE	Department of Environment
DOWRAM	Department of Water Resources and Meteorology
DPWS	Department of Potable Water Supply
DPWT	Department of Public Works and Transports
EAC	Electricity Authority of Cambodia
EC	Expropriation Committee
EDC	Electric du Cambodia
EIA	Environmental Impact Assessment
EMOP	Environmental Monitoring Plan
EMP	Environmental Management Plan
FS (F/S)	Feasibility Study
GOJ	Government of Japan
HDPE	High Density Polyethylene
HW	Headworks
HWL	High Water Level
IBA	Important Bird Area
IEE	Initial Environmental Examination
IEIA	Initial Environmental Impact Assessment
IMF	International Monetary Fund
IMO	Independent Monitoring Organization
IRC	Inter-ministerial Resettlement
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature and Natural Resources
IWRM	Integrated Water Resources Management
JEC	Japanese Electrotechnical Committee
JICA	Japan International Cooperation Agency
JIS	Japanese Industrial Standard
KBA	Key Biodiversity Area
KHR	Cambodia Riel
LC	Least Concern
LCC	Life-cycle cost
Lpcd (LPCD)	litre per capita day, unit water consumption per day per capita
LWL	Low Water Level

MCM	Million Cubic Meter
MD	Minute of Discussion
MDGs	Millennium Development Goals
MEF	Ministry of Economic and Finance
MEK-WATSAN	Mekong Region Water Supply and Sanitation Initiative
MIH	Ministry of Industry and Handicraft
MIME	Ministry of Industry, Mines and Energy
MME	Ministry of Mines and Energy
MOE	Ministry of Environment
MOP	Ministry of Planning
MOWRAM	Ministry of Water Resources and Meteorology
MP (M/P)	Master Plan
MPWT	Ministry of Public Works and Transport
MRD	Ministry of Rural Development
MWL	Mean Water Level
NCDD	National Committee for Sub-National Democratic Development
NPRS	National Poverty Reduction Strategy
NRW	Non-Revenue Water
NSDP	National Strategic Development Plan
PAC	Poly-Aluminium Chloride
PAP	Project Affected Person / People
PIU	Project Implement Unit
PMO	Project Management Office
PMR	Project Monitoring Report
PPWSA	Phnom Penh Water Supply Authority
PWWs	Pursat Waterworks
RAP	Resettlement Action Plan
RGC	Royal Government of Cambodia
ROW	Right of Way
S/V	Supervision
SDGs	Sustainable Development Goals
SEC	Expropriation Sub Committee
SEDP	Socioeconomic Development. Plan
SEZ	Special Economic Zone
SOP	Standard Operating Procedure
SPM	Suspended Particulate Matter
SUMS	Synergistic Utility Management System
SUR	Svay Rieng
TOR	Terms of Reference
TPW	Targeted Provincial Waterworks
TSP	Total Suspended Particles
UN	United Nations
UNESCO	United Nations Educational, Scientific, and Cultural Organization
UN-Habitat	United Nations Human Settlements Programme
USGS	United States Geological Survey
UXO	Unexploded Ordnance
WB	World Bank
WTP	Water Treatment Plant
WWs	Waterworks

UNITS

Length /Thickness	:	km, m, cm, mm, μm
Weight	:	mg, g, kg, t
Time	:	second: s, sec・minute: min・hour: h, hr・day: d・year: y, yr
Pressure	:	Pa, kPa, MPa, mmAq, atm,bar
Volume	:	cm^3, m^3, L (L: liter), MCM
Flow Rate (volume)	:	m^3/h, m^3/min, m^3/d, L/min, mL/min
Flow Rate (mass)	:	kg/h, t/h
Density	:	kg/m^3, g/cm^3, mg/L
Velocity	:	cm/s, m/s, km/h
Viscosity	:	Pa･s, mPa･s
Area	:	mm^2, cm^2, m2, km^2, ha
Frequency	:	Hz
Power	:	W, kW
Voltage	:	V, kV
Electric Current	:	A, mA, kA
Temperature	:	degree C , degC, ℃
Torque	:	N・m
Rotation Speed	:	min-1
Force	:	N
Efficiency	:	%

Chapter 1. Background of the Project

1-1 Project Background

After the improvement of water supply system in Phnom Penh by the RGC, the government keeps improving the system in the provincial cities in Cambodia by expanding the accomplishment of water supply system in Phnom Penh. JICA has supported the government in the progress through Technical Cooperation, Grant Aid and ODA Loan.

"The Master Plan of Greater Phnom Penh Water Supply in the Kingdom of Cambodia" was formulated by the support of JICA in 1993 after the civil war. Based on the master plan, the WTP and distribution water pipe network were constructed through Japanese Grant Aid. Strengthening of management, operation and maintenance for the water supply system progressed through the technical cooperation with Water and Sewer Bureau, City of Kitakyushu and so on.

Synergistic effect with other donor's supports made Phnom Penh Water Supply Authority (PPWSA) as one of the best water supply corporations in Asia: 90% of water supply coverage ratio, 8% of water loss rate and 24-hour water supply in 2006. Meanwhile, the water supply coverage ratio in the provincial cities of Cambodia was at 35% in 2005.

The target water supply ratio of urban areas in provincial the cities is disseminated in the Ministry of Industry and Handicraft (MIH) to be 100% by 2025, and RGC is proceeding with the expansion of water supply facilities in the provincial cities.

As a result, it is possible to operate water supply system fairly: however, the water supply coverage ratio of the provincial cities is low now because of their low production capacity.

1-2 Natural Conditions

Topographic and line survey, soil investigation, water quality survey and river flow measurement survey described as below were carried out to determine the design conditions for the proposed project sites. The existing environmental conditions for the project sites are described in section "1.3 Environmental and Social Considerations".

1-2-1 Topographic and Line Survey

Topographic Survey

Topographic survey was conducted for new intake facility and WTP. As for planned intake facility site, cross-sectional survey of Pursat River was included to examine riverbed condition near the river banks. Plane survey was conducted spontaneously to design bank protection around new intake facility and range of cofferdam.

Line Survey

The line surveying was conducted on major routes of distribution pipes. Since this area is relatively flat, it is necessary to secure enough water supply pressure in a water distribution plan.

1-2-2 Soil Investigation

Proposed River Intake Site

The soil from the ground surface to 4.0m to 4.5m is cohesive soil, and the deeper than there is alternated layers of sandy clay and clayey sand. Since N-value of designated excavation depth for the intake site is around 10, it is possible to excavate with backhoe.

Proposed WTP Site

The soil from the ground surface to 8.5m to 9.5m near the WTP is sandy clay, and the deeper than there is alternated layers of sandy clay and clayey sand. The clayey sand includes small gravel slightly. Since N-value to the designated excavation depth for the WTP is around 20, it is possible to excavate with backhoe.

N-value of sandy clay deeper than 8.5 to 9.5m at the plant is more than 50. Therefore, its soil condition is regarded as bearing stratum for such as the administration building with piled raft foundations in the WTP.

1-2-3 Water Quality Survey

The monthly water quality survey was conducted at Pursat River considered main water source from July 2017, and the survey results are shown in Table 1-3-3 and Table 1-3-4. The water quality near the proposed intake point is briefly described as follows.

- The turbidity is high whole year round, which always exceeds 50 NTU. The water color is brown.
- Hazardous elements have not been detected.
- The concentration of aluminum and iron is high, which is included in turbid material.
- BOD as an indicator of domestic wastewater contamination and is low.
- Ammonium is detected at all measurement point in low level (0.01 – 0.23 mg/L).

According to the monthly water quality survey of Pursat River, hazardous elements which are difficult to remove have not been detected. The water turbidity is too high to drink; however, it will become suitable level after conventional water treatment process.

1-2-4 River Flow Measurements

A discharge measurement was conducted from June 2017 to October 2017 to check the quantity of water intake.

River flow discharge at Damnak Ampil HW is estimated to be slightly smaller than 9 to 9.5m^3/s in 2015 which is the most drought year recently.

ADB's plan of the Damnak Chheukrom Irrigation System (DCIS)[1)] has been formulated based on the design drought with 5-year return period. According to this plan, in case of future development of the DCIS under the existing Damnak Ampil Irrigation System (DAIS), the normal discharge of 4.74 m^3/s will be constantly released from the Damnak Ampil HW to the river all through the year even under 5-year return period of drought.

Based on the above analysis, water intake quantity for domestic water supply (Existing 7,260 m^3/day x 1.1 =7,986 m^3/day, New 6,600 m^3/day x 1.1 =7,260 m^3/day, and Total 15,246 m^3/day m^3/day = 0.18 m^3/s) can be ensured even under 10-year return period of drought.

[1] ADB TA 6456-REG: Preparing he Greater Mekong Sub region Flood and Drought Risk Management and Mitigation Project, Irrigation Engineers Report (May 2012). 0.26m^3/s is based on the Hydrological Aspect Presentation of the River Basin Water Resources Utilization Project of JICA.

1-3 Environmental and Social Considerations

1-3-1 Project Component and JICA Environmental Categories

This is a project which sets out to expand the existing water supply system, based on a request from the Cambodian Government. It does not fall in a project of water supply, sewage, and wastewater treatment that have sensitive characteristics or that are in sensitive areas as discussed in the JICA Guidelines for Environmental and Social Consideration (April 2010; hereinafter JICA Environmental Guidelines). Given this, the project was classified as Environmental Category B based on the JICA Environmental Guidelines.

In consultations with MIH and MOE, it is confirmed that an Initial Environmental Impact Assessment (IEIA) is required for this project according to Cambodian regulations. As such, the Survey has assisted in preparing as an IEIA.

There are three components which are considered to make impact on environment and social conditions, i.e., (1) construction of intake facilities, WTP, pipe laying work, (2) operation of intake facilities and WTP, and (3) equity of beneficiaries.

1-3-2 Basic Environmental and Social Circumstances

Cambodia (official name: Kingdom of Cambodia) is a country located in the south of Indochina Peninsula in the Southeast Asia. It belongs to tropical monsoon of climate zone and has clear rainy season and dry season. The project area is shown in the following figure.

Figure 1-3-1 Project Area

1-3-2-1 Protected Area

"Royal Decree on the Protection of the Natural Area, 1993" is the first regulation determining natural protection area in Cambodia. The Decree defines 23 natural protection areas into four categories.

The "Law on Natural Protected Areas" was enacted in 2008, and it defined eight categories of protection purposes and four management zones. Furthermore, in 2017, "Sub decree on Establishment of Biodiversity Conservation Corridor in Natural Protected Area" was enacted to determine biodiversity conservation corridor, which resulted in about 40% of the country declared as natural protected areas. The following map shows the protected areas.

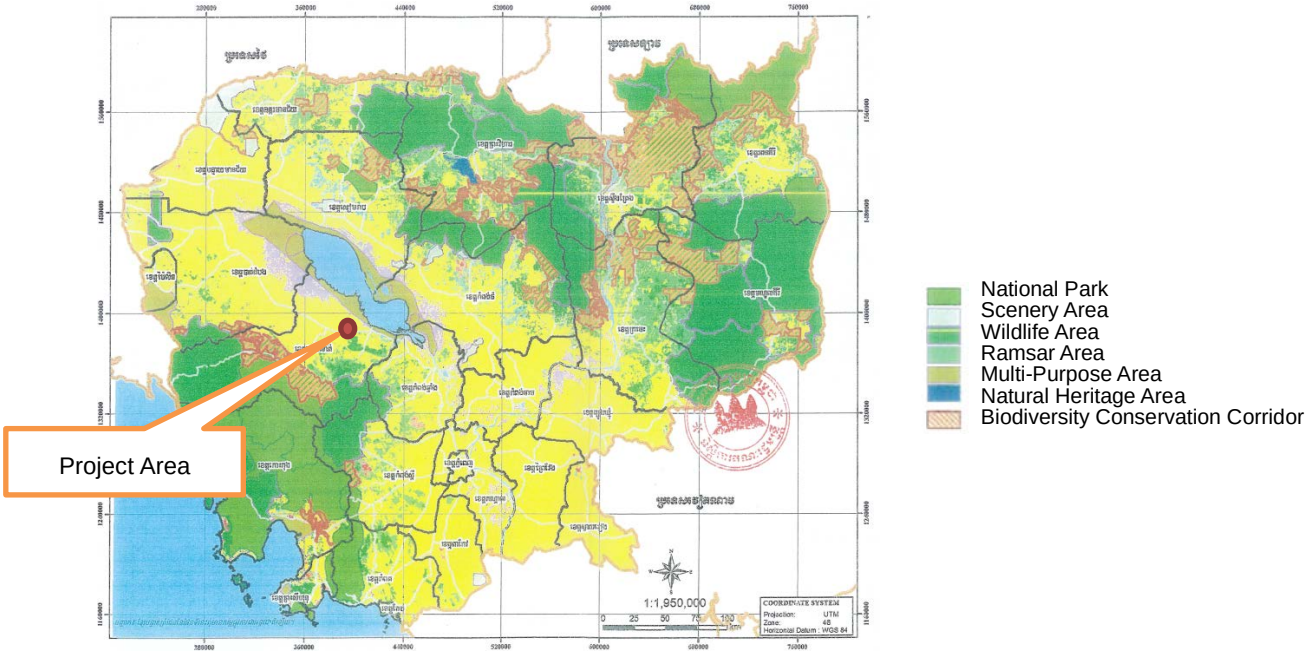


Figure 1-3-2 Protected Areas in Cambodia

Source：Sub Decree on Establishment of Biodiversity Conservation Corridor in Natural Protected Area

There are some protected areas in Pursat province, which are located near the Tonle Sap Lake and the forest area at southwest part of the province. There is no protected area near the project area. It is also confirmed that there is no protected area by the provincial order with Pursat provincial department of environment.

There are 40 areas of Key Biodiversity Areas (KBAs) which are considered as important places for the protection of biodiversity, and 36 places out of KBAs are Important Bird Areas (IBAs). The nearest KBA from the project area is Dei Roneat which is located in the lakeshore of Tonle Sap Lake, and the distance from the project area is more than 10 km.

1-3-2-2 Cultural Heritage etc.

There are three important heritages registered as World Heritage by UNESCO such as Angkor, but the location of them is more than 100 km far from the project site.

1-3-2-3 State of Natural Environment

Cambodia has very rich natural environment. There are ecologically important places such as Tonle Sap Lake, Mekong River and its tributaries. As described above, Cambodian government declares more than 40 % of land as protected area so that they endeavor to conserve the natural environment. In this rich environment, there are many kinds of threatened species. The next table shows the species of critically endangered and endangered species in Cambodia.

Table 1-3-1 Endangered Species in Cambodia

Status		Class	Number	Species
Critically Endangered CR	Fauna	Mammalia	5	Sumatran Rhinoceros, etc.
		Birds	7	Indian Black Vulture, etc.
		Fishes	6	Mekong Giant Catfish, etc.
		Amphibian	4	Damleis
		Reptiles	4	Common Batagur, etc.
	Flora	Vascular plant	8	Agar Wood, etc.
Endangered EN	Fauna	Mammalia	14	Indian Hog Deer, etc.
		Birds	10	Yellow-breasted Bunting, etc.
		Reptiles	3	Elongated Tortoise, etc.
		Amphibian	2	Musical leaf-litter toad, etc.
		Fishes	13	Jullien's Golden Carp, etc.
		Corals, sea cucumber	7	Golden Sandfish, etc.
	Flora	Vascular plant	17	White Meranti, etc.

Source: IUCN Red List

The project area and its surroundings consist of urbanized area and farming land. The only small area has secondary forest in a part of uncultivated land. The area shows beautiful rice field and countryside scenery, but it is considered natural with artificial modification.

The project area is in a flood plain of the Pursat River that flows into the west side of Tonle Sap Lake, and it has relative flat topography. The upper stream of the Pursat River is designated as a protected area with a rich ecosystem. On the other hand, the project area has no significant forest, therefore the habitats for wildlife are cultivated land, scrub, river and river forest. The survey for ecosystem was conducted by interviewing and practical survey at the site. The results are summarized below.

(1) Birds

There are 49 species of bird recorded. All of them are listed as Least Concern (LC) in IUCN Red list and don't fall in any categories of CITES[2] list. These species are common and widely spread. The typical species observed in the site prefer the open, cultivated, or wetland, such as Paddy field Pitpit,

[2] Convention on International Trade in Endangered Species of Wild Fauna and Flora

Scaly-breasted Munia and Common Tailorbird. These species have habitat in the project area where are developed area. Therefore, the population density is not so high.

(2) Reptiles and Amphibian

There are 11 species of amphibian and 7 species of reptiles recorded. According to IUCN Red List, all of them are categorized in LC and not listed in CITES.

(3) Fish

The survey was conducted at the LoLok Sor Commune beside the Pursat River by interviewing and a practical survey in the river. The results recognized 112 species of fish. Among them, there are two Endangered species, four Vulnerable species, four Near Threatened species and 102 Least Concern species based on IUCN Red List. Ministry of Agriculture Forestry and Fishery has own Red List, and Thickip barb is defined as critically endangered and Dwarf goonch is defined as vulnerable.

1-3-2-4 Air Quality

The scheduled monitoring of the air quality in this area has not been conducted. The Department of Environment (DOE) of Pursat has no equipment and manpower to carry out the air quality monitoring, therefore, the air quality measurement must be conducted by MOE survey team if needs arise.

The project area has not been industrialized, so that the discharge of air pollutant from industrial activities is expected to be very low. Therefore, the major source of air pollution is exhaust gas of vehicles. Although the national highway five passes the center of the Pursat city, its traffic is not so much and the emission loads from vehicles is considerably limited. The topography of this area does not allow the stay of the pollutant in the area. For these reasons, the ambient air quality in this area is expected to be good.

The Survey Team requested MOE to carry out the air quality survey. It was conducted on 2nd February 2018, and its result is summarized in the following table.

Table 1-3-2 Results of Air Quality Measurement (mg/ m^3)

Parameter		Site 1	Site 2	Cambodian Standards	Environmental Standards in Japan (24 hours average)
Carbon oxide	CO	0.85	0.50	20 (8 hours average)	10
Nitrogen dioxide	NO2	0.011	0.009	0.1 (24 hours average)	0.04～0.06 or less
Sulfur dioxide	SO2	0.006	0.004	0.3 (24 hours average)	0.04
Total suspended particulate matter	TSP	0.150	0.094	0.33 (24 hours average)	0.1（SPM:10μm >）

Source: Survey Team

All parameters satisfy the Cambodian standards requirement and are also less than the Japanese environmental standards. Japanese standard of suspended particulate matter is for the particle which is less than 10μm in diameter, so that it is not referable directly. TSP shall include bigger size of particles and it might give larger value, thus the TSP is in an acceptable level.

1-3-2-5 Water Use and Water Quality

There are several surface water sources, such as the Pursat River flowing from the west to the east and irrigation canals using the Pursat River water. Since there are not good groundwater sources due to hydrogeological conditions, the groundwater use is limited in this area. because. According to the result of the social survey, about 60% of people who live outside the existing water supply area use rainwater for drinking purpose, and 9 % use well water, 4 % use surface water, and 2% use dug well to collect drinking water. The remaining 16 % of people purchase water from water vendors.

On the other hand, the people connected to the provincial water supply say that they use rainwater as the second drinking water source. This suggests that people in this area are used to drinking rainwater. Besides, 15 % of the people connected to the existing water supply answered that they used bottled water as a primary source of drinking water.

There are no commercial fishing activities in the Pursat River but only fishing for fan or for family consumption. It was observed that people washed clothes and children played with water at the irrigation canals in this field survey.

The main industry in Pursat is agriculture, especially rice farming. Therefore, there is fear of water pollution from agrochemicals. Most of the pesticides used in this area are products of Vietnam and Thai land. Additionally, Chinese, Japanese and European products are imported and used. Only the registered fertilizers to MOE are allowed to be used in Cambodia, but the illegal use of unregistered pesticides is reported[3]. The rice grown is mostly single cropping, and there is rarely double cropping in this area. Farmers usually apply fertilizers and pesticides for about one month after seeding and it is the main season of agrochemicals application. They sometimes apply agrochemical additionally at later time. Some farmers grow watermelon etc. in the dry season, but the use of agrochemical is limited. Accordingly, the Survey Team considered that the highest pollution period is one month after seeding and carried out the sampling on 18th July 2017 in accordance with the result of interview to provincial Department of Agriculture (DOA) and farmers. The Survey Team brought samples to Japan to be analyzed by a certified and experienced laboratory because there is no laboratory which has capability to analyze trace level of pesticides in Cambodia. All the 18 pesticides of Drinking Water Quality Standards of Cambodia (2004) [4] and the 328 pesticides which are frequently detected at the Japanese

[3] V. Preap, et. Al. (2015), "Current use of pesticides in the agricultural products of Cambodia", FFTC-KU International

[4] The Drinking Water Quality Standards of Cambodia (2004) was updated in 2015. The new standards do not include pesticides because parameters which cannot be monitored in Cambodia were omitted. The Survey Team refer the old standards because there is no referable document.

quarantine station were analyzed, and no pesticides were detected. Therefore, it is concluded that the pesticides from rice production does not significantly pollute the water source.

The monthly water quality survey conducted at Pursat River which was considered as main water source from July 2017 to May 2018, and the results are summarized in following table. The water quality near the planned intake point is briefly described as follows.

- The turbidity is high whole year round, which always exceeds 50 NTU. The water color is brown.
- Hazardous elements have never been detected.
- The concentration of aluminum and iron is high, which is included in turbid material.
- BOD as an indicator of domestic wastewater contamination is relatively low.
- The parameters which indicate the domestic wastewater contamination, e.g., coliform, E-Coli and ammonia are observed relatively high at the existing intake site than at the planned intake site.
- Ammonium is detected at all measurements even in low level, the range at the planned intake site is from 0.01 to 0.24 mg/L, and range at the existing intake site is from 0.01 to 0.61mg/l.

The water turbidity is too high to drink; however, it will become suitable level after conventional water treatment process.

