Appendices

Appendices

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Appendix 1　Member List of the Study Team

1-1 Basic Design Survey

（1）Ms. Keiko　YAMAMOTO,　Leader
Senior Technical Advisor,
Japan International Cooperation Agency (JICA)

（2）Ms. Makiko WATANABE, Project Coordinator
First Project Management Division, Grant Aid Management Department,
Japan International Cooperation Agency (JICA)

（3）Mr. Hidetoshi HAGA, Project Manager / Operation and Management Planning
TOKYO ENGINEERING CONSULTANTS CO., LTD.

（4）Mr. Hirotaka SATO, Water Treatment Planning
TOKYO ENGINEERING CONSULTANTS CO., LTD.

（5）Mr. Takayuki TANGE, Facility Planning
TOKYO ENGINEERING CONSULTANTS CO., LTD.

（6）Mr. Junichi WATANABE, Socio-Economic Survey
NIHON SUIDO CONSULTANTS CO., LTD.

（7）Mr. Hisamitsu TANAKA, Cost Estimation
TOKYO ENGINEERING CONSULTANTS CO., LTD.

（8）Mr. Takuro NUKAZAWA, Facility Planning (CAD), Cost Estimation
TOKYO ENGINEERING CONSULTANTS CO., LTD.

1-2　Explanation and Discussion for the Draft Basic Design Report

（1）Ms. Keiko　YAMAMOTO,　Leader
Senior Technical Advisor,
Japan International Cooperation Agency (JICA)

（2）Ms. Makiko WATANABE, Project Coordinator
First Project Management Division, Grant Aid Management Department,
Japan International Cooperation Agency (JICA)

（3）Mr. Hidetoshi HAGA, Project Manager / Operation and Management Planning
TOKYO ENGINEERING CONSULTANTS CO., LTD.

（４）Mr. Hirotaka SATO, Water Treatment Planning
TOKYO ENGINEERING CONSULTANTS CO., LTD.

（５）Mr. Takayuki TANGE, Facility Planning
TOKYO ENGINEERING CONSULTANTS CO., LTD.

Appendix 2 Survey Schedule

2-1 Basic Design Survey

No.	Date		JICA Officers	Project Manager/ Operation and Management Planning	Water Treatment Planning	Facility Planning	Socio-Economy Survey	Cost estimation / Procurement Planning
1	6/10	Sat				Narita to Bangkok		
2	11	Sun				Arrive to Phnom Penh, Preparation for soil testing		
3	12	Mon				Courtesy call to and discussion with PPWSA,		
4	13	Tue				Preparation for soil testing		
5	14	Wed				Preparation for geographic survey		
6	15	Thu				Preparation for geographic survey		
7	16	Fri				Preparation for geographic survey		
8	17	Sat				Preparation for geographic survey		
9	18	Sun	Narita to Bangkok					
10	19	Mon	Arrive to Phnom Penh, Courtesy call on Embassy of Japan and JICA Cambodia Office, Discussion with PPWSA (Explanation of Inception Report)					
11	20	Tue	Site survey (Phum Prek, Chrouy Chang War, Chamcar Morn treatment plant, 7th January/Toul Kork district)					
12	21	Wed	Discussion with PPWSA, Courtesy call on ADB and World Bank Meeting with Mr. Ueda (JICA expert)					
13	22	Thu	Discussion with PPWSA (Discussion on M/M)					
14	23	Fri	Discussion with PPWSA (Discussion on M/M) Signing of the M/M					
15	24	Sat	Additional site survey/discussion (if necessary)					
16	25	Sun	Internal meeting					
17	26	Mon	Report to Embassy of Japan and JICA Office Leave Phnom Penh					
18	27	Tue	Arrive to Narita		Internal discussion on components of the project and the survey Formulation of survey contents and schedule			
19	28	Wed		Confirmation of contents of the project and the survey	Site investigation and data collection of water source	Preparation for soil testing and route and plan survey	Data collection on socio-economy	
20	29	Thu		Site investigation for surveys	Site investigation and data collection of water source	Site investigation for surveys	Data collection on socio-economy	
21	30	Fri		Contract with surveyor	Analysis of evaluation of water sources	Contract with surveyor	Data collection on socio-economy	
22	7/1	Sat		Data and report review	Data and report review	Data and report review	Data and report review	
23	2	Sun						
24	3	Mon		Investigation and date collection of existing facility	Investigation and date collection of existing facility	Investigation and date collection of existing facility	Data collection of water supply condition, Environmental survey	
25	4	Tue		Investigation and date collection of existing facility	Investigation and date collection of existing facility	Investigation and date collection of existing facility	Data collection of water supply condition	
26	5	Wed		Investigation and date collection of existing facility	Investigation and date collection of existing facility	Investigation and date collection of existing facility	Data collection of water supply condition	
27	6	Thu		Analysis and evaluation of existing facility	Analysis and evaluation of existing facility	Analysis and evaluation of existing facility	Water demand estimation	
28	7	Fri		Analysis and evaluation of existing facility	Analysis and evaluation of existing facility	Analysis and evaluation of existing facility	Water demand estimation	
29	8	Sat		Data and report review	Data and report review	Data and report review	Water demand estimation	
30	9	Sun						
31	10	Mon		Data collection of management and O&M	Additional investigation and date collection	Additional investigation and date collection	Environmental survey	
32	11	Tue		Investigation of management and O&M	Additional investigation and date collection	Investigation of power supply	Water demand estimation,	Narita to Bangkok

							Environmental survey	
33	12	Wed		Data collection of management and O&M	Water demand estimation, Environmental survey	Investigation of power supply	Water demand estimation, Environmental survey	Arrival to Phnom Penh Formulation of survey contents and schedule
34	13	Thu		Data collection of management and O&M	Analysis for expansion capacity	Analysis for expansion capacity	Report writing on socio-economy and water demand estimation	Data collection of procurement and cost estimate
35	14	Fri		discussion on socio-economy and water demand estimation	discussion on socio-economy and water demand estimation	Analysis for expansion	discussion on socio-economy and water demand estimation	Data collection of procurement and cost estimate
36	15	Sat		Data and report review	Data and report review	Data and report review	Handing over data and survey results	Data review
37	16	Sun					Leave Phnom Penh	
38	17	Mon		Data collection of O&M	Planning of WTP	Designing of WTP	Arrival to Narita	Data collection of procurement and cost estimate
39	18	Tue		Data collection of O&M	Planning of WTP	Designing of WTP		Data collection of procurement and cost estimate
40	19	Wed		Data collection of O&M	Planning of WTP	Designing of WTP		Data collection of procurement and cost estimate
41	20	Thu		Analysis and evaluation of management and O&M	Analysis of distribution networks	Summary of soil testing and surveys		Data collection of procurement and cost estimate
42	21	Fri		Analysis and evaluation of management O&M	Analysis of distribution networks	Summary of soil testing and surveys		Survey of construction
43	22	Sat		Data and report review	Data and report review	Data and report review		Data and report review
44	23	Sun						
45	24	Mon		Summary of facility planning and designing	Summary of facility planning and designing	Summary of facility planning and designing		Survey of construction
46	25	Tue		Discussion on technical cooperation	Analysis of project benefits	Discussion on technical cooperation		Preliminary estimation of the project cost
47	26	Wed		Confirmation of the works to be conducted by the Cambodian side	Analysis of project benefits	Confirmation ofthe works to be conducted by the Cambodian side		Preliminary estimation of the project cost
48	27	Thu		Internal meeting and report writing	Internal meeting and report writing	Internal meeting and report writing		Internal meeting and report writing
49	28	Fri		Reporting survey results to PPWSA	Reporting survey results to PPWSA	Reporting survey results to PPWSA		Reporting survey results to PPWSA
50	29	Sat		Report writing	Report writing	Report writing		Report writing
51	30	Sun						
52	31	Mon		Report to Embassy of Japan and JICA Office, Leave Phnom Penh	Report to Embassy of Japan and JICA Office, Leave Phnom Penh	Report to Embassy of Japan and JICA Office, Leave Phnom Penh		Report to Embassy of Japan and JICA Office, Leave Phnom Penh
53	8/1	Tue		Arrival to Narita	Arrival to Narita	Arrival to Narita		Arrival to Narita

2-2 Explanation and Discussion for the Draft Basic Design Report

No.	Date	Moving	Contents
1	10/1(Sun)	Leave Japan and arrive Bangkok	Stay Bangkok
2	2(Mon)	Leave Bangkok and arrive Phnom Penh	Courtesy Call on the Embassy of Japan JICA Cambodia Office and PPWSA and submission of the draft report
3	3(Tue)		Explanation and discussion of the draft report
4	4(Wed)		Additional site survey Courtesy call of the Council for the Development of Cambodia(CD) Discussion of the draft report
5	5(Thu)		Discussion of the draft report and M/D
6	6(Fri)		Signing of M/D Report to the Embassy of Japan and JIA Cambodia Office
7	7(Sat)	JICA members leave Phnom Penh	Collection of additional data on cost estimation
8	8(Sun)		Analysis of the data
9	9(Mon)	Consultant members leave Phnom Penh and arrive Bangkok	Collection of additional data on cost estimation Report to PPWSA
10	10(Tue)	Consultant members leave Bangkok and arrive Japan	Arrive in Japan

Appendix 3　List of Party Concerned in the Recipient Country

◆ Phnom Penh Water Supply Authority (PPWSA)

Mr. EK SONG CHAN	General Director
Mr. Long Naro	Director of Technical and Project Department
Mr. Ma Noravin	Hydraulic and design engineer, Technical and Project Dept.
Mr.Tan Bounneth	Vice Chief, Phum Prek Water Treatment Plant
Mr. Sun Sokhe	Water and Wastewater engineer
Mr. Chia Shim	Dept of Sanitation
Mr. Sim Kheng Lin	Director of Commercial Dept.
Mr.	
Mr. Tetsuya Ueda	Short-term professional
Ms. Atsuko Kobashikawa	JOCV (Water quality management)
Ms. Amporn Kakanlaung	Third Country JICA Expert (Bangkok Metropolitan Water Supply Authority in Thailand)

◆ Municipality of Phnom Penh

Mr. Chea Sophara	Governor
Mr. Mann Chhceurn	Chie Cabinet
Mr. Tauch Lavinoran	Assistant to H.E. Sengtong、Vice Governor of Phnom Penh Municipality
Mr. Ouch Vann	Director, Waste Water Cleaning
Mr. Chhorng Vautha	Chief of planning of Section of drainage and Sewage
Dr. Chhouv Kongphally	Chief of Health Promotion, Dept. of Health
Ms. Mom Sandap	Director, Dept. of Planning
Mr. Ean Narin	Project Manager, Project Management Unit

◆ Ministry of Planning

Mr. San Sy Than	Director, National Institute of Statistics
San Sy Than	Director National Institute of
Mr. Son Seng Huot	Director

◆ Ministry of Post and Telecommunication

Mr. Ly Sam An	Director of International Telecom Department

◆ Ministry of Industry, Mines and Energy

Mr. Son Seng Huot	Director

◆ Council for the Development of Cambodia

Cambodia Rehabilitation and Development Board (CDC/CRDB)

Mr. Leaph Vannden	Deputy Secretary General
Ms. Heng Sokum	Deputy Director, Bilateral Aid Coordination Dept. Japan – Asia Pacific – America
Ms. Michiko Umezaki	JICA Expert on Aid Coordination & Management

◆ Asian Development Bank (ADB)

Mr. Anthony Jude	Project Officer, Cambodia Resident Mission
Mr. Tadayuki Kanazawa	Senior Project Engineer, Water Supply, Urban Dev. and Housing Div.

◆ Parsons (Consultant for Chruy Chang War WTP)

Mr. Robert Board	Resident Project Manager

Minutes of Discussions
on
the Basic Design Study on the Project for Expansion of
Phum Prek Water Treatment Plant
in
The Kingdom of Cambodia

In response to a request from the Royal Government of Cambodia, the Government of Japan decided to conduct a Basic Design Study on the Project for Expansion of Phum Prek Water Treatment Plant (hereinafter referred to as "the Project"), and entrusted the study to Japan International Cooperation Agency (hereinafter referred to as 'JICA').

JICA sent to Cambodia the Basic Design Study Team (hereinafter referred to as 'the Team'), which is headed by Ms. Keiko Yamamoto, Senior Technical Adviser, JICA, and is scheduled to stay in the country from the 19th June to the 31st July, 2000.

The Team held a series of discussions with the concerned officials of the Royal Government of Cambodia and conducted a field survey at the study area.

In the course of discussions and field survey, both parties confirmed the main items described on the attached sheets. The Team will proceed to further work and prepare the Basic Design Study Report.

Phnom Penh, 23rd June, 2000

Ms. Keiko Yamamoto
Leader
Basic Design Study Team
Japan International Cooperation Agency

Mr. Sonn Chan
General Director
Phnom Penh Water Supply Authority

ATTACHMENT

1. Objective of the Project

The objective of the Project is to improve the health and living standard of the people in Phnom Penh City by improving the water supply condition through expansion of Phum Prek Water Treatmen Plant.

2. Project site

The site of the Project is Phum Prek Water Treatment Plant, as shown in Annex-1.

3. Responsible and Implementing Organization

Responsible organization and the implementing organization is Phnom Penh Water Supply Authority (PPWSA). The organization chart is shown in Annex-2.

4. Items requested by PPWSA

After discussions with the Team, the items described in Annex-3 were finally requested by Cambodian side. However, both sides agreed that the final components of the Project will be determined by Japanese side after further studies in Japan.

5. Japan's Grant Aid Scheme

5-1.Cambodian side understood the system and characteristics of Japan's Grant Aid Scheme explained by the Team, as described in Annex-4.
5-2.Cambodian side will take necessary measures, as described in Annex-5, for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

6. Schedule of the Study

6-1.The consultants will proceed to further studies in Cambodia until the 31st July, 2000.
6-2.JICA will prepare the draft report in English and dispatch a mission to Cambodia in order to explain its contents in or around October, 2000.
6-3.In case the contents of the report is accepted in principle by PPWSA, JICA will complete the final report and send it to PPWSA in or around January, 2001.

7. Other relevant issues

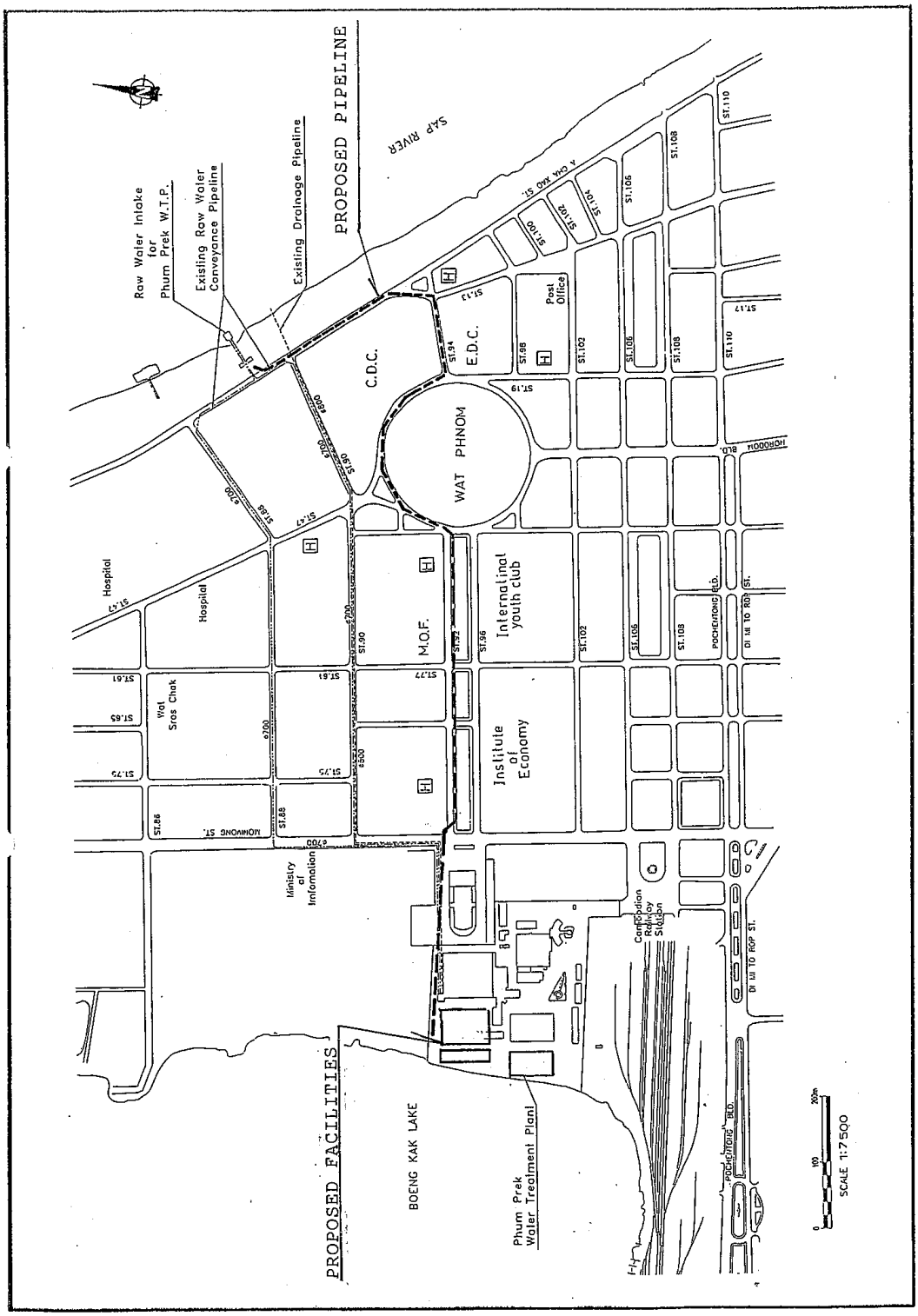
7-1.Cambodian side promised to submit the land use permission for conveyance pipeline and the land use right for the reclaimed land for distribution water reservoir from the Municipality of Phnom Penh by 31st July, 2000.

7-2.Both sides agreed to set the target year of the Project at the year 2005, and review the future water demand until the year 2015 in accordance with the action plan developed by PPWSA.

7-3. Cambodian side promised that PPWSA will allocate enough budget and staff with appropriate technical skills to ensure proper and effective operation and maintenance of the facilities and equipment provided under the Project.

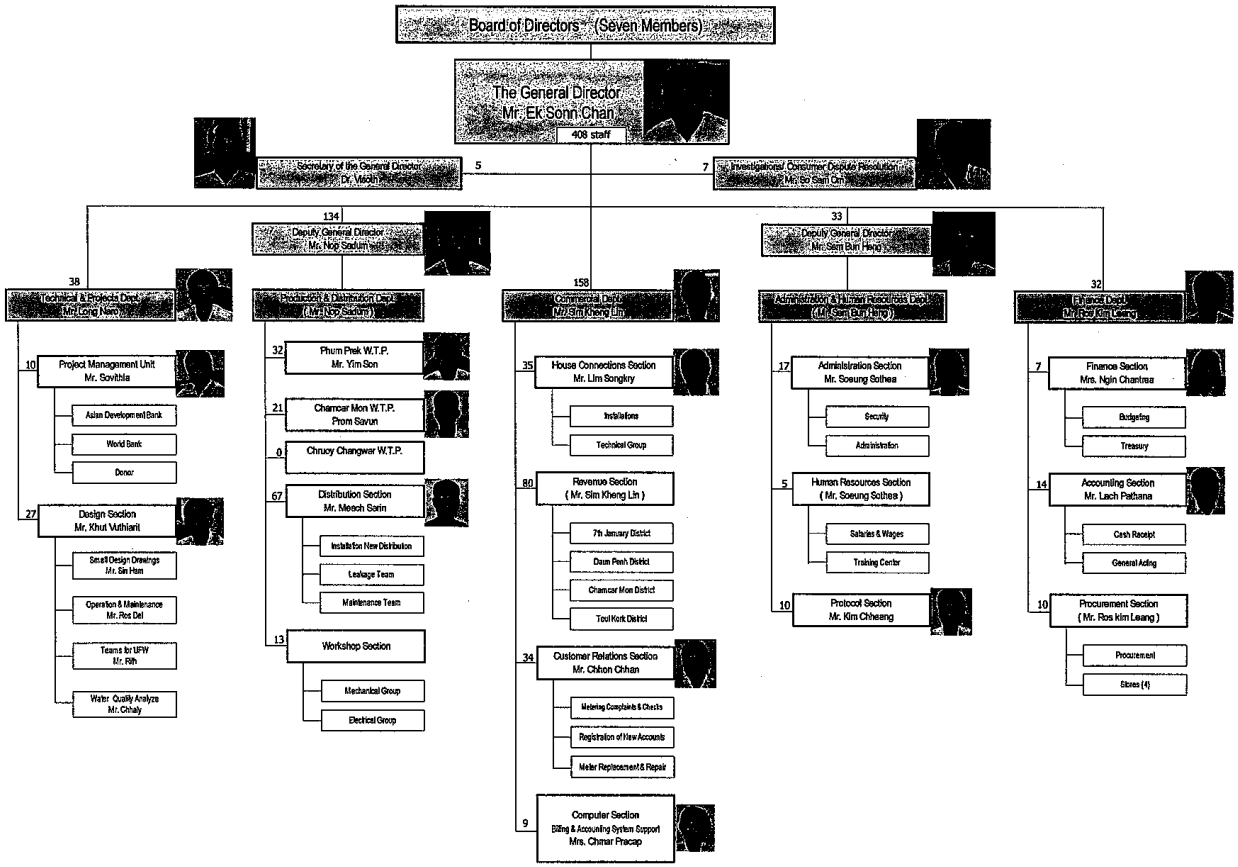
7-4. With concern to the quality of water from existing treatment facility, PPWSA requested an assistance of a Japanese expert regarding the water treatment process.

Annex-1 Site of the Project



Organiz _ on Chart of Phnom Penh Water Suppl, ..uthority

Annex-2



Annex-3 List of requested items

1. Expansion of the facilities
   (1) Water treatment facility for 50,000m3/day
      - Receiving chamber
      - Rapid mixing chamber
      - Flocculation basin
      - Sedimentation basin
      - Rapid sand gravity filter
   (2) Chemical dosing system for 150,000m3/day
      - Chemical house including storage and laboratory with necessary equipment
      - Chemical dosing facilities
   (3) Distribution water reservoir for 10,000m3/day
   (4) Distribution pump (1 unit)
   (5) Conveyance pipeline of dia. 1200mm * 1.5km
   (6) Raw water intake pumps (2 units)
   (7) Electrical instruments

2. Rehabilitation of the existing facilities
   (1) Distribution pumps (3 units)
   (2) Raw water intake pumps (3 units)

Annex-4 Japan's Grant Aid Scheme

1. Grant Aid Procedures

a. Japan's Grant Aid Program is executed through the following procedures.

・Application	(A request made by the recipient country)
・Study	(Basic Design Study conducted by JICA)
・Appraisal &Approval	(Appraisal by the Government of Japan and Approval by the Cabinet of Japan)
・Determination of Implementation	(Exchange of Notes between the Governments of Japan and the recipient country)

b. Firstly, the application or request for a Grant Aid project submitted by a recipient country is examined by the Government of Japan (the Ministry of Foreign Affairs) to determine whether or not it is eligible for Grant Aid. If the request is deemed appropriate, the Government of Japan assigns JICA (Japan International Cooperation Agency) to conduct a study on the request.

Secondly, JICA conducts the study (Basic Design Study) using (a) Japanese consulting firm(s).

Thirdly, the Government of Japan appraises the project to see whether or not it is suitable for Japan's Grant Aid Scheme, based on the Basic Design Study Report prepared by JICA, and the results are then submitted to the Cabinet for an approval.

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes signed by the Governments of Japan and recipient country.

Finally, for the implementation of the project, JICA will assists the recipient country in such matters as preparing tenders, contract and so on.

2. Basic Design Study

a. Contents of the study

The aim of the Basic Design Study (hereafter referred to as "the Study") conducted by JICA on a requested project (hereafter referred to as "the Project") is to provide a basic document necessary for the appraisal of the Project by the Government of Japan. The contents of the Study are as follows :

a) Confirmation of the background, objectives, and benefits of the Project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation.

b) Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economic point of view.

c) Confirmation of items agreed on by both parties concerning the basic concept of the Project.

d) Preparation of a basic design of the Project.

e) Estimation of costs of the Project.

The contents of the original request are not necessarily approved in their initial form as the contents of the Grant Aid project. The Basic Design of the Project is confirmed considering the guidelines of the Japan's Grant Aid Scheme.

The Government of Japan requests the Government of the recipient country to take whether measures are necessary to ensure its self-reliance in the implementation of the Project. Such measures must be guaranteed even though they may fall outside of the jurisdiction of the organization in the recipient country actually implementing the Project. Therefore, the implementation of the Project is confirmed by all relevant organizations of the recipient country through the Minutes of Discussions.

b. Selection of Consultants

For smooth implementation of the Study, JICA uses (a) registered consultant firm(s). JICA select (a) firm(s) based on proposals submitted by interested firms. The firm(s) selected carry(ies) out a Basic Design Study and write(s) a report, based upon terms of reference set by JICA.

The consultant firm(s) used for the Study is(are) recommended by JICA to the recipient country to also work on the Project's implementation after the Exchange of Notes, in order to maintain technical consistency.

3. Japan's Grant Aid Scheme

a. Grant Aid

The Grant Aid Scheme provides a recipient country with non-reimbursable funds to procure the facilities, equipment and services (engineering services and transportation of the products, etc.) for economic and social development of the country under principles in accordance with the relevant laws and regulations of Japan. Grant Aid is not supplied through the donation of materials as such.

b. Exchange of Notes (E/N)

Japan's Grant Aid is extended in accordance with the Notes exchanged by the two Governments concerned, in which the objectives of the Project, period of execution, conditions and amount of the Grant Aid, etc., are confirmed.

c. Period

"The period of the Grant Aid" means the one fiscal year which the Cabinet approves the Project for. Within the fiscal year, all procedures such as exchanging of the Notes, concluding contracts with (a) consultant firm(s) and (a) contractor(s) and final payment to them must be completed.

However, in case of delays in delivery, installation or construction due to unforeseen factors such as weather, the period of the Grant Aid can be further extended for a maximum of one fiscal year at most by mutual

agreement between the two Governments.

d. Purchase of the Products and or Services

Under the Grant Aid, in principle, Japanese products and services including transport or those of the recipient country are to be purchased.

When the two Governments deem it necessary, the Grant Aid may be used for the purchase of the products or services of a third country.

However, the prime contractors, namely, consulting, constructing and procurement firms, are limited to "Japanese nationals". (The term "Japanese nationals" means persons of Japanese nationality or Japanese corporations controlled by persons of Japanese nationality.)

e. Necessity of "Verification"

The Government of recipient country or its designated authority will conclude contracts denominated in Japanese yen with Japanese nationals. Those contracts shall be verified by the Government of Japan. This "Verification" is deemed necessary to secure accountability to Japanese taxpayers.

f. Undertakings required of the Government of the Recipient Country

(As described in ANNEX 5)

g. Proper Use

The recipient country is required to maintain and use the facilities constructed and the equipment purchased under the Grant Aid properly and effectively and to assign staff necessary for this operation and maintenance as well as to bear all the expenses other than those covered by the Grant Aid.

h. Re-export

The products purchased under the Grant Aid should not be re-exported from the recipient country.

i. Banking Arrangements (B/A)

a) The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in an authorized foreign exchange bank in Japan (hereinafter referred to as "the Bank"). The Government of Japan will execute the Grant Aid by making payments in Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts.

b) The payments will be made when payment requests are presented by the Bank to the Government of Japan under an authorization to pay issued by the Government of the recipient country or its designated authority.

Annex-5 Necessary Measures to be taken by the Cambodian side

The following necessary measures should be taken by the Cambodian side on condition that the Grant Aid by the Government of Japan is extended to the Project:

1. To provide data and information necessary for the Project.

2. To secure and provide cleared and leveled land for the Project and secure the authority to build facilities prior to the commencement of the construction, especially the land for a new distribution water reservoir.

3. To remove existing facilities such as the existing chemical storage.

4. To use and maintain properly and effectively all the equipment purchased and facilities constructed under the Grant.

5. To bear commissions to the Japanese bank for its banking services based upon the Banking Arrangement, namely the advising commission of the "Authorization to Pay" and payment commission.

6. To ensure prompt unloading, tax exemption, customs clearance at the port of disembarkation and prompt internal transportation therein of the materials and equipment for the Project purchased under the Grant Aid.

7. To exempt Japanese juridical and physical nationals engaged in the Project from customs duties, internal taxes and other fiscal levies which may be imposed in Cambodia with respect to the supply of the products and services under the verified contracts.

8. To accord Japanese nationals whose services may be required in connection with the supply of the products and the services under the verified contract such facilities as may be necessary for their entry into Cambodia and stay therein for the performance of their work in accordance with the relevant laws and regulations of Cambodia.

9. To provide necessary permissions, licenses and other authorizations for implementing the Project, if necessary.

10. To bear all the expenses, other than those to be borne by the Japan's Grant Aid within the scope of the Project.

Minutes of Discussions
of
Basic Design Study on the Project for Expansion of Phum Prek Water Treatment Plant
in
The Kingdom of Cambodia
(Explanation on Draft Report)

In June 2000, the Japan International Cooperation Agency (hereinafter referred to as JICA) dispatched a Basic Design Study Team on the Project for Expansion of Phum Prek Water Treatment Plant (hereinafter referred to as the Project), and through discussion, field survey, and technical examination of the results in Japan, JICA prepared a draft report of the Study.

In order to explain and consult with the concerned officials of the Royal Government of Cambodia on the components of the draft report, JICA sent to Cambodia the Draft Report Explanation Team (hereinafter referred to as 'the Team'), headed by Ms. Keiko Yamamoto, Senior Technical Adviser, JICA, from 2nd October to 9th October, 2000.

As a result of discussions, both parties confirmed the main items described on the attached sheets.

Phnom Penh, 6th October, 2000

Ms. Keiko Yamamoto
Leader
Draft Report Explanation Team
Japan International Cooperation Agency

H.E. Soth Chan
General Director
Phnom Penh Water Supply Authority

ATTACHMENT

1. Components of the Draft Basic Design Report

The Cambodian side agreed and accepted in principle the components of the draft report explained by the Team.

2. Japan's Grant Aid System

The Cambodian side understood the Japan's Grant Aid System as explained by the Team and described in Annex-4 of the Minutes of Discussions signed by both parties on 23rd June, 2000.

3. Schedule of the Study

JICA will complete the final report in accordance with the confirmed item and send it to the Cambodian side in or around January 2001.

4. Other Relevant Issues

4-1 Both sides agreed that PPWSA will take necessary measures described in the draft report for smooth implementation of the Project. PPWSA promised to complete the following undertakings by the end of August 2001, prior to the commencement of the construction.

- Acquisition of necessary permissions for expansion of water treatment plant.
- Provision of construction site for air vessels and expanded water treatment facilities.
- Removal of pipe materials located at the construction site for the new resevoir.
- Removal the existing chemical storage located at the construction site for the new water treatment plant.
- Leveling the land for the construction of water treatment plant and resevoir.

4-2 Both sides agreed that PPWSA will secure enough budget for the above mentioned necessary undertakings.

4-3 Both sides agreed that PPWSA will take necessary measures such as utilization of other water treatment plants and explanation to the local community to minimize the influence of the reduction or cut-off of water supply during the construction.

4-4 Both sides agreed that PPWSA will ensure a good coordination with the Project during its construction stage to secure the daily operation of the water treatment plant and smooth implementation of the construction.

4-5 Both sides reconfirmed that PPWSA will allocate enough budget and staff with appropriate technical skills to ensure proper and effective operation and maintenance of the facilities and equipment provided under the Project.

4-6 Both sides agreed that PPWSA will continue to endeavor in strengthening the water quality control, extending the distribution pipeline, educating the local community and improving the water charge collection in order to maximize the effect of the Project.

Appendix 5 Other Relevant Data

Appendix 5- 1 Investment Program for PPWSA from 1993-2004

Name of project	term of project	Name of facility or district	budget			name of donor	kind of cooperation
			total	Cambodia input %	Donor input %		
Improvement of Distribution Network	1992-1993	Replacement of Water Distribution System in Sras Chak Sub-district, Don Penh District	$ 1,630,000.00	10	90	French Protocol	Grant Aid
Improvement of Water Supply Facilities in Phnom Penh	1993-1994	Rehabilitation of Filter System in Phum Prek Water Treatment Plant	$ 3,260,000.00	0	100	French Protocol	Grant Aid
Technical Assistance for the Rehabilitation of Water Utilities of Phnom Penh and Sihanoukville	1993-1995	Strengthen the Managerial and Operational Capacities of the Water Utilities of the cities of Phnom Penh and Sihanoukville by Expert	$ 4,110,900.00	0	100	UNDP/ World Bank	Grant Aid
Improvement of Water Supply Facilities in Phnom Penh	1995-1996	Extension of 10,000m3/day in Chamcar Morn Water Treatment Plant	$ 5,300,000.00	0	100	French Protocol	Grant Aid
Improvement of Distribution Network	1995-1996	Replacement of Water Distribution System in Don Penh District	$ 4,906,650.00	10	90	World Bank and French Protocol	Loan and Grant Aid
Improvement of Water Supply Facilities in Phnom Penh	1996-1997	Rehabilitation of Existing Chamcar Morn Water Treatment Plant 10,000 m3/day	$ 1,705,000.00	30	70	French Protocol	Grant Aid
Phnom Penh Water Supply and Drainage Project. Part A- Water Supply ADB Loan No.1468-CAM(SF)	1997-1999	Replacement of Water Distribution System in Chamcar Morn District	$ 2,269,800.00	20	80	Asian Development Bank	Loan
Phnom Penh Water Supply and Drainage Project. Part A- Water Supply ADB Loan No.1468-CAM(SF)	1997-1999	Supply of Institutional Supporting Equipment (Vehicles and Machinery for Pipelaying Teams)& Office Equipment (Computer, Printer and etc.)	$ 442,415.00	0	100	Asian Development Bank	Loan

Name of project	term of project	Name of facility or district	budget			name of donor	kind of cooperation
Phnom Penh Water Supply and Drainage Project. Part A- Water Supply ADB Loan No.1468-CAM(SF)	1997-2001	Design and Supervision of Water Transmission Pipeline in the City of Phnom Penh (600 mm to 1600 mm, 15 Km)	$ 1,065,951.00	30	70	Asian Development Bank	Loan
Phnom Penh Water Supply and Drainage Project. Part A- Water Supply ADB Loan No.1468-CAM(SF)	1999-2001	Supply, Delivery and Installation of Water Transmission Pipelines in the City of Phnom Penh (600 mm to 1600 mm, 15 Km)	$12,200,000.00	15	85	Asian Development Bank	Loan
Cambodia Urban Water Supply Project, IDA Credit No. 3041 KH	1998-2001	Replacement of Water Distribution System in Toul Kork District	$ 2,819,925.00	26	74	World Bank	Loan
Cambodia Urban Water Supply Project, IDA Credit No. 3041 KH	1998-2001	Construction Supervision Consultant for the Rehabilitation and Extension of Chruoy Chang War Water Treatment Plant	$ 1,179,730.00	0	100	World Bank	Loan
Cambodia Urban Water Supply Project, IDA Credit No. 3041 KH	1998-2001	Rehabilitation and Extension of the Chtuoy Chang War Water Treatment Plant 65 000 m3/day	$11,100,000.00	10	90	World Bank	Loan
Cambodia Urban Water Supply Project, IDA Credit No. 3041 KH	1998-2002	Technical Assistance to Improve of Operational (Water Loss Control Expert, Training Expert) and Financial (Accounting Software Expert) Performance	$ 1,064,900.00	0	100	World Bank	Loan
Cambodia Urban Water Supply Project, IDA Credit No. 3041 KH	1998-2002	Supply of Leakage Detection, Training Equipment, Computer for Accounting System Equipment	$ 626,400.00	0	100	World Bank	Loan
Cambodia Urban Water Supply Project, IDA Credit No. 3041 KH	1998-2002	Pilot Program for financing domestic connections to the poor family as revolving Fund	$ 260,000.00	0	100	World Bank	Loan
Cambodia Urban Water Supply Project, IDA Credit No. 3041 KH	1998-2002	Training to the PPWSA	$ 380,000.00	0	100	World Bank	Loan
Cambodia Urban Water Supply Project, IDA Credit No. 3041 KH	2000-2001	Replacement of Additional Distribution System in Phnom Penh City	$ 1,300,000.00	25	75	World Bank	Loan
Cambodia Urban Water Supply Project, IDA Credit No. 3041 KH	2001-2003	Extension of Distribution System to Su-urban Area	$ 4,700,000.00	25	75	World Bank	Loan