Table 1-3-3 Result of Water Quality Survey (1)

No	Parameter	Site	Intake 1 (Planned intake site)											NDWQS	Japanese drinking water standards	WHO guidelines
		Year	2017						2018							
		Month	7	8	9	10	11	12	1	2	3	4	5			
1	pH	-	6.76	6.14	5.64	5.87	6.76	6.56	6.96	7	7.56	7.6	7.4	6.5-8.5	5.8-8.6	—
2	Water Temperature	°C	29	31	30	28	28	27	28.5	26	31.8	31.1	32	—	—	—
3	Electrical Conductivity(EC)	µs/cm	55.6	79	46.2	40.1	56.5	28.9	71.9	75.8	100.4	96.7	78.6	—	—	—
4	Total Dissolve Solids (TDS)	mg/L	53	76	44	39	54	28	69	73	98	95	77	<800	<500	—
5	Dissolved Oxygen(DO)	mg/L	7.21	7.05	6.64	6.3	4.49	4.78	5.98	6.5	5.95	6.3	6.2	—	—	—
6	Turbidity	NTU	115	135	50	94	66	70	28	30	26	46	62	<5.0	< 2	—
7	Color	mg/L Pt	430	>500	290	350	150	270	140	155	137	185	297	<5.0	<5	—
8	Total Suspended Solid(TSS)	mg/L	83	97	83	87	46	53.3	19.5	28	25.5	36.5	52	—	—	—
9	Total Hardness(as CaCO3)	mg/L	110	110	110	90	92	95	80	120	105	145	150	<300	<300	—
10	Biochemical Oxygen demand (BOD)5	mg/L	1.8	1.88	2.05	2.6	0.09	1.02	1.6	1.2	1.2	1.25	1.6	—	—	—
11	Cyanide(CN-)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	<0.02	<0.01	—
12	Chloride (Cl^-)	mg/L	22.6	19.3	1.11	1.91	1.19	0.44	8.5	3.4	4.6	9.3	8.5	<250	<200	—
13	Ammonia (NH_3)	mg/L	0.01	0.01	0.01	0.07	0.23	0.16	0.05	0.18	0.18	0.24	0.24	<1.5	—	—
15	Fluoride (F)	mg/L	0.24	0.29	0.14	0.14	0.21	0.1	0.15	0.1	0.25	0.05	0.05	<1.5	<0.8	<1.5
16	Nitrite (NO2)	mg/L	ND	ND	0	0	0	0.008	0.03	0.01	0.09	0.03	0.03	<3.0	<44*	<3
17	Nitrate (NO_3^-)	mg/L	0.45	0.25	0.46	0.612	0.52	0.05	0.09	0.1	0.18	0.31	0.34	<50	as NO_2 + NO_3	<50
18	Aluminum (Al)	mg/L	5.09	4.9	1.86	0.45	0.22	4.62	1.02	0.86	1.03	0.31	0.74	<0.2	<0.2	—
19	Arsenic (As)	mg/L	ND	ND	ND	ND	ND	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01	<0.01
20	Barium (Ba)	mg/L	0.0002	0.0002	0.00953	0.106	0.006	0.02	0.02	0.02	0.02	0.03	0.03	<0.7	—	<1.3
21	Cadmium (Cd)	mg/L	ND	ND	ND	ND	ND	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.003	<0.003
22	Chromium(Cr)	mg/L	0.009	0.008	0.00908	0.016	ND	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.05 as Cr^{6+}	<0.05
23	Iron (Fe)	mg/L	0.51	0.21	0.102	0.05	0.05	2.24	1.36	1.07	1.15	1.48	1.46	<0.3	<0.3	—
24	Lead (Pb)	mg/L	0.001	0.003	0.00059	0.003	ND	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.01
25	Manganese (Mn)	mg/L	0.05	0.1	0.02762	0.048	0.02	0.01	0.08	0.06	0.05	0.1	0.08	<0.3	<0.05	—
26	Mercury (Hg)	mg/L	ND	ND	ND	ND	ND	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.0005	<0.006
27	Nickel (Ni)	mg/L	0.003	0.004	0.0034	0.006	ND	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.02	—	<0.07
28	Selenium (Se)	mg/L	—	—	—	—	—	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.01	<0.01	<0.04
29	Total Coliform	MPN/100ml	$2.1X10^3$	$1.5X10^3$	$2.1X10^3$	$2.1X10^3$	92	$1.5X10^3$	$1.5X10^3$	$2.0X10^2$	$4.3X10^2$	$1.5X10^2$	$1.5X10^3$	0	—	—
30	E-Coli	MPN/100ml	$2.8X10^2$	$2.9X10^2$	$2.8X10^2$	61	36	36	$1.5X10^2$	61	92	61	$1.5X10^2$	0	0	0

Source: Survey Team

Table 1-3-4 Result of Water Quality Survey (2)

No	Parameter	Site	Intake 2 (Existing intake site)											NDWQS	Japanese drinking water standards	WHO guidelines
		Year	2017						2018							
		Month	7	8	9	10	11	12	1	2	3	4	5			
1	pH	-	6.64	6.19	5.74	5.84	6.48	6.52	7.01	7.2	7.43	7.2	7.2	6.5-8.5	5.8-8.6	–
2	Water Temperature	°C	29.5	31	31	28	27.5	28	29	26.8	32.5	30.4	30.4	–	–	–
3	Electrical Conductivity(EC)	µs/cm	55.8	56	44.8	37.7	58	47.9	69.3	92.2	84.6	85	102.7	–	–	–
4	Total Dissolve Solids (TDS)	mg/L	53	58	43	36	56	46	67	89	83	83	101	<800	<500	–
5	Dissolved Oxygen(DO)	mg/L	6.03	6.53	6.95	5.68	5.4	5	5.2	6.5	4.5	5.8	5.8	–	–	–
6	Turbidity	NTU	115	110	60	86	52	70	32	26	26	48	54	<5.0	< 2	–
7	Color	mg/L Pt	400	500	295	360	205	320	175	165	180	160	290	<5.0	<5	–
8	Total Suspended Solid(TSS)	mg/L	79	82	79	75	54	78.89	30	31.5	24	34	44	–	–	–
9	Total Hardness(as CaCO3)	mg/L	135	115	135	70	84	95	80	135	115	130	165	<300	<300	–
10	Biochemical Oxygen demand (BOD)5	mg/L	1.4	1.55	1.4	1.2	1.05	1.15	1.2	1	1.4	1.62	2	–	–	–
11	Cyanide(CN-)	mg/L	ND	ND	ND	ND	ND	ND	ND	ND	ND	DN	DN	<0.02	<0.01	–
12	Chloride (Cl^-)	mg/L	22.95	13.78	0.97	1.03	1.28	0.29	9	6.5	7.4	9.3	17.7	<250	<200	–
13	Ammonia (NH_3)	mg/L	0.008	0.007	0.008	0.19	0.3	0.23	0.05	0.18	0.22	0.61	0.37	<1.5	–	–
15	Fluoride (F)	mg/L	0.1	0.11	0.13	0.14	0.21	0.05	0	0.15	0.05	0.1	0.02	<1.5	<0.8	<1.5
16	Nitrite (NO2)	mg/L	ND	ND	0	0	0	0	0.03	0.02	0.08	0.09	0.21	<3.0	<44*	<3
17	Nitrate (NO_3^-)	mg/L	0.27	0.12	0.49	0.54	0.66	0.02	0.11	0.02	0.35	0.44	0.66	<50	as NO_2 + NO_3	<50
18	Aluminum (Al)	mg/L	4.39	3.6	2.357	0.92	0.18	4.97	1.44	1.14	2.17	0.31	0.73	<0.2	<0.2	–
19	Arsenic (As)	mg/L	ND	0.01	ND	ND	ND	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.01	<0.01
20	Barium (Ba)	mg/L	0.0003	ND	0.00995	0.15	0.006	0.02	0.02	0.03	0.02	0.01	0.02	<0.7	–	<1.3
21	Cadmium (Cd)	mg/L	ND	ND	ND	ND	ND	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.003	<0.003	<0.003
22	Chromium(Cr)	mg/L	0.009	0.007	0.00969	0.018	ND	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.05	<0.05 as Cr^{6+}	<0.05
23	Iron (Fe)	mg/L	0.19	0.15	0.11097	0.07	0.051	2.27	1.58	1.29	1.81	0.74	1.46	<0.3	<0.3	–
24	Lead (Pb)	mg/L	0.001	0.002	0.00319	0.003	ND	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.01	<0.01
25	Manganese (Mn)	mg/L	0.03	0.08	0.02697	0.06	0.024	0.01	0.06	0.07	0.06	0.06	0.08	<0.3	<0.05	–
26	Mercury (Hg)	mg/L	ND	ND	ND	ND	ND	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.001	<0.0005	<0.006
27	Nickel (Ni)	mg/L	0.002	0.002	0.00534	0.007	ND	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.02	–	<0.07
28	Selenium (Se)	mg/L	—	—	—	—	—	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	<0.01	<0.01	<0.04
29	Total Coliform	MPN/100ml	$1.1X10^4$	$4.6X10^3$	$1.1X10^4$	$1.1X10^4$	$1.1X10^4$	$1.1X10^4$	$4.3X10^3$	$2.8X10^2$	$1.1X10^4$	$9.3X10^2$	$2.1X10^3$	0	–	–
30	E-Coli	MPN/100ml	$3.6X10^2$	$3.6X10^2$	$3.6X10^2$	72	$4.3X10^2$	74	36	74	$1.5X10^3$	72	$4.3X10^2$	0	0	0

* Japanese standard defines value of sum of nitrate nitrogen and nitrite nitrogen as 10mg/l. This is a converted value as nitrate concentration.

Source: Survey Team

The Pursat River water is mainly used for irrigation purposes, but the amount for water supply and environmental management flow will be secured even further development of irrigation water. On 14th September,2017, MOWRAM issued an approval letter to extract water from the Pursat River.

1-3-2-6 Noise and Vibration

The project area is not industrialized, and the traffic is not much except on the national road, so that the source of noise and vibration is limited. On the other hand, the registered number of vehicles is rapidly increasing which was reported as 14% increasing rate in 2015. Therefore, a certain level of road noise is expected alongside the main road. There was no available monitoring data, thus the Survey Team conducted continuous 24 hours survey for noise and vibration on 2nd and 3rd February 2018. The results are summarized in the following table. Site 1 and Site 2 are located near the planned intake site and the planned WTP site respectively. The table shows the equivalent continuous sound (vibration) levels, and maximum levels are indicated in parentheses. It was reported that the maximum value was recorded at the heavy rain period.

Table 1-3-5 Results of Noise and Vibration Survey

	Site 1	Site 2	Referable Standards		
Noise（6：00～18：00）	54.6 (118.4)	49.7 (101.5)	II	III	Cambodian noise standards II：Residential area III：Commercial area
			60	70	
Noise（18：00～22：00）	46.5 (54.9)	46.1 (54.9)	50	65	
Noise（22：00～6：00）	42.7 (49.9)	42.3 (38.3)	45	50	
Vibration（6：00～18：00）	27.3 (32.6)	12.9 (42.5)	65		Request limit of road traffic vibration in Japan (category 1 area)
Vibration（18：00～6：00）	25.9 (42.5)	12.5 (40.7)	60		

Source: Survey Team

The Cambodian noise level standards have categories, i.e., I: Quiet area, II: Residential area, III: Commercial and service areas and mix, IV: Small industrial factories intermingling in residential areas. DOE of Pursat consulted us that the project area fell in the category III. The result of survey shows that it satisfies the standards of category II as well as III.

Because there is no standard or guidelines for vibration in Cambodia, the result is compared with the “Request limit of road traffic vibration” under the Vibration Regulation Act in Japan. Category 1 area is the area of keeping quiet to conserve the good environment, and the area for residential use. Both noise and vibration are recorded as low level, and the environment in these terms is good.

1-3-2-7 Economic Indicators

The main industry in Pursat is agriculture, and the area of paddy field is the largest there. Additionally, there are other agricultural activities such as food cash crops like corn, cassava, bean and vegetables, stock farming, and the fishery in the Tonle Sap Lake.

The following figure shows the target districts and communes[5] of the Project. The area shown in green color is the target communes.

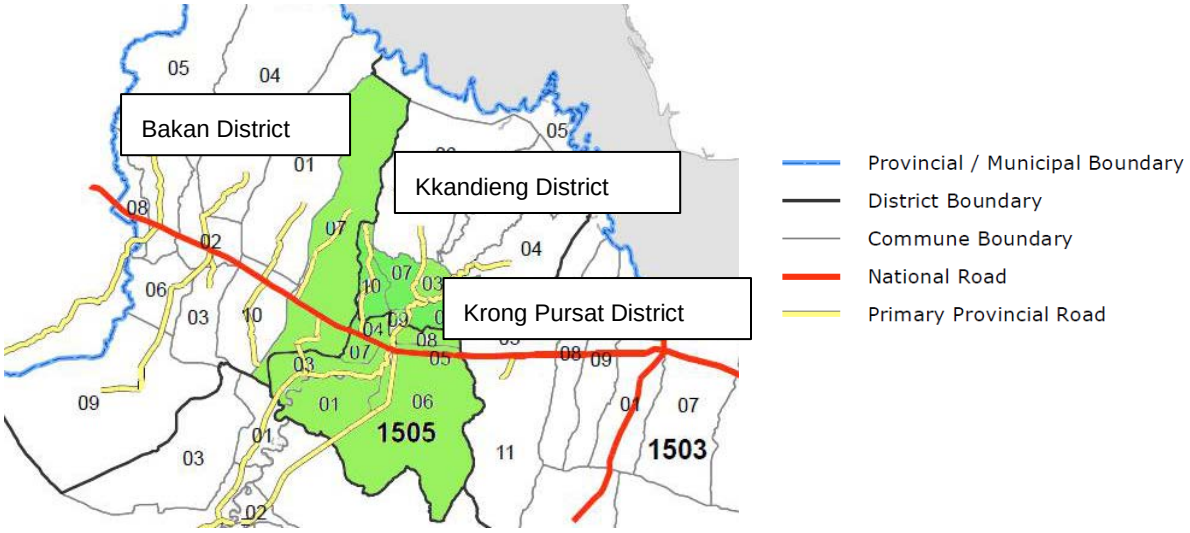


Figure 1-3-3 Target Administrative Area

The district-wise occupation in the project area is shown in the following table. Krong Pursat district including Pursat city is relative urbanized area and its ratio of employment worker is higher than other districts; however, the ratio of farmer is still more than half. Most of the beneficiaries of the Project will be farmers.

Table 1-3-6 Occupation (%)

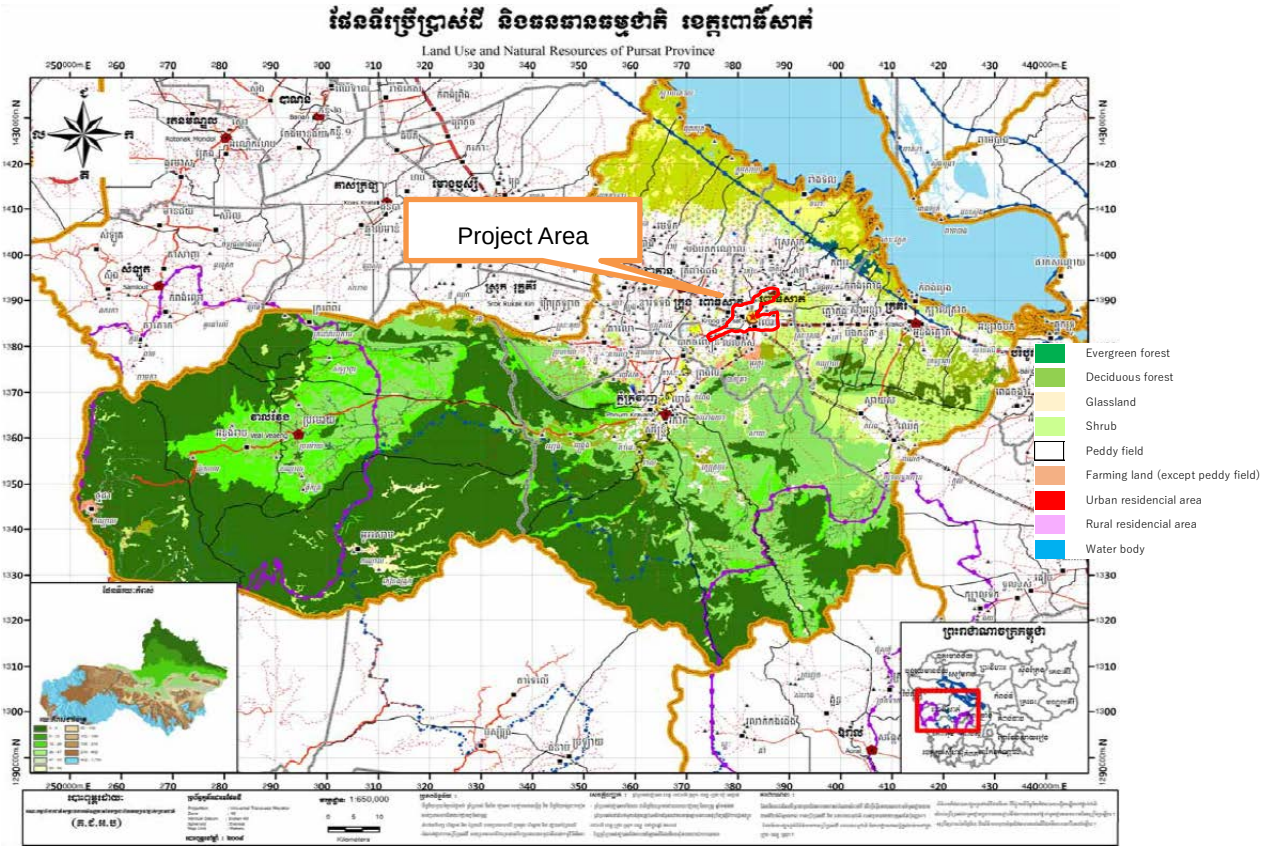
District	Agriculture	Craft work	Service
Pursat Province	85.4	0.4	12.4
Bakan	90.3	0.2	7.6
Kandieng	86.2	0.1	13.3
Krong Pursat	57.0	2.0	37.5

Source: NCDD, Commune Database Online

1-3-2-8 Land Use

The following figure shows land use in Pursat Province and table shows the area of the purpose of use.

[5] Cambodia consists of 25 Provinces which include special administrative area of Phnom Penh. Province is subdivided into Districts. Commune is a further subdivided administrative area.



Source: Based on Pursat Data Book 2009

Figure 1-3-4 Land used Area by Category

Table 1-3-7 Area by Land Use

Land Type	Area（ha）	%
Settlement	7,359.62	0.6
Paddy Field	154,373.54	13.3
Farming Land	10,035.53	0.9
Evergreen Forest	463,925.44	40.0
Deciduous Forest	198,603.23	17.1
Mixed Forest	81,364.82	7.0
Other Forest	123,520.39	10.7
Grassland	23,158.65	2.0
Scrub	31,800.37	2.7
Barren Land	57,772.66	5.0
Water	6,244.30	0.5

Source: Based on Pursat Data Book 2009

Seventy five percentage of land in Pursat province is covered by forest. It is clearly shown in the land use map that the forest area is mainly located in the south west area, and the north east area including

project area is covered by the farming land, urban and residential area. The three forth of farming land grows rice and it is mainly single cropping.

1-3-2-9 Solid Waste

The construction waste can be disposed at the land belonged to the project proponent if it is not hazardous. If there is hazardous material, the waste will be analyzed by MOE.

Based on the agreement between Pursat Waterworks (PWWs) and DOE, sludge generated from Pursat WTP is discharged to Pursat River now. In case of dried sludge, it can be treated same as nonhazardous construction waste, if it does not contain hazardous material. Since the sludge is a mixture of turbid materials in raw water and coagulant, the existence of hazardous materials is not expected. MIH indicated that the land owners accepted to receive such material for land filling as countermeasure of flooding, therefore the dumping of sludge would not be a problem.

1-3-2-10 Poverty

The Ministry of Planning of Royal Government of Cambodia carried out a household survey nationwide to identify poor households for the purpose of a poverty reduction program with the help of German Federal Ministry for Economic Cooperation & Development (BMZ), the Australian Department of Foreign Affairs & Trade and Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH. The program identifies households as Poor Level 1 (very poor) and Poor Level 2 (poor r), and provides Equity Cards to such households which enables them to receive appropriate support and benefits. The latest survey in Pursat province was conducted in 2013.

The following table shows the situation of the project area.

Table 1-3-8 Poverty Households in Project Area

District	Commune	Poverty Level 1		Poverty Level 2		Total
		Number	%	Number	%	Number
Bakan	Snam Preah	499	12.8%	521	13.4%	1020
Kandieng	Anlong Vil	230	19.1%	132	11.0%	362
	Kandieng	207	14.0%	299	20.3%	506
	Svay Luong	151	11.4%	209	15.8%	360
	Veal	174	15.2%	198	17.3%	372
	Kaoh Chum	154	9.2%	330	19.8%	484
Krong Pursat	Chamraeun Phal	291	21.5%	223	16.5%	514
	Lolok Sa	116	6.1%	170	8.9%	286
	Phteah Prey	44	2.5%	212	12.3%	256
	Prey Nhi	106	9.7%	133	12.1%	239
	Roleab	182	6.3%	359	12.4%	541
	Svay at	102	10.2%	187	18.7%	289

District	Commune	Poverty Level 1		Poverty Level 2		Total
		Number	%	Number	%	Number
	Sangkat Banteay Dei	102	8.0%	206	16.1%	308
	Sum	2,358		3,179		5,537

Source: Ministry of Planning, Identification of Poor Households Programme database

The number of poor households in this area is from 15% to 35% of total number of households.

1-3-2-11 Minority

The ethnic composition in Cambodia is 97.6% Khmer, 1.2% Cham, 0.1% Chinese, 0.1% Vietnamese and 0.9% of others (CIA world fact book, 2013 estimation). According to the hearing from DOE and city hall, there is no minority group in the project area.

1-3-2-12 Education and Literacy Rate

The following table shows the literacy rate and primary school enrolment ratio in Pursat province and the related districts to the project area.

Table 1-3-9 Literacy Rate and Primary School Enrolment Ratio（%）

District	Literacy rate（15~60 year-old）	Primary School Enrolment Ratio
Pursat Province	86.4	84.0
Bakan	88.0	87.0
Kandieng	82.9	78.7
Krong Pursat	92.3	90.2

Source: Based on NCDD, Commune Database Online

Krong Pursat district which contains urban area shows high score of literacy and primary school enrolment. Incidentally, the literacy rate in Phnom Penh which is the biggest city is about 98%. The next table shows the literacy rate in generation. It clearly shows that the literacy rate of younger generation is higher than elder generation.

Table 1-3-10 Literacy Rate of Pursat Province by Generation（%）

	15~60 year-old total	15~60 year-old Female	15~17 year old	18~24 year-old	25~60 year-old
Literacy Rate (%)	86.4	85.9	92.5	90.4	83.3

Source: Based on NCDD, Commune Database Online

According to the result of the social survey, the education level of head of household is that 91% went to school and about 10 % were educated up to high school and more.

1-3-2-13 State of Health and Hygiene

The data related health and hygiene obtained by the social survey are summarized in the following table. The samples consist of two groups, i.e., group of households receiving water supply from provincial waterworks (Connected HHs) and group of households living outside of supply area (Non-connected HHs).

Table 1-3-11 State of Health and Hygiene of Project Area

	Total	Connected HHs	Non-connected HHs
Ratio of owing Toilet（%）	86	98	75
Morbidity of Waterborne Disease （last three years）（%）	6	1	12

Source: Result of Social Survey

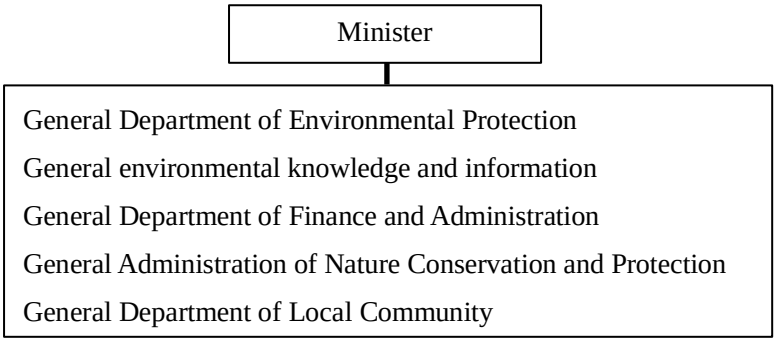
Ownership of toilets in Cambodia is relatively high. The morbidity of waterborne disease in last three years is significantly low in connected HHs than non-connected HHs.

According to the database of NCDD（National Committee for Sub-National Democratic Development）, the infant mortality (death under 5 year-old per 1,000 birth) is 26.7 in Pursat province and 8.1 in Pursat city. The health and hygiene condition in the urban area seems better than the rural area.

1-3-3 Environmental and Social Consideration Systems and Organizations in Cambodia

1-3-3-1 Environmental and Social Consideration Systems and Organizations

The Cambodian agency in charge of environmental issues is the Ministry of Environment (MOE). Five departments under the minister of MOE are working for their responsible subjects.



Each province has Department of Environment (DOE), and DOE is responsible for the environmental issues in the province. The legal framework in Cambodia is summarized below.

Table 1-3-12 Environmental Law and Regulations in Cambodia

Name	Purpose
Constitution（1993）	Article 59 states to preserve and protect environment and natural conditions by organizing a precise planning for the management.
Royal Decree on Creation and Designation of Protected Areas (1993)	This decree defines the area for projection, designation, management and responsibility.
Law on the Establishment of the Ministry of Environment (1996)	The Law states the establishment of Ministry of Environment and its obligations.
Law on Environmental Protection and Natural Resource Management (1996)	The Law is created to protect and promote environmental quality and public health.
Law on Protection of Cultural Heritage (1996)	The Law is for protection of national cultural heritage and cultural property.
Law on the Adoption of the Convention on Wetlands of International Importance (1996)	The Law is created for protection of wetland, especially for the Convention of Ramsar.
Sub-Decree on Environmental Impact Assessment Process (1999)	The Sub-Decree clarifies environmental assessment, application, procedure, etc.
Sub-Decree on Water Pollution Control (1999)	The Sub-Decree defines the management of ambient water quality, effluent regulation, etc.
Sub-Decree on Solid Waste Management (1999)	The Sub-Decree defines appropriate solid waste disposal, and related issues.
Sub-Decree on Air Pollution Control and Noise Disturbance (2000)	The Sub-Decree defines management of ambient air quality, controlling noise, vibration, and exhaust gas.
Law on Forestry (2002)	The Law is created for the protection of forest and wildlife.
Law on Water Resource Management (2007)	The Law clarifies principles of water management and organization in charge.
Protected Areas Law (2008)	The law defines the framework of management, conservation and development of protected areas.
Prakas on Registration of Consulting Firms for Studying and Preparing Environmental and Social Impact Assessment Reports（2014）	The Prakas (declaration) declares necessity of registration of consulting firm for EIA survey and preparation.
Sub-Decree on Establishment of Biodiversity Conservation Corridor in Natural Protected Area (2017)	The Sub-Decree declared the conservation corridor for the protection of natural environment.

Source: JICA Survey Team based on Laws and Regulations of Cambodia

1-3-3-2 Environmental Standards

The environmental standards and emission standards are summarized in the following table.

Table 1-3-13 Environmental Standards

Target		Parameters	Remarks	Source
Air	Ambient air quality	CO, NO_2, SO_2, O_3, Pb, TSP		Sub-decree on Control of Air Pollution and Noise Disturbance
	Ambient air (hazardous)	30 hazardous materials		
	Emission (Immobile source)	66 parameters		
	Emission (Mobile source)	CO, HC	Emission for vehicle type	
	Content of fuel and coal	S, Pb		
Noise	Noise of vehicle	Noise level	Maximum level of type of vehicles	
	Public and residential area noise	Noise level	Permissible level at 4 types of areas	
	Noise level at factory	Noise level	Maximum period at levels	
Water	Discharge standards	52 parameters		Sub-decree on Water Pollution Control, 1999
	Ambient water	5 - 7 parameters for waterbodies	Conservation of biodiversity at the public water areas	
	Ambient water	25 parameters	Protection of public health at the public water areas	

Source: JICA Survey Team based on Sub-Decrees of Cambodia

The maximum permissible level of noise by area is shown below. There is no standards and regulatory limits for vibration in Cambodia. This standard is applied to control noise level of any source of activity that emitted noise into the public and residential areas. The project area falls into the category 3.

Table 1-3-14 Maximum Permissible Level of Noise dB(A)

	Area	Period of Time		
		From 6 to 18	From 18 to 22	From 22 to 6
1	Quiet Areas -hospitals, Libraries, School, Kindergarten	45	40	35
2	Residential Areas -Hotels, Administration offices, Houses	60	50	45
3	Commercial and service areas and mix	70	65	50
4	Small industrial factories intermingling in residential areas	75	70	50

Source: Sub-decree on Control of Air Pollution and Noise Disturbance

Provincial DOE of Pursat does not monitor above standards and regulatory limits as they don't have instruments for measuring, facilities and capacity. Discharge standards have many parameters but there are limited laboratories which can measure them. DOE is also not able to measure. Therefore, these parameters are practically not managed. The existing WTPs in Cambodia usually discharge treatment sludge into river directly based on the agreement with DOE.

Annex of "Sub-decree on Water Pollution Control (1999)" defines 67 types of pollution sources which need the permission of MOE before discharging or transporting their wastewater. Category I type source needs permission when its discharge amount exceeds 10 m^3/day. Category II type source needs

permission always. “Pure drinking water manufacturing” is included in Category I but the Project does not discharge wastewater.

1-3-3-3 Environmental Impact Assessment Procedure

Sub-Decree on Environmental Impact Assessment Process (1999) has a list of projects that require EIA or IEIA as an annex; however, there is no clear description whether EIA or IEIA, therefore, it is decided by MOE. In case of more than 200 million USD project cost, EIA/IEIA is examined by MOE, if it is less, it is examined by the provincial government. The project cost will exceed 200 million USD and it is under MOE responsibility.

The process flow of EIA/IEIA approval is shown below.

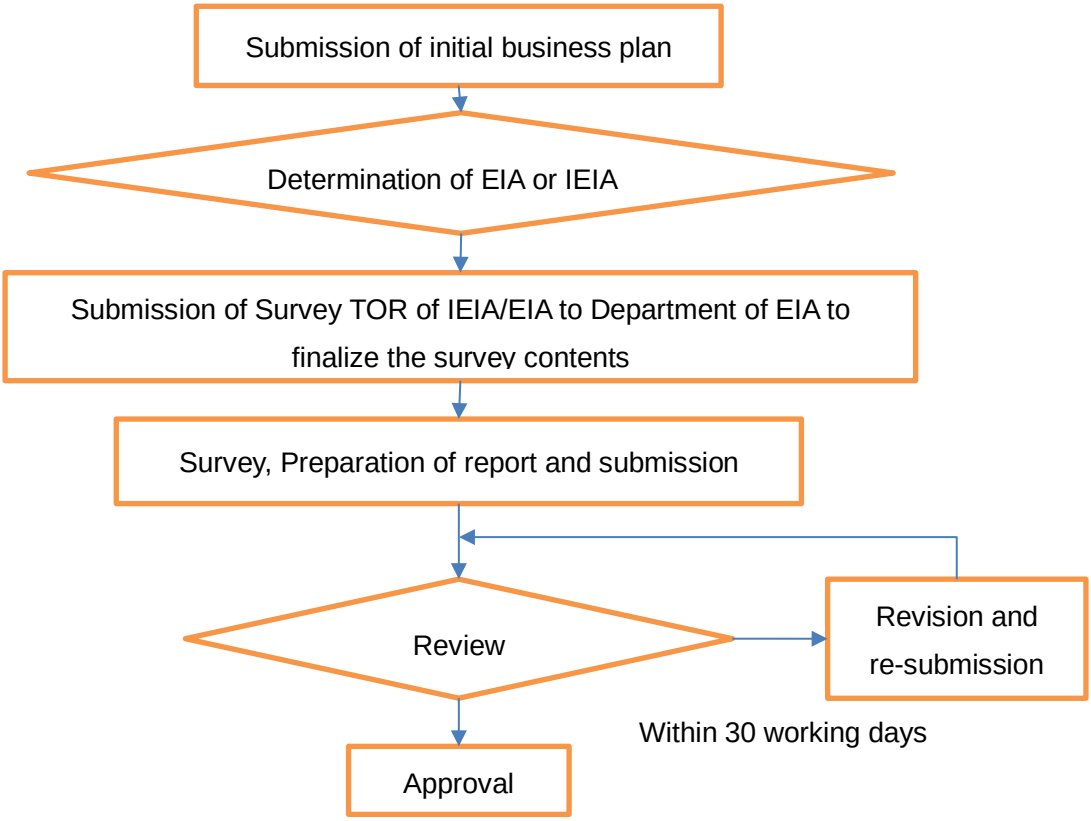


Figure 1-3-5 Process of EIA/IEIA Approval

Source: Sub-Decree on Environmental Impact Assessment Process (1999) with the hearing

The Parkas (declaration) on Registration of Consulting Firms for Studying and Preparing Environmental and Social Impact Assessment Reports was enacted in May 2014, and EIA/IEIA survey and report preparation should be conducted by the registered consulting firm.

1-3-3-4 Comparison between Cambodian Regulations and JICA Guidelines

There is no big difference between Cambodian environmental regulation system and JICA Guidelines. The following table shows the difference between Cambodian system and JICA guidelines, and defined policy of the Project.

Table 1-3-15 Difference between Cambodian Regulation and JICA Guidelines

No.	JICA Guidelines	Cambodian Laws and Regulations	Difference	Policy of the Project
1.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives. (JICA GL)	Constitution (1993) Article 44 Legal private ownership shall be protected by the law. The right to confiscate possessions from any person shall be exercised only in the public interest as provided for under law and shall require fair and just compensation in advance. Land Law (2001) Article 4 The right of ownership, recognized by Article 44 of the 1993 Constitution, applies to all immovable properties within the Kingdom of Cambodia in accordance with the conditions set forth by this law. Article 5 No person may be deprived of his ownership, unless it is in the public interest. An ownership deprivation shall be carried out in accordance with the forms and procedures provided by law and regulations and after the payment of fair and just compensation in advance.	Cambodian laws /regulations do not stipulate avoidance of resettlement and loss of means of livelihood while the JICA guidelines stipulate them.	Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives
2.	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken. (JICA GL)	Constitution (1993) Article 44 (refer to 1) Land Law (2001) Article 5 (refer to 1)	There is no line in Cambodian laws /regulations which stipulates minimization of resettlement and loss of means of livelihood while JICA guideline stipulates them.	When population displacement is unavoidable, effective measures to minimize impact and to compensate for losses should be taken.
3.	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels. (JICA GL)	Constitution (1993) Article 44 (refer to 1) Land Law (2001) Article 5 (refer to 1) Expropriation Law (2009) Article 4 Expropriation refers to confiscation of ownership of, with fair and just compensation in advance, immovable property or the real right to immovable property of a physical person or legal entity or legal public entity, which includes land, buildings, and cultivated plants, and for construction, for rehabilitation or for expansion of public physical infrastructure which is in the national and public interests. Article 22 Financial compensation given to the property owner and/or rightful owner shall be based on a market	Both Cambodian Laws / Regulations and JICA guideline stipulate compensation while no explicit scope for the compensation is given in Cambodian laws /regulations. Also, as described in Section 2, JICA guidelines stipulate compensation for loss of means of livelihood while the Cambodian laws/regulations stipulate compensation for the property of owner or rightful owner only. In addition to above, the JICA guidelines stipulate the objective of the	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.

No.	JICA Guidelines	Cambodian Laws and Regulations	Difference	Policy of the Project
		price or replacement price on the date of declaration of the expropriation. The market price or the replacement price shall be determined by an independent committee or agent selected by the Expropriation Committee.	compensation is that resettled residents can improve or restore their standard of living.	
4.	Compensation must be based on the full replacement cost as much as possible. (JICA GL)	Expropriation Law (2009) Article 23 The owner and/or the rightful owner has the right to compensation for actual damages commencing from the last date of declaration of expropriation for which they are entitled to fair and just compensation.	Compensation stipulated by JICA guideline includes essential costs for recovering livelihood as pre-project conditions while that of the Cambodian laws /regulation is stipulated as "actual damage" without detailed information.	Compensation must be based on the full replacement cost as much as possible.
5.	Compensation and other kinds of assistance must be provided prior to displacement. (JICA GL)	Constitution (1993) Article 44 (refer to 1) Land Law (2001) Article 5 (refer to 1) Expropriation Law (2009) Article 19 The expropriation of the ownership of immovable property and real right to immovable property can be exercised only if the Expropriation Committee has paid fair and just compensation to the property's owner and/or rightful owner in advance, in accordance with the compensation procedures and principles set out in Section 3 of Chapter 4 of this law.	Both the Cambodian laws/regulations and the JICA guidelines stipulate that compensation must be provided prior to displacement while the Cambodian laws/regulations do not stipulate "other kinds of assistance"	Compensation and other kinds of assistance must be provided prior to displacement.
6.	For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. (JICA GL)	No matching regulations or Laws exist.	Cambodian laws/regulations do not stipulate RAP preparation.	In case of large-scale involuntary resettlement, RAP shall be prepared.
7.	In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. (JICA GL)	Expropriation Law (2009) Article 16 In conducting this survey, the Expropriation Committee shall arrange a public consultation with the authorities at provincial, district and commune level, the commune councils and village representatives or the communities or persons affected by the expropriation in order to give them clear and specific information and to have all opinions from all concerned parties about the propose for public physical infrastructure project.	Both stipulate holding public consultation with sufficient information while Cambodian laws/regulations do not stipulate RAP preparation	In preparing RAP, the public consultation shall be held with the consideration of language and procedure.

No.	JICA Guidelines	Cambodian Laws and Regulations	Difference	Policy of the Project
8.	When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people. (JICA GL)	Expropriation Law (2009) Article 16 (refer to 7) Note: No description exists for manner and language.	Both stipulate holding public consultation while JICA guideline specifies more detailed manners, especially, accessibility for conducting the consultation.	Consultation meeting is conducted by understandable language and procedure for the residents.
9.	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans. (JICA GL)	Expropriation Law (2009) Article 16 In conducting this survey, the Expropriation Committee shall arrange a public consultation with the authorities at provincial, district and commune level, the commune councils and village representatives or the communities affected by the expropriation. Sub-decree on Environmental Impact Assessment Process (1999) Article 1 Encourage public participation in the implementation of EIA process and take into account of their conceptual input and suggestion for re-consideration prior to the implementation of any project.	Expropriation law stipulates participation of the affected people in public consultation while JICA guideline promotes participation of the affected people in all stages of the project	Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of RAP.
10.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities. (JICA GL)	Expropriation Law (2009) Article 14 A Complaint Resolution Committee shall be established and led by representatives of Ministry of Land Management, Urban Planning and Construction, and representatives of other concerned ministries/institutions shall be involved. The organization and functioning of the Complaint Resolution Committee shall be determined by a separate sub-decree.	Both stipulate establishment of grievance mechanisms. Expropriation law is short on applicability for affected people while JICA guideline specifies more detailed manners, especially, accessibility for conducting the consultation.	Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.
11.	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to	Expropriation Law (2009) Article 16 Before proposing an expropriation project, the Expropriation Committee shall publicly conduct a survey by recording a detailed description of all rights of the owners and/or rightful owners to the immovable property and other properties which might be needed for compensation; all other related problems shall be recorded as well.	Both stipulate conduction of precise survey. Expropriation focuses on the rightful property and its owner while JICA guideline following OP4.12 includes affected person who have formal legal rights to land and also affected person who don't have formal legal rights.	Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey.

No.	JICA Guidelines	Cambodian Laws and Regulations	Difference	Policy of the Project
	prevent a subsequent influx of encroachers of others who wish to take advance of such benefits. (WB OP4.12 Para.6)			
12.	Eligibility of benefits includes, the Project Affected Person: PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying. (WB OP4.12 Para.15)	Expropriation Law (2009) Article 4 Owner of immovable property and/or rightful owner refers to a physical person, private legal person, or public legal entity including a proprietor, possessor and all persons who have rights to land and are affected by the expropriation project. Article 18 The following are null and void and cannot be made legal in any form whatsoever: - any entering into possession of public properties of the State and public legal entities and any transformation of possession of private properties of the State into ownership rights that was not made pursuant to the legal formalities and procedures that had been stipulated prior to that time, irrespective of the date of the creation of possession or transformation; - any transformation of a land concession, into a right of ownership, regardless of whether the transformation existed before this law came into effect, except concessions that are in response to social purposes; - any land concession which fails to comply with the provisions of Chapter 5; - any entering into possession of properties in the private property of the State, through any means, that occurs after this law comes into effect.	Expropriation law stipulates “owner of immovable property and rightful owner” as eligible person for compensation while JICA guideline includes PAPs who don't have formal legal rights to land as eligible person	Eligibility shall be given not only for PAP having legal rights but also PAP not having legal rights.
13.	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based. (WB OP4.12 Para.11)	No matching regulations or Laws exist.	Cambodia laws /regulations do not stipulate any provision of preference to land-based resettlement strategies.	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.
14.	Provide support for the	No matching regulations or Laws	Cambodia laws	PAP will receive

No.	JICA Guidelines	Cambodian Laws and Regulations	Difference	Policy of the Project
	transition period (between displacement and livelihood restoration). (WB OP4.12 Para.6)	exist.	/regulations do not stipulate provision of support for the transition period.	the support during transition period.
15.	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc. (WB OP4.12 Para.8)	No matching regulations or Laws exist.	Cambodia laws /regulations do not stipulate assistance, care or attention toward vulnerable group.	Particular attention shall be given to minority and indigenous people.
16.	For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared. (WB OP4.12 Para.25)	No matching regulations or Laws exist.	Cambodia Laws /Regulations do not stipulate preparation of RAP nor ARAP.	ARAP shall be prepared for the small scale land acquisition and involuntary resettlement.

Source: JICA Survey Team by Cambodian Laws and Regulations

1-3-3-5 Comparison of Alternatives

This project aims at expanding the existing water supply system in Pursat. It is important to maximize the benefit with the consideration of harmonization with existing system, future population growth and urbanization. Moreover, it should be considered to maximize the positive impact and minimize negative impact in the environmental and social conditions. The regular water supply will improve the hygiene and basic living standards.

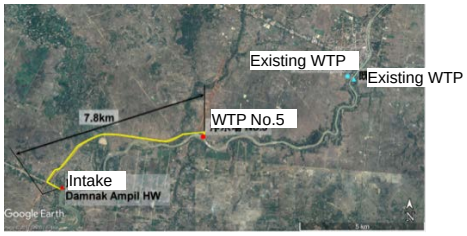
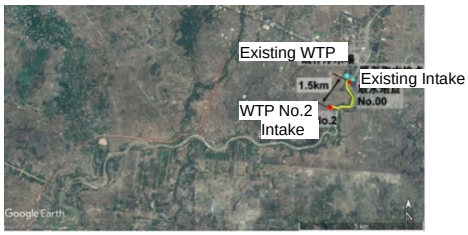
The water supply coverage ratio in Pursat is about 38% now. On the other hand, MIH has set a target of 100% supply in the urban areas by 2025. The implementation of this project is essential to achieve the target. “Ensure availability and sustainable management of water and sanitation for all” is one of SDGs goals. To achieve the goal, basic infrastructure should be constructed for safe, accessible and affordable water supply. From the above viewpoints, the option of no implementation is not considered as one of alternatives.

The result of comparison of alternatives is described as follows.

(1) Alternatives of Location of WTP and Intake Facility

The location of WTP and Intake facility are examined and put the score in 3 degrees (3 is the best) as the following table.

Table 1-3-16 Comparison of Alternatives

Item		Alternative 1		Alternative 2	
Summary		Intake at just upward of Damnak Ampil Headwork and No.5 site of WTP		Intake at just upward of the existing intake position and No.2 site of WTP	
Location					
Water source		Certain amount of floating sand is removed by sedimentation.	2	Sandy soil disturbs water intake.	1
Land		Space of land is applicable for the future expansion.	3	There is no further space for future use.	2
Transmission		Length of transmission is long (8.3km).	1	Transmission is short.	3
Environmental & Social	Impact of construction for surroundings	There are a few houses within the vicinity of the construction site, so that the potential affected people is limited.	3	The site is crowded, and some houses are closely-situated to the construction site. The impact of construction is significant. There is a primary school to be taken care of.	1
	Natural environment	These sites are located in cultivated land and the impact on natural condition is ignorable.	2	These sites are located in urbanized developed area and the impact on natural condition is ignorable.	2
	Water quality	Water intake is located at upper stream of urban area, so the water quality is good.	2	Water intake is located at the urban area, so there is possibility of pollution by inhabitants.	1
	Land acquisition and resettlement	Resettlement is not required. Acquisition of private land is required.	2	Resettlement is not required. Acquisition of private land is required in urbanized area.	1
Cost		O&M*2) cost is higher than alternative 2 and construction*1) cost is lower than alternative 2. The cost of this case is totally lower than alternative 2.	2	O&M*2) cost is lower than alternative 1 and construction*1) cost is higher than alternative 1. The cost of this case is totally higher than alternative 1.	1
Evaluation		It is better location	17	Development in the urbanized area may create bigger adverse effect.	12

Note: *1) Construction cost consists of laying pipeline, construction of intake facilities, pumping house, earthwork of WTP site. *2) O&M cost consists of employment, electricity, chemicals and machinery
Above construction and O&M cost are shown in Annex 4-1 “Pursat water intake and WTP site selection” of “4. Minutes of Discussion (MD)”.
Source: JICA Survey Team

Alternative 1 is considered preferable from the view point of environmental and social condition, such as less impact of construction, better water quality. Alternative 1 also has advantages in cost effectiveness in both construction and operation, quality of water source, and future expandability. Therefore, Alternative 1 is selected comprehensively.

On the other hand, the other locations of water intake were examined; however, they were located in meandering section of river and expected to be affected by too much amount sand and soil for water intake. Therefore, they were rejected in the early stage.

(2) Distribution Area

Distribution area of the project was evaluated based on the request of MIH and consideration of effectiveness of the project. The result is shown in section 2-2-2-6.

The request of MIH covered more wide area including less populated area, therefore, it is evaluated in low profitability. The irrationalistic extension would lead to high water rate and increase of negative social impact. The locations of WTP and intake were selected in consideration of the adaptability of future expansion against population growth. The same considerable attention was payed to determine the distribution area.

1-3-3-6 Result of Scoping and Environmental and Social Survey TOR

Following table shows the result of scoping and draft TOR.

Table 1-3-17 Result of Scoping

Category	Impacts		Evaluation		Reasons for Assessment
			Design/ Construction	Operation	
Pollution	1	Air Pollution	B-	D	Construction: While it is temporary, operation of construction machinery and vehicles is expected to worsen air quality. Operation: The operation of WTP has no impact on ambient air.
	2	Water Pollution	B-	B-	Construction: Turbid water from the work site might cause pollution. Operation: Treatment of sludge should be managed well.
	3	Solid Waste	B-	B-	Construction: Asphalt and concrete waste will be generated at pipe laying at road, and construction waste of earth materials will be generated at construction of WTP and Intake. Domestic waste will also increase due to workers. Operation: Dried sludge should be disposed appropriately.
	4	Soil Pollution	D	D	Construction/Operation: No work expected to cause soil pollution.
	5	Noise and Vibration	B-	B-	Construction: Noise and vibration is expected from operation of construction equipment and vehicles. Operation: Noise and vibration will be generated by pumping station.
	6	Ground Subsidence	D	D	Construction/Operation: No work or other factors expected to cause ground subsidence.
	7	Offensive Odor	D	D	Construction/Operation: No work or other factors expected to cause offensive odors.
	8	Sediment	B-	D	Construction: Construction work of intake in the river may stir up bottom sediment. Operation: No possibility of impact on sediment.
Natural Environment	9	Protected Area	D	D	Construction/Operation: There is no particular protected area within the vicinity of the project area.
	10	Ecosystem	B-	D	Construction: Impact on ecosystem by construction work is not significant because project area is located in the urbanized area and farming land, however the ecological survey will be conducted to check the existence of important species and habitat. Operation: Impact on ecosystem is not significant.
	11	Hydrology	B-	D	Construction: Construction work of intake in the river

Category	Impacts		Evaluation		Reasons for Assessment
			Design/ Construction	Operation	
					might affect the water flow. Operation: Intake amount of water is less to compare with the use of irrigation, and impact is not significant.
	12	Topography and geology	D	D	Construction/Operation: Construction work does not change topography and geology significantly.
Social Environment	13	Resettlement	D	D	Construction/Operation: There is no resident in the project area, and no necessity of resettlement.
	14	Poverty	C	B+	Construction: existence of poverty households is under study. Operation: Water supply to poverty households will be enhanced by the MIH policy.
	15	Ethnic minorities and indigenous peoples	D	D	Construction/Operation: There is no ethnic minority and indigenous people to be taken care of in the project area.
	16	Employment, livelihood and local economy	B+	B+	Construction: Construction employment will be a plus for the local economy. Operation: The expansion of water supply likely to have a positive effect on the local economy.
	17	Land and local resource usage	B-	D	Construction: The land surrounding the work site will need to be borrowed temporarily. Operation: The project involves the expansion of the water supply system and the scale is not large, therefore the impact on land and local resource usage is not significant.
	18	Water Usage	D	D	Construction: Some people do their washing and bathe in the river but the extent of construction of intake is small and the impact is limited. Operation: Intake amount of 0.17 m^3/s is much less than expected discharge in drought year of 9～9.5 m^3/s. Intake amount is also less than the planned discharge of 0.26 m^3/s for water supply by Damnak Chheukrom Irrigation System. Therefore, it will not bring about problem. The impact on water flow of river is discussed under 'hydrology'.
	19	Existing social infrastructure and services	B-	B+	Construction: Disturbance to traffic will occur due to construction vehicles, temporal blockage during pipe laying, etc. Operation: Particular negative impact is not expected. The improvement of water supply may create positive ripple effect for existing services.
	20	Social capital, local decision-making bodies and other social organizations	D	D	Construction/Operation: The Project is not expected to impact social capital or social organizations.