Source: PPWSA

Appendix 5- 2　Present Conditions of Phum Prek Water Treatment Plant

Existing Facility		Present Conditions and Necessary Improvement Measures of Phum Prek WTP	The Year Constructed or Installed
Intake Facility in the Sap River	Intake Tower	RC Lower structure ; Dia. 4.95 m × H 11.60 m Upper structure ; W 10.0m × L 11.0m × H 8.7 m	1966
	Intake Gate	H 1.0m × W 1.0m 4 gates （including 2 upper gates for the rainy season and 2 lower gates for the dry season) Operating apparatus Lod end bearing φ50 mm （13.42 m － 2 lods、7.16 m － 2 lods） Remarks: The gates can work and be used but the operating apparatus and lod end bearings are malfunction. They need to replace.	1966
	Intake Pump	Vertical mixed flow pump 3 sets (including one reserve) Diameter ；500 mm Discharge rate ；2,200 m3/hr Total head ；21.0 m Motor output ；50 Hz, 3,000 V, 18.5 kw Material of impeller ；Bronze Accessory ；φ700 mm check valve Remarks: Existing pumps were installed in 1989 and 11 years have already elapsed. The impeller in the pump is made of bronze and its service life is about 15 years. It will be required to replace within 4~5 years.	1989
	Overhead traveling Crane	Hoisting load ；6.0 ton H steel ；440 × 300 mm Travelling motion ；10.0 m Traverse motion ；8.0 m Span ；10.0 m Hoisting height ；5.0 m Remarks: The motor for the traverse-moving trolley of the crane has broken down and the trolley is incapable of traverse motion. The gear for the trolley which has worn out. There is a distinct possibility that the gear may slip and drop the pump when it is being raised or lowered. Repairs to the trolley are required.	
	Access Bridge	Steel truss bridge Span ；L 42 m × W 4.0m Main pipe girder ；φ900 mm × 2 pipes	1966
	Air Vessel (Anti-Water Hammer Facility)	Volume ；15 m3／tank ×2 tank Pressure ；5.0 kg/cm^2 Remarks: The pressure tank (air vessel) is installed on the shore of the river adjacent to the access bridge of the intake tower. Since this tank is partially embedded in the ground, water enters the tank chamber at high water levels during floods. Consequently, the bottom part of the steel pressure tank has corroded, and its performance as a pressure vessel has deteriorated.	1966
	Air Valve	；φ65 mm (注) Air Valve is malfunction.	1966

Existing Facility		Present Conditions and Necessary Improvement Measures of Phum Prek WTP	The Year Constructed or Installed
Raw Water Mains	Raw Water Mains	Cast iron pipes ; φ700 mm × 2 pipes L1 = 1,270 m × 1 pipe、 L2 = 1,214 m × 1 pipe Remarks: Part of the L1 pipe was installed in 1958 and the remaining part and L2 pipe were installed in 1966. The inner of the both pipes are deteriorated by rust and adhered sand silt. Furthermore, sand is settled at the bottom. The value of flow coefficient (C) is 70 ~ 80, which indicates that the pipes are much worsen condition.	1958 1966
Water Treatment Facility	Receiving Well	RC 1 basin W 4.50 m × L 5.75 m × Water depth 4.74 m V = 123 m^3 Sludge valve ; φ100 mm 1 set Overflow weir ; L = 4.0 m 1 set	1966
	Rapid Mixing Well	RC 2 basins W 2.80 m × L 2.95 m × Water depth 2.23 m V = 18.5 m3／basin Inlet gate ; W 1.0 m × H 1.0 m、2 sets Chemical feeding equipment ; 1 tank Remarks: Retention time for rapid mixing is not enough and thus mixing of chemicals are not adequate. Flush mixer ; φ320 × 348 rpm × 4 kw × 380 V Outlet gate ; W 1.0 m × H 1.0 m 2 sets Top valve ; φ80、2 sets	1966
	Flocculation Basin	RC 6 basin W 11.10 m × L 5.53 m × Average depth of water 3.29 m V = 202 m^3 Inlet gate ; φ300 inside screw type 12 sets Flocculater ; φ4.50 m× H 2.5 m × 25／37 rpm × 1.3／2.0 kw × 380 V 12 sets Remarks: Retention time is not enough and thus floc growth and formation is not enough and inadequate.	1966
	Chemical Sedimentation Basin	RC 6 basins W 11.10 m × L 53.20 m × Ave. depth of water 2.45 m V = 1,467 m^3 - Drainage for wastewater and sludge Top valve ; φ200 mm、18 sets Inlet equipment ; Spilt roll 6 sets - Collecting well Top valve ; φ100 mm 6 sets Valve for cleaning ; Angle valve φ60 mm 28 sets Pump for cleaning ; φ80 mm × Q = 30 m^3/hr × H 61.55 m × 17.6 kw × 380 V Remarks: Inlet wooden structure is corroded and the structure is inadequate to make tabulation in the basin. As a result, appropriate sedimentation of the floc formed is not occurred.	1966

Existing Facility		Present Conditions and Necessary Improvement Measures of Phum Prek WTP	The Year Constructed or Installed
Water Treatment Facility	Rapid Sand Filter	RC 12 basins Water and air backwash type W 4.50 m × L 11.90 m Area = 53.55 m^2／filter Inlet gate ; Clap gate type 24 sets 600 × 250 mm Drain valve ; φ100 mm 12 sets Control devise ; Air pressure working and 2 basins operation type 6 sets Filter bed ; Water and air backwash type 53.55 m^2／basin × 12 basins Filter sand ; Thickness: 1.0 m ; Effective diameter: 1.0 mm ; Uniformity coefficient: below 1.6 ; Sand type: silica Control of filter amount ; Siphon type, Inlet pipe φ300 mm 12 sets Water backwash valve ; Air pressure working flangeless butterfly valve φ400 mm 12 valves Water backwash main pipe ; φ450 mm 1 set Air backwash valve ; Air pressure working flangeless butterfly valve φ200 mm 12 valve Air backwash main pipe ; φ250 mm 1 set Filter water valve ; Air pressure working flangeless butterfly valve φ300 mm 12 sets	1994 rehabilitated
		Backwash pump ; φ250/φ300 mm × Q 1,100 m3/hr × 8.0 m × 45 kw × 380 V / 660 V × 2 set Air blower for backwash ; Roots type ① φ200 × Q 3,700 m3/hr × P 0.3 bar × 45 kw × 380 V × 1 set ② φ200 × Q 3,000 m3/hr × P 0.3 bar × 45 kw × 380V / 660 V × 1 set Air compressor ; For use of air pressure working valve Q 11.42 m3/hr × P 21.0 bar × 1.5 kw × 380 V × 300 lit. tank×2 sets	
	Chemical Feeding Facility	Dissolution tank room (1st floor) 360 m^3 Chemical feeding room (2nd floor) 264 m^3 total 624 m^3 Aluminum sulfate solution tank ; W 2.0 m × L 2.0 m × 2 tanks Aluminum sulfate mixing equipment ; Air compressor 1 set Aluminum sulfate feeding pump ; φ11/2" × 0.23 lit/sec × 3kg/cm^2 × 0.75 kw × 380 V × 3 sets Slaked lime solution tank ; W 2.0 m × L 3.0 m × 2 tanks Slaked lime mixing equipment ; φ330 × 125 rpm × 2.2 kw × 2 sets Slaked lime feeding pump ; φ70 × Q 36 m3/hr × H15 m × 7.5 kw × 380 V × 2 sets Chlorine feeding equipment ; 10 kg/hr 2 sets Chlorine feeding pump ; 1 set Remarks: The aging of the existing chemical feeding equipment is excessive. Part of the aluminum sulfate and slaked lime feeding equipment malfunctions. It is impossible to adjust chemicals feeding rate and difficult to feed appropriate quantity of chemicals. Rehabilitation of the existing equipment is required.	Approx.s 1989
	Drain Facility	Between the Sap river and the treatment plant. φ800 RC pipe、L = 1,200 m 1 line	

Existing Facility		Present Conditions and Necessary Improvement Measures of Phum Prek WTP	The Year Constructed or Installed
Water Distribution Facility	Water Reservoir	No.1 Reservoir ; RC 1 basin W 50.0 m × L 50.0 m × Effective depth of water 4.0 m = 10,000 m^3 No.2 Reservoir ; RC 2 basins W 31.4 m × L 39.4 m × Effective depth of water 4.06 m = 5,000 m^3	1959 1995
	Pump Room	RC building 2 rooms No.1pump room W 8.25 m × L 19.45 m × H 6.0 m No.2 pump room W 8.25 m × L 20.00 m × H 6.0 m	1966 1995
	Distribution Pump	DP-1、2 & 3（KBU） 3 sets φ500/φ400 × Q 2,100 m3/hr × H 42.0 m × 325 kw × 3,000 V DP-4（Ebara）1 set φ500/φ400 × Q 2,100 m3/hr × H 42.0 m × 325 kw × 3,000 V DP-5 & 6（Kubota） 2 sets φ350/φ200 × Q 1,050 m3/hr × H 42.0 m × 180 kw × 3000 V	1966 1995 1994, 95
	Transmission Pump	TP-1 & 2（Kubota）2 sets φ350/φ200 × Q 1,050 m3/hr × H 42.0 m × 180 kw × 3000 V	1994, 95
	Vacuum pump for distribution/ transmission pump	2 sets, Vacuum pump	
	Overhead traveling Crane	No.1crahe 1 set Hoisting load ; 3 ton traveling motion ; 19.0 m Traverse motion ; 5.0 m Span ; 6.25 m Hoisting height ; 5.0 m No.2 crane 1 set Hoisting load ; 4 ton traveling motion ; 19.0 m Traverse motion ; 5.0 m Span ; 6.25 m Hoisting height ; 5.0 m	1966 1994
Electrical and Control Facility	Electrical and Control Facility	Complete sets of necessary facilities for the machine, etc. adopted above.	

Source ：JICA B/D Study Team, July 2000

Appendix 5- 3 Results of Population Projection and Water Demand Estimation

PPWSA Scenario (Scenario A)	1992	1994	1998	Growth rate (92-98)	Growth rate (94-98)	Land Area (m2)	Density in 1998 (per./ha)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Density in 2015 (per./ha)	Average annual growth rate
Don Penh	106,907	118,344	118,501	1.73	0.03	7.69	156	118,501	119,874	121,262	122,667	124,088	125,525	126,979	128,450	129,938	131,444	132,966	134,507	136,065	137,641	139,235	140,848	142,480	144,130	190	1.16
7 January	87,840	97,238	92,771	0.91	-1.17	2.35	395	92,771	94,129	95,507	96,906	99,325	99,764	101,225	102,707	104,211	105,737	107,285	108,855	110,449	112,066	113,707	115,372	117,061	118,775	505	1.46
Chamcar Morn	111,301	123,209	162,565	6.52	7.18	9.50	171	162,565	167,364	173,542	179,306	185,260	191,413	197,770	204,336	211,124	218,136	225,381	232,866	240,599	248,590	256,846	265,376	274,189	283,295	298	3.32
Toul Kork	96,022	106,295	141,838	6.72	7.48	9.25	153	141,838	150,163	158,976	168,307	178,185	188,643	199,715	211,436	223,846	236,984	250,893	265,618	281,208	297,713	315,186	333,685	353,270	374,004	404	5.87
Russey Keo	120,108	132,958	168,515	5.81	6.10	99.06	17	168,515	180,374	193,067	206,654	221,196	236,762	253,424	271,258	290,347	310,779	332,649	356,058	381,115	407,934	436,642	467,369	500,259	535,463	54	7.04
Dang Kor	63,361	70,162	92,978	6.60	7.29	112.67	8	92,978	99,903	107,344	115,340	123,930	133,161	143,079	153,736	165,187	177,491	190,711	204,915	220,178	236,578	254,199	273,132	293,476	315,336	28	7.45
Mean Chey	97,377	107,795	159,599	8.59	10.31	44.00	36	159,599	175,773	193,585	213,203	234,808	258,603	284,810	313,672	345,459	380,467	419,023	461,497	508,253	559,758	616,483	678,957	747,761	823,538	187	10.13
Total PHNOM PENH	682,936	756,000	936,767	5.41	5.51	284.43	33	936,767	988,179	1,043,284	1,102,381	1,165,793	1,233,873	1,307,002	1,385,598	1,470,112	1,561,037	1,658,908	1,764,306	1,877,867	2,000,280	2,132,298	2,274,739	2,428,495	2,594,540	91	6.18
Central Districts (Urban)	402,070	445,086	515,675	4.23	3.75	28.7	180	515,675	532,130	549,288	567,195	585,858	605,346	625,689	646,932	669,120	692,300	716,525	741,846	768,321	796,010	824,974	855,281	887,000	920,204	321	3.47
Suburbs	280,866	310,914	421,092	6.98	7.88	265.7	16	421,092	456,050	493,996	535,186	579,935	628,527	681,313	738,666	800,993	868,737	942,383	1,022,460	1,109,546	1,204,270	1,307,324	1,419,458	1,541,496	1,674,336	65	8.46

Medium Growth Scenario (Scenario B: Adopted)	1992	1994	1998	Growth rate (92-98)	Growth rate (94-98)	Land Area (m2)	Density in 1998 (per./ha)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Density in 2015 (per./ha)	
Don Penh	106,907	118,344	118,501	1.73	0.03	7.6	156	118,501	120,121	121,712	123,272	124,799	126,294	127,754	129,179	130,570	131,926	133,248	134,535	135,788	137,009	138,197	139,355	140,482	141,582	186	1.05
7 January	87,840	97,238	92,771	0.91	-1.17	2.4	395	92,771	93,835	94,890	95,936	96,974	98,003	99,023	100,035	101,038	102,034	103,022	104,004	104,980	105,950	106,915	107,877	108,835	109,791	467	1
Chamcar Morn	111,301	123,209	162,565	6.52	7.18	9.5	171	162,565	170,094	177,737	185,478	193,304	201,199	209,147	217,134	225,142	233,156	241,159	249,136	257,071	264,948	272,754	280,475	288,097	295,610	311	3.58
Toul Kork	96,022	106,295	141,838	6.72	7.48	9.3	153	141,838	150,344	159,123	168,175	177,498	187,093	196,960	207,097	217,507	228,191	239,153	250,395	261,925	273,748	285,874	298,313	311,079	324,189	350	4.98
Russey Keo	120,108	132,958	168,515	5.81	6.10	99.1	17	168,515	179,159	190,323	202,021	214,273	227,097	240,513	254,543	269,211	284,543	300,567	317,315	334,821	353,124	372,267	392,297	413,266	435,232	44	5.74
Dang Kor	63,361	70,162	92,978	6.60	7.29	112.7	8	92,978	99,396	106,158	113,276	120,764	128,635	136,902	145,581	154,690	164,244	174,265	184,772	195,790	207,343	219,460	232,172	245,514	259,525	23	6.22
Mean Chey	97,377	107,795	159,599	8.58	10.31	44.0	36	159,599	174,280	190,100	207,133	225,464	245,180	266,377	289,159	313,639	339,940	368,199	398,564	431,199	466,284	504,020	544,628	588,354	635,472	144	8.47
Total PHNOM PENH	682,936	756,000	936,767	5.41	5.51	284.4	33	936,767	987,229	1,040,043	1,095,291	1,153,076	1,213,501	1,276,675	1,342,728	1,411,797	1,484,034	1,559,613	1,638,721	1,721,574	1,808,406	1,899,497	1,995,117	2,095,527	2,201,401	77	5.15
Central Districts (Urban)	402,070	445,086	515,675	4.23	3.75	28.7	180	515,675	534,394	553,462	572,861	592,575	612,589	632,884	653,445	674,257	695,307	716,582	738,070	759,764	781,655	803,740	826,020	848,493	871,172	304	3.13
Suburbs	280,866	310,914	421,092	6.98	7.88	265.7	16	421,092	452,835	486,581	522,430	560,501	600,912	643,792	689,283	737,540	788,727	843,031	900,651	961,810	1,026,751	1,095,747	1,169,097	1,247,134	1,330,229	52	7

Low Growth Scenario (Scenario C)	1992	1994	1998	Growth rate (92-98)	Growth rate (94-98)	Land Area (m2)	Density in 1998 (per./ha)	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	Density in 2015 (per./ha)	
Don Penh	106,907	118,344	118,501	1.73	0.03	7.6	156	118,501	120,368	122,162	123,877	125,511	127,062	128,528	129,908	131,202	132,409	133,529	134,563	135,512	136,377	137,159	137,861	138,485	139,033	183	0.94
7 January	87,840	97,238	92,771	0.91	-1.17	2.4	395	92,771	93,540	94,272	94,967	96,623	96,241	96,821	97,362	97,865	98,331	98,760	99,153	99,510	99,833	100,123	100,381	100,609	100,807	429	0.49
Chamcar Morn	111,301	123,209	162,565	6.52	7.18	9.5	171	162,565	172,225	181,931	191,650	201,347	210,984	220,524	229,929	239,160	248,176	256,938	265,407	273,542	281,307	288,663	295,574	302,005	307,924	324	3.83
Toul Kork	96,022	106,295	141,838	6.72	7.48	9.3	153	141,838	150,525	159,270	168,043	176,812	185,544	194,205	202,758	211,168	219,398	227,412	235,172	242,641	249,783	256,561	262,941	268,889	274,374	297	3.96
Russey Keo	120,108	132,958	168,515	5.81	6.10	99.1	17	168,515	177,945	187,578	197,389	207,350	217,432	227,603	237,829	248,076	258,307	268,485	278,571	288,527	298,314	307,893	317,225	326,274	335,002	34	4.12
Dang Kor	63,361	70,162	92,978	6.60	7.29	112.7	8	92,978	98,889	104,972	111,213	117,598	124,108	130,724	137,426	144,192	150,998	157,819	164,629	171,401	178,108	184,721	191,212	197,553	203,715	18	4.72
Mean Chey	97,377	107,795	159,599	8.58	10.31	44.0	36	159,599	172,788	186,614	201,064	216,120	231,757	247,944	264,645	281,818	299,413	317,375	335,642	354,145	372,810	391,557	410,299	429,947	447,405	102	6.25
Total PHNOM PENH	682,936	756,000	936,767	5.41	5.51	284.4	33	936,767	966,282	1,036,802	1,088,207	1,140,366	1,193,132	1,246,354	1,299,864	1,353,488	1,407,039	1,460,325	1,513,143	1,565,284	1,616,537	1,666,682	1,715,499	1,762,767	1,808,264	64	3.94
Central Districts (Urban)	402,070	445,086	515,675	4.23	3.75	28.7	180	515,675	536,660	557,637	578,539	599,295	619,833	640,080	659,960	679,398	698,317	716,642	734,297	751,207	767,301	782,507	796,758	809,989	822,139	286	2.78
Suburbs	280,866	310,914	421,092	6.98	7.88	265.7	16	421,092	449,622	479,165	509,668	541,070	573,299	606,274	639,904	674,090	708,722	743,683	778,846	814,077	849,236	884,175	918,741	952,778	986,125	39	5.13