Category	Impacts		Evaluation		Reasons for Assessment
			Design/ Construction	Operation	
	21	Misdistribution of benefits and damages	D	D	Construction/Operation: No elements of the Project will impact distribution of benefits and damages in the local area.
	22	Local conflicts of interest	D	D	Construction/Operation: The Project should not create any local conflicts of interest.
	23	Cultural heritage	C	C	Construction/Operation: There is no cultural heritage in the project site and its surroundings, but there is a possibility of the existence of Buddhist facilities like pagoda. It will be confirmed by the survey.
	24	Landscape	B-	D	Construction: Construction work in the city area will affect the view temporary. Operation: Structure of WTP and intake is not so large and special, therefore the impact on landscape is not significant.
	25	Gender	D	D	Construction/Operation: The Project is not expected to have any particularly negative impact on gender relations.
	26	Children's right	D	D	Construction/Operation: The Project is not expected to have any particularly negative impact on children's rights.
	27	HIV/AIDS and other infectious diseases	B-	D	Construction: While the scale of construction is not so large, the possibility of increased infectious disease due to an influx of construction workers will be reviewed. Operation: No possibility of impact.
	28	Working conditions (incl. occupational safety)	B-	D	Construction: Working environment for construction workers must be considered. Operation: No possibility of impact
Other	29	Accidents	B-	C	Construction: Measures should be considered for preventing accident of construction vehicles and work-related injury. Operation: In case of the use of chlorine gas for disinfection, the possibility of gas leak is expected.
	30	Transnational impacts and climate change	D	D	Construction/Operation: This Project should not have much transnational impact or negative impact on climate change.

Scores:
A: Great impact expected. B: Some impact expected. C: Impact unknown; confirmation study required. D: Slight impact; no study needed.
+: Positive impact; -: Negative impact
Source: JICA Survey Team

Table 1-3-18 TOR

Impacts		Study Items	Study Method
1	Air Pollution	(1) Applicable standards (2) Current air quality (3) Impacts during construction	(1) Literature research, precedents, hearings (2) Literature research, interviews, measurement of ambient air (3) To estimate emissions for construction vehicles/ machinery, generators, etc.
2	Water pollution	(1) Turbid water (2) Treatment sludge	(1) To check construction methods and work which could cause turbid water, estimate scale, study water quality (2) Study for existing similar facilities
3	Solid Waste	(1) Construction waste (2) General waste (3) Treatment sludge	(1) To estimate type/volume of construction waste generated by removal of existing bridge, hearings on how to dispose (2) To check the procedure of method of disposing the sludge, study precedents
5	Noise and Vibration	(1) Applicable standards (2) Current noise and vibration (3) Impacts during construction (4) Impacts during service	(1) Literature research, precedents, hearings (2) Literature research, interviews, measurement at the site. (3) To estimate levels for construction vehicles/ machinery, generators, etc. (4) To estimate levels from pumping station
6	Sediment	(1) Effect of construction	(1) Survey of literature and precedent
7	Ecosystems	(1) Ecosystems	(1) Site survey for flora and fauna, literature survey about important species in and vicinity of project site
8	Hydrology	(1) Impact of construction	(1) River flow condition, study of construction method
9	Poverty	(1) Poverty households and necessary support	(1) Poverty households in the site by literature and site survey, and interviews
10	Land and local resource usage	(1) Current land use	(1) Interviews and cadastral survey
11	Existing social infrastructures and services	(1) Construction vehicle (2) Duration of construction on the road	(1) To estimate the impact on traffic by construction vehicles (2) Duration of construction work on road, study of countermeasure for disturbance of traffic
12	Cultural Heritage	(1) Cultural conservation	(1) Literature survey and interviews about the existence of cultural important place and possible measures to conserve.
13	Landscape	(1) Landscape of the construction site	(1) Site survey of current landscape
14	HIV/AIDS and other infectious diseases	(1) Current state of infectious diseases (2) Impact from the Project	(1) Interviews on current state of infectious diseases (2) Estimate scale and duration of the work

Impacts		Study Items	Study Method
15	Working conditions (incl. occupational safety)	(1) Current status of work-related injury (2) Current status of implemented work safety measures	(1) Literature research, interviews (2) Interviews
16	Accidents	(1) Current traffic accident status (2) Chlorine gas leak	(1) Literature survey, interviews (2) To check the procedure and facilities of disinfection, study of precedent

Source: JICA Survey Team

1-3-3-7 Results of Environmental and Social Study (Including Projection)

Following table shows the result of site survey, environmental and social survey and projection study of impacts.

Table 1-3-19 Results of environmental and social study

<table>
<tr><th>Field</th><th>Impact</th><th>Result</th></tr>
<tr><td>Pollution Control</td><td>Air Pollution</td><td>
Ambient air quality monitoring system has not been established in Cambodia, and the basic data of air quality in Pursat does not exist. The Survey Team conducted the survey to obtain baseline data, and all measured parameters meet the requirement of Cambodian standards. The current air quality condition is good.
Pursat City has not industrialized, and the main emission source of air pollution is vehicles. It is a small provincial city and the traffic is not much without the national road. The baseline air quality is good, therefore, the air pollution caused by the construction work would be in an acceptable range. On the other hand, the vehicles used for the project must follow the emission standards of Cambodia as shown below. The construction machinery and vehicles should be maintained to be in a good condition in order to emit exhaust gas which is within the acceptable range.

Table: Gas Emission Standards of Mobile Sources (Cambodia)
<table>
<tr><th rowspan="2">Type</th><th rowspan="2">Fuel</th><th colspan="5">Level of Emission</th></tr>
<tr><th colspan="2">CO (%)</th><th colspan="2">HC (ppm)</th><th>Fume (%)</th></tr>
<tr><th></th><th></th><th>A</th><th>B</th><th>A</th><th>B</th><th>(%)</th></tr>
<tr><td>Motorcycle (2 stroke engine)</td><td>Petrol</td><td>5</td><td>4</td><td>10</td><td>3,000</td><td></td></tr>
<tr><td>Motorcycle (4 stroke engine)</td><td>Petrol</td><td>5</td><td>4</td><td>10</td><td>2,400</td><td></td></tr>
<tr><td>All kinds of vehicles</td><td>Petrol</td><td>5</td><td>4</td><td>1,200</td><td>800</td><td></td></tr>
<tr><td>All kinds of vehicles</td><td>Diesel</td><td></td><td></td><td></td><td></td><td>50</td></tr>
</table>
(A refer to all kinds of vehicles used over 5 years as from production, B refer to less than A)

The dust generated at the construction site of intake and WTP is ignorable because there are no residents in the vicinity of the project. At the pipe laying work, the road pavement will be removed temporarily. This will generate dust and may affect people at the roadside.
The emission of chlorine gas from water disinfection may affect air quality. However, this project plans to use breaching powder and dissolve it for disinfectant. Therefore, the fear of chlorine gas leak is not expected.
The target concentration of chlorine gas in air in Japan is set as 0.5 ppm, but there is no such similar standards in Cambodia. On the other hand, there is maximum allowable standards of pollution substance for immobile sources in Cambodia, and the maximum level of discharge is set as 20mg/m^3 (30mg/m in Japan) for chlorine gas.
Breaching powder is stable as a disinfectant, and the emission to air is limited, so that the impact on air quality is not significant.
</td></tr>
</table>

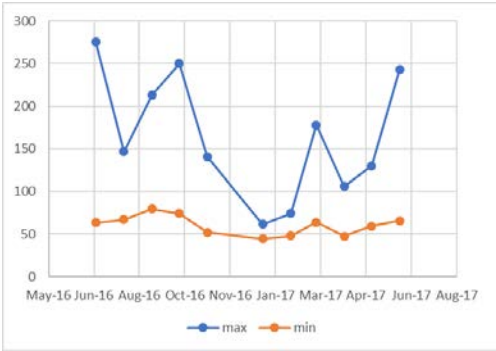
<table>
<tr><th>Field</th><th>Impact</th><th>Result</th></tr>
<tr><td></td><td>Water Pollution</td><td>Some part of construction work of intake will be done in the river, and it may increase turbidity of water. The construction at river will be conducted inside of temporary coffer dam, so that the chance of making impact on river water is a little. PWWs has monitored the Pursat River water quality continuously, and the results for the last one year are shown in the following figure. Turbidity of the Pursat River is always higher than 40NTU and the color is brown. The maximum value of 276 NTU was recorded in July. The background turbidity is always high, therefore, the turbid water generated at construction work will not disturb the current water quality.
 

Figure: Maximum and Minimum Turbidity of Pusat River from June 2016 to July 2017
Source: PWWs

At the stage of operation, sludge will be generated from the treatment process. The moisture will be separated and recycled to treatment after liquid-solid separation, so wastewater is not generated by this system.
Operators will generate domestic wastewater and it is limited. The domestic wastewater will be treated by a septic tank and the top clear layer will soak into the ground. The wastewater discharge to the river is zero but only rainwater discharging facilities is planned.</td></tr>
<tr><td></td><td>Solid Waste</td><td>The regulations for solid waste in Cambodia is “Sub decree in Solid Waste Management (1999)” and related ministerial orders. Ministry responsible for waste administration is MOE and implementing agency is local government. According to the census of 2008, the coverage of solid waste collection is low as of 29% in Pursat City, but it is improving. The city hall makes contract with private company for general solid waste. There are no regulations for construction waste, and it is said that the incombustible material is usually used for back-filling purpose and wood scrap is incinerated. It is flood suffering area and the land owners prefer land filling, so that soil dumping is easy in this area.

Table: Expected Construction Waste
<table>
<tr><th>Material</th><th>Amount (m^3)</th><th>Source</th><th>Handling method</th></tr>
<tr><td>Surplus soil</td><td>1,300</td><td>Intake</td><td>landfill</td></tr>
<tr><td>Surplus soil</td><td>9,600</td><td>WTP</td><td>landfill</td></tr>
<tr><td>Surplus soil, concrete waste, asphalt waste</td><td>34,000</td><td>Pipe laying work</td><td>landfill</td></tr>
<tr><td>Formwork</td><td>1,200</td><td>Intake</td><td>incineration</td></tr>
<tr><td>Formwork</td><td>13,000</td><td>WTP</td><td>incineration</td></tr>
</table>
Source: JICA Survey Team</td></tr>
</table>

<table>
<tr><th>Field</th><th>Impact</th><th>Result</th></tr>
<tr><td></td><td>Noise and vibration</td><td>
The current noise level at the project site meets the requirement of category III that is applied to the site, and it also meets the requirement of category II for residential area.
The impact of noise and vibration is big for the residents in vicinity. The project sites for WTP and intake are cultivated land and the residential houses is less. The nearest house to the WTP site is at the distance of 180 m, and second nearest is at 270 m distance. In case of intake site, there are three houses in a range of 90m to 130m distance. Noise and vibration have large distance attenuation and the distance of 90m is enough to reduce the impact, and the level will meet the required level of standards.
The construction vehicles will generate road noise. The noise emission standards for the vehicles in public and residential area in Cambodia is shown below. The vehicles should be maintained and managed to keep the noise within the permitted level.

Table: Maximum noise level of vehicles in public and residential area
<table>
<tr><th>Category of vehicle</th><th>Maximum permitted noise level (dB(A))</th></tr>
<tr><td>Motorcycle, cylinder capacity <125cm^3</td><td>85</td></tr>
<tr><td>Motorcycle, cylinder capacity >125cm^3</td><td>90</td></tr>
<tr><td>Motorize tricycle</td><td>90</td></tr>
<tr><td>Cars, taxi, passenger vehicle not more than 12 passengers</td><td>80</td></tr>
<tr><td>Cars, taxi, passenger vehicle more than 12 passengers</td><td>85</td></tr>
<tr><td>Truck maximum weight < 3.5 ton</td><td>85</td></tr>
<tr><td>Truck maximum weight > 3.5 ton</td><td>88</td></tr>
<tr><td>Truck engine capacity > 150 kW</td><td>89</td></tr>
<tr><td>Other truck and tractor</td><td>91</td></tr>
</table>
Source: Sub-decree on Control of Air Pollution and Noise Disturbance

In a stage of operation, the noise and vibration level should be kept at acceptable level. The following table shows the list of machineries which generate noise and vibration, and the measures considered in design. The generators are emergency source for power failure, and only used on a temporary basis.

Table: Noise Generating Machinery and Measures of Impact Reduction
<table>
<tr><th>Facility</th><th>Machinery</th><th>Specification</th><th>Mitigation measures</th></tr>
<tr><td>WTP</td><td>Blower of filter basin</td><td>15kW x 2</td><td>Installed at basement</td></tr>
<tr><td></td><td>Generator (Backup)</td><td>350kVA</td><td>Bonnet type, Sound absorption wall at generator room</td></tr>
<tr><td>Intake</td><td>Pump</td><td>30kW</td><td>Installed at basement</td></tr>
<tr><td></td><td>Generator (Backup)</td><td>125kVA</td><td>Bonnet type, Sound absorption wall at generator room</td></tr>
</table>
Source: JICA Survey Team
</td></tr>
<tr><td></td><td>Soil</td><td>The potential risk of oil leak of fuel for generator will be mitigated by the oil retaining wall at the fuel storage tank.</td></tr>
<tr><td>Natural Environment</td><td>Ecosystem</td><td>
The project area is in a city area or cultivated land. There is a riparian forest near the river and small patch of secondary forest. Accordingly, it is not a good habitat for wildlife, and the general and common species are observed in this area.
The following table shows the summary of the species found in the project area by the site survey. Critically endangered species were not recorded.
</td></tr>
</table>

<table>
<tr><th>Field</th><th>Impact</th><th>Result</th></tr>
<tr><td></td><td></td><td>Table: Summary of fauna survey
<table>
<tr><th></th><th>Endangered
EN</th><th>Vulnerable
VU</th><th>Near Threatened
NT</th><th>Least Concern
LC</th></tr>
<tr><td>Bird</td><td>0</td><td>0</td><td>0</td><td>49</td></tr>
<tr><td>Amphibia</td><td>0</td><td>0</td><td>0</td><td>11</td></tr>
<tr><td>Reptile</td><td>0</td><td>0</td><td>0</td><td>7</td></tr>
<tr><td>Fish</td><td>2</td><td>4</td><td>4</td><td>102</td></tr>
</table>
Source: JICA Survey Team

Threatened species and CITES listed species are not recorded at the site for bird, amphibia, and reptile. 112 species of fish are recorded including 2 endangered, 4 vulnerable and 4 near threatened species.
Because the planned intake site is located upper stream of the headwork, the width of river is wide, and water is stagnant, therefore, the construction of the structure will rarely create problems on fish. The baseline turbidity of the river is always high entire year, thus the turbid water of construction work will not make significant impact on the river and fish.
There are two project areas, i.e. WTP site, and water intake/pumping station site. These are currently within rice fields and no natural vegetation. The pipe will be buried under the road or side strip, so the project will not affect any vegetation.</td></tr>
<tr><td></td><td>Hydrology</td><td>The intake structure will be constructed within the temporary coffer dam. A part of intake structure and coffer dam jut into the river. However, these are not expected to disturb the hydrological condition because the location is just upward of the headwork and the river flow around the site is very wide and slow.</td></tr>
<tr><td>Social Environment</td><td>Land use</td><td>PWWs obtained the land for WTP and intake construction. The area is about 1 ha for both and the effect on land use is limited.
These were private lands used for rice farming and shrub. PWWs negotiated the terms of sales with owners and obtained the approval of stakeholders. The owners agreed to sale the land and the value was much higher than the market price. The payment has been done. The process of transfer of land ownership is appropriate in consideration of JICA guidelines.
During construction, temporary use of land by lease is necessary for stockyard, office, etc. PWWs has selected candidate land and these are paddy field or fallow field, therefore the effect on land use is not significant. The process of making lease contract will be checked at the time of detail design.
The project will use the existing borrow pit owned by private company, so the environmental impact will not be newly created.</td></tr>
<tr><td></td><td>Poverty</td><td>Poverty households exist at a certain level in the project area, it varies from 15 % to 35 % in village-wise. MIH has a policy to support poverty households by the exemption of connection fee. The poverty households will also be able to receive the benefit.</td></tr>
<tr><td></td><td>Existing social infrastructure and services</td><td>The number of construction vehicles is estimated as follows.
Pipe laying work: 12 (2/team x 6 teams)
Construction of WTP: 4
Construction of intake: 2
The site is provincial city and baseline traffic is not much. The increase of estimated number of vehicles will not seriously affect traffic.
On the other hand, the pipe laying work will create traffic disturbance in case of temporary one-way traffic. The construction of intake requires to lay the pipe crossing the road. Such work needs to stop traffic at certain period.</td></tr>
<tr><td></td><td>Cultural heritage</td><td>There is no cultural heritage, religious symbol, etc. inside and vicinity of project site.</td></tr>
</table>

Field	Impact	Result
	Landscape	The project will construct two buildings of WTP and Intake/pumping station. These are constructed in a rice field, there is no particular view and any affected resident/ buildings. Therefore, these buildings do not disturb the landscape.
	Infectious diseases	Epidemic of HIV in Cambodia recorded a peak in 1995, and there were 20,000 incidents HIV infections. RGC has taken the measures strongly and the number of new incidents is less than 1/10 currently. It is the outcome of educational activities, increase of medical care station, enhancement of medical check, etc. However, still the new patients appear mainly in sex workers. RGC continuously strengthens the preventive action to eradicate new infection. The number of workers of the construction is estimated as 140 at maximum. Many of them will be hired in the project area, and the new inflow population will not be large. However, the project should take the awareness raising activities for the worker to prevent the new infection by the workers from outside.
	Working Environment	The legal basis of occupational safety in Cambodia is "Labor Law (1997)" and there are supporting ministerial regulations and ILO conventions which Cambodia ratified. The workers at the construction site in Cambodia usually put helmet and safety goods. The working condition seems relative good. Compliance with laws and regulations is necessary. The following measures are considered to protect workers from accidental injury. 1: Installation of a lightning rod for lightning prevention 2: Installation of earth leakage circuit breaker 3: Installation of lighting equipment for night 4: Installation of fall preventive handrail
	Accident	The Number of casualties by traffic accident in Cambodia recorded a peak as 27,403 people in 2007. It has been decreasing and 18,287 people in 2010. The total number of casualties is decreasing, however, the number of fatalities is increasing. The project activities could increase risk of accidents due to the increase in traffic by construction vehicles. But the location of the site is not facing main road and it is a place of good visibility, so the effect is not significant. Since the project uses breaching powder as disinfectant, the risk of gas leak does not occur. Countermeasures for occupational safety is described above in working environment.

Source: JICA Survey Team

1-3-3-8 Stakeholder Meeting

The following table is a summary of stakeholder meetings.

Table 1-3-20 Summary of Stakeholder Meeting

Topic	Date/Place	Participants	Format	Details Discussed
Pursat Department of Environment (DOE)	2017/7/6 DOE office	DOE PWWs Survey Team Total 4	Meeting	Explanation of project plan and possible impact. Q & A for the project implementation. There were no particular remarks.
Pursat Department of Agriculture, Forestry and Fisheries (DOA)	2017/7/6 DOA Office	DOA PWWs Survey Team Total 7	Meeting	Explanation of project plan and possible impact. Exchange opinion about the effect on activities of agriculture and fishery, water source, and protection. Q & A for the project implementation. There were no particular remarks.
Pursat City Hall	2017/7/13 City Hall	Mayor PWWs Survey Team Total 4	Meeting	Explanation of project plan and possible impact. Q & A for the project implementation. Exchange opinion about appropriate

Topic	Date/Place	Participants	Format	Details Discussed
				procedure of construction and domestic waste generated by the project activities. information about Pursat City future developing plan. Mayor was very positive for water supply project.
Villagers in Damnak Ampil	2017/12/6 House of commune chief	Villagers Total 20 (women 12, men 8)	Group discussion	They welcome the water supply project for safe, clean and cheap water. It will be cheaper than bottled water. They hope the affordable price and assistance for poor people to create connection.
Representative of community in project area	2017/12/4~6 House of representative	Representative of Lolok Sor, Phsar Leu, Luong Pagoda, Chumrum Seam Damnak Ampil	Meeting	All representatives agreed on the project and hoped for an early implementation. They requested lower tariff and connection fee. They expect the increase of employment. Due to concern to traffic disturbance by pipe laying, they requested to share construction schedule in advance.
Departments of city hall	2018/2/19 City hall	Representative of all departments DIH, PWWs, Survey Team Total 14	Meeting	They requested that the project should satisfy the legal requirement, pay attention to occupational safety and hygiene. All departments will cooperate with the project for smooth implementation.

Source: JICA Survey Team

1-3-3-9 Impact Assessment

The result of impact assessment is shown in the following table based on site visit, environmental & social survey and discussions with stakeholders.

Table 1-3-21 Impact Assessment

Impact	Impact Assessment at Scoping		Impact Assessment Based on Study Results		Reason of Assessment
	Design/ Construction	Operation	Design/ Construction	Operation	
Air Pollution	B-	D	B-	D	Construction: by removing road pavement and from the pipe laying work, dust is expected. Air pollution is expected from the exhaust gas emitted by the construction vehicles and machineries. Operation: Any work which causes air pollution is not expected.
Water Pollution	B-	B-	B-	D	Construction: Basement construction of intake may generate turbid water. Operation: The waste water generated at the treatment process will be recycled, and no discharge to outside of the system. Thus, the post survey evaluation is D.
Solid Waste	B-	B-	B-	B-	Construction: Construction work generates the solid waste, e.g., removed pavement of the road, scrap of form. Workers of construction will generate domestic waste. Operation: Treatment sludge will be dried and become solid waste, it shall be treated appropriately.
Noise and Vibration	B-	B-	B-	B-	Construction: Construction vehicles and machinery generate noise and vibration, but it is temporary and there is no resident in the circle of influence. The site and its surroundings are rice field, and there are

Impact	Impact Assessment at Scoping		Impact Assessment Based on Study Results		Reason of Assessment
	Design/ Construction	Operation	Design/ Construction	Operation	
					no animals to be affected. Therefore, the post survey evaluation is D. Operation: Pumping station and WTP generate noise and vibration during operation but there is no person living in the circle of influence at present. However, the countermeasure should be considered to keep the appropriate level of noise and vibration.
Sediment	B-	D	B-	D	Construction: Construction work of intake could increase the turbidity due to disturbing sediment. Operation: No impact on sediment.
Protected Area	D	D	D	D	There is no protected area in the range of the influence of the project.
Ecosystem	B-	D	B-	D	Construction: Ten endangered fish species were recorded in the project area. fishing of important species around the site should be prevented. Operation: The operation will not give any impact on ecosystem.
Hydrology	B-	D	D	D	Construction: Construction of intake will be conducted within temporary coffer dam. The coffer dam will not disturb the river flow because the site is just upward of the headwork and flow rate is very low. Thus, the hydrological impact is limited, and post-study evaluation is D. Operation: A part of intake structure exists in river, but the flow rate is very low, and the impact is ignorable.
Poverty Households	C	B+	D	B+	Construction: Certain rate of poverty households exist in project site, and they will not incur any problem by the project. Operation: The poverty households will receive benefit because of the enhancement of water supply to poverty households.
Employment, livelihood and local economy	B+	B+	B+	B+	Construction: Construction employment will be a plus for the local economy. Operation: The expansion of the water supply is likely to have a positive effect on the local economy.
Land and local resource usage	B-	D	B-	D	Construction: Operation: Environmental flow will be secured in water operation plan of MOWRAM, therefore, there is no significant impact on water use and fishing activities.
Existing social infrastructure and services	B-	B+	B-	B+	Construction: The detours for the road user will be temporally required during construction period. Operation: Standard social service level will be improved by the expansion of the water supply facilities.
Cultural heritage	C	C	D	D	Construction/ Operation: There is no such buildings or facilities in and within the vicinity of the project area.
Landscape	B-	D	D	D	Construction: The construction site is paddy field, not much effect on the landscape. There are no residents in the vicinity of the project, so that the impact on the landscape is not significant. Therefore, the post survey evaluation is D. Operation: The buildings constructed by the project are WTP and intake facilities, and the sites are within rice fields, not much effect on the landscape. Thus the impact is not significant.

Impact	Impact Assessment at Scoping		Impact Assessment Based on Study Results		Reason of Assessment
	Design/ Construction	Operation	Design/ Construction	Operation	
HIV/AIDS and other infectious diseases	B-	D	B-	D	Construction: The extent of the construction is not large but the influx of workers will increase the possibility of infectious diseases. Operation: There is no component to increase the infectious diseases.
Working conditions (incl. occupational safety)	B-	D	B-	D	Construction: It is necessary to consider the workers' working conditions. Operation: The facilities are designed with the consideration of safely including countermeasures. Considerable danger does not exist.
Accidents	B-	C	B-	D	Construction: Measures to be taken for preventing accident of construction vehicles and work-related accident. Operation: This project does not use chlorine gas for disinfection. Thus, there is no possibility of gas leak. The post study evaluation is D.
Impacts to transboundary or global issues	D	D	D	D	Construction: There is low possibility of the transboundary movement of pollutant generated by the construction. Operation: Pollution of water supply is limited and the possibility to impact on global issue is ignorable.

Source: JICA Survey Team

1-3-3-10 Mitigation Measures and Their Implementation Cost

The mitigation measures to be taken based on the results of the environmental and social assessments and impact assessments given above are as outlined in the table below.

Table 1-3-22 Impacts and Mitigation Measures (Construction)

Impacts	Mitigation Measures (During Construction)	Implementing Body	Supervisory Authority	Costs
Air pollution	Dust will be minimized by spreading water during the work which expect to generate dust. The soil material should be covered to prevent the dust flying at transportation by vehicle. Exhaust gas emitted by construction vehicles and machinery will be reduced by enforcing registration of vehicles and machinery and keeping them well maintained and managed.	Contractor	MIH/DIH/ PWWs	Construction cost
Water pollution	Construction work of intake may generate turbid water. It will be done inside temporary coffer dam to prevent the direct discharge to river. Contractor shall monitor and control water quality, especially turbidity and oil spill by visual inspection. If anything is found to be abnormal, work will stop immediately so that appropriate measures can be taken.	Contractor	MIH/DIH/PWWs	Construction cost
Solid waste	Main part of construction waste is surplus soil. The contractor will re-use the construction waste as much as possible. The	Contractor	MIH/DIH/PWWs	Construction cost

Impacts	Mitigation Measures (During Construction)	Implementing Body	Supervisory Authority	Costs
	soil which cannot be reused will be used at landfill site. PWW has an obligation of preparation of landfill site. For domestic waste from the workers, disposal will be outsourced at a fee according to local rules for general waste disposal.		Pursat City hall	
Noise and vibration	Construction vehicles and machinery are registered and maintained well to keep the noise and vibration level in acceptable range. Operators shall be trained for the proper procedure of operation to prevent generating abnormal noise and vibration.	Contractor	MIH/DIH/PWWs	Construction cost
Sediment	It is included in the measures of water quality.	Contractor	MIH/DIH/PWWs	Construction cost
Ecosystem	Workers shall be guided that they don't hunt and do fishing for the preservation of important species. They shall attend the edification program periodically.	Contractor	MIH/DIH/PWWs	Construction cost
Land and local resource usage	MIH is responsible for renting land for temporary use of construction work around the site.	MIH/DIH/PWWs	MCF	GOC budget
Existing social infrastructure and services	Impacts from traffic congestion and detours rising from the work will be minimized by posting signboards, deploying traffic guides, and making public announcements to local residents.	Contractor	MIH/DIH/PWWs	Construction cost
HIV/AIDS and other infectious disease	The working parties will be educated on a periodic basis in efforts to prevent infectious diseases.	Contractor	MIH/DIH/PWWs	Construction cost
Working condition	The working parties will be educated on a periodic basis in efforts to prevent work accidents. Safe tools will be supplied as necessary.	Contractor	MIH/DIH/PWWs	Construction cost
Accident	For construction vehicle operation, a safe driving plan will be prepared, and drivers will attend safety classes to prevent accidents.	Contractor	MIH/DIH/PWWs	Construction cost

Source: JICA Survey Team

Table 1-3-23 Impacts and Mitigation Measures (Operation)

Impacts	Mitigation Measures (During Construction)	Implementing Body	Supervisory Authority	Costs
Solid waste	Disposal of solid waste will be monitored and recorded to manage it. PWWs shall confirm that the dried sludge is transferred to the appropriate dumping yard.	PWWs	DIH Pursat city hall	PWWs
Noise and vibration	PWWs shall standardize the procedure to check acceptability of noise and vibration level and monitor it. PWWs will guide operators about the procedure in case of occurrence of abnormal noise and vibration.	PWWs	MIH/DIH/PWWs	PWWs

Source: JICA Survey Team

1-3-3-11 Land Acquisition and Resettlement

(1) Need for Land Acquisition and Resettlement

The project needs land for WTP and water intake site. PWWs searched for appropriate land and all candidate sites were paddy fields. There were no resident and building, thus, resettlement is not required. PWWs negotiated with landowners and purchased land on market price. The committee of MIH, DIH (Department of Industry and Handicraft) and MEF (Ministry of Economy and Finance) evaluated the trade and concluded that it was appropriate trade. On the other hand, the water pipes will be basically laid on land along the road. If the building exists inside the ROW, the countermeasures will be taken to prevent any effect on buildings and residents, for example, the pipe will be laid under side strip.

(2) Legal Framework on Land Acquisition and Resettlement

The legal basis of the land ownership, acquisition and resettlement belong to Constitution (1993), Land Law (2001) and Expropriation Law (2009). The main contents of these laws are explained below.

1) Constitution (1993)

Article 44 states that all persons shall have the right to land ownership, as well as expropriation shall be possible only if public utility demands in the cases stipulated by the law and if prior appropriate and fair compensation is granted.

Article 58 states that State property notably consists of land, underground, mountains, sea, sea-bed, undersea-bed, coastline, airspace, islands, rivers, canals, streams, lakes, forests, natural resources, economic and cultural centers, national defense bases, other building facilities belonging to the State.

2) Land Law 2001

Article 4 refers Article 44 of Constitution and ensure the ownership.

Article 5 states that no person may be deprived of his ownership, unless it is in the public interest, as well as an ownership deprivation shall be carried out in accordance with the forms and procedures provided by law and regulations and only after the payment of just and equitable compensation.

Article 12 states that the State is the owner of the properties in the territory of the Kingdom of Cambodia enumerated in Article 58 of the Constitution and of all properties that are escheat, or that are voluntarily given to the State by their owners, that have not been the subject of due and proper private appropriation or that are not presently being privately occupied.

Article 15 defines the property that falls within the public property of the State and public legal entities.

Article 35 states that only the competent authorities may, on behalf of the State and public legal entities, force occupants without title or insufficient titles to vacate the immovable property.

3) Expropriation Law, 2009

Article 1 explains aims of this law.

Article 3 describes applicability of the law, and states that the law does not govern any issues on expropriation in any agreement or memorandum on supporting investment between the Royal Government of Cambodia and partner countries.

Article 5 defines public physical infrastructure which will be target of expropriation.

Article 12, 13 and 14 explains mechanism of expropriation, i.e., establishment of Expropriation Committee (EC), Expropriation Sub Committee (ESC), and Complaint Resolution Committee (CRC). Article 13 states that the establishment and functioning of the sub-committee shall be determined by the sub-decree, however it has not been issued yet.

Article 19 states that the expropriation can be exercised only if the Expropriation Committee has paid fair and just compensation to the property's owner and/or rightful owner in advance.

Article 22 defines that financial compensation shall be based on a market price or replacement price on the date of declaration of the expropriation. The market price or the replacement price shall be determined by an independent committee or agent selected by the Expropriation Committee.

(3) Area and Scale for Land Acquisition and Resettlement

There is no resident in target area of the project site, so that no resettlement is required. The members of PWWs, DIH, MIH and MEF made an agreement with the land owners of the sites for WTP and intake site. The land currently used as paddy field has already been purchased based on the market price.

The pipes will be laid under the road and the land acquisition is not required.

Table 1-3-24 Necessary land for the project

Purpose of use	Area	Current use	Owner
Intake	0.27 ha	Paddy field	Farmer (independent)
WTP	1 ha	Paddy field	Farmer (independent)

Source: JICA Survey Team

The target land has been cultivated by the owner; thus, the range of compensation covered land and expected crop to cultivate.

(4) Compensation and Support

PWWs had negotiated with a number of land owners about the price and condition of sale and found the appropriate land. The commune chief was involved on this issue. The family member participated as a witness at making final decision.

Compensation was done by paying money. The price of land was determined using the price proposed by the owner, which were 1.3 times of market price for the land for the WTP and 1.6 times of market price for the land for the intake. This was approved by the committee and has been paid already.

The target land owner was only two in this case, and the process followed usual land sales, therefore, the EC and CRC were not specially established. The grievance response follows the process of (1) Commune chief is the first window of complaint, (2) Commune chief will hold a meeting to solve a problem with PWWs and DIH, (3) When (2) does not work, the upper authority such as MIH and city hall will be involved. In this case, the price was already paid and there were no any grievances.

As a result, all the processes meet the requirements of JICA Guidelines and are completed.

1-3-3-12 Monitoring Plan

Monitoring plan is made based on the above survey.

Table 1-3-25 Monitoring Plan (Tentative)

Impact	Parameter	Monitoring Method	Monitoring Point	Frequency	Responsibility
Construction					
Air Pollution	Dust	Visual observation	Vicinity of construction site	Daily	Contractor
	Exhaust gas	Inspection of registered vehicle	Construction Office	Monthly	Contractor
Noise and vibration	Working time	Working record	Construction site	Daily during construction	Contractor
	Management of vehicles	Inspection of registered vehicles	Construction Office	Monthly	Contractor
	Guidance to operator	Training record	Construction Office	Once during construction	Contractor
Water Pollution and sediment	Turbidity, oil	Visual inspection	Inlet of discharge	Weekly but daily during construction of foundation	Contractor
	Water quality	pH, EC, BOD, turbidity, oil	Inlet of discharge	When abnormal incident is observed	Contractor
Solid Waste (domestic)	Proper management	Visual inspection	Domestic waste	Weekly	Contractor
Solid Waste (Construction)	Proper dumping	Visual inspection	Temporary damping yard	At the time of damping	Contractor
	Preparation of dumping site	Contract document	Dumping site for soil waste	At the time of contract	PWWs, MIH

Impact	Parameter	Monitoring Method	Monitoring Point	Frequency	Responsibility
Ecosystem	Ban of hunting and fishing	Training record	Construction Office	Monthly	Contractor
Hydrology	Construction schedule in rainy season	Monthly construction report	Construction Office	Monthly during rainy season	Contractor
Land and local resource usage	Lease of land	Contract document	Construction Office	At the time of contract of lease	PWWs、MIH
Existing social infrastructure and services	Mitigation measures to prevent traffic disturbance	Monthly construction report	Construction Office	Monthly	Contractor
HIV/AIDS and other infectious disease	Management of occupational safety and hygiene	Monthly construction report	Construction Office	Monthly	Contractor
Working condition	Management of occupational safety and hygiene	Monthly construction report	Construction Office	Monthly	Contractor
Accident	Traffic plan of construction vehicle	Plan	Construction Office	At planning	Contractor
	Safety training	Monthly construction report	Construction Office	Monthly	Contractor
Miscellaneous	Complaint management	Analysis of complaint	Construction Office	Monthly	Contractor
Operation					
Waste	Appropriate treatment of sludge	Monitoring record	WTP	Every three months	PWWs
	Preparation of dumping site for sludge	Contract document	PWW	At the time of contract	PWWs
Noise and vibration	Monitoring with standard operating procedure (SOP)	SOP and monitoring record	Pumping station	Every three months	PWWs
	Guidance for operators	Training record	Pumping station	Every three months	PWWs

Source: JICA Survey Team

1-3-3-13 Monitoring Form (draft)

Based on the above discussions, the monitoring form is drafted and shown in the following tables for both construction stage and operation stage. The reference value of water quality is different from the national standards, because it is known from the monitoring result of water quality from July 2017 that the current water quality does not meet the standards in some parameters. The reference values of such parameters are determined by the observed range of monitoring result.

Table 1-3-26 Monitoring Form (Construction)

Construction site (Daily monitoring)

Monitoring Item	Procedure	Result	Measures to be taken	Reference standard	Frequency
Dust	Visual inspection			Acceptable or not	Daily
Noise	Sensory inspection			Acceptable or not	Daily

Monitoring Item		Procedure	Result	Measures to be taken	Reference standard		Frequency
		Operation time check			Stated operation time in EMP		Daily
Water Quality (turbidity, oil)		Visual inspection			Acceptable or not		Daily (during foundation work)
Water Quality	pH	Laboratory test			5 - 7	Determined by the monitoring result	In case of abnormal observation of turbidity or oil
	EC				80		
	BOD				10		
	Turbidity				250		

Construction site (Weekly monitoring)

Monitoring Item	Procedure	Result	Measures to be taken	Reference standard	Frequency
Waste (Domestic)	Patrol			Acceptable or not	Weekly

Construction site (Monthly monitoring)

Monitoring Item	Procedure	Result	Measures to be taken	Reference standard	Frequency
Condition of construction machinery and vehicles	Maintenance record check			Acceptable or not (Exhaust gas, noise, vibration, and usual safety check)	
Traffic management	Patrol			Stated procedure in EMP	Monthly
Accident	Patrol			Acceptable or not	Monthly
Training and educational meeting to worker	Report check			Stated procedure in EMP (frequency, contents, target, etc.)	
Claim and comment	Report check			Acceptable or not	Monthly

Others

Monitoring Item	Procedure	Result	Measures to be taken	Reference standard	Frequency
Land for waste dumping Land for temporary use	Lease condition			Appropriate or not	Contract of lease
Plan of safety transportation	Plan check			Acceptable or not	At planning

Source: JICA Survey Team

Monitoring Item	Procedure	Result	Measures to be taken	Reference standard	Frequency
Waste (treatment sludge)	Patrol			Appropriate or not	Monthly
Land for waste dumping	Procedure check			Appropriate or not	At contract agreement
Noise and vibration*	Patrol and maintenance			Normal condition or not	Daily

*Noise and vibration of pump shall be checked in an operation record every day.
Source: JICA Survey Team

1-3-3-14 Schedule for Environmental and Social Consideration

(1) Temporary Land Use for Construction Work and Dumping Yard for Treatment Sludge

The construction work needs the temporary use of land for stockyard, construction office and so on. The sludge will be generated from the water treatment process; then, the dumping yard will be required. MIH is responsible for renting such land; however, the location has not been determined. This matter will be finalized at the detail design stage of the project.

(2) Approval of IEIA

The IEIA report was prepared and submitted to MOE from MIH on 7th May 2018. The site survey and interview of stakeholders were conducted. Based on the survey, the comment letter was issued by MOE and the IEIA report has been revised. After that, the revised report was resubmitted and the report was approved by MOE in January 2019.

1-3-3-15 Environmental Checklist

The environmental checklist is prepared based on above discussions as shown below.

Table 1-3-27 Environmental Checklist

Category	Environmental Item	Main Check Items	Yes: Y No: N	Specific Environmental and Social Considerations (Reason for Yes or No, rationale, mitigation measures, etc.)
1 Approvals, explanations	(1) EIA and Environmental Permits	(a) Have EIA reports been already prepared in official process? (b) Have EIA reports been approved by authorities of the host country's government? (c) Have EIA reports been unconditionally approved? If conditions are imposed on the approval of EIA reports, are the conditions satisfied? (d) In addition to the above approvals, have other required environmental permits been obtained from the appropriate regulatory authorities of the host country's government?	(a) Y (b) Y (c) Y (d) Y	(a) IEIA is required. Preparation is in the process. MIH submitted the report to MOE on 7th May 2018. (b) The report has been revised on the basis of comments by MOE. (c) MOE will give the all consents at approval of IEIA. (d) MIH obtained the permission of water extraction from Pursat River by MOWRAM.
	(2) Explanation to the Local Stakeholders	(a) Have contents of the project and the potential impacts been adequately explained to the Local stakeholders based on appropriate procedures, including information disclosure? Is understanding obtained from the Local stakeholders? (b) Have the comment from the stakeholders (such as local residents) been reflected to the project design?	(a) Y (b) N	(a) All related departments of city hall understood the project purpose and contents, and they agreed on the implementation. At the public hearing, the villagers welcomed the project. They wished for the affordable price setting of connection and assistance to poor. There is no particular objection. (b) Disturbance on traffic was suspected, it will be solved by the setting of detour and information sharing of construction program.
	(3) Examination of Alternatives	(a) Have multiple alternative plans for the Project been analyzed? (Including analysis of items related to the environment/society.)	(a) Y	(a) Alternatives have been examined for the site selection of intake and WTP, and extent of the supply area.
2 Pollution Measures	(1) Air Quality	(a) Is there a possibility that chlorine from chlorine storage facilities and chlorine injection facilities will cause air pollution? Are any mitigating measures taken? (b) Do chlorine concentrations within the working environments comply with the country's occupational health and safety standards?	(a) N (b) Y	(a) The Project plans to use breaching power for disinfection. This reagent is stable, and occurrence of air pollution is considered less. The exhaust fan will be situated at the facilities of disinfection. (b) The above measures serve to keep appropriate working condition.
	(2) Water Quality	(a) Do pollutants, such as SS, BOD, COD contained in effluents discharged by the facility operations comply with the country's effluent standards?	(a) N/A	Discharge generated at the treatment process will be recycled, and sludge will be dried. Therefore, any effluent from treatment process will not be generated. Sewage will be treated by septic tanks and clear upper portion will be infiltrated into ground. Therefore, the discharge water is not generated.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Specific Environmental and Social Considerations (Reason for Yes or No, rationale, mitigation measures, etc.)
	(3) Wastes	(a) Are wastes, such as sludge generated by the facility operations properly treated and disposed in accordance with the country's regulations?	(a) Y	(a) Sludge will be treated and dried at dry-bed, then dumped to the dumping yard prepared by the PWWs.
	(4) Noise and vibration	(a) Do noise and vibrations generated from the facilities, such as pumping stations comply with the country's standards?	(a)Y	(a) The pump will be installed at basement made by the RC with the noise reducing walls. The noise will be controlled within the limit of GOC requirement. There are no standards of vibration, but it is controlled in permissible limit by the above measures.
	(5) Subsidence	(a) In the case of extraction of a large volume of groundwater, is there a possibility that the extraction of groundwater will cause subsidence?	(a)N	(a) The Project does not use groundwater.
3 Natural Environment	(1) Protected areas	(a) Is the project site or discharge area located in protected areas designated by the country's laws or international treaties and conventions? Is there a possibility that the project will affect the protected areas?	(a) N	(a) There are no protected areas within the vicinity of the Project Site.
	(2) Ecosystems	(a) Does the project site encompass primeval forests, tropical rain forests, ecologically valuable habitats (e.g., coral reefs, mangroves, or tidal flats)? (b) Does the project site or discharge area encompass the protected habitats of endangered species designated by the country's laws or international treaties and conventions? (c) If significant ecological impacts are anticipated, are adequate protection measures taken to reduce the impacts on the ecosystem? (d) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by project will adversely affect aquatic environments, such as rivers? Are adequate measures taken to reduce the impacts on aquatic environments, such as aquatic organisms?	(a) N (b) N (c) N (d) N	(a) The site does not contain any virgin forests, tropical old-growth forests, or important ecological habitats. (b) No habitats for any rare species are present in the site. (c) No major concerns. (d) No major concerns
	(3) Hydrology	(a) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect surface water and groundwater flows?	(a) N	(a) At the time of serious drought, the Pursat river had enough discharge to cover the intake amount for the project. Therefore, the hydrological impact is not significant.
4.Social Environment	(1) Resettlement	(a) Is involuntary resettlement caused by project implementation? If involuntary resettlement is caused, are efforts made to minimize the impacts caused by the resettlement? (b) Is adequate explanation on compensation and resettlement assistance given to affected people prior to resettlement? (c) Is the resettlement plan, including compensation with full replacement costs, restoration of livelihoods and living standards developed based on socioeconomic studies on resettlement?	(a)N (b) N/A (c) N/A (d) N/A (e) N/A (f) N/A (g) N/A (h) N/A	(a) There will be no involuntary settlement, meaning that questions (b)-(j) are not applicable.

Category	Environmental Item	Main Check Items	Yes: Y No: N	Specific Environmental and Social Considerations (Reason for Yes or No, rationale, mitigation measures, etc.)
		(d) Is the compensations going to be paid prior to the resettlement? (e) Is the compensation policies prepared in document? (f) Does the resettlement plan pay particular attention to vulnerable groups or people, including women, children, the elderly, people below the poverty line, ethnic minorities, and indigenous peoples? (g) Are agreements with the affected people obtained prior to resettlement? (h) Is the organizational framework established to properly implement resettlement? Are the capacity and budget secured to implement the plan? (i) Are any plans developed to monitor the impacts of resettlement? (j) Is the grievance redress mechanism established?	(i) N/A (j) N/A	
	(2) Living and Livelihood	(a) Is there a possibility that the project will adversely affect the living conditions of inhabitants? Are adequate measures considered to reduce the impacts, if necessary? (b) Is there a possibility that the amount of water used (e.g., surface water, groundwater) by the project will adversely affect the existing water uses and water area uses?	(a) N (b) N	(a) The project has positive impact to improve basic human needs. There is no particular negative impact. (b) The Pursat River has enough discharge capacity and the intake of water supply does not affect significantly.
	(3) Heritage	(a) Is there a possibility that the project will damage the local archeological, historical, cultural, and religious heritage? Are adequate measures considered to protect these sites in accordance with the country's laws?	(a) N	(a) No anthropological, historical, cultural, religiously important heritages or historical remains have been identified in the project site.
	(4) Landscape	(a) Is there a possibility that the project will adversely affect the local landscape? Are necessary measures taken?	(a) N	(a) The building location is in paddy field and very rare residents in vicinity, therefore the impact on landscape is not significant.
	(5) Ethnic Minorities and Indigenous Peoples	(a) Are considerations given to reduce impacts on the culture and lifestyle of ethnic minorities and indigenous peoples? (b) Are all of the rights of ethnic minorities and indigenous peoples in relation to land and resources respected?	(a) N/A (b) N/A	(a)(b) There are no ethnic minorities or indigenous peoples living near the project site.
	(6) Working Conditions	(a) Is the project proponent not violating any laws and ordinances associated with the working conditions of the country which the project proponent should observe in the project? (b) Are tangible safety considerations in place for individuals involved in the project, such as the installation of safety equipment which prevents industrial accidents, and management of hazardous materials? (c) Are intangible measures being planned and implemented for individuals involved in the project, such as the establishment of a safety and health program, and safety training (including traffic safety and public health) for workers etc.?	(a) Y (b) Y (c) Y (d) Y	(a) Adherence to laws concerning working conditions will be made explicit in contracts with contractors and managed. (b) Countermeasures such as installation of safety handrail are taken. (c) It will be achieved to set as an obligation of contractor in contract document. (d) Security guards will be included in target members of worker training. .