Projected growth rate																											
Total PHNOM PENH									5.29	5.12	4.96	4.79	4.63	4.46	4.29	4.13	3.95	3.79	3.62	3.45	3.27	3.1	2.93	2.76	2.58		
Central Districts (Urban)									4.07	3.91	3.75	3.59	3.43	3.27	3.11	2.95	2.78	2.62	2.46	2.30	2.14	1.98	1.82	1.66	1.50	Precondition	
Suburbs									6.78	6.57	6.37	6.16	5.96	5.75	5.55	5.34	5.14	4.93	4.73	4.52	4.32	4.11	3.91	3.70	3.50	Precondition	
Increased population from the previous year																											
Total PHNOM PENH									49,515	50,520	51,405	52,158	52,767	53,222	53,510	53,624	53,551	53,286	52,818	52,141	51,253	50,145	48,817	47,268	45,497		
Central Districts (Urban)									20,985	20,977	20,902	20,756	20,538	20,247	19,880	19,438	18,919	18,325	17,655	16,910	16,094	15,206	14,251	13,231	12,150		
Suburbs									28,530	29,543	30,503	31,402	32,229	32,975	33,630	34,186	34,632	34,961	35,163	35,231	35,159	34,939	34,566	34,037	33,347		
Population Estimation using 1992-1998 average growth rate(%)																											
Don Penh				1.73				118,501	120551	122637	124759	126917	129113	131347	133619	135931	138283	140675	143109	145585	148104	150666	153273	155925	158623		
7 January				0.91				92,771	93616	94467	95327	96194	97069	97952	98843	99742	100650	101566	102490	103423	104364	105314	106272	107239	108215		
Chamcar Morn				6.52				162,565	173164	184454	196480	209290	222936	237471	252964	269447	287015	305728	325661	346894	369511	393603	419266	446602	475720		
Toul Kork				6.72				141,838	151370	161542	172396	183983	196347	209542	223623	238650	254687	271802	290067	309560	330362	352562	376264	401538	428521		
Russey Keo				5.81				168,515	178306	188666	199627	211225	223497	236482	250222	264760	280143	296419	313641	331864	351145	371547	393134	415975	440143		
Dang Kor				6.60				92,978	99115	105657	112630	120064	127988	136435	145440	155039	165272	176180	187808	200203	213416	227501	242516	258522	275584		
Mean Chey				8.58				159,599	173293	188162	204306	221835	240868	261534	283974	308339	334794	363519	394709	428575	465347	505274	548627	595699	646810		
Total PHNOM PENH				5.41				936,767	989414	1045585	1105527	1169508	1237818	1310763	1388675	1471908	1560844	1655889	1757485	1866104	1982249	2106467	2239342	2381500	2533616		
Central Districts (Urban)				4.23				515,675	538700	563100	588964	616384	645465	676312	709039	743770	780636	819771	861327	905462	952341	1002145	1055065	1111304	1171079		
Suburbs				6.98				421,092	450714	482485	516953	553124	592353	634451	679636	728138	780209	836118	896158	960642	1029908	1104322	1184277	1270196	1362537		
Increased population from the previous year																											
Don Penh									2,050	2,086	2,122	2,158	2,196	2,234	2,272	2,312	2,352	2,392	2,434	2,476	2,519	2,562	2,607	2,652	2,698		
7 January									844	852	860	867	875	883	891	899	908	916	924	933	941	950	958	967	976		
Chamcar Morn									10,599	11,290	12,026	12,810	13,646	14,535	15,483	16,493	17,568	18,713	19,933	21,233	22,617	24,092	25,663	27,336	29,118		
Toul Kork									9,532	10,172	10,856	11,585	12,364	13,195	14,081	15,027	16,037	17,115	18,265	19,493	20,802	22,200	23,692	25,284	26,983		
Russey Keo									9,791	10,360	10,961	11,598	12,272	12,985	13,740	14,538	15,383	16,276	17,222	18,223	19,281	20,402	21,587	22,841	24,168		
Dang Kor									6,137	6,542	6,973	7,434	7,924	8,447	9,005	9,599	10,233	10,908	11,628	12,395	13,213	14,085	15,015	16,006	17,062		
Mean Chey									13,894	14,869	16,144	17,529	19,033	20,666	22,440	24,365	26,455	28,725	31,190	33,868	36,772	39,927	43,353	47,072	51,111		
Total PHNOM PENH									52,647	56,171	59,942	63,981	68,310	72,945	77,912	83,233	88,936	95,045	101,596	108,619	116,145	124,218	132,875	142,158	152,116		
Central Districts (Urban)									23,025	24,400	25,864	27,420	29,081	30,847	32,727	34,731	36,865	39,136	41,556	44,135	46,879	49,804	52,920	56,239	59,775		
Suburbs									29,622	31,771	34,078	36,561	39,229	42,098	45,185	48,502	52,071	55,909	60,040	64,484	69,266	74,414	79,955	85,919	92,341		

Water Demand Analysis (Water Demand at the End of the Year)

Year	2000	2001	after 2002	
Connection increase rate	10,000	12,000	18,000	per year

Conditions

Actual average household size(pers) of Phnom Penh (Census 1998)	5.7	persons
Actual domestic connection ratio of total connections in 1999	85	%

Population and water demand in Phnom Penh

Total (Urban and Suburban)

		Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Population																				
Total Population		(pers)	936,767	987,229	1,040,043	1,095,291	1,153,076	1,213,501	1,276,676	1,342,728	1,411,797	1,484,034	1,559,613	1,638,721	1,721,574	1,808,406	1,899,487	1,995,117	2,095,627	2,201,401
PPWSA piped supply		(pers)	234,234	283,832	332,267	390,426	477,638	564,850	652,055	739,270	826,476	913,685	1,000,898	1,088,107	1,175,317	1,262,530	1,349,737	1,436,946	1,524,160	1,611,368
Others including WS		(pers)	702,533	703,397	707,756	704,865	675,438	648,651	624,621	603,458	585,321	570,349	558,715	550,614	546,257	545,876	549,750	558,171	571,467	590,033
PPWSA piped supply service ratio		(%)	25	29	32	36	41	47	51	55	59	62	64	66	68	70	71	72	73	73
Number of connections at the end of year																				
Total connections		(Nos.)	48,714	58,345	68,345	80,345	98,345	116,345	134,345	152,345	170,345	188,345	206,345	224,345	242,345	260,345	278,345	296,345	314,345	332,345
Total connection increase		(Nos.)		9,631	10,000	12,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000	18,000
Domestic connections		(Nos.)	41,093	49,796	58,296	68,496	83,796	99,096	114,396	129,696	144,996	160,296	175,596	190,896	206,196	221,496	236,796	252,096	267,396	282,696
Domestic connection increase		(Nos.)		8,703	8,500	10,200	15,300	15,300	15,300	15,300	15,300	15,300	15,300	15,300	15,300	15,300	15,300	15,300	15,300	15,300
Accounted-for water																				
Domestic	Per capita	(l/c/d)	-	133	132	132	130	129	129	128	126	124	123	122	121	120	119	118	118	117
	Demand	(m3/d)	28,252	34,340	43,782	51,453	62,138	72,912	83,818	94,838	104,224	113,619	123,021	132,429	141,844	151,266	160,694	170,128	179,568	189,015
Commercial & Industri	Demand	(m3/d)	12,819	15,106	19,222	22,591	27,221	31,896	36,640	41,443	45,404	49,371	53,340	57,313	61,289	65,270	69,253	73,239	77,228	81,221
Administration	Demand	(m3/d)	5,407	6,595	3,682	4,329	5,128	5,946	6,791	7,659	8,188	8,719	9,251	9,785	10,320	10,857	11,394	11,933	12,474	13,016
Whole-seller	Demand	(m3/d)	1,473	1,139	949	759	570	380	190	0	0	0	0	0	0	0	0	0	0	0
Total	Demand	(m3/d)	47,951	57,180	67,635	79,132	95,057	111,134	127,439	143,940	157,816	171,709	185,612	199,527	213,453	227,393	241,341	255,300	269,270	283,252
Per capita AFW 1)		(l/c/d)	205	201	204	203	199	197	195	195	191	188	185	183	182	180	179	178	177	176
Per capita AFW 2)		(l/c/d)	51	58	65	72	82	92	100	107	112	116	119	122	124	126	127	128	128	129
Accounted - for water	Ratio	(%)	44	55	65	69	73	76	80	80	80	80	80	80	80	80	80	80	80	80
Water Demand																				
Daily Average water demand		(m3/d)	107,206	102,425	104,054	114,684	130,215	146,229	159,299	179,926	197,270	214,636	232,015	249,409	266,817	284,241	301,677	319,125	336,588	354,065
Per capita Average water demand		(l/c/d)	458	361	313	294	273	259	244	243	239	235	232	229	227	225	224	222	221	220
Daily Maximum water demand		(m3/d)	111,494	116,765	135,270	149,089	169,280	190,098	207,089	233,904	256,451	279,027	301,620	324,232	346,862	369,513	392,180	414,863	437,564	460,285
Per capita Maximum water demand		(l/c/d)	476	411	407	382	354	337	318	316	310	305	301	298	295	293	291	289	287	286
Peak factor (Daily-Max demand/Daily-Average dem			1.04	1.14	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30

Water Production Capacity (m3/day)

	Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Phum Prek WTP		100,000	100,000	100,000	100,000	100,000	100,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000	150,000
Chagcar Morn WTP		20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Chruoy Changwar					65,000	65,000	65,000	65,000	65,000	65,000	65,000	65,000	130,000	130,000	130,000	130,000	130,000	130,000	130,000
Cham															100,000	100,000	100,000	200,000	200,000
		120,000	120,000	120,000	185,000	185,000	185,000	235,000	235,000	235,000	235,000	235,000	300,000	300,000	400,000	400,000	400,000	500,000	500,000

Notes: 1) Per capita AFW is calcurated by dividing AFW into PPWSA piped water supply population

2) Per capita AFW is calcurated by dividing AFW into total population

Water Demand Analysis (Water Demand at the End of the Year)

	2000	2001	after 2002	
Connection increase rate	10,000	12,000	**18,000**	per year

Conditions

Actual average household size(pers) of Phnom Penh (Census 1998)	5.7	persons	
Actual domestic connection ratio of total connections in 1999	85	%	
Actual water demand ratio of each category to domestic in 1999			Average Daily Demand in Urban in 1999 (m3/day)
Domestic demand	100.0	60.2	33,932
Commercial & Industrial	43.9	26.5	14,902
Administration	19.2	11.6	6,516
Whole-seller	2.9	1.7	984
Total			56,334

Population and Water Demand Forecast inPhnom Penh

Urban

		Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Population																				
Total Population		(pers)	515,875	534,394	553,462	572,861	592,575	612,589	632,884	653,445	674,257	695,307	716,582	738,070	759,764	781,655	803,740	826,020	848,493	871,172
PPWSA piped supply		(pers)	231,900	281,330	329,785	387,827	449,172	513,350	581,620	653,445	674,257	695,307	716,582	738,070	759,764	781,655	803,740	826,020	848,493	871,172
Others including Wholeseller		(pers)	283,975	253,064	223,677	185,034	143,403	99,239	51,264	0	0	0	0	0	0	0	0	0	0	0
PPWSA piped supply service ratio		(%)	45	53	59.6	67.7	75.8	83.8	91.9	100	100	100	100	100	100	100	100	100	100	100
Number of connections at the end of year																				
Total connections		(Nos.)	48,148	57,769	67,789	79,749	92,410	105,656	119,748	134,571	138,868	143,213	147,603	152,038	156,516	161,034	165,593	170,191	174,829	179,510
Total connection increase		(Nos.)		9,621	10,000	11,960	12,661	13,246	14,092	14,824	4,296	4,345	4,391	4,435	4,478	4,518	4,559	4,599	4,638	4,681
Domestic connections		(Nos.)	40,666	49,357	57,857	68,040	78,802	90,061	102,039	114,639	118,291	121,984	125,716	129,486	133,292	137,132	141,007	144,916	148,858	152,837
Domestic connection increase		(Nos.)		8,691	8,500	10,183	10,762	11,259	11,978	12,600	3,652	3,693	3,732	3,770	3,806	3,840	3,875	3,909	3,942	3,979
Accounted-for water																				
Domestic	Per capita	(l/c/d)		132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132
	Demand	(m3/d)	27,900	33,932	43,532	51,193	59,291	67,762	76,774	86,255	89,002	91,781	94,589	97,425	100,289	103,178	106,094	109,035	112,001	114,995
Commercial & Industri	Demand	(m3/d)	12,672	14,902	19,118	22,483	26,039	29,759	33,717	37,981	39,087	40,308	41,541	42,786	44,044	45,313	46,594	47,885	49,188	50,503
Administration	Demand	(m3/d)	5,315	6,516	3,671	4,317	5,000	5,715	6,475	7,274	7,506	7,740	7,977	8,216	8,458	8,702	8,947	9,195	9,446	9,698
Whole-seller	Demand	(m3/d)	1,284	984	820	656	492	328	164	0	0	0	0	0	0	0	0	0	0	0
Total	Demand	(m3/d)	47,171	56,334	67,141	78,649	90,822	103,564	117,130	131,410	135,595	139,829	144,107	148,427	152,791	157,193	161,635	166,115	170,635	175,196
Per capita AFW 1)		(l/c/d)	203	200	204	203	202	202	201	201	201	201	201	201	201	201	201	201	201	201
Per capita AFW 2)		(l/c/d)	91	105	121	137	153	169	185	201	201	201	201	201	201	201	201	201	201	201
Accounted - for water	Ratio	(%)	44	55	65	69	73	76	80	80	80	80	80	80	80	80	80	80	80	80
Water Demand																				
Daily Average water demand		(m3/d)	107,206	102,425	103,294	113,984	124,414	136,268	146,413	164,263	169,494	174,788	180,134	185,534	190,989	196,491	202,044	207,644	213,294	218,995
Per capita Average water demand		(l/c/d)	462	364	313	294	277	265	252	251	251	251	251	251	251	251	251	251	251	251
Daily Maximum water demand		(m3/d)	111,092	117,244	134,282	148,179	161,738	177,148	190,337	213,542	220,342	227,222	234,174	241,194	248,286	255,438	262,657	269,937	277,282	284,694
Per capita Maximum water demand		(l/c/d)	479	417	407	382	360	345	327	327	327	327	327	327	327	327	327	327	327	327
Peak factor (Daily-Max demand/Daily-Average dem			1.04	1.14	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30

Notes: 1) Per capita AFW is calcurated by dividing AFW into PPWSA piped water supply population

2) Per capita AFW is calcurated by dividing AFW into total population

Water Demand Analysis (Water Demand at the End of the Year)

Case -A	2000	2001	after2002				
Connection increase rate	10,000	12,000	**18,000**	per year			
Conditions							
Actual average household size(pers) of Phnom Penh (Census 1998)					5.7	persons	
Actual domestic connection ratio of total connections in 1999					85	%	
Actual water demand ratio of each category to domestic in 1999						Average Ratio of 7th January and Chamcar Morn in 1999	
Domestic demand					100.0	64.7	17,865
Commercial & Industrial					41.5	26.9	7,414
Administration					10.8	7.0	1,935
Whole-seller					2.1	1.4	384
Total						100.0	

Population and Water Demand Forecast inPhnom Penh

Suburban

			Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Population																					
Total Population			(pers)	421,092	452,835	486,581	522,430	560,501	600,912	643,792	689,283	737,540	788,727	843,031	900,651	961,810	1,026,751	1,095,747	1,169,097	1,247,134	1,330,229
PPWSA piped supply			(pers)	2,434	2,502	2,502	2,599	28,466	51,500	70,435	85,825	152,219	218,378	284,316	350,037	415,553	480,875	545,997	610,926	675,667	740,196
Others including WS			(pers)	418,658	450,333	484,079	519,831	532,035	549,412	573,357	603,458	585,321	570,349	558,715	550,614	546,257	545,876	549,750	558,171	571,467	590,033
PPWSA piped supply service ratio			(%)	0.6	0.6	0.5	0.5	5.1	8.6	10.9	12.5	20.6	27.7	33.7	38.9	43.2	46.8	49.8	52.3	54.2	55.6
Number of connections at the end of year																					
Total connections			(Nos.)	566	576	576	596	5,935	10,689	14,597	17,774	31,477	45,132	58,742	72,307	85,829	99,311	112,752	126,154	139,516	152,835
Total connection increase			(Nos.)		10	0	20	5,339	4,754	3,908	3,176	13,704	13,655	13,609	13,565	13,522	13,482	13,441	13,401	13,362	13,319
Domestic connections			(Nos.)	427	439	439	456	4,994	9,035	12,357	15,057	26,705	38,312	49,880	61,410	72,904	84,364	95,789	107,180	118,538	129,859
Domestic connection increase			(Nos.)		12	0	17	4,538	4,041	3,322	2,700	11,648	11,607	11,568	11,530	11,494	11,460	11,425	11,391	11,358	11,321
Accounted-for water																					
Domestic	Per capita		(l/c/d)	145	163	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
	Demand		(m3/d)	352	408	250	260	2,847	5,150	7,044	8,583	15,222	21,838	28,432	35,004	41,555	48,088	54,600	61,093	67,567	74,020
Commercial & Industria	Demand		(m3/d)	147	204	104	108	1,182	2,137	2,923	3,562	6,317	9,063	11,799	14,527	17,245	19,957	22,659	25,354	28,040	30,718
Administration	Demand		(m3/d)	92	79	11	12	128	231	316	385	682	979	1,274	1,569	1,862	2,155	2,447	2,738	3,028	3,318
Whole-seller	Demand		(m3/d)	189	155	129	103	78	52	26	0	0	0	0	0	0	0	0	0	0	0
Total	Demand		(m3/d)	780	846	494	483	4,235	7,570	10,309	12,530	22,221	31,880	41,505	51,100	60,662	70,200	79,706	89,185	98,635	108,056
Per capita AFW 1)			(l/c/d)	320	338	197	186	149	147	146	146	146	146	146	146	146	146	146	146	146	146
Per capita AFW 2)			(l/c/d)	2	2	1	1	8	13	16	18	30	40	49	57	63	68	73	76	79	81
Accounted - for water	Ratio		(%)			65	69	73	76	80	80	80	80	80	80	80	80	80	80	80	80
Water Demand																					
Daily Average water demand			(m3/d)			760	700	5,801	9,961	12,886	15,663	27,776	39,860	51,881	63,875	75,828	87,750	99,633	111,481	123,294	135,070
Per capita Average water demand			(l/c/d)			304	269	204	193	183	182	182	182	182	182	182	182	182	182	182	182
Daily maximum water demand			(m3/d)			988	910	7,541	12,949	16,752	20,362	36,109	51,805	67,445	83,038	98,576	114,075	129,523	144,925	160,282	175,591
Per capita maximum water demand			(l/c/d)			395	350	265	251	238	237	237	237	237	237	237	237	237	237	237	237
Peak factor (Daily-Max demand/Daily-Average demand)						1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30	1.30

Notes: 1) Per capita AFW is calcurated by dividing AFW into PPWSA piped water supply population

2) Per capita AFW is calcurated by dividing AFW into total population

Appendix 5- 4　Water Quality Monitoring Date

Table 1　Monthly average of raw water characteristics in 1999

No.	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave.
1	Temp. (℃)	27.3	28.4	29.9	30.4	30.2	28.9	29.3	28.7	29.2	29.9	28.7	25.2	28.8
2	Colour (Pt/Co)	41	233	252	224	438	245	335	240	241	173	95	110	219
3	Cond. (μs)	90	84	77	78	82	113	113	90	126	106	80	67	92
4	TDS (mg/L)	45	42	39	39	41	57	57	45	63	53	40	34	46
5	SS (mg/L)	37	63	27	100	54	246	109	408	280	47	48	66	124
6	Turbidity (NTU)	30	45	35	99	100	216	148	360	250	49	50	74	121
7	pH-value	7.12	7.09	6.84	7.01	7.04	6.85	7.10	6.85	7.82	7.15	6.80	6.79	7.04
8	CO_2(mg/L)	6	12	23	45	30	10	12	18	10	17	21	20	19
9	Alkalinity ($mgCaCO_3$/L)	40	36	28	32	36	42	40	38	60	54	41	54	42
10	Total Hardness (mg/L)	35	32	32	24	32	40	44	34	54	50	22	21	35
11	Caicium ($mgCaCO_3$/L)	31	20	20	22	28	36	36	28	38	42	21	16	28
12	Magnesium (mg/L)	4	12	12	2	4	4	8	6	16	8	1	5	7
13	Potassium (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
14	Alminum (mg/L)	0.008	0.007	0.004	-	0.008	0.011	0.023	0.008	0.023	0.004	0.000	0.002	0.009
15	Iron (mg/L)	0.26	0.48	0.51	0.45	1.56	1.62	1.34	0.89	0.35	0.46	0.29	0.55	0.73
16	Manganese (mg/L)	0.1	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0
17	Sulfate (mg/L)	0	0	0	0	1	8	8	2	8	0	0	0	2
18	Nitrate (mg/L)	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
19	Nitrite (mg/L)	0.011	0.012	0.105	0.017	0.009	0.004	0.002	0.000	0.010	0.002	0.002	0.001	0.015
20	N-Ammonium (mg/L)	2.37	0.49	-	-	-	-	-	-	-	-	-	-	1.43
21	Phosphate (mg/L)	0.01	0.14	0.64	0.30	0.00	0.49	0.16	0.16	0.06	0.22	0.17	0.01	0.20
22	Chloride (mg/L)	5.5	27.5	36.0	41.5	12.4	-	-	-	4.0	3.8	28.0	4.3	18.1
23	Fluoride (mg/L)	0.11	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.21	0.00	0.03
24	Sulfide (mg/L)	0.013	0.034	0.037	0.022	0.050	0.055	0.050	0.051	0.033	0.002	0.014	0.028	0.032
25	Cyanide (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
26	Chromium (mg/L)	0.08	0.08	0.07	0.10	0.08	0.09	0.00	0.17	0.13	0.10	0.15	0.15	0.10
27	Copper (mg/L)	0.01	0.01	0.00	0.01	0.03	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.01
28	Zinc (mg/L)	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.01	0.10	0.01	0.00	0.00	0.01
29	COD (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
30	Total Coliform (cfu/100mL)	12000	7000	5800	22000	7200	31800	13000	8600	18000	1600	2000	2800	10983.3
31	Fecal Coliform (cfu/100mL)	800	12500	8400	11400	6600	13600	11800	5400	17400	2600	6200	2200	8241.67

Source: PPWSA Water quality monitoring laboratory

Table 2 Monthly average of treated water characteristics in 1999

No.	Parameter	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Ave.
1	Temp. (℃)	27.8	28.7	30.3	31.0	30.7	29.3	29.4	28.6	28.9	29.6	28.8	25.7	29.1
2	Colour (Pt/Co)	17	13	13	11	7	7	4	0	19	2	18	2	9
3	Cond. (μs)	95	90	77	85	96	129	125	104	134	114	85	70	100
4	TDS (mg/L)	48	45	39	43	48	64	62	52	67	57	42	35	50
5	SS (mg/L)	3	3	2	1	2	1	1	2	2	0	0	0	1
6	Turbidity (NTU)	1.5	1.6	1.2	1.5	6.0	1.2	1.2	1.4	1.2	0.4	0.9	0.5	1.6
7	pH-value	6.80	6.88	6.43	6.71	6.66	6.44	6.94	6.60	7.50	6.74	6.64	6.70	6.75
8	CO2(mg/L)	25	40	47	48	65	50	20	43	67	5	40	30	40
9	Alkalinity (mgCaCO3/L)	28	28	20	24	24	30	30	24	60	60	40	30	33
10	Total Hardness (mg/L)	22	24	20	23	28	36	40	30	54	52	21	21	31
11	Caicium ($mgCaCO_3$/L)	12	20	16	16	20	30	34	24	38	40	20	16	24
12	Magnesium (mg/L)	10	4	4	7	8	6	6	6	16	12	1	5	7
13	Potassium (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
14	Alminum (mg/L)	0.029	0.034	0.012	-	0.012	0.002	0.014	0.005	0.010	0.008	0.001	0.003	0.012
15	Iron (mg/L)	5.50	0.10	0.05	0.03	0.27	0.03	0.05	0.02	0.09	0.04	0.05	0.03	0.52
16	Manganese (mg/L)	0.0	0.1	0.0	0.1	0.2	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1
17	Sulfate (mg/L)	11	10	15	19	2	24	18	22	28	17	13	11	16
18	Nitrate (mg/L)	0.7	1.0	1.2	2.8	1.8	0.8	1.0	0.9	1.5	0.9	0.6	0.6	1.2
19	Nitrite (mg/L)	0.002	0.002	0.001	0.002	0.002	0.001	0.002	0.002	0.003	0.003	0.002	0.002	0.002
20	N-Ammonium (mg/L)	0.06	0.00	-	-	-	-	-	-	-	-	-	-	0.03
21	Phosphate (mg/L)	0.31	0.02	0.08	0.20	0.03	0.07	0.67	0.04	0.01	0.09	0.01	0.03	0.13
22	Chloride (mg/L)	8.0	43.5	40.5	46.0	10.4	-	-	-	5.0	4.9	45.0	4.5	23.1
23	Fluoride (mg/L)	0.18	0.00	0.13	0.00	0.00	0.00	0.00	0.18	0.32	0.07	0.24	0.13	0.10
24	Sulfide (mg/L)	0.001	0.001	0.011	0.000	0.006	0.004	0.006	0.004	0.000	0.004	0.001	0.004	0.004
25	Cyanide (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
26	Chromium (mg/L)	0.08	0.07	0.08	0.13	0.12	0.10	0.12	0.14	0.16	0.13	0.16	0.19	0.12
27	Copper (mg/L)	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.01	0.02	0.01	0.03	0.01
28	Zinc (mg/L)	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.01	0.00	0.01
29	COD (mg/L)	-	-	-	-	-	-	-	-	-	-	-	-	-
30	Total Coliform (cfu/100mL)	0	0	0	0	0	0	0	0	0	0	0	0	0
31	Fecal Coliform (cfu/100mL)	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: PPWSA Water Quality Monitoring Laboratory

Table 3 Typical Water Quality Data of Each Process of Phum Prek Water Treatment Plant at the Beginning of the Dry Season in 1999

Time	Water Quality Item		Raw water	Rapid mixing	Floccu-lation basin	Sedimentation basin	After filtration	Tap water in the Plant
07:30	Temperature	℃	28.2	27.8	27.8	27.3	28.7	27.8
	pH	—	6.85			6.80	6.57	6.58
	Turbidity (NTU)	NTU	21	18	16	10	2.3	1.8
	Free-Chlorine	mg/l						0.16
	Total Chlorine	mg/l						0.64
	TDS	mg/l	35	36	36	36	32	37
	Electric Conductivity	μs/cm	75	73	73	73	74	74
	SS	mg/l	15			9		3
10:30	Temperature	℃	28.5	28.4	28.4	28.5	28.7	28.7
	pH	—						
	Turbidity (NTU)	NTU	17	18	17	10	1.4	1.3
	Free-Chlorine	mg/l						
	Total Chlorine	mg/l						
14:30	Temperature	℃	28.8	28.8	28.6	28.9	29.0	29.6
	pH	—	6.67			6.57	6.54	6.51
	Turbidity (NTU)	NTU	19	18	19	9	1.2	1.4
	Free-Chlorine	mg/l						0.11
	Total Chlorine	mg/l						0.68
	TDS	mg/l	35	36	36	36	37	36
	Electric Conductivity	μs/cm	70	72	73	73	74	73
	SS	mg/l	19			9		3

Coagulant feeding rate：10 mg/l

Source: PPWSA Water Quality Monitoring Laboratory

Table 4　Typical Water Quality Data of Each Process of Phum Prek Water Treatment Plant at the end of the Dry Season in 1999

Time	Water Quality Item		Raw water	Rapid mixing	Floccu-lation basin	Sedimentation basin	After filtration	Tap water in the Plant
07:30	Temperature	℃	28.5	28.2	28.1	28.1	28.7	29.0
	pH	—	6.95			6.53	6.40	6.48
	Turbidity (NTU)	NTU	60	50	50	4	0.4	1.7
	Free-Chlorine	mg/l						0.30
	Total Chlorine	mg/l						0.50
	TDS	mg/l	30	32	33	33	33	33
	Electric Conductivity	μs/cm	60	65	66	66	66	67
	SS	mg/l	72			13		1
10:30	Temperature	℃	28.6	28.6	28.4	28.4	28.4	29.2
	pH	—						
	Turbidity (NTU)	NTU	50	50	42	5	0.6	1.3
	Free-Chlorine	mg/l						
	Total Chlorine	mg/l						
14:30	Temperature	℃	29.2	29.3	29.4	29.3	28.7	29.4
	pH	—	6.94			6.73	6.50	6.49
	Turbidity (NTU)	NTU	55	60	64	9.5	1.8	1.4
	Free-Chlorine	mg/l						0.60
	Total Chlorine	mg/l						0.70
	TDS	mg/l	31	33	33	34	34	34
	Electric Conductivity	μs/cm	61	67	67	67	68	67
	SS	mg/l	66			10		1

Coagulant feeding rate：20 mg/l

Source: PPWSA Water Quality Monitoring Laboratory

Table 5 Typical Water Quality Data of Each Process of Phum Prek Water Treatment Plant at the end of the Rainy Season in 1999

Time	Water Quality Item		Raw water	Rapid mixing	Floccu-lation basin	Sedimentation basin	After filtration	Tap water in the Plant
07:30	Temperature	℃	27	27.1	27.1	26.9	27	27.1
	pH	—	6.88			6.76	6.70	6.65
	Turbidity (NTU)	NTU	385	432	456	10	2	1.3
	Free-Chlorine	mg/l						0.80
	Total Chlorine	mg/l						0.90
	TDS	mg/l	45	46	53	51	51	50
	Electric Conductivity	μs/cm	89	93	106	101	102	100
	SS	mg/l	488			7		1
10:30	Temperature	℃	28.2	28.1	28.0	27.9	27.6	27.6
	pH	—						
	Turbidity (NTU)	NTU	462	426	396	22	6	5.6
	Free-Chlorine	mg/l						
	Total Chlorine	mg/l						
14:30	Temperature	℃	27.2	27.3	27.2	27.2	27.4	27.2
	pH	—	6.80			6.54	6.51	6.54
	Turbidity (NTU)	NTU	396	369	405	12	1.6	3.1
	Free-Chlorine	mg/l						1.4
	Total Chlorine	mg/l						1.45
	TDS	mg/l	46	53	53	53	54	52
	Electric Conductivity	μs/cm	93	106	106	106	107	104
	SS	mg/l	412			13		8

Coagulant feeding rate：35 mg/l

Source: PPWSA Water Quality Monitoring Laboratory

Table 6 Tap Water Quality in Phnom Penh City

No.	Location	Temp. (℃)	pH	Turbid. (NTU)	Conduct. (μS/cm)	Total Chlorine (mg/l)	Free Chrorine (mg/l)	Total Bacteria	E. Coli
1	No.1792	29.3	6.9	3	120.6	1.04	0.93	-	0
2	No.31	29.4	6.4	4	116	1.19	1.03	0	0
3	No.25	29.4	6.4	2	115	0.98	0.97	-	0
4	No.477	30.2	6.5	3	117	0.90	0.77	-	0
5	No.35	30.2	6.8	1	117.7	0.62	0.75	-	0
6	No.52	30.8	6.8	1	118	0.79	0.72	-	0

Measured date: June 29 2000

Source: PPWSA Water Quality Monitoring Laboratory

Table 7 Tap Water Quality in Phnom Penh City

No	Location	DAte	Temp (℃)	pH	Turbid. (NTU)	Conduct. (μ S/cm)	Total Chlorine (mg/l)	Free Chrorine (mg/l)
1	No.5 St. 75	00 5/16	30	7.2	0.9	175	0.61	0.49
2	No.2248, St. 93	00 5/16	30	6.9	1.0	174	0.48	0.38
3	No. 265, St. 1	00 5/16	30	6.9	1.0	159	0.23	0.14
4	No. 120, St.3	00 5/16	30	7.0	1.7	172	0.42	0.26
5	No. 8, St. 242	00 5/16	31	6.9	1.0	172	0.36	0.26
6	No. 274, St. 93	00 5/16	30	6.8	1.1	173	0.04	0.04
7	Fish	00 5/16	29.5	6.9	1.8	174	0.76	0.60
8	No. 103C, St. 67	00 5/16	29.5	6.9	0.9	176	0.88	0.80
9	No. 97 St. Sihanuk	00 5/14	30.2	7.2	1.4	179	0.51	0.35
10	No. 198 St. Norodom	00 5/14	30.7	7.2	4.4	181	0.75	0.6
11	No. 447 St. 271	00 5/14	29.4	7.5	0.9	181	0.15	0.1
12	No. 25 St. 490		31.4	7.1	2.7	178	0.73	0.66
13	No. 90B St. 432		31.7	7.1	5.1	178	0.6	0.51
14	No. 158 St. 173		31.6	7.0	4.0	179	0.48	0.35
15	No. 40 St. 368		31.8	6.9	3.1	180	0.14	0.05
16	No. 202 St. 143		31.6	6.9	1.1	179	0.16	0.05
17	No. 13B St. 47	99 5/31	29.9	6.9	12.8	130.4	0.36	0.24
18	No.18 St. 5	99 5/31	29.6	6.8	12	124.4	0.46	0.39
19	No.203 St. 19	99 5/31	29.7	6.9	11.8	121.7	0.36	0.29
20	No.28 E0 St. Paster	99 5/31	29.8	7.0	19	124.7	0.04	0.02
21	No. 473 St.1	99 5/31	30.4	6.9	19	126	0.13	0.06
22	No.33D St.134	99 5/31	30.0	6.8	10	124.4	0.63	0.31
23	No.40 St.213	99 5/31	30.8	6.8	11	126	0.33	0.2
24	No.482 E0+E1 St.230	99 5/31	28.9	7.1	14	136.5	0.06	0.06
25	No.329 St.112	99 5/31	30.6	6.8	12	126	0.09	0.06
26	No.1792 St.5	99 6/29	29.3	6.9	3	120.6	1.04	0.93
27	No.31 St. Srisanud	99 6/29	29.4	6.4	4	116	1.19	1.04
28	No.36 St.136	99 6/29	29.4	6.4	2	115	0.98	0.97
29	No.477 St.51(?)	99 6/29	30.2	6.5	3	117	0.9	0.77
30	No.35 St.51	99 6/29	30.2	6.8	1	117.7	0.62	0.75
31	No.12 St.289	99 6/7	30	7.0	4.12	149	0.55	0.40
32	No.03 St.562	99 6/7	30.4	6.9	5.27	148	0.13	0.05
33	No.51 St.287	99 6/7	30.5	6.9	3.14	148	0.48	0.24
34	No.99 St.315	99 6/7	30	6.66	3.4	147	0.05	0.02
35	No.4 St.265	99 6/7	31.8	6.8	3.17	147	0.39	0.1
36	No.235A St.138	99 6/7	31.2	6.8	3.23	146	0.76	0.68
37	No.25E0 St.Paster	99 6/7	30.7	6.9	3.5	147.4	0.05	0.02
38	No.18 St.5	99 6/7	30.4	6.65	2.2	146	0.94	0.89
39	No.488 St.	99 6/7	31.0	6.8	3.36	146	0.92	0.8
40	No.6A St.27	99 6/7	31	6.64	1.2	148	0.11	0.16