Category	Environmental Item	Main Check Items	Yes: Y No: N	Specific Environmental and Social Considerations (Reason for Yes or No, rationale, mitigation measures, etc.)
		(d) Are appropriate measures taken to ensure that security guards involved in the project not to violate safety of other individuals involved, or local residents?		
5 Others	(1) Impacts during Construction	(a) Are adequate measures considered to reduce impacts during construction (e.g., noise, vibrations, turbid water, dust, exhaust gases, and wastes)? (b) If construction activities adversely affect the natural environment (ecosystem), are adequate measures considered to reduce impacts? (c) If construction activities adversely affect the social environment, are adequate measures considered to reduce impacts? (d) If the construction activities might cause traffic congestion, are adequate measures considered to reduce such impacts?	(a) Y (b)N (c) Y (d)N	(a) Mitigation measures will be taken under EPM for managing all noise, vibration, turbid water, dust, gas emissions, and waste discharged from the work site. (b)Particular negative impact is not expected. (c) Temporary traffic disturbance will occur. The negative effect will be minimized by the measures such as setting of detour, assignment of traffic guide, installation of signboard, appropriate information sharing. (d) This is an expansion of the water supply and construction site is out of the city center. Therefore, the serious traffic congestion is not expected.
	(2) Monitoring	(a) Does the proponent develop and implement monitoring program for the environmental items that are considered to have potential impacts? (b) What are the items, methods and frequencies of the monitoring program? (c) Does the proponent establish an adequate monitoring framework (organization, personnel, equipment, and adequate budget to sustain the monitoring framework)? (d) Are any regulatory requirements pertaining to the monitoring report system identified, such as the format and frequency of reports from the proponent to the regulatory authorities?	(a) Y (b) Y (c) Y (d) Y	(a) MIH is responsible for the monitoring as in previous similar project which they are experienced. (b) It will be determined in EMOP. (c) Monitoring by proponent is a part of usual operation activities. The training will be given as a part of soft component. (d) It is stipulated in the EMP.
6 Focal points	Reference to Checklist of Other Sectors	(a) Where necessary, pertinent items described in the Dam and River Projects checklist should also be checked.	(a) N	(a) The intake amount is not much, and the intake structure is small scale at the upper flow of existing headwork. Therefore, it is not necessary to refer the checklist of Dam and River Projects
	Precautions when using the environmental checklist	(a) If necessary, the impacts to transboundary or global issues should be confirmed (e.g., the project includes factors that may cause problems, such as transboundary waste treatment, acid rain, destruction of the ozone layer, or global warming).	(a) N	(a) None

1-4 Present Conditions of Project Area

1-4-1 Organization and Number of Staff

PWWs is operated by 37 staffs including a director general and two deputy director generals. Its organization system consists of the following 5 sections: administration & planning section, accounting & financial section, business section, network section and water production section. Table 1-4-1 shows breakdown of duties and number of staffs.

Table 1-4-1 Breakdown of duties and number of staffs

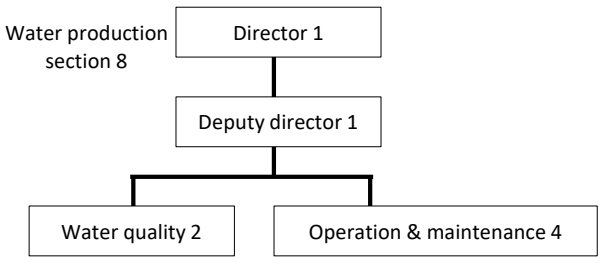
	Duties	Number of staffs
Director General	Comprehensive management in charge of administration and planning section and accounting and financial section	1
Deputy Director General	Technical summarization in charge of water production section and network section	1
Deputy Director General	In charge of business section	1
Administration and Planning Section	General affair, personnel, planning and progress management	2
Accounting and Financial Section	Accounting and finance	7
Business Section	Customer management, meter reading and service connection	10
Water Production Section	Operation and maintenance of WTP Water quality test	8
Network Section	Leakage survey, repairing, network management, network expansion and renewal	7
Total		37

Source: PWWs

Detailed organization system of the water production section, the network section and the business section are as follows.

(1) Water Production Section

The organization system of the water production section which is handling operation and maintenance of the existing WTP is shown in Figure 1-4-1.



Source: PWWs

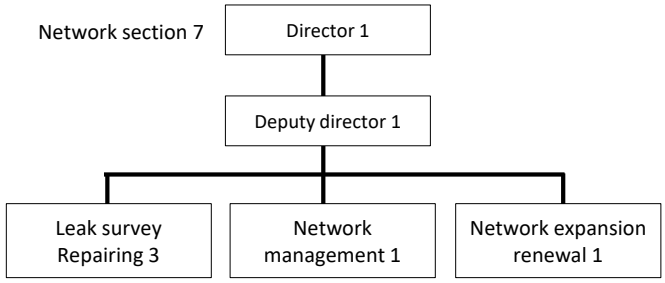
Figure 1-4-1 Organization System of the Water Production Section

The operation and maintenance of the existing WTP which is operated 24 hours is carried out by the deputy director and the four operators in shift. Five staff members are engaged in daytime work and

two staff members are engaged in the night-time work basically except weekend. Water quality test is performed by other two staff members in the daytime. The operation and maintenance are implemented in accordance with five kinds of action plan such as daily, weekly, monthly, quarterly and yearly plan. The work results are reported to the director.

(2) Network Section

Main activities of the network section are leakage survey, leakage repairing, network management, expansion and renewal. The organization system of the network section is shown in Figure 1-4-2.



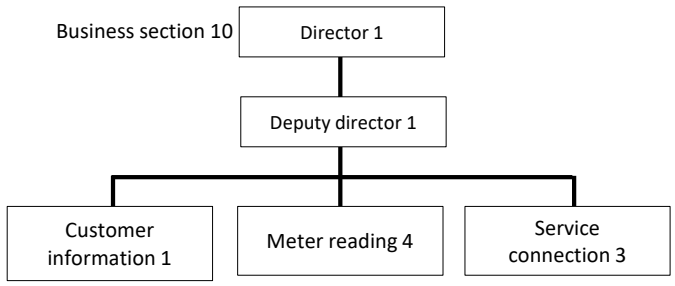
Source: PWWs

Figure 1-4-2 Organization System of the Network Section

Leakage survey is performed in combination of daytime survey using listening bar and night-time survey using leakage detector which are provided by the capacity building project. The night step test is also performed as necessary. As the result of the survey, 51 leakages were found last year. Repairing of leakages is performed by staff of PWWs. Water quality of 32 drains are checked periodically, and pipe flashing is done when the water quality doesn't meet water quality standard. Regarding the pipe installation, the staff of PWWs have responsibility for the pipe jointing and other works, such as trench excavation performed by external staff. In case of lack of human resources, they sometimes bring in staff from other section. The network section has not prepared action plans clearly like the water production section. Their works are performed periodically, and implementation records are necessary to be made carefully in accordance with the guidance in the capacity building project.

(3) Business Section

The business section has responsibility for customer information management, meter reading and service connection. The organization system of the business section is shown in Figure 1-4-3.



Source: PWWs

Figure 1-4-3 Organization System of the Business Section

Installation of service connection is performed by a team of 3 staff from the business section, and they can install 45 to 50 service connections per month in case where the pipe length is around 5.0m. Regarding meter reading, four meter readers check 7,300 water meters every month. One staff member manages information on all customers by using Excel. In addition, a preparation for transfer of customer data into SUMS system which was introduced by the capacity building project has just started.

1-4-2 Finance and Budget

As for finance and budget, section “2-5-2-1 Analysis of Financial Conditions” in “2-5-2 Budget for Operation and Maintenance” shall be referenced.

1-4-3 Technological Level

PWWs is a provincial waterworks that is the target of a project on capacity building for urban water supply system in Cambodia (phase 2 and 3) by the Japan International Cooperation Agency (JICA). Technical transfer on the operation and maintenance of WTPs, water quality tests and the operation & maintenance of distribution facilities were implemented for five years from 2007 to 2012. The technical transfer related to the improvement of management has been carried out from 2012. The supplied water satisfies national drinking water quality standards at present, except in the case of turbidity in raw water which rises rapidly due to sudden heavy rain.

Even when the turbidity of raw water rises suddenly, injection rate of flocculation agent is adjusted by a jar test. It can recover to a normal treatment condition. It can be concluded that the staffs of PWWs have necessary skills on the water treatment for the existing WTP.

Operation and maintenance of the existing WTP is performed periodically and check sheets and Standard Operating Procedures (SOP) prepared in the capacity building project are utilized. Although the existing WTP has aged and encountered small troubles, such as leakage from pipelines, they can fix by themselves.

Although the skills transferred through the capacity building project, such as leakage surveys and creating construction records are adequately utilized, vital skills for the maintenance of distribution

facilities, such as distribution flow monitoring, flow data analysis and countermeasures for reducing non-revenue water (NRW) based on flow analysis have not been established yet.

When service connections are installed, excavation is done by hand and material for the piping is polyethylene that does not require special tools. Although the staff are familiar with the work process, efforts for quality improvement is not performed in particular. The work procedure should be examined and improved rapidly to ensure the quality of service connection installations.

Overall, few technical staff have completed higher education in engineering, and each staff member has no necessary high-level expertise. Although existing water facilities can be operated, maintained and managed according to the prescribed procedures, technical skills can be improved.

1-4-4 Existing Facilities

1-4-4-1 Water Intake Facility

(1) Surface Water Source

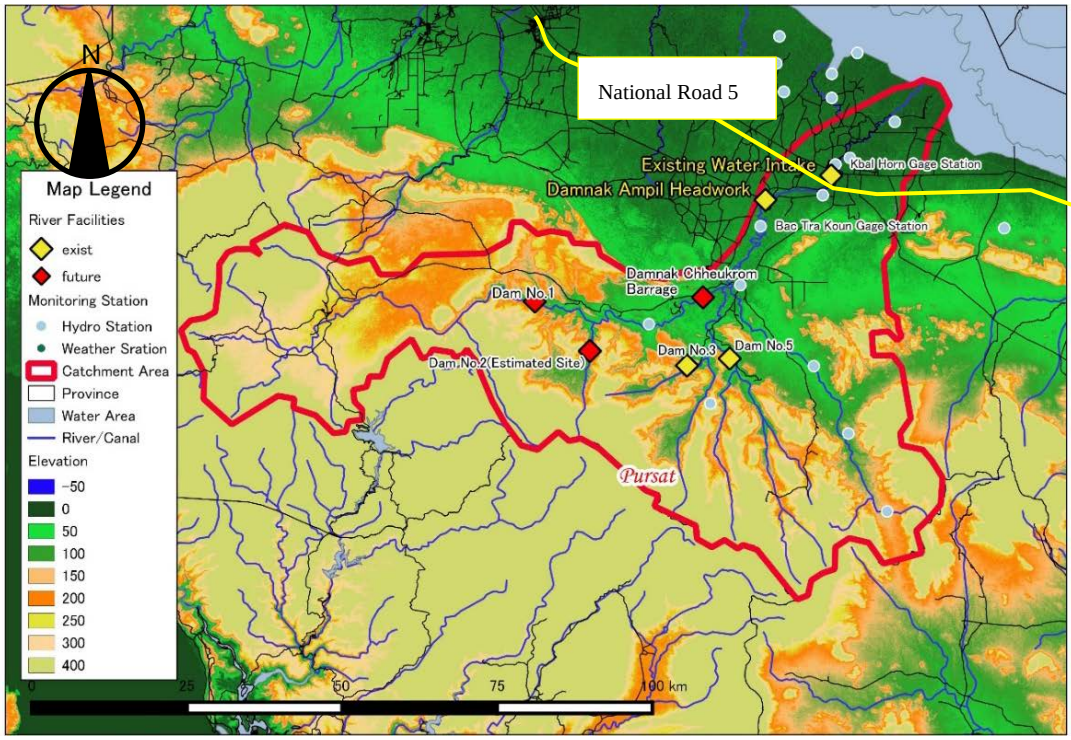
1) Pursat River Basin and River Facilities

The Pursat River originates from the water source in Cardamon Mountains with peak elevation of El. 1,771m. Catchment area of the Pursat River is 5,964km^2 and its length is about 180km. Figure 1-4-4 shows the Pursat River Basin and the locations of the existing river facilities as well as the locations of the planned river facilities, which will be constructed in the future. These river facilities are related to the study on surface water sources.

In addition, there is an existing water intake pumping station of domestic water supply at about 800m upstream from the National Road (NR) No.5.

In the right tributaries in the upstream river basin of the Pursat River, there are two existing dams for supplementing irrigation water during drought period. They are the Dam No.3 with gross storage of 25.5 million cubic meters (MCM) and the Dam No.5 with gross storage of 24.5MCM. These two dams were constructed by the end of 2015. In addition, the Dam No.1 for hydropower generation is planned in the main stream of the Pursat River at about 150km upstream from its river mouth. Furthermore, the Dam No.2 with gross storage of about 200MCM for mainly supplementing irrigation water is planned in the right tributary. However, as DOWRAM Pursat does not have information about the exact location of the site of the Dam No.2, estimated location of the Dam No.2 is indicated in Figure 1-4-4 based on the information from DOWRAM Pursat.

In the mid-stream reach, there is the Damnak Ampil Headworks (HW). Irrigation water is taken from the left and right bank sides of the HW. About 30km upstream from the Damnak Ampil HW, there is a plan for constructing Damnak Chheukrom HW (movable weir) and new irrigation system. Detailed design of the Damnak Chheukrom HW and the irrigation system are being conducted.



Data Source: JICA Survey Team

Figure 1-4-4 Pursat River Basin and the Locations of the River Facilities

2) The Maximum Drought Year and Drought Return Period in the Recent Years

Daily rainfall data from 1996 to 2015 was provided from MOWRAM. Table 1-4-2 shows monthly and annual rainfall amount and rainfall amount of the dry season (from November to April) at Pursat City. Annual average rainfall amount is about 1,400mm, and average rainfall of the dry season is about 290mm. The minimum rainfall amount of the dry season from 1996 to 2015 is 75mm in 2015 and the second minimum is 82mm in 2005. Hence, it can be estimated that 2015 is the drought year with occurrence of once in 10 to 20 years.

Table 1-4-2 Annual and Monthly Rainfall at Pursat

Pursat: Monthly and Annual Rainfall (Unit: mm)

Year	Jan.	Feb.	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Nov. to Apr.
1996	0.2	10.1	2.3	198.2	269.8	131.2	128.2	133.4	193.4	595.5	132.8	38.7	1833.8	
1997	6.2	19.1	20.3	124.0	111.2	176.5	178.3	274.1	266.2	189.4	8.7	0.2	1374.2	341.1
1998	0.0	35.2	0.1	64.2	42.2	155.5	138.1	193.6	257.4	237.1	153.5	9.4	1286.3	**108.4**
1999	29.9	0.8	20.9	190.0	229.1	212.5	219.9	112.9	112.0	112.0	111.7	37.4	1389.1	404.5
2000	2.5	6.9	35.0	183.4	234.3	229.1	190.9	199.0	182.6	413.5	37.9	25.3	1740.4	376.9
2001	0.0	0.0	214.1	25.4	143.4	132.7	79.0	246.8	225.7	170.1	32.8	22.0	1292.0	302.7
2002	0.0	0.0	31.5	208.6	82.7	102.0	65.7	314.3	177.0	253.2	139.3	11.6	1385.9	294.9
2003	0.0	2.0	245.4	14.8	94.0	210.2	234.0	37.8	207.2	455.8	78.6	1.8	1581.6	413.1
2004	2.0	9.8	48.4	65.5	176.0	140.6	143.4	105.0	255.6	103.2	6.3	0.0	**1055.8**	206.1
2005	0.0	0.0	42.8	32.7	140.6	150.3	133.3	195.3	314.5	154.2	84.2	4.5	1252.4	**81.8**
2006	0.0	6.5	88.5	101.8	89.7	180.2	120.0	329.2	199.8	191.7	0.9	82.4	1390.7	285.5
2007	0.0	0.3	88.2	123.1	185.7	205.9	43.9	217.9	198.4	197.9	111.9	0.0	1373.2	294.9
2008	13.5	7.0	77.0	154.5	218.1	169.4	191.8	314.3	209.8	287.1	228.2	4.8	1875.5	363.9
2009	3.6	28.4	56.2	117.9	108.0	130.4	146.1	185.6	175.2	162.7	34.9	132.6	1281.6	439.1
2010	0.0	26.7	49.6	81.0	86.8	195.5	161.5	222.4	167.1	277.9	26.6	3.4	1298.5	324.8
2011	0.0	0.7	62.7	51.4	114.3	106.1	201.0	214.9	206.1	418.1	69.2	44.0	1488.5	144.8
2012	12.1	26.3	156.4	161.5	170.6	57.8	252.6	155.8	248.1	209.5	189.5	8.4	1648.6	469.5
2013	0.0	0.0	90.3	93.3	75.7	281.8	225.6	239.3	22.1	132.9	132.9	22.1	1316.0	381.5
2014	0.0	0.0	9.3	75.5	72.4	123.6	218.1	124.7	236.3	268.2	0.0	0.0	**1128.1**	239.8
2015	1.9	0.4	54.1	18.3	179.7	84.8	122.1	219.3	128.5	240.4	171.8	4.4	**1225.7**	**74.7**
Average	3.6	9.0	69.7	104.3	141.2	158.8	159.7	201.8	199.2	253.5	87.6	22.7	1410.9	292.0

Source: MOWRAM

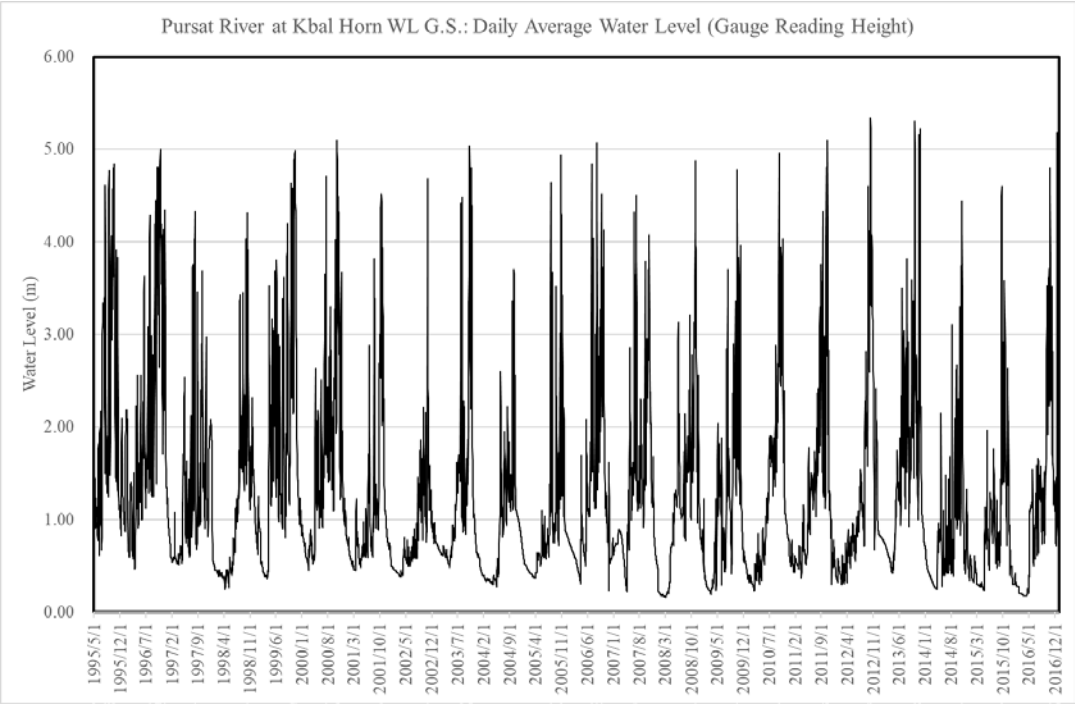
Note: Shaded cells in the above table show the values for the lowest three years.

Discharge measurement is conducted at Bac Tra Koun Gauging Station in the mid-stream reach of the Pursat River. However, it seems that reliability of its discharge data is insufficient. This is because there are cases of very small discharge amount among the data of the Station, even if discharges exist during the dry season in the actual case. Considering this, the discharge data of Bac Tra Koun station were not referred to in the drought analysis of this Survey.

3) Characteristic of Water Level Variation of the Pursat River

It is important to grasp characteristics of water level fluctuation of the Pursat River for designing the intake facility. Figure 1-4-5 shows daily water level change at Kbal Horn.

Annual water level fluctuation at Kbal Horn is about less than 7m. It is noted that water level fluctuation of the impounding portion of Damnak Ampil HW is controlled to be within 3m by the operation of its gates (based on the information from MOWRAM and DOWRAM).



Data source: MOWRAM

Figure 1-4-5 Daily Water Level at Kbal Horn (Gauge Reading Values)

4) Water Use Systems along the Pursat River

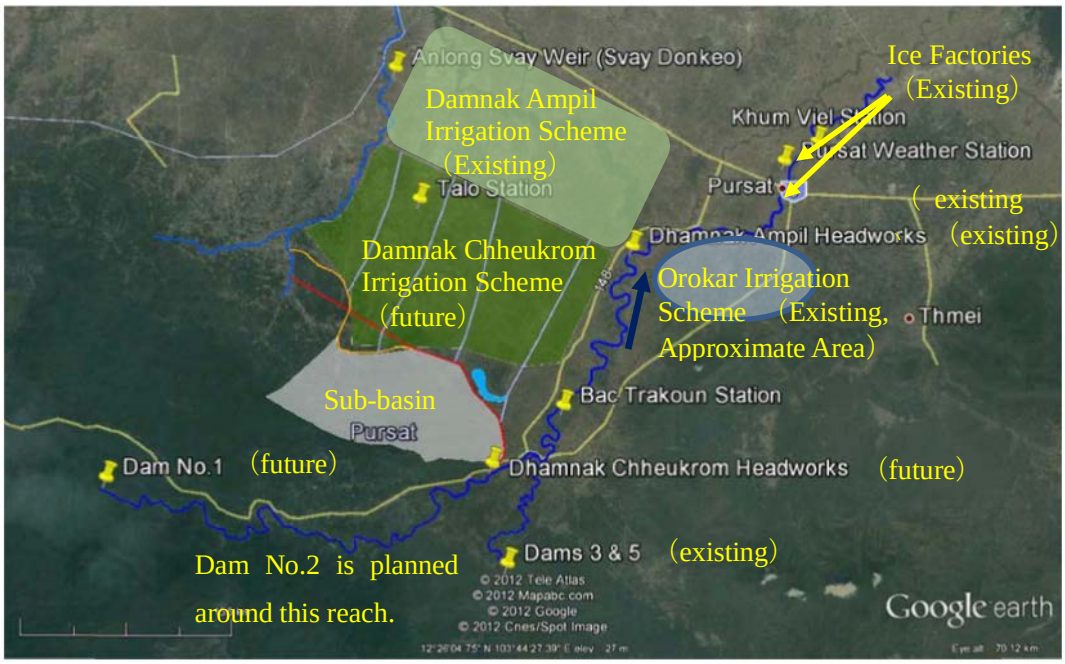
The water use systems along the Pursat River are as follows (see Table 1-4-3 and Figure 1-4-6).