Source: PPWSA Water Quality Monitoring Laboratory

Appendix 5- 5 Analysis of Distributed Water Volume, Leakage and Daily Maximum Coefficient

(m^3/hour)

District name Zone No.	7th January 1	7th January 2	7th January 3	7th January 4	7th January 5	7th January 6	7th January 7	7th January 8	7th January TOTAL
Hour/Date	02/15/00	02/15/00	02/28/00	02/29/00	03/01/00	02/17/00	02/15/00	02/02/00	
00:00-01:00	6.5	2.9	16.1	4.7	68.1	17.20	6.56	6.01	128.07
01:00-02:00	12.0	25.9	36.4	19.3	20.7	16.40	6.64	3.80	141.14
02:00-03:00	21.9	4.8	14.1	20.4	42.9	15.60	6.87	15.27	141.84
03:00-04:00	12.1	21.5	30.5	40.1	43.7	26.60	20.73	20.28	215.51
04:00-05:00	36.7	31.2	39.9	50.5	76.7	31.30	21.63	14.35	302.28
05:00-06:00	48.2	25.9	99.3	99.6	139.2	72.10	30.58	33.60	548.48
06:00-07:00	62.5	31.5	113.8	137.3	128.0	76.70	50.63	32.64	633.07
07:00-08:00	49.0	44.5	97.8	112.2	130.3	77.30	58.09	40.61	609.80
08:00-09:00	57.3	29.9	124.6	157.4	123.3	77.50	45.43	37.95	653.38
09:00-10:00	67.3	31.1	88.9	140.2	125.7	74.60	41.69	42.84	612.33
10:00-11:00	59.2	24.0	123.7	113.3	129.3	66.80	45.51	38.01	599.82
11:00-12:00	69.8	28.9	110.9	113.2	97.0	67.60	45.29	24.85	557.54
12:00-13:00	60.4	37.5	102.1	118.0	94.3	74.60	42.28	40.67	569.85
13:00-14:00	56.2	30.9	119.0	101.4	89.5	73.90	33.31	39.76	543.97
14:00-15:00	55.2	28.4	93.1	136.2	89.8	64.90	53.73	30.86	552.19
15:00-16:00	51.4	29.3	101.3	128.9	108.7	61.50	44.15	33.47	558.72
16:00-17:00	41.4	33.4	106.8	132.2	130.2	61.60	44.68	28.63	578.91
17:00-18:00	51.7	28.4	79.0	97.7	125.4	71.20	48.10	37.38	538.88
18:00-19:00	62.6	29.0	73.9	100.0	123.3	74.60	51.37	31.89	546.66
19:00-20:00	47.6	29.3	91.6	106.5	122.9	65.50	45.89	3.59	512.88
20:00-21:00	43.4	30.9	111.7	56.7	64.8	40.80	38.44	10.75	397.49
21:00-22:00	14.6	21.7	42.4	0.5	44.4	40.10	25.12	19.78	208.60
22:00-23:00	27.5	4.9	26.3	72.3	42.6	19.80	8.08	4.49	205.97
23:00-24:00	16.6	25.1	20.9	44.9	30.0	18.60	6.73	5.25	168.08
Max	69.80	44.50	124.60	157.40	139.20	77.50	58.09	42.84	653.38
Average	42.96	26.29	77.67	87.65	91.28	53.62	34.23	24.86	438.56
Total distribution	1031.10	630.90	1864.10	2103.50	2190.80	1286.80	821.53	596.73	10525.46
Hourly maximum dist./average dist. (Peak	1.62	1.69	1.60	1.80	1.52	1.45	1.70	1.72	1.49
Hourly dist. - Average Daily dist.									
00:00-01:00	(36.46)	(23.39)	(61.57)	(82.95)	(23.18)	(36.42)	(27.67)	(18.85)	(310.49)
01:00-02:00	(30.96)	(0.39)	(41.27)	(68.35)	(70.58)	(37.22)	(27.59)	(21.06)	(297.42)
02:00-03:00	(21.06)	(21.49)	(63.57)	(67.25)	(48.38)	(38.02)	(27.36)	(9.59)	(296.72)
03:00-04:00	(30.86)	(4.79)	(47.17)	(47.55)	(47.58)	(27.02)	(13.50)	(4.58)	(223.05)
04:00-05:00	(6.26)	4.91	(37.77)	(37.15)	(14.58)	(22.32)	(12.60)	(10.51)	(136.28)
05:00-06:00	5.24	(0.39)	21.63	11.95	47.92	18.48	(3.65)	8.74	109.92
06:00-07:00	19.54	5.21	36.13	49.65	36.72	23.08	16.40	7.78	194.51
07:00-08:00	6.04	18.21	20.13	24.55	39.02	23.68	23.86	15.75	171.24
08:00-09:00	14.34	3.61	46.93	69.75	32.02	23.88	11.20	13.09	214.82
09:00-10:00	24.34	4.81	11.23	52.55	34.42	20.98	7.46	17.98	173.77
10:00-11:00	16.24	(2.29)	46.03	25.65	38.02	13.18	11.28	13.15	161.26
11:00-12:00	26.84	2.61	33.23	25.55	5.72	13.98	11.06	(0.01)	118.98
12:00-13:00	17.44	11.21	24.43	30.35	3.02	20.98	8.05	15.81	131.29
13:00-14:00	13.24	4.61	41.33	13.75	(1.78)	20.28	(0.92)	14.90	105.41
14:00-15:00	12.24	2.11	15.43	48.55	(1.48)	11.28	19.50	6.00	113.63
15:00-16:00	8.44	3.01	23.63	41.25	17.42	7.88	9.92	8.61	120.16
16:00-17:00	(1.56)	7.11	29.13	44.55	38.92	7.98	10.45	3.77	140.35
17:00-18:00	8.74	2.11	1.33	10.05	34.12	17.58	13.87	12.52	100.32
18:00-19:00	19.64	2.71	(3.77)	12.35	32.02	20.98	17.14	7.03	108.10
19:00-20:00	4.64	3.01	13.93	18.85	31.62	11.88	11.66	(21.27)	74.32
20:00-21:00	0.44	4.61	34.03	(30.95)	(26.48)	(12.82)	4.21	(14.11)	(41.07)
21:00-22:00	(28.36)	(4.59)	(35.27)	(87.15)	(46.88)	(13.52)	(9.11)	(5.08)	(229.96)
22:00-23:00	(15.46)	(21.39)	(51.37)	(15.35)	(48.68)	(33.82)	(26.15)	(20.37)	(232.59)
23:00-24:00	(26.36)	(1.19)	(56.77)	(42.75)	(61.28)	(35.02)	(27.50)	(19.61)	(270.48)
Necessary reservoir volume (m3)	197.36	79.89	398.54	479.41	390.92	256.15	176.05	145.08	2038.07
Necessary volume /average hourly dist. Volume (hour)	4.59	3.04	5.13	5.47	4.28	4.78	5.14	5.84	4.65

(m^3/hour)

District name Zone No.	Chamcar Morn 1	Chamcar Morn 3	Chamcar Morn 4	Chamcar Morn 7	Chamcar Morn 8	Chamcar Morn 10	Chamcar Morn 11	Chamcar Morn 12	CHAMCAR MORN TOTAL
Hour/Date	05/18/00	03/27/00	04/07/00	06/15/00	04/03/00	03/27/00	05/02/00	05/03/00	
00:00-01:00	28.88	16.6	24.60	20.6	9.25	19.60	7.40	2.23	129.16
01:00-02:00	29.99	42.8	43.60	17.8	11.27	20.80	7.20	2.82	176.28
02:00-03:00	37.70	32.1	28.60	25.4	30.86	22.10	4.00	2.73	183.49
03:00-04:00	35.20	42.6	40.10	15.8	32.94	26.60	15.50	3.71	212.45
04:00-05:00	63.21	85.8	38.00	35.2	23.59	41.40	9.50	5.70	302.40
05:00-06:00	74.10	90.9	37.70	42.0	33.02	56.70	18.90	6.78	360.10
06:00-07:00	77.50	118.8	38.70	74.8	27.26	52.40	23.40	6.87	419.73
07:00-08:00	79.65	120.7	51.90	64.2	32.05	61.90	31.00	9.75	451.15
08:00-09:00	80.05	106.3	51.00	78.6	42.00	59.20	28.40	12.19	457.74
09:00-10:00	72.01	104.1	37.70	61.8	46.90	63.60	24.00	15.96	426.07
10:00-11:00	72.21	92.6	63.20	64.3	55.47	60.00	33.10	10.58	451.46
11:00-12:00	68.26	113.7	44.70	57.8	50.05	50.20	13.60	13.73	412.04
12:00-13:00	69.63	99.4	51.10	56.1	33.87	44.10	37.20	12.19	403.59
13:00-14:00	70.05	99.0	49.20	39.9	27.01	67.10	16.50	11.66	380.42
14:00-15:00	67.37	108.5	37.10	52.6	31.68	46.00	28.90	12.23	384.38
15:00-16:00	73.61	107.5	48.90	34.6	35.26	73.60	15.80	13.79	403.06
16:00-17:00	69.08	108.3	50.00	50.4	43.38	47.50	22.90	10.97	402.53
17:00-18:00	70.61	103.6	59.70	58.9	31.26	55.40	33.00	14.39	426.86
18:00-19:00	65.20	110.8	44.84	43.7	40.10	55.10	15.10	10.12	384.96
19:00-20:00	43.00	112.7	54.86	36.9	32.08	56.50	23.10	9.56	368.70
20:00-21:00	43.49	83.4	37.40	48.1	28.51	44.20	16.70	4.14	305.94
21:00-22:00	34.90	67.7	58.40	42.1	27.54	52.60	19.20	5.56	308.00
22:00-23:00	33.70	21.8	32.20	26.1	20.01	16.60	14.20	2.04	166.65
23:00-24:00	32.52	39.3	32.00	6.9	18.54	7.00	10.40	3.46	150.12
Max	80.05	120.70	63.20	78.60	55.47	73.60	37.20	15.96	457.74
Average	58.00	84.54	43.98	43.94	31.83	45.84	19.54	8.47	336.14
Total distribution	1391.92	2029.00	1055.50	1054.60	763.90	1100.20	469.00	203.16	8067.28
Hourly maximum dist./average dist. (Peak	1.38	1.43	1.44	1.79	1.74	1.61	1.90	1.89	1.36

00:00-01:00	(29.12)	(67.94)	(19.38)	(23.34)	(22.58)	(26.24)	(12.14)	(6.24)	(206.98)
01:00-02:00	(28.01)	(41.74)	(0.38)	(26.14)	(20.56)	(25.04)	(12.34)	(5.65)	(159.86)
02:00-03:00	(20.30)	(52.44)	(15.38)	(18.54)	(0.97)	(23.74)	(15.54)	(5.74)	(152.65)
03:00-04:00	(22.80)	(41.94)	(3.88)	(28.14)	1.11	(19.24)	(4.04)	(4.76)	(123.69)
04:00-05:00	5.21	1.26	(5.98)	(8.74)	(8.24)	(4.44)	(10.04)	(2.77)	(33.74)
05:00-06:00	16.10	6.36	(6.28)	(1.94)	1.19	10.86	(0.64)	(1.69)	23.96
06:00-07:00	19.50	34.26	(5.28)	30.86	(4.57)	6.56	3.86	(1.60)	83.59
07:00-08:00	21.65	36.16	7.92	20.26	0.22	16.06	11.46	1.29	115.01
08:00-09:00	22.05	21.76	7.02	34.66	10.17	13.36	8.86	3.73	121.60
09:00-10:00	14.01	19.56	(6.28)	17.86	15.07	17.76	4.46	7.50	89.93
10:00-11:00	14.21	8.06	19.22	20.36	23.64	14.16	13.56	2.12	115.32
11:00-12:00	10.26	29.16	0.72	13.86	18.22	4.36	(5.94)	5.27	75.90
12:00-13:00	11.63	14.86	7.12	12.16	2.04	(1.74)	17.66	3.73	67.45
13:00-14:00	12.05	14.46	5.22	(4.04)	(4.82)	21.26	(3.04)	3.20	44.28
14:00-15:00	9.37	23.96	(6.88)	8.66	(0.15)	0.16	9.36	3.77	48.24
15:00-16:00	15.61	22.96	4.92	(9.34)	3.43	27.76	(3.74)	5.33	66.92
16:00-17:00	11.08	23.76	6.02	6.46	11.55	1.66	3.36	2.51	66.39
17:00-18:00	12.61	19.06	15.72	14.96	(0.57)	9.56	13.46	5.93	90.72
18:00-19:00	7.20	26.26	0.86	(0.24)	8.27	9.26	(4.44)	1.66	48.82
19:00-20:00	(15.00)	28.16	10.88	(7.04)	0.25	10.66	3.56	1.10	32.56
20:00-21:00	(14.51)	(1.14)	(6.58)	4.16	(3.32)	(1.64)	(2.84)	(4.33)	(30.20)
21:00-22:00	(23.10)	(16.84)	14.42	(1.84)	(4.29)	6.76	(0.34)	(2.91)	(28.14)
22:00-23:00	(24.30)	(62.74)	(11.78)	(17.84)	(11.82)	(29.24)	(5.34)	(6.43)	(169.49)
23:00-24:00	(25.48)	(45.24)	(11.98)	(37.04)	(13.29)	(38.84)	(9.14)	(5.01)	(186.02)
Necessary reservoir volume (m3)	202.59	330.03	100.05	184.24	95.17	170.18	89.58	47.08	1090.74
Necessary volume /average hourly dist. Volume (hour)	3.49	3.90	2.27	4.19	2.99	3.71	4.58	5.56	3.24

(m^3/hour)

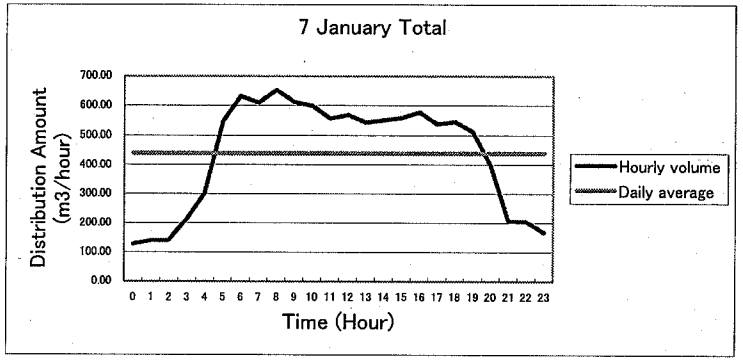
District name	Tuol Kork	TUOL KORK	09h	Daun Penh	Daun Penh	Daun Penh	Daun Penh	DAUN PENH	DAUN PENH
Zone No.	2	TOTAL	5A	1	*7B	12	14	TOTAL	TOTAL
Hour/Date	06/26/00		02/14/00	05/18/00	09/14/99	01/17/00	10/28/99		(without 14)
00:00-01:00	9.2	9.2	14.49	57.94	77.9	2.19	112	264.52	152.52
01:00-02:00	9.1	9.1	8.01	49.18	118.0	2.10	62	239.29	177.29
02:00-03:00	8.8	8.8	14.98	53.74	121.4	2.98	43	236.10	193.10
03:00-04:00	19.9	19.9	20.08	66.57	120.9	3.14	60	270.69	210.69
04:00-05:00	28.4	28.4	31.82	72.75	247.0	3.06	117	471.63	354.63
05:00-06:00	39.7	39.7	57.07	151.23	241.0	8.29	142	599.59	457.59
06:00-07:00	54.5	54.5	72.89	142.55	248.3	8.18	154	625.92	471.92
07:00-08:00	50.7	50.7	80.66	166.06	243.7	11.65	170	672.07	502.07
08:00-09:00	33.9	33.9	62.82	168.42	249.0	10.08	150	640.32	490.32
09:00-10:00	67.1	67.1	81.04	175.57	254.3	9.92	142	662.83	520.83
10:00-11:00	83.9	83.9	58.10	148.37	231.7	10.36	170	618.53	448.53
11:00-12:00	65.8	65.8	78.97	155.31	222.0	9.79	140	606.07	466.07
12:00-13:00	48.0	48.0	73.19	162.39	243.9	11.07	150	640.55	490.55
13:00-14:00	49.1	49.1	70.81	152.46	230.1	6.89	138	598.26	460.26
14:00-15:00	46.7	46.7	78.89	135.93	214.7	4.12	150	583.64	433.64
15:00-16:00	49.9	49.9	66.20	142.41	224.8	5.57	148	586.98	438.98
16:00-17:00	51.9	51.9	79.40	149.09	222.8	4.92	120	576.21	456.21
17:00-18:00	49.9	49.9	71.42	152.44	227.1	4.76	30	485.72	455.72
18:00-19:00	49.9	49.9	75.91	145.19	224.6	5.69	21	472.39	451.39
19:00-20:00	50.1	50.1	75.57	122.80	223.9	6.21	189	617.48	428.48
20:00-21:00	36.5	36.5	83.50	71.77	247.7	5.17	118	526.14	408.14
21:00-22:00	45.5	45.5	27.92	88.06	120.5	2.97	126	365.45	239.45
22:00-23:00	15.4	15.4	23.72	53.00	111.3	2.71	137	327.73	190.73
23:00-24:00	13.5	13.5	17.56	43.17	131.0	2.44	104	298.17	194.17
Max	83.90	83.90	83.50	175.57	254.30	11.65	189.00	672.07	520.83
Average	40.73	40.73	55.21	117.77	199.90	6.01	120.54	499.43	378.89
Total distribution	977.40	977.40	1325.02	2826.40	4797.60	144.26	2893.00	11986.28	9093.28
Hourly maximum dist./average dist. (Peak	2.06	2.06	1.51	1.49	1.27	1.94	1.57	1.35	1.37