Table 1-4-3 Water Use System along the Pursat River (Existing and Future Systems)

Water Use System	Existing/ Plan	Size	Water Source
Irrigation System (IS)			
Damnak Ampil IS	Existing and future expansion plan	Existing: 7,500ha Future: 15,000ha	Damnak Ampil HW (left bank side)
Other IS	Existing	6,930ha	Damnak Ampil HW (left bank side)
Orokar IS	Existing	4,700ha	Damnak Ampil HW (right bank side)
Kbal Horn IS	Existing	3,200ha	Kbal Horn Weir (As the Weir was already removed, irrigation water is not taken in the present.)
Charak IS	Existing and future expansion plan	Existing: 5,540ha Future: 11,000ha	Charak HW (located about 17km downstream from the National Road (NR) No.5.)
Damnak Chheukrom IS	Future plan	16,100ha	Damnak Chheukrom HW
Irrigation canals used only during rainy season	Existing	5 canals	Water is taken only when water level of the Pursat River between Damnak Ampil HW and Kbal Horn Weir is high. Water is taken by gravity at 4 places and by pump at 1 place.
Total of the Irrigation Systems		Existing: 27,870ha Existing (actual): 24,670ha	

Water Use System	Existing/ Plan	Size	Water Source
		Future: 53,730ha	
Domestic and Industrial Water Supply (WS)			
2-1 Domestic WS	Existing	7,000m^3/day x 1.1/86,400s= 0.09m^3/s	Water intake pumping station of domestic WS located on the left bank about 900m upstream from the NR5.
2-2 Ice Factory	Existing	0.01m^3/s (Estimated quantity based on ice production volume)	Among the two ice factories, only one factory takes water from the Pursat River.

Note: The irrigation areas are based on the information from the "River Basin Water Resources Utilization" JICA Survey Team.



Sources: 1) Irrigation areas in the left bank side: ADB TA 6456-REG: Preparing the Greater Mekong Subregion Flood and Drought Risk Management and Mitigation Project, Irrigation Engineers report (May 2012), and 2) Irrigation areas in the right bank side: JICA Survey Team based on Google Earth, and 3) Ice factories: JICA Survey Team.

Figure 1-4-6 Major Water Use System along the Pursat River (Upstream from the Town Area)

5) Discharge of the Pursat River during Dry Season

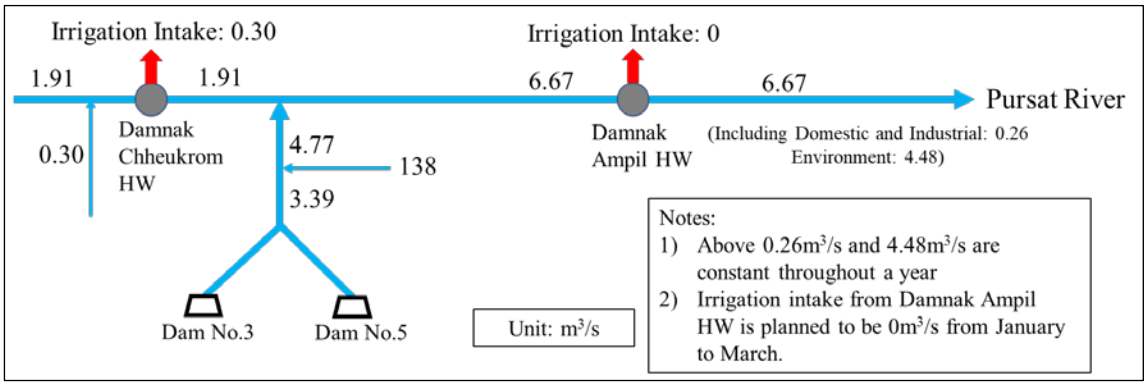
ADB's Plan of the Damnak Chheukrom Irrigation System (DCIS)

ADB's plan of the Damnak Chheukrom Irrigation System (DCIS)[6]) has been formulated based on the design drought with 5-year return period. In this plan, in case of future development of the DCIS under the existing Damnak Ampil Irrigation System (DAIS), normal discharge of 4.74 m^3/s will be constantly released from the Damnak Ampil HW to the river whole year round even under 5-year return period of drought. The normal discharge of 4.74 m^3/s is composed of 0.26 m^3/s for domestic and industrial water supply and 4.48 m^3/s for environmental flow. This will be done both cases of

[6] ADB TA 6456-REG: Preparing he Greater Mekong Sub region Flood and Drought Risk Management and Mitigation Project, Irrigation Engineers Report (May 2012). 0.26m^3/s is based on the Hydrological Aspect Presentation of the River Basin Water Resources Utilization Project of JICA.

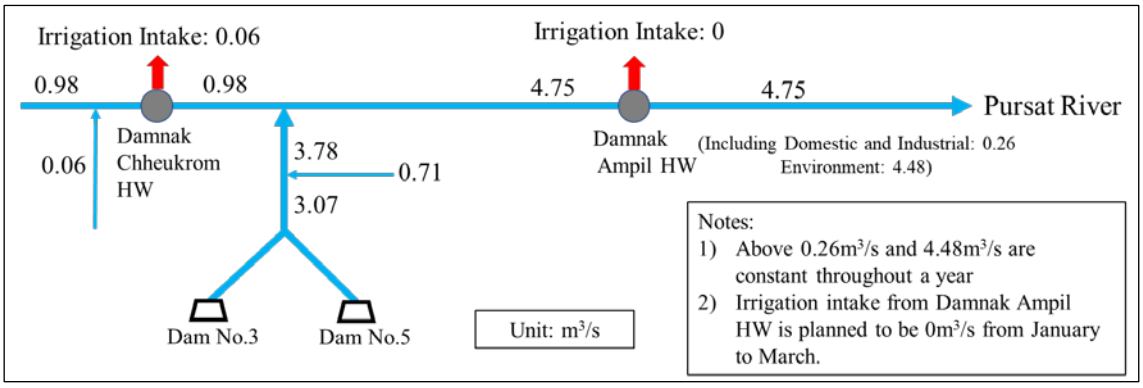
without and with climate change impacts. According to the Pursat DOWRAM, this normal discharge will be ensured even under completion of construction of the DCIS in the future. Furthermore, the ADB's plan will be the basic plan for operating the irrigation systems.

Based on the above ADB's plan, water balance plans under the present hydrological conditions and hydrological conditions considering climate change are shown in Figure 1-4-7 and Figure 1-4-8 respectively. These figures show the water balances for the months, when discharge in the downstream reach of the Pursat River becomes the smallest. In the ADB's plan, irrigation water is planned to be taken from the Damnak Chheukron HW and Damnak Ampil HW within the range of the river discharges in the upstream of these headworks. In addition, it is planned that irrigation water will not be taken from the Damnak Ampil HW from January to March in the dry season.



Data source: ADB TA 6456-REG

Figure 1-4-7 Water Balance Plan of the ADB's Irrigation Plan under the Present Hydrological Conditions of the Pursat River (Case with the smallest river discharge in the downstream reach in a year under 5-year return period of drought: March)



Data source: ADB TA 6456-REG

Figure 1-4-8 Water Balance Plan of the ADB's Irrigation Plan under Climate Change Conditions of the Pursat River (Case with the smallest river discharge in the downstream reach in a year under 5-year return period of drought: February)

Water Balance Analysis by the River Basin Water Resources Utilization Project of JICA (for Reference)

According to the water balance analysis by the "River Basin Water Resources Utilization Project" of JICA, under the present irrigation systems including DAIS with design drought of 5-year return period of drought and only with the existing Dam No.3 and Dam No.5, 75MCM of irrigation water will be annually short. For this analysis, 6,000 m^3/day (0.07 m^3/s) for domestic and industrial water quantity and 0.1 m^3/s/ km^2 of river maintenance discharge (4,480 km^2 of catchment area at Damnak Ampil HW with 4.48 m^3/s) are included. Furthermore, for the analysis, irrigation areas are set at 10,000ha in the dry season, 4,500ha in the beginning of the rainy season, and 28,400ha in the rainy season. In addition, in case of constructing the new DCIS and implementing the expansion of DAIS, 297MCM will be annually short under the condition of 5-year return period of drought and only with the existing Dam No.3 and Dam No.5. For this analysis, 12,000 m^3/day (0.14 m^3/s) for domestic and industrial water quantity and 0.1 m^3/s/ km^2 of river maintenance discharge (4.48 m^3/s at Damnak Ampil HW) are included. Furthermore, for the analysis, the irrigation areas are set at 10,000ha in the dry season, 4,500ha in the beginning of the rainy season, and 28,400ha in the rainy season. In order to solve this water shortage, a new dam with storage volume of 297MCM is necessary to be constructed in the upstream reach. It is noted that the Dam No.2, which will be planned in the right tributary in the upstream basin, will have gross storage of more than 200MCM. By constructing the Dam No.2, although some control of irrigation water intake might be necessary, water shortage of irrigation will be significantly solved.

Necessity of Water Resources Management

As described above, the normal discharge (domestic and industrial water plus environmental discharge) will be ensured in the ADB's plan by setting 5-year return period of drought as the design drought and irrigation water will be taken within the possible range of residual river discharge.

On the other hand, the analysis of the "River Basin Water Resources Utilization Project" of JICA sets the irrigation areas for the dry season, the beginning of the rainy season and the rainy season under present and future conditions respectively. Then, it concluded that shortage of river discharge will occur against the water demand composed of irrigation, domestic and industrial water and environmental discharge.

Under the condition of non-existence of the Dam No.2, as irrigation water will be taken from the existing Damnak Ampil HW and the future Damnak Chheukrom HW, water has to be taken within the range of river discharge. According to the DOWRAM, basically by following the ADB's plan, irrigation water will be taken within the range of river discharge and normal discharge will be released to the downstream reach.

However, there is a possibility that irrigation water demand will be much bigger than the river discharge as the analysis of the JICA Project. Therefore, if there is a possibility of water shortage due to drought, it is necessary to conduct water resources management based on the discussion among all the water users by conducting monitoring of river discharge and irrigation water. The water resources management shall ensure domestic water quantity as top priority, and shall include stage-wise reduction of water intake.

Estimated Drought Discharge of 2015 Drought and Future Drought Discharge

It can be estimated that discharge of 10 m^3/s was flowing in the Pursat River at the existing water intake pumping station for domestic water supply during the recent severest drought in 2015 based on the calculation described below. At that time, the discharge at Damnak Ampil HW is estimated at 9 to 9.5 m^3/s (Based on the discharge measurement of this Survey, discharge at Damnak Ampil HW = 0.9 to 0.95 x discharge at the existing intake pumping station of domestic water supply). According to the information from DOWRAM, the constructions of the Dam No.3 and Dam No.5 were almost completed by the drought in 2015, and supplemental water was released from these dams to the rivers.

- Based on the information from the PWWs and the data on the measured flow areas by the discharge measurement from this Survey, the minimum water depth and flow area at the existing water intake pumping station of the domestic water supply in the Pursat River were estimated at 1.5m and 70 m^2 respectively.
- Based on the results of the discharge measurement at the existing water intake site of domestic water supply and at Kbal Horn Weir, slope of water surface in longitudinal direction of the Pursat River is estimated at 1/6,400 and Manning's roughness coefficient is estimated at n=0.1 respectively (Note: Kbal Horn Weir is currently removed.). Normally, as the Manning's roughness coefficient of the river is set at 0.03 to 0.045, n=0.1 is safety side value.
- Based on the above, velocity during the minimum water level in 2015 is estimated at 0.15m/s. Then, discharge is estimated at 10 m^3/s by multiplying flow area (70 m^2 of flow area x 0.15m/s of estimated velocity = about 10 m^3/s).

Based on the above analysis, water intake quantity of domestic water supply (Existing 7,260 m^3/day x 1.1 =7,986 m^3/day, New 6,600 m^3/day x 1.1 =7,260 m^3/day, and Total 15,246 m^3/day = 0.18 m^3/s) can be ensured even under 10-year return period of drought.

Furthermore, when the Damnak Chheukrom HW will be constructed in the future, drought discharge, which is equivalent of 2015 drought, at Damnak Ampil HW is estimated to be slightly smaller than 9 to 9.5 m^3/s (difference of less than 0.3 m^3/s) (see (1) 4)). Hence, drought discharge with 10 to 15-year return period at Damnak Ampil HW will be sufficiently bigger than the water intake quantity of domestic water supply (0.18 m^3/s). Therefore, it is estimated that water quantity of domestic water supply can be ensured.

6) Flood Characteristics of the Pursat River

Location of surface water intake and WTP must be decided grasping characteristics of floods of the Pursat River to ensure safety of their facilities against floods.

Based on the information from the inhabitants around the Pursat River and DOWRAM, it was confirmed that the recent large floods of the Pursat River occurred in 1996 and 2006. According to the information from the inhabitants in the downstream areas, both floods had almost the same scale of flood inundation; however, 1996 Flood caused slightly higher inundation water level than that of 2006 Flood.

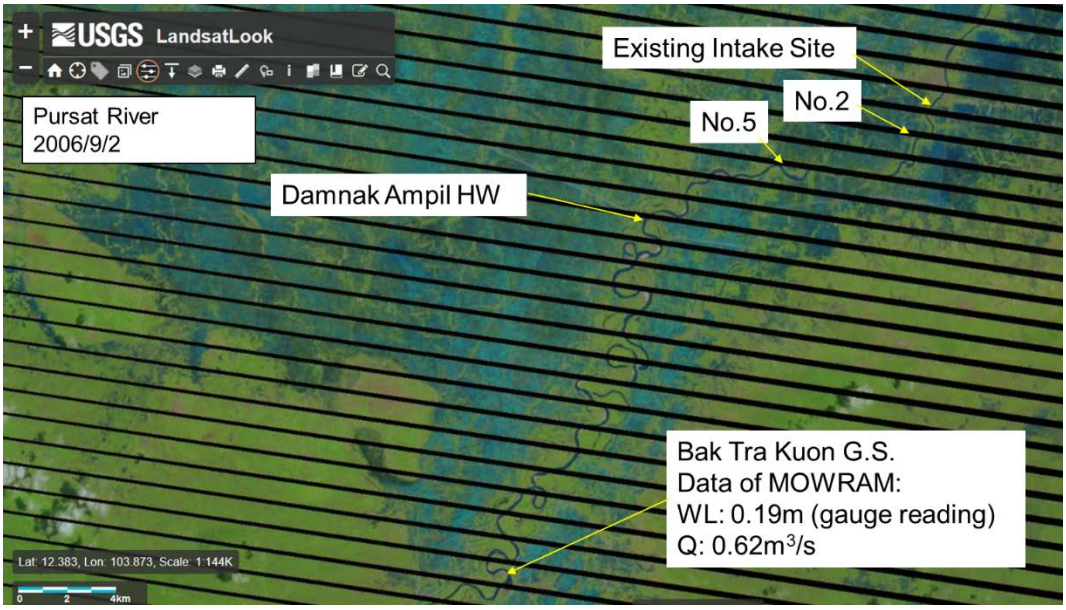
It was not possible to collect some reference about the inundation area of 1996 Flood. It can be estimated that the 2006 Flood occurred around the latter half of August to the beginning of September. Figure 1-4-9 shows the satellite image on September 2, 2006, which was downloaded from the home page of the United States Geological Survey (USGS). The blue portion of this satellite image shows approximate inundation area of 2006 Flood. It can be understood that very wide flood inundation occurred in both sides of the Pursat River from around Bac Tra Koun in the mid-stream reach to the downstream reach.

Based on the interview of this Survey to the inhabitants about flood conditions, inundation depth of 2006 Flood in the left bank side is estimated at about 1m in the flood plain in the mid-stream reach around the water treatment candidate site of No.5 (about 8km downstream from Damnak Ampil HW along the River). The inundation depth in the flood plain in the downstream reach around the water treatment candidate site of No.2 (about 14km downstream from Damnak Ampil HW along the River) is estimated at about 2m.

By the 2006 Flood, the existing water intake facility of domestic water supply was not inundated, but about 1m inundation occurred over the ground of the house on the left bank about 50m upstream from the existing water intake facility.

Inundation did not occur at place of Damnak Ampil HW by the 2006 Flood, but several 10cm of inundation occurred around the paddy field located about 200m upstream from the location of the HW. The recorded maximum water level at the Damnak Ampil HW is El. 19.00m in 2011 based on MOWRAM's elevation.

By considering the above characteristics of flood inundation in the whole Pursat River and those at the candidate sites for intake and WTP, it is necessary to set the elevation of the facilities and the land reclamation for the areas of the facilities so that the facilities will not be damaged by the floods.



Note: Details of the candidate sites of WTP (No.2 and No.5) are shown in Figure 1-4-10.
Source: Landsat image of USGS

Figure 1-4-9 Inundation Area of 2006 Flood of the Pursat River

7) Condition of Pollution Source in the Pursat River Basin

There are no large solid waste disposal sites or pig farms from the Kbal Horn Weir in the downstream reach to the Damnak Ampil HW in the mid-stream reach, which will deteriorate water quality in the river. However, it can be estimated that domestic wastewater from houses along the river flows into the river. There are no development plans around the Damnak Ampil HW and in the upstream reach, which will affect water quality in the river.

8) Condition of Sand Mining in the Pursat River

Large, medium or small scaled sand mining are conducted disorderly in the Pursat River. The sand is taken not only from river bed but from the bank by excavating on a large scale. Some locations of the river have very wide river width due to sand mining. The river channels in these reaches are significantly disturbed. It is noted that sand mining is prohibited in the reaches of 800m downstream and 800 upstream from Damnak Ampil HW. The statement about this prohibition is written in the contract (license) between Ministry of Mines & Energy (MME) and the sand mining companies. Furthermore, there are poles one each at the upstream end and downstream end of the prohibited reaches of sand mining (note: information from Pursat DIH).

The permission of sand mining here has been issued already by the MOWRAM together with Ministry of Industry Mines and Energy (MIME) that was the former ministry before separating the MIH, which was in-charge of domestic water supply at that time. At present, permission of sand mining is issued only by MME together with MOE without MOWRAM. Pursat DOWRAM recognizes that this is a problem.

Strengthening management of sand mining including regulation is necessary as early as possible to conserve river channels and to control sediment runoff. Furthermore, sand mining management must be conducted under supervision by the river basin management committee from the viewpoints of river channels and river basins management. MOWRAM should become the main agency of the sand mining management.

Source: JICA Survey Team
Satellite image: Google Earth

Figure 1-4-10 Locations of the Sand Mining in the Pursat River between Damnak Ampil HW and the existing water intake site of the domestic water supply

(2) Existing Water Intake Facilities and Water Intake Method

1) Existing Water Intake Facilities

The existing water intake method is to take the water from river under natural inflow through two transmission pipes with a strainer submersed in the river as shown in Photo-1. The transmission pipes are laid on up and down under the water, and an intake gate is placed at the outlet of the down pipe as shown in Photo-4. When the water level of river is lower than the level of upper transmission pipe, the gate is opened for taking water from river. Even though the dry season, the transmission pipe of downside is planned to be submersed all the time.

Pump type is of a vertical mixed flow pump. Three pumps are installed in the existing intake pump station and all pumps can be operated now. Each pump is manually operated to average the operation hour of pumps. Since there are no pump construction drawings, the type of submersible bearing is unclear, but it can be presumed that the type of original bearing is of the metal or carbon sleeve bearings which does not require lubricating water supply. Bearings of handmade bamboo were used for a period because of the inability to procure bearings made of original material, but recently they were changed to rubber bearings.

Since the water leaks from the pump column pipes due to incomplete installation or damage, the operation condition of pumps is considerably bad.

There is no sediment pond before the pump pit. For that reason, the silt and sand flowing in from the river is transmitted directly to the sedimentation pond shown in the Photo-3 in the WTP by the intake pumps, and a part of them accumulates in the pump pit. The silt and sand accumulated in the intake pump pit are designed to be discharged by agitating of jet flow from the water spray pipe laid on the

bottom of pump pit and they are transmitted together with discharge water of intake pump to the sedimentation pond. The pressure of the jet flow used the waterfall of the elevated water tank shown in the Photo-5 constructed in the WTP, but this sand removal system is not used now because the elevated water tank is not operating. For that reason, the silt and sand accumulated in the pump pit are discharged periodically by hand works. The silt and sand taken out from the sedimentation pond are shown in the Photo-6, and it seems like clayey. Now, the intake gate cannot be closed because the extended axis is damaged. For that reason, it is difficult to bring out the silt and sand from inside the pump pit, therefore, emergency repair as rapidly as possible was proposed to the PWWs.

Photo-1 Existing upper transmission pipe with strainer (Lower transmission pipe is laid underwater)

Photo-2 Existing vertical drive motors for pumps

Photo-3 Existing head tank not used now due to insufficient water pressure.

Poto-4 Opening handle of Intake gate, now broken

Photo-5 Sedimentation pond in the WTP

Photo-6 Silt and sand accumulated in pit

Source: JICA Survey Team

2) Problems of Existing Intake Pump Station

Problems of existing intake pump station at the time of the survey are as follows.

Intake water from river contains a large amount of silt and sand. The jet flow piping installed for discharging the silt and sand is inactive; therefore, the silt and sand cannot be discharged. The sediment having about 50 cm thickness in the rainy season which must be taken out manually at about once every 15 days.

Since the river water containing a large amount of silt and sand is transferred by the intake pump as it is, the impellers and the sliding parts of the pumps wear out in a short time and they must be replaced or repaired. Worn impeller is changed with impeller made of poor materials such as steel plate instead of stainless steel casting, furthermore, worn parts are reused after being welded. Submersible bearings were exchanged at a frequency of once every two months before, but their lifetime now has been extended by changing to rubber bearings. However, it is recommended as a long-term solution to improve pump station such as replacement of pumps / pump impellers and construction with protection wall for submersible vortex generation and with drain pit for sand pump.

1-4-4-2 Conveyance Pipe

The existing conveyance pipe connects between the existing intake pump station and grid chamber which is inside the premise of existing WTP. The material of conveyance pipe is steel pipe with flange and the diameter is 350mm. The length of the conveyance pipe is about 200m from intake pump station to the grid chamber. The pipe crosses under the road which is in front of the entrance gate of the WTP site. Though the earth and sand from the river tends to accumulate in the intake pump pit, clogging of the conveyance pipe has not been occurred.

1-4-4-3 WTP

The existing WTP in Pursat City was constructed with ADB funds for the Provincial Towns Improvement Project (2000 - 2006) which covered Battambang, Pursat, Kampong Cham, Kampong Thom, Svay Rieng, and Kampot provinces. The WTP started operation in 2007 with an initial capacity of 5,760 m^3/d. Thereafter, a monitoring system was introduced in 2013 through JICA Grant Aid Project: "Project for Replacement and Expansion of Water Distribution Systems in Provincial Capitals". Tube-settlers were installed in the sedimentation basin in 2015 by funds of PWWs to improve water quality and increase water quantity. The capacity of the plant was thereby increased to 7,260 m^3/d. The plant is well maintained with minimal water outage and quality related incidents; however, the existing WTP site has expansion limitations – only 10m of space (at the maximum) is available around each facility. Therefore, it is necessary to secure a new site for installing a new WTP.

Schematic map of the facilities at the existing WTP is shown in Figure 1-4-11, an overview from an elevated tank is shown in Figure 1-4-12, and a summary of facilities at the WTP is outlined in Table 1-4-4.

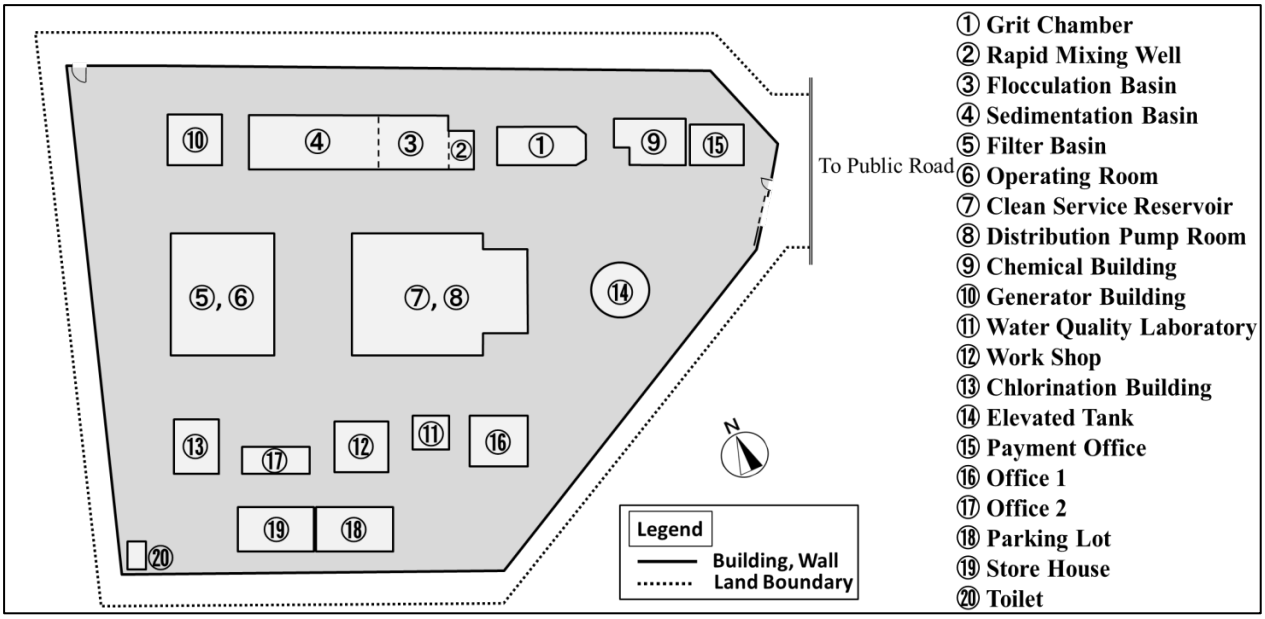


Figure 1-4-11 Schematic Map of the Facilities at the Existing WTP

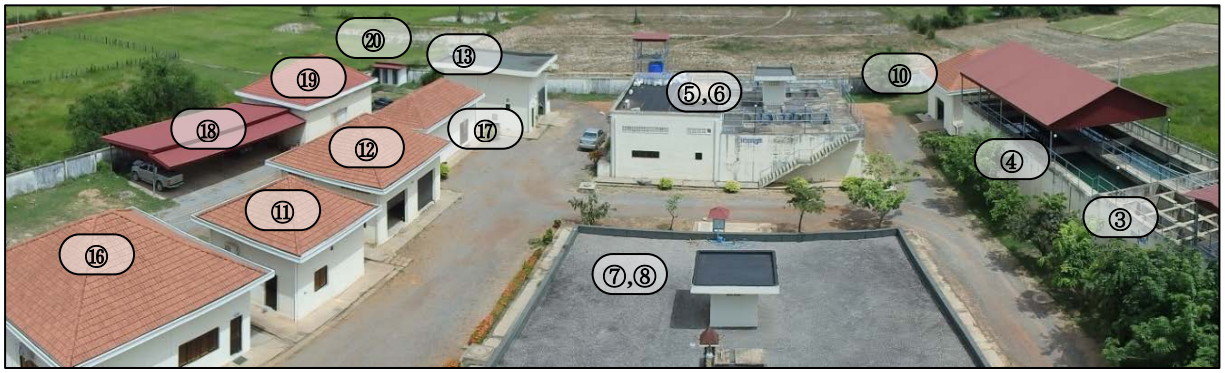


Figure 1-4-12 Overview of the Existing WTP from an Elevated Tank

(Note: Facility corresponding to each ID is presented in Figure 1.4.3-1)

Table 1-4-4 Summary of Facilities at the Existing WTP

No.	Section	Facility Outline	Contents
1	Grit Chamber	Reinforced Concrete Construction $30m^2$×2 Basins（Depth 3.7m）	・No significant deterioration, water leaks, etc. were observed on the building surface. ・Sludge is discharged every two months, and the maintenance situation is good.
2	Rapid Mixing Well *1	Reinforced Concrete Construction $8.5m^3$	・No significant deterioration, water leaks, etc. were observed on the building surface. ・The mixing condition is mostly good.
3	Flocculation Basin *1	Reinforced Concrete Construction 2 Basins, Zigzag Flow Method Total $135m^3$	・No significant deterioration, water leaks, etc. were observed on the building surface. ・The chemical feeding is done properly, and the maintenance situation is good.
4	Sedimentation Basin *1	Reinforced Concrete Construction 2 Basins (Front Stage, Back stage) <<Front stage>> Normal Sedimentation Basin $40m^2$ （Depth 4.18m） <<Back stage>> Sedimentation with Tube Settler $40m^2$ （Depth 4.18m）	・The treated water quality is very good. ・No significant deterioration, water leaks, etc. were observed on the building surface. ・Tube-settlers and a roof were installed at the time of extension in 2015. ・The maintenance conditions are good.
5	Filter Basin *2	Reinforced Concrete Construction, 4 Basins, Total $49m^2$ <<Washing Method>> Backwash + Air Wash <<Backwash pump>> $5m^3/min^2$ Units <<Brower for Air Wash>> $16.15m^3/min$×2Units	・No significant deterioration, water leaks, etc. were observed on the building surface. ・Although the motorized valves have malfunctioned, proper maintenance has been maintained via manual operation.
6	Operating Room *2	Reinforced Concrete Construction 1 story	・A monitoring system was introduced in 2013 through JICA Grant Aid Project, and its operation condition is good. ・The control room is an integral construction with the filter basins and is located on the first floor.
7	Clean Service Reservoir	Reinforced Concrete Construction 2 Basins Total $2,030m^3$ (Nominal $2,000m^3$)	・No significant deterioration, water leaks, etc. were observed on the building surface. ・Although the initial water level indicator is damaged, the water level is managed by a float type water gauge that was installed on their own.
8	Distribution Pump Room	Reinforced Concrete Construction 1 story & 1 basement story <<Distribution Pump>> 4Units ($120m^3/h$×3units, $273m^3/h$×1unit）	・With the increase in the number of water supply connections, one additional water distribution pump was installed in 2015 with self-funds in order to switch from the gravity (using elevated tank) to pumping distribution (using pump pressure). ・Although the flowmeter installed during construction is non-operational, newly installed flowmeters (through funds from JICA Grant Aid Project, 2013) are properly operated. ・The distribution pumping room and the clear water reservoir are an integral construction.
9	Chemical Building	Reinforced Concrete Construction 3 stories	・Aluminum chloride (manufactured in China) is used as a coagulant. ・The flow rate adjustment tank is installed on the secondary side of the coagulant mixing tank to manage adequate coagulant feeding rate. ・The injection equipment for slaked lime is not in operation.
10	Generator Building	Reinforced Concrete Construction First floor above ground Generator×2units	・The generator main unit is operated properly. ・The initial generator control board at the beginning of construction malfunctioned and a new control panel was installed through funds from JICA Grant Aid Project in 2013.
11	Water Quality Laboratory	Reinforced Concrete Construction 1 story	・The water quality test equipment can test almost all the parameters as required by National Standards.
12	Work Shop	Reinforced Concrete Construction 1 story	・The building has no remarkable deterioration, and the management condition is good.
13	Chlorination Building	Reinforced Concrete Construction	・At the beginning of construction (2006), liquid chlorine was used, but the equipment was damaged from 2013 to 2015. ・From June 2015, chlorine feeding is carried out by dissolving calcium hypochlorite (Chlorine powder) in a PE tank, which was installed at the top of the filter basin with self-funds. ・The building has no noticeable deterioration, but liquid chlorine was no longer utilized. ・A chlorine generator (manufactured in China) that uses salt electrolysis is installed.
14	Elevated Tank	Reinforced Concrete Construction 1 Building $350m^3$	・Since the number of water supply connections increased from 4,000 at the start of operation to about 7,000 at present and the distribution area expanded, the advantage of utilizing the elevated tank was lost. ・Therefore, distribution was switched from gravity to pumping method in 2015, and the elevated tank is currently not utilized.
15	Operation & Maintenance	・For operation and maintenance, 6 staffs are in charge of the facilities and 2 staffs are in charge of water quality analysis ・No serious maintenance problems such as long-hours water outage or water quality accidents were confirmed.	

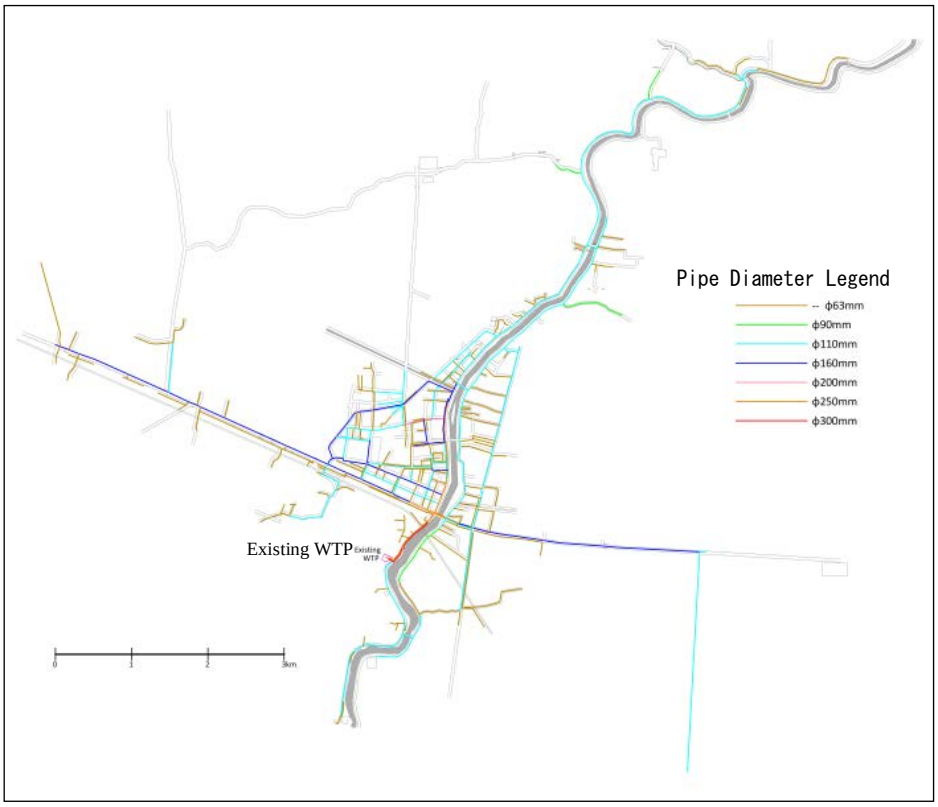
*1 The rapid mixing well, the flocculation basins and the sedimentation basins are an integral construction.

*2 The filter basins and the control room are an integral construction.

1-4-4-4 Distribution Facilities

(1) Water Distribution System

Figure 1-4-13 shows the outline of the existing distribution system. At the beginning of its operation, water was distributed by gravity flow from elevated tank; however, water is distributed directly now from the distribution pump without going through the elevated tank because of increasing distribution flow. The distribution pump keeps water pressure of about 0.45 MPa by human monitoring for 24 hours and by controlling water volume. The distribution pipe network was constructed with nominal diameter φ 63 mm to φ 300 mm and water is distributed for 24 hours.

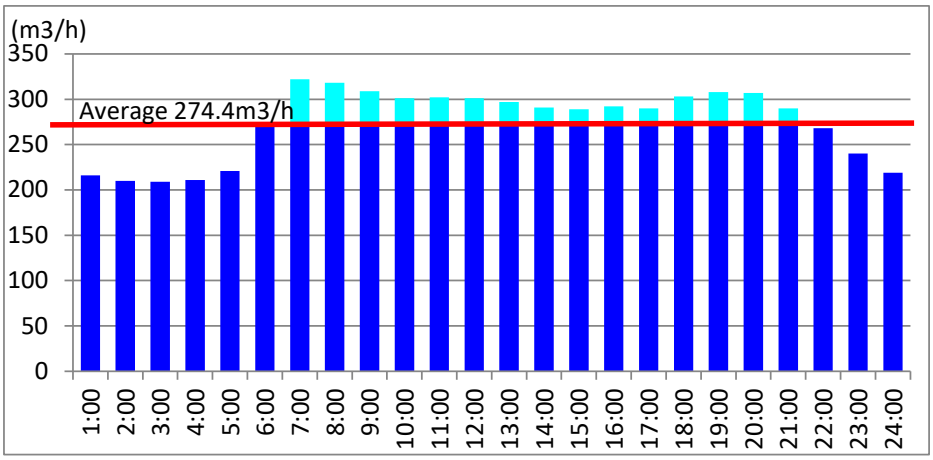


Source：JICA Survey Team

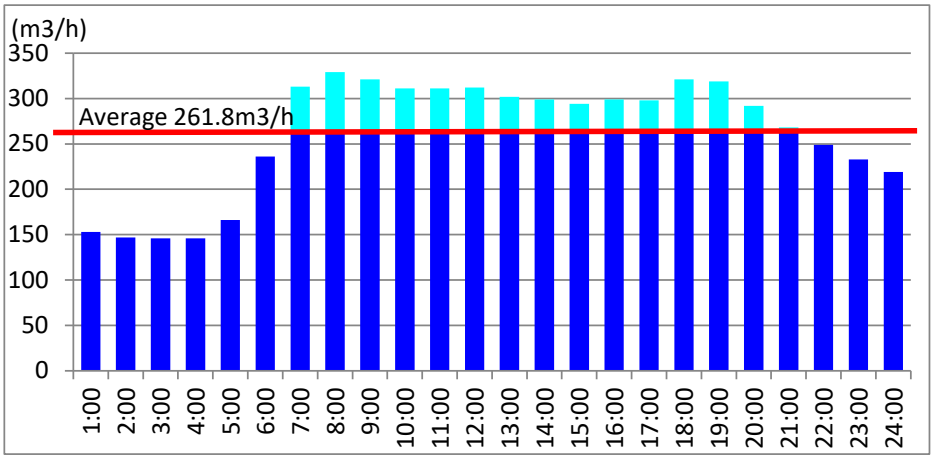
Figure 1-4-13 Outline of Existing Water Distribution System

(2) Capacity of Service Reservoir

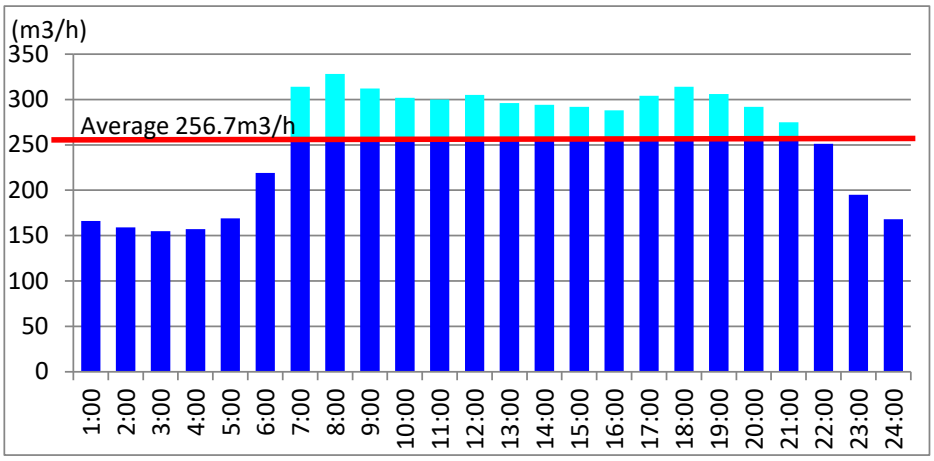
The appropriateness of the capacity of existing service reservoir was confirmed as nominal 2,000 m^3. The existing service reservoir capacity has 7.3 hours of the past maximum daily supply (6,586 m^3 / day). According to the demand fluctuation of the maximum daily supply in the past, the total flow exceeding the time average distribution flow per hour at the time of maximum daily supply is 410 to 670 m^3 (light blue part of Figure 1-4-14). It equals to 2.6 hours of the maximum daily supply. Therefore, the capacity of the existing service reservoir is sufficient.



7th of July, 2015（Flow：6,586m3/day）



7th of March, 2015（Flow：6,284m3/day）



28th of February, 2015（Flow：6,161m3/Day）

* The top three days that recorded the maximum water distribution per day in 2015. After 2016 there is no record due to breakdown of the water distribution record system.
Source：JICA Survey Team

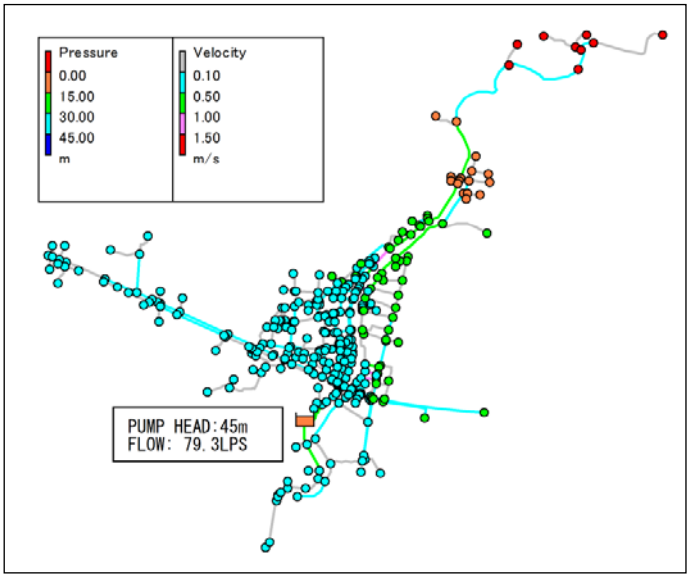
Figure 1-4-14 Maximum Daily Supply Trend in the Past

(3) Time Coefficient

From the trend of the maximum daily supply in Figure 1-4-14, the maximum of the time coefficient in the past is 1.30.

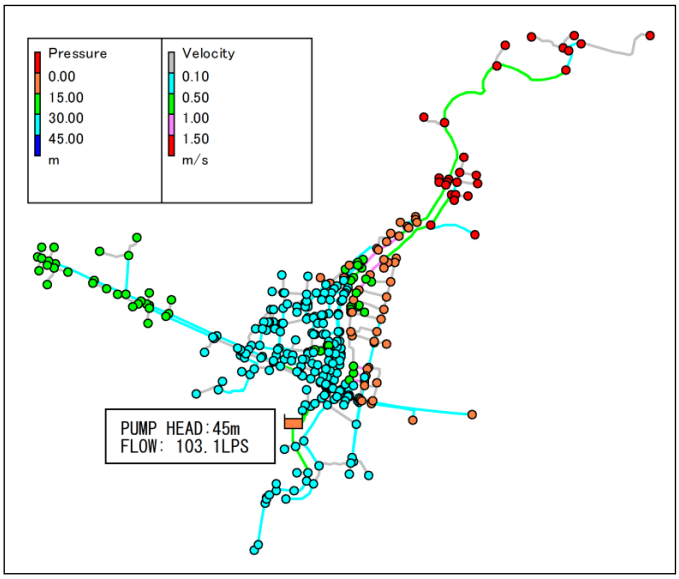
(4) Water Distribution Pressure

According to the interview from PWWs, there were complaints due to lack of water pressure at the end of the pipe in the northern area along Pursat River. As a result of the network hydraulic analysis as shown in Figure 1-4-15, only the end of the pipe in the northern area along Pursat River has negative pressure at the maximum daily supply, and the negative pressure range at the northern area has expanded at maximum hourly distribution flow as shown in Figure 1-4-16. It suggests that adequate water pressure can be secured for the northern area along Pursat River within the existing water distribution network.



Source：JICA Survey Team

Figure 1-4-15 Water Distribution Pressure, Flow Velocity at Maximum Daily Supply



Source：JICA Survey Team

Figure 1-4-16 Water Distribution Pressure, Flow Velocity at Maximum Hourly Distribution Flow (time coefficient 1.30)

1-4-5 The Proposed Site for the New WTP

The planned site for the new WTP was chosen from a list provided by the Cambodian side in which checked the ease of site acquisition and positional relationship between the new intake site and the water distribution area. The site (rectangular; about 1.0ha) is shown in Figure 1-4-17. The site area and its vicinity are flat and covered by well spread paddy fields.

The planned site consists of a sandy clay layer with sand mixing up to a depth of 8.5–9.5m; sandy clay layer and clayey sand layer are mutually located below a depth of 8.5–9.5m. The soil has N values of 20 or higher below depths of 3m and 50 or higher between depths of 8m and 12m. Thus, the geology of the planned site can be considered relatively suitable for the project.

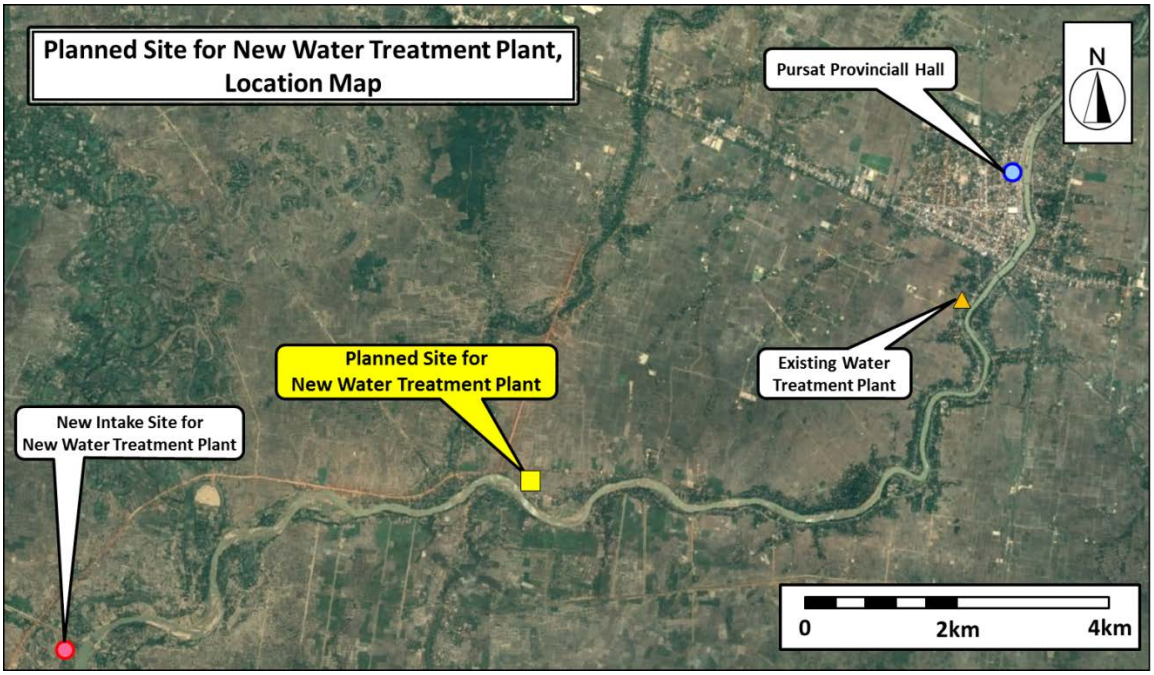


Figure 1-4-17 Location map of the planned site of the new WTP

Source: JICA Study Team

1-4-6 Power Supply Situation

Cambodia's electricity supply business is carried out by "Electricite Du Cambodge" (EDC). In the case of power supply capacity in Pursat City, there is a short breakdown and so on sometimes; however, it is conceivable that there is no hindrance about the normal power supply to the new WTP and water intake facility. Since EDC's three-phase 22 kV 50 Hz distribution line is laid near the new WTP and water intake site, power supply to them is enough.