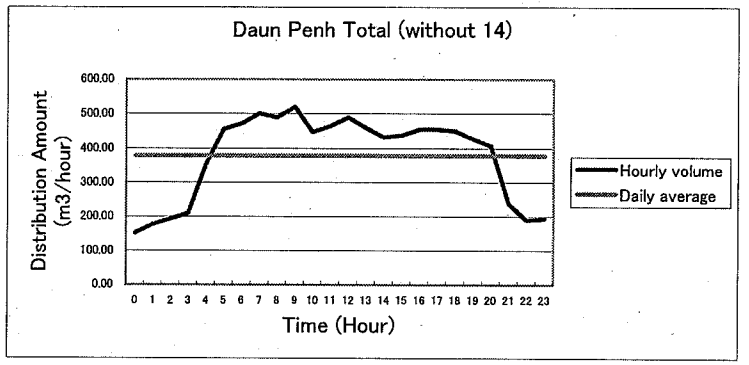
00:00-01:00	(31.53)	(31.53)	(40.72)	(59.83)	(122.00)	(3.82)	(8.54)	(234.91)	(226.37)
01:00-02:00	(31.63)	(31.63)	(47.20)	(68.59)	(81.90)	(3.91)	(58.54)	(260.14)	(201.60)
02:00-03:00	(31.93)	(31.93)	(40.23)	(64.03)	(78.50)	(3.03)	(77.54)	(263.33)	(185.79)
03:00-04:00	(20.83)	(20.83)	(35.13)	(51.20)	(79.00)	(2.87)	(60.54)	(228.74)	(168.20)
04:00-05:00	(12.33)	(12.33)	(23.39)	(45.02)	47.10	(2.95)	(3.54)	(27.80)	(24.26)
05:00-06:00	(1.03)	(1.03)	1.86	33.46	41.10	2.28	21.46	100.16	78.70
06:00-07:00	13.78	13.78	17.68	24.78	48.40	2.17	33.46	126.49	93.03
07:00-08:00	9.98	9.98	25.45	48.29	43.80	5.64	49.46	172.64	123.18
08:00-09:00	(6.83)	(6.83)	7.61	50.65	49.10	4.07	29.46	140.89	111.43
09:00-10:00	26.38	26.38	25.83	57.80	54.40	3.91	21.46	163.40	141.94
10:00-11:00	43.18	43.18	2.89	30.60	31.80	4.35	49.46	119.10	69.64
11:00-12:00	25.08	25.08	23.76	37.54	22.10	3.78	19.46	106.64	87.18
12:00-13:00	7.28	7.28	17.98	44.62	44.00	5.06	29.46	141.12	111.66
13:00-14:00	8.38	8.38	15.60	34.69	30.20	0.88	17.46	98.83	81.37
14:00-15:00	5.98	5.98	23.68	18.16	14.80	(1.89)	29.46	84.21	54.75
15:00-16:00	9.18	9.18	10.99	24.64	24.90	(0.44)	27.46	87.55	60.09
16:00-17:00	11.18	11.18	24.19	31.32	22.90	(1.09)	(0.54)	76.78	77.32
17:00-18:00	9.18	9.18	16.21	34.67	27.20	(1.25)	(90.54)	(13.71)	76.83
18:00-19:00	9.18	9.18	20.70	27.42	24.70	(0.32)	(99.54)	(27.04)	72.50
19:00-20:00	9.38	9.38	20.36	5.03	24.00	0.20	68.46	118.05	49.59
20:00-21:00	(4.23)	(4.23)	28.29	(46.00)	47.80	(0.84)	(2.54)	26.71	29.25
21:00-22:00	4.78	4.78	(27.29)	(29.71)	(79.40)	(3.04)	5.46	(133.98)	(139.44)
22:00-23:00	(25.33)	(25.33)	(31.49)	(64.77)	(88.60)	(3.30)	16.46	(171.70)	(188.16)
23:00-24:00	(27.23)	(27.23)	(37.65)	(74.60)	(68.90)	(3.57)	(16.54)	(201.26)	(184.72)
Necessary reservoir volume (m3)	192.85	192.85	283.09	503.72	598.30	32.33	418.42	1535.88	1318.51
Necessary volume /average hourly dist. Volume (hour)	4.74	4.74	5.13	4.28	2.99	5.38	3.47	3.08	3.48

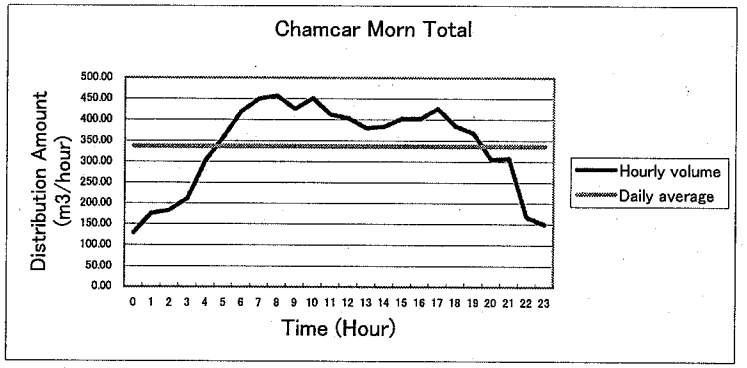
(m^3/hour)

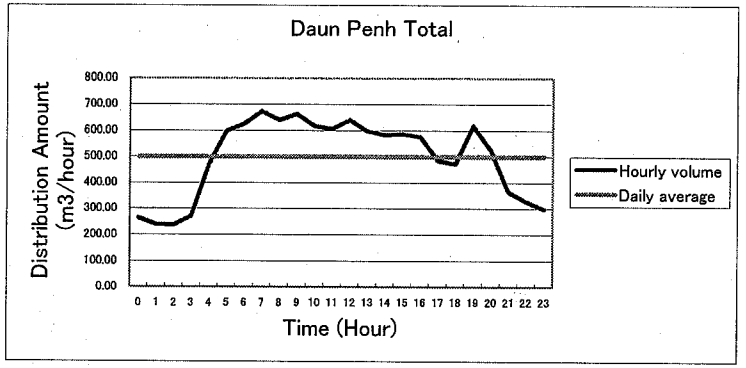
District name / Zone No.	GRAND TOTAL	GRAND TOTAL (without14)
Hour/Date		
00:00–01:00	530.95	418.95
01:00–02:00	565.81	503.81
02:00–03:00	570.23	527.23
03:00–04:00	718.55	658.55
04:00–05:00	1104.71	987.71
05:00–06:00	1547.87	1405.87
06:00–07:00	1733.22	1579.22
07:00–08:00	1783.72	1613.72
08:00–09:00	1785.34	1635.34
09:00–10:00	1768.33	1626.33
10:00–11:00	1753.71	1583.71
11:00–12:00	1641.45	1501.45
12:00–13:00	1661.99	1511.99
13:00–14:00	1571.75	1433.75
14:00–15:00	1566.91	1416.91
15:00–16:00	1598.66	1450.66
16:00–17:00	1609.55	1489.55
17:00–18:00	1501.36	1471.36
18:00–19:00	1453.91	1432.91
19:00–20:00	1549.16	1360.16
20:00–21:00	1266.07	1148.07
21:00–22:00	927.55	801.55
22:00–23:00	715.75	578.75
23:00–24:00	629.87	525.87
Max	1785.34	1635.34
Average	1314.85	1194.31
Total distribution	31556.42	28663.42
Hourly maximum dist./average dist. (Peak	1.36	1.37

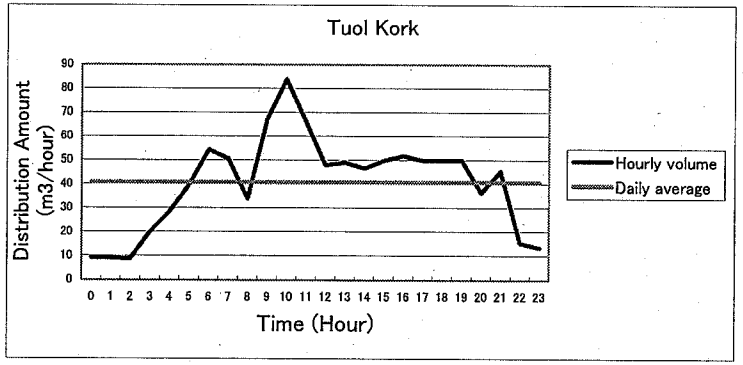
00:00–01:00	(783.90)	(775.36)
01:00–02:00	(749.04)	(690.50)
02:00–03:00	(744.62)	(667.08)
03:00–04:00	(596.30)	(535.76)
04:00–05:00	(210.14)	(206.60)
05:00–06:00	233.02	211.56
06:00–07:00	418.37	384.91
07:00–08:00	468.87	419.41
08:00–09:00	470.49	441.03
09:00–10:00	453.48	432.02
10:00–11:00	438.86	389.40
11:00–12:00	326.60	307.14
12:00–13:00	347.14	317.68
13:00–14:00	256.90	239.44
14:00–15:00	252.06	222.60
15:00–16:00	283.81	256.35
16:00–17:00	294.70	295.24
17:00–18:00	186.51	277.05
18:00–19:00	139.06	238.60
19:00–20:00	234.31	165.85
20:00–21:00	(48.78)	(46.24)
21:00–22:00	(387.30)	(392.76)
22:00–23:00	(599.10)	(615.56)
23:00–24:00	(684.98)	(668.44)
Necessary reservoir volume (m3)	4804.17	4598.29
Necessary volume /average hourly dist. Volume (hour)	3.65	3.85

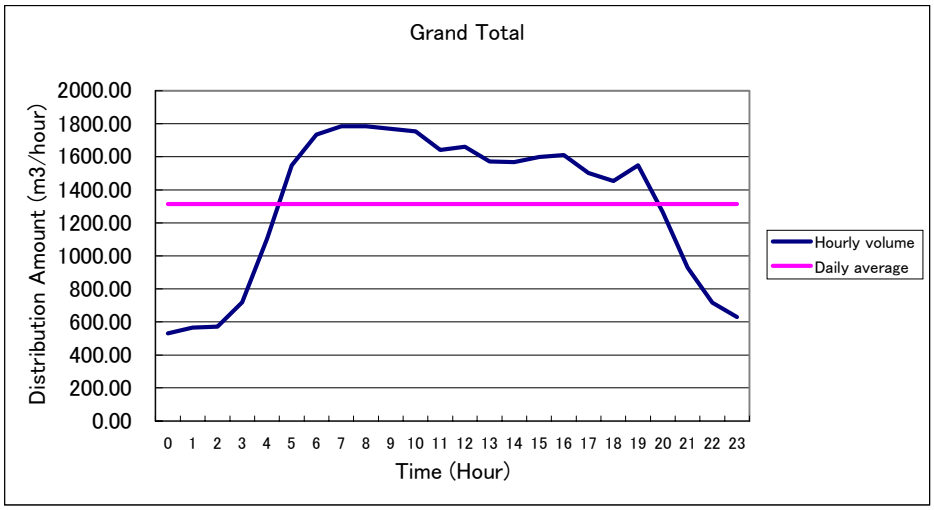

7 January Total
Distribution Amount (m3/hour)
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time (Hour)
Hourly volume
Daily average

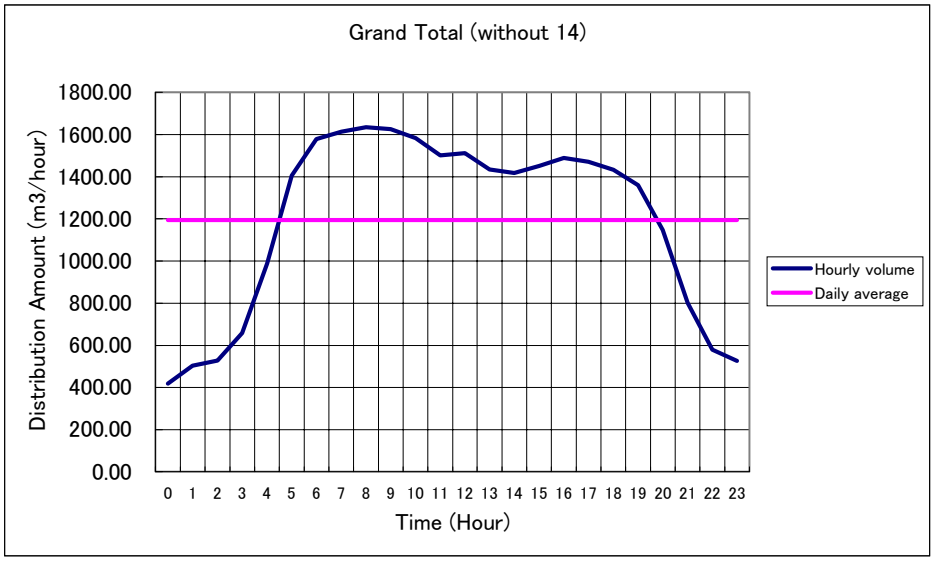

Daun Penh Total (without 14)
Distribution Amount (m3/hour)
600.00
500.00
400.00
300.00
200.00
100.00
0.00
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time (Hour)
Hourly volume
Daily average


Chamcar Morn Total
Distribution Amount (m3/hour)
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
0.00
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time (Hour)
Hourly volume
Daily average


Daun Penh Total
Distribution Amount (m3/hour)
800.00
700.00
600.00
500.00
400.00
300.00
200.00
100.00
0.00
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time (Hour)
Hourly volume
Daily average


Tuol Kork
Distribution Amount (m3/hour)
90
80
70
60
50
40
30
20
10
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23
Time (Hour)
Hourly volume
Daily average



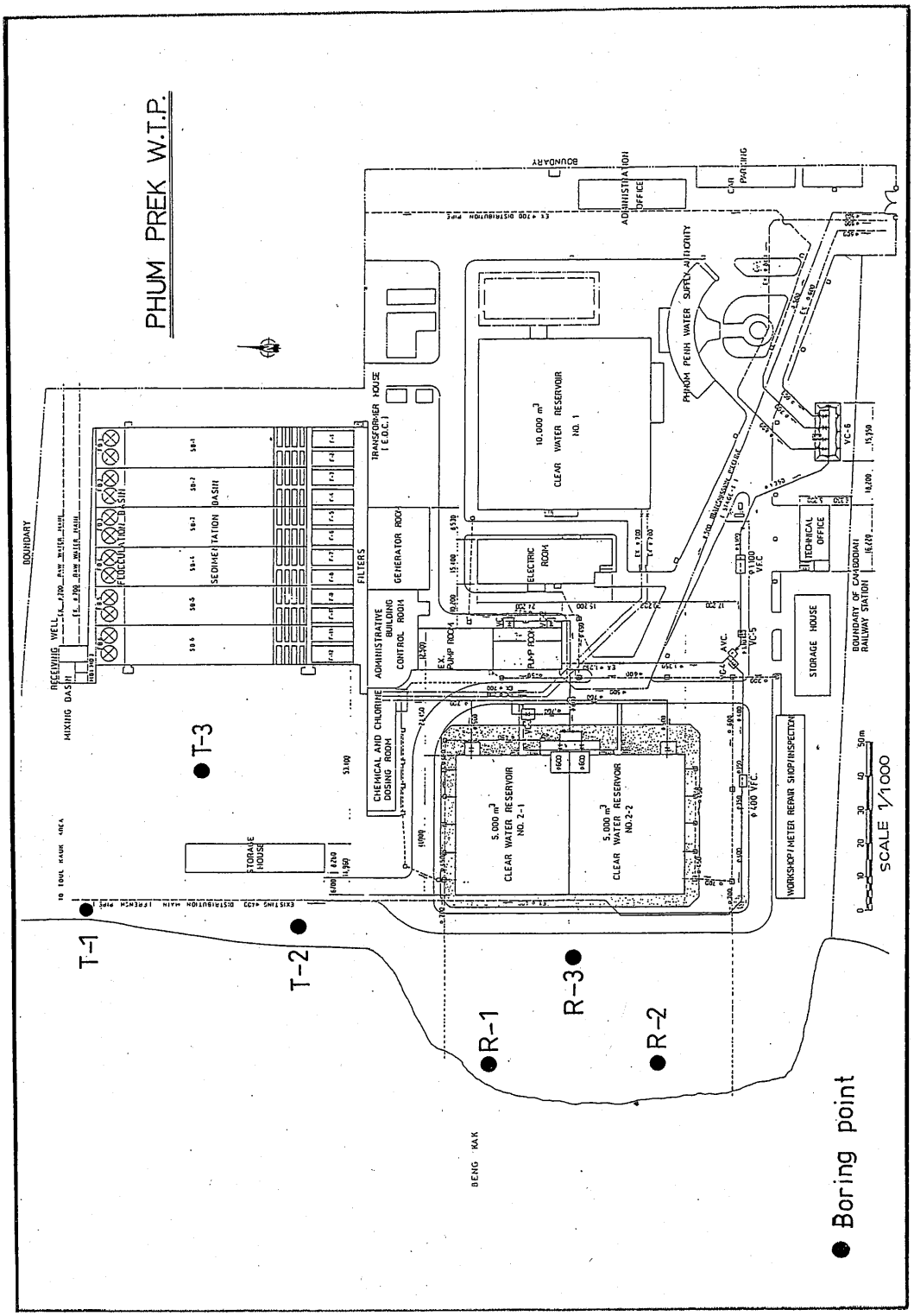


Estimation of Unaccounted-For Water (UFW)

District	Zone	Zone meter reading (Total amount of distributed water in the zone) m^3/3days	Customer's meter reading (Total amount of consumed in the zone) m^3/3days	UFW or Leakage amount m^3/3days	% of UFW or Leakage %	The month in which it is measured
Don Penh	Zone 1	8,479	6,549	1,930	23	Nov. 1999
	Zone 5A	4,260	3,746	514	12	Oct. 1999
	Zone 5B	1,892	1,598	294	16	Sept. 1999
	Zone 6	3,316	2,726	590	18	Jan. 2000
	Zone 7A	3,358	2,635	723	22	Aug. 1999
	Zone 12	373	287	86	23	Feb. 2000
	Zone 14	8,268	7,623	645	8	Mar. 2000
	Zone 15	1,985	1,628	357	18	Dec. 1999
	total/ave.	31,931	26,792	5,139	16	
7th January	Zone 1	3,118	2,829	289	9	Feb. 2000
	Zone 2	1,907	1,761	146	8	Feb. 2000
	Zone 7	2,813	2,477	336	12	Feb. 2000
	Zone 8	1,997	1,690	307	15	Feb. 2000
	Zone 10	2,656	2,474	182	7	Mar. 2000
	total/ave.	12,491	11,231	1,260	10	
tota/ave.		44,422	38,023	6,399	14	

Source：PPWSA

Appendix 5- 6 Boring Date (Survey Locations)



Results of Boring Survey

RESEARCH AND DESIGN ENTERPRISE — *FIELD BORING LOG* — SHEET 1

SOIL TESTING LABORATORY — *BOREHOLE No..R-1*

STANDARD PENETRATION TEST

Project: W.T. P	Date started..13/06/2000	Location:Phum prek W.T.P, khan toul kork, Phnom Penh
	Date finished 13/06/2000	Kingdom of Cambodia.
Owner :	Method :Rotary Auger	Size 120mm ,Elevation:. + 11.615
Contractor :	Depth to water flow : 4.50m.	On 13/06/2000 Time...07h30 am
sub contractor :	Depth to water level: 2.70m.	On 13/06/2000 Time. 10 h30 am

DEPTH and TYPE OF SAMPLE (M)	(M)	D	U	No	DESCRIPTION OF STRATA	DEPTH and THICK.	LEGEND of SOIL	S P T (N) BLOWS/300MM	RECOVERY RATIO (MM)
0 - 1					1/ Made ground(brown silt, clay, sand, crushed stone, crushed brick and plastic bag, encountered from ground surface to 1.00m depth.	0.00			
- 2		D		1	Dark-grey, brown silt, clay, silt and sand encountered from 1.00 to 4.00m depth.	(4.00)		1.50 to 1.95m = 1, 2 , 4 , N -6	200/450
- 3									
- 4		D		2				3.00 to 3.45m = 1, 1 , 2 , N -3	300/450
- 5			U	3		4.00			
- 6		D		4	2/ Medium brown silty lean CLAY(CL).	(3.00)		5.00m to 5.45m = 1, 3 ,2 , N-5	300/450
- 7		D	U	5 6		7.00		6.00m to 6.45m = 2, 3, 5, N-8	300/450
- 8		D		7	3/ Stiff red, grey fat CLAY(CH).	(1.00) 8.00		7.50m to 7.95m = 2, 4, 6, N-10	300/450
- 9			U	8					
- 10		D		9	4/ Medium dense yellow and grey very clayey fine to medium SAND(CS), with gravel.	(3.00)		9.00m to 9.45m = 3, 5,10, N-15	320/450
- 11		D		10		11.00		10.50m to 10.95m 6, 10,11, N-21	300/450
- 12					5/ Dense grey and yellow very clayey fine to	(2.00)			
- 13		D		11	medium SAND(CS), with gravel.	13.00		12.00m to 12.45m 9,20,22, N-42	450/450
- 14		D		12				13.50m to 13.95m 10, 20, 20, N-40	330/450
- 15					6/ Dense yellow and very clayey medium to coarse SAND(CS), with gravel.	(3.00)			

consistency	SPT(N),Blows/300mm
Very soft	0 to 2
Soft	2 to 4
Medium	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	30 to 50

RELATIVE DENSITY	SPT(N),Blows/300mm
Very loose	0 to 4
Loose	4 to 10
Medium dense	10 to 30
Dense	30 to 50
Very dense	Over 50

TYPE OF SAMPLE

D-disturbed sample

U-Undisturbed sample

TYPE OF FIELD TEST

SPT	Standard penetration test
VT	Shear vane test
PT	pocket penetrometer test
q_u	=.....Kgf/cm^2
K	Permeability

Figure 2

RESEARCH AND DESIGN ENTERPRISE — *FIELD BORING LOG* — SHEET 2

SOIL TESTING LABORATORY — *BOREHOLE No..R-1*

STANDARD PENETRATION TEST

Project: W.T. P	Date started..13/06/2000	Location:Phum prek W.T.P, khan toul kork, Phnom Penh
	Date finished 13/06/2000	Kingdom of Cambodia.
Owner :	Method :Rotary Auger	Size 120mm ,Elevation:. + 11.645
Contractor :	Depth to water flow : 4.50m.	On 13/06/2000 Time:..07h30 am
sub contractor :	Depth to water level: 2.70m.	On 13/06/2000 Time. 10 h30 am

DEPTH and TYPE OF SAMPLE (M)	(M)	D	U	No	DESCRIPTION OF STRATA	DEPTH and THICK.	LEGEND of SOIL	S P T (N) BLOWS/300MM	RECOVERY RATIO (MM)
15		D		13	6/ Dense yellow and very clayey medium to coarse SAND(CS), with gravel.	16.00		15.00m to 15.45 = 9, 13, 20, N-33	450/450
16					7/ Very dense yellow and grey very clayey medium to coarse SAND(CS), with gravel.	(1.00)			
17		D		14		17.00		16.50m to 16.95m 25, 25,15,N>50	250/400
18					End of borehole No R-1 at 17.00m depth.				
19									
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

consistency		RELATIVE DENSITY	
SPT(N),Blows/300mm		SPT(N),Blows/300mm	
Very soft	0 to 2	Very loose	0 to 4
Soft	2 to 4	Loose	4 to 10
Medium	4 to 8	Medium dense	10 to 30
Stiff	8 to 15		
Very stiff	15 to 30	Dense	30 to 50
Hard	30 to 50	Very dense	Over 50

TYPE OF SAMPLE	TYPE OF FIELD TEST	
D-disturbed sample	SPT	Standard penetration test
U-Undisturbed sample	VT	Shear vane test
	PT	pocket penetrometer test
	q_u	=.....Kgf/cm^2
	K	Permeability

Figure 2a

RESEARCH AND DESIGN ENTERPRISE
SOIL TESTING LABORATORY

FIELD BORING LOG
BOREHOLE No..R-2
STANDARD PENETRATION TEST

SHEET 1

Project: W.T. P
Owner :
Contractor :
sub contractor :

Date started..12/06/2000
Date finished 12/06/2000
Method :Rotary Auger
Depth to water flow : 4.50m.
Depth to water level: 2.50m.

Location:Phum prek W.T.P, khan toul kork, Phnom Penh Kingdom of Cambodia.
Size 120mm ,Elevation:. + 11.250
On 12/06/2000 Time...10h0am
On 12/06/2000 Time. 15 h15pm

DEPTH and TYPE OF SAMPLE (M)	(M)	D	U	No	DESCRIPTION OF STRATA	DEPTH and THICK.	LEGEND of SOIL	S P T (N) BLOWS/300MM	RECOVERY RATIO (MM)
0 - 1					1/ Made ground (Brown silt, clay, sand, crushed stone and crushed brick, encountered from surface to 2.00m depth.	0.00			
- 2		D		1				1.50 to 1.95m = 1, 1 , 2 , N -3	200/450
- 3					Dark-grey, black clay, silt, sand and peat, encountered from 2.00m to 4.50m depth.	(4.50)			
- 4		D		2				3.00 to 3.45m = 0, 0, 0, N<1	250/450
- 5		D		3	2/ Stiff trace sandy fat CLAY(CH).	4.50 5.00		4.50m to 4.95m = 2, 3, 7, N-10	250/450
- 6		D		4	3/ Very soft dark-grey clay, silt, sand and peat.	(1.50)		5.50m to 5.95m = 1, 1, 1, N-2	300/450
- 7		D		5	4/ Stiff yellow and grey fine sandy lean CLAY (CL).	6.50 (1.00)			
- 8			U	6	5/ Medium dense yellow F-M SAND, gravel.	7.50 8.00			
- 9		D		7	6/ Very dense yellow F-M SAND, gravel.	8.50		7.90m to 8.35m = 6, 8, 43, N-51	400/450
- 10		D		8	7/ Medium dense grey, yellow fine to medium SAND(CS), with gravel.	(1.00) 9.50		9.00m to 9.45m = 5,10,10, N-20	400/450
- 11		D		9	8/ Medium dense grey and yellow very clayey medium to coarse SAND(CS), with gravel.	(1.50) 11.00		10.50m to 10.95m 8, 13,15, N-28	350/450
- 12 - 13		D		10	9/ Very stiff grey and yellow fine to medium sandy lean CLAY(CL).	(3.00)		12.00m to 12.45m 11,14,15, N-29	370/450
- 14		D		11		14.00		13.50m to 13.95m 9, 13, 14, N-27	350/450
- 15					10/ Dense yellow and grey very clayey medium to coarse SAND(CS), gravel.				

consistency	*SPT(N),Blows/300mm*
Very soft	0 to 2
Soft	2 to 4
Medium	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	30 to 50

RELATIVE DENSITY	*SPT(N),Blows/300mm*
Very loose	0 to 4
Loose	4 to 10
Medium dense	10 to 30
Dense	30 to 50
Very dense	Over 50

TYPE OF SAMPLE
D-disturbed sample
U-Undisturbed sample

TYPE OF FIELD TEST
SPT Standard penetration test
VT Shear vane test
PT pocket penetrometer test
q_u =.....Kgf/cm^2
K Permeability

Figure 3

RESEARCH AND DESIGN ENTERPRISE — *FIELD BORING LOG* — SHEET 2

SOIL TESTING LABORATORY — *BOREHOLE No..R-2*

STANDARD PENETRATION TEST

Project: W.T. P	Date started..12/06/2000	Location:Phum prek W.T.P, khan toul kork, Phnom Penh
	Date finished 12/06/2000	Kingdom of Cambodia.
Owner :	Method :Rotary Auger	Size 120mm ,Elevation:. + 11.250
Contractor :	Depth to water flow : 4.50m.	On 12/06/2000 Time...10h0am
sub contractor :	Depth to water level: 2.50m.	On 12/06/2000 Time. 15 h15pm

DEPTH and TYPE OF SAMPLE (M)	(M)	D	U	No	DESCRIPTION OF STRATA	DEPTH and THICK.	LEGEND of SOIL	S P T (N) BLOWS/300MM	RECOVERY RATIO (MM)
15 - 16		D		12	10/ Dense yellow and grey very clayey medium to coarse SAND(CS), gravel.			15.00m to 15.45 = 25, 20, 21, N-41	450/450
						16.50			
- 17		D		13	11/ Hard grey mottled yellow fine to medium sandy lean CLAY(CL).	(1.00)		16.50m to 16.95m 10, 20, 19, N-39	300/450
						17.50			
- 18		D		14				18.00m to 18.45m 10, 19, 19, N-38	320/450
- 19			U	15	12/ Dense yellow very clayey medium to coarse SAND(CS), with gravel.	(2.50)			
- 20		D		16		20.00		19.50m to 19.95m 25, 22, 22, N-44	330/450
- 21					End of borehole No R-2 at 20.00m depth.				
- 22									
- 23									
- 24									
- 25									
- 26									
- 27									
- 28									
- 29									
- 30									

consistency		*RELATIVE DENSITY*		*TYPE OF SAMPLE*	*TYPE OF FIELD TEST*	
SPT(N),Blows/300mm		*SPT(N),Blows/300mm*		D-disturbed sample	SPT	Standard penetration test
Very soft	0 to 2	Very loose	0 to 4	U-Undisturbed sample	VT	Shear vane test
Soft	2 to 4	Loose	4 to 10		PT	pocket penetrometer test
Medium	4 to 8	Medium dense	10 to 30		q_u	=.....Kgf/cm^2
Stiff	8 to 15				K	Permeability
Very stiff	15 to 30	Dense	30 to 50			
Hard	30 to 50	Very dense	Over 50			Figure 3a

RESEARCH AND DESIGN ENTERPRISE — *FIELD BORING LOG* — SHEET 1

SOIL TESTING LABORATORY — *BOREHOLE No..R-3*

STANDARD PENETRATION TEST

Project: W.T. P	Date started..13/06/2000	Location:Phum prek W.T.P, khan toul kork, Phnom Penh
	Date finished 13/06/2000	Kingdom of Cambodia.
Owner :	Method :Rotary Auger	Size 120mm ,Elevation:. + 11.575
Contractor :	Depth to water flow : 6.00m.	On 13/06/2000 Time...11h00Am
sub contractor :	Depth to water level: 2.60m.	On 13/06/2000 Time. 18 h00 Pm

DEPTH and TYPE OF SAMPLE (M)	(M)	D	U	No	DESCRIPTION OF STRATA	DEPTH and THICK.	LEGEND of SOIL	S P T (N) BLOWS/300MM	RECOVERY RATIO (MM)
0					1/ Made ground(Reddish-brown sand, clay, silt and gravel(laterite), encountered from ground surface to 0.30m and crushed stone encountered from 0.30m to 0.50m depth. Medium brown silt, clay and sand from 0.5m to..	0.00			
1						(2.50)			
2		D		1				1.50 to 1.95m = 1, 2 , 3 , N -5	350/450
3			U	2		2.50			
		D		3	2/ Stiff brown mottled grey fat CLAY(CH).			3.00 to 3.45m = 1, 2 , 2 , N -4	350/450
4						(3.00)			
5		D		4				4.50m to 4.95m = 2, 4 , 6, N-10	270/450
			U	5		5.50			
6					3/ Soft dark-grey clay, silt, sand and peat.	(1.00)			
		D		6		6.50		6.00m to 6.45m = 1, 1, 2, N-3	400/450
7									
8		D		7		(4.50)		7.50m to 7.95m = 4, 9, 11, N-20	300/450
9					4/ Medium dense yellow, grey very silty fine medium SAND(MS). with gravel.				
		D		8				9.00m to 9.45m = 8,18,12, N-30	320/450
10						10.00			
			U	9					
11		D		10	5/ Medium dense grey, yellow very clayey fine to medium SAND(CS).	(1.50)		10.50m to 10.95m 6, 10,13, N-23	300/450
12						11.50			
		D		11				12.00m to 12.45m 10,17,24, N-41	350/450
13					6/ Dense greenish-grey very clayey medium to coarse SAND(CS), with gravel.	(4.50)			
14		D		12				13.50m to 13.95m 7, 13, 17, N-30	350/450
15		D		13	END OF BOREHOLE No R-3 at 15.00m.	15.00		14.50m to 14.95m 7, 18, 19, N-37	300/450

consistency	*SPT(N),Blows/300mm*
Very soft	0 to 2
Soft	2 to 4
Medium	4 to 8
Stiff	8 .to 15
Very stiff	15 to 30
Hard	30 to 50

RELATIVE DENSITY	*SPT(N),Blows/300mm*
Very loose	0 to 4
Loose	4 to 10
Medium dense	10 to 30
Dense	30 to 50
Very dense	Over 50

TYPE OF SAMPLE

D-disturbed sample

U-Undisturbed sample

TYPE OF FIELD TEST

SPT Standard penetration test

VT Shear vane test

PT pocket penetrometer test

q_u = ...Kgf/cm^2

K Permeability

Figure 4

RESEARCH AND DESIGN ENTERPRISE
SOIL TESTING LABORATORY

FIELD BORING LOG
BOREHOLE No..T-1
STANDARD PENETRATION TEST

SHEET 1

Project: W.T. P
Owner :
Contractor :
sub contractor :

Date started..15/06/2000
Date finished 15/06/2000
Method :Rotary Auger
Depth to water flow : 3.20m.
Depth to water level: 1.70m.

Location:Phum prek W.T.P, khan toul kork, Phnom Penh
Kingdom of Cambodia.
Size 120mm ,Elevation:. + 10.395
On 15/06/2000 Time...07h00Am
On 15/06/2000 Time. 11 h30am

DEPTH and TYPE OF SAMPLE (M)	(M)	D	U	No	DESCRIPTION OF STRATA	DEPTH and THICK.	LEGEND of SOIL	S P T (N) BLOWS/300MM	RECOVERY RATIO (MM)
0 - 1					1/ Made ground(brown silt,clay and sandy) encountered from ground surface to 1.00m. Medium brown clay and lean SILT(ML),	0.00			
- 2		D		1	encountered from 1.00m to 3.50m depth.	(3.50)		1.50 to 1.95m = 1, 2 , 3 , N -5	200/450
- 3		D		2		3.50		3.00 to 3.45m = 1, 2 , 3 , N -5	250/450
- 4			U	3	2/ Very loose dark-grey silty fine SAND(MS).	(1.50)			
- 5		D		4		5.00		4.50m to 4.95m = 1, 1 , 1, N-2	400/450
- 6			U	5	3/ Very soft brown clay, SILT(ML).	(2.00)		6.00m to 6.45m = 0, 1, 1, N-2	300/450
- 7		D		6		7.00			
- 8		D	U	7 8	4/ Stiff grey, yellow and brown fat CLAY(CH).	(1.00) 8.00		7.50m to 7.95m = 3, 4, 7, N-11	350/450
- 9		D		9	5/ Very stiff orange, grey and yellow fine to medium sandy lean CLAY(CL).	(1.50) 9.50		9.00m to 9.45m = 6,12,14, N-26	300/450
- 10 - 11		D		10	6/ Medium dense yellow and grey very clayey medium to coarse SAND(CS), gravel.	(3.50)		10.50m to 10.95m 10, 11,11, N-22	320/450
- 12 - 13		D		11		13.00		12.00m to 12.45m 8,13,16, N-29	370/450
- 14 - 15		D		12	7/ Dense greenish-grey very clayey medium to coarse SAND(CS), with gravel.	(2.50)		13.50m to 13.95m 9, 18, 29, N-47	300/450

consistency	SPT(N),Blows/300mm
Very soft	0 to 2
Soft	2 to 4
Medium	4 to 8
Stiff	8 to 15
Very stiff	15 to 30
Hard	30 to 50

RELATIVE DENSITY	SPT(N),Blows/300mm
Very loose	0 to 4
Loose	4 to 10
Medium dense	10 to 30
Dense	30 to 50
Very dense	Over 50

TYPE OF SAMPLE
D-disturbed sample
U-Undisturbed sample

TYPE OF FIELD TEST

SPT	Standard penetration test
VT	Shear vane test
PT	pocket penetrometer test
q_u	=.....Kgf/cm^2
K	Permeability

Figure 5

RESEARCH AND DESIGN ENTERPRISE — *FIELD BORING LOG* — SHEET 2

SOIL TESTING LABORATORY — *BOREHOLE No..T-1*

STANDARD PENETRATION TEST

Project: W.T. P	Date started..14/06/2000	Location:Phum prek W.T.P, khan toul kork, Phnom Penh
	Date finished 14/06/2000	Kingdom of Cambodia.
Owner :	Method :Rotary Auger	Size 120mm ,Elevation:. + 10.395
Contractor :	Depth to water flow : 3.20m.	On 14/06/2000 Time...07h00Am
sub contractor :	Depth to water level: 1.40m.	On 14/06/2000 Time. 11 h30am

DEPTH and TYPE OF SAMPLE (M)	(M)	D	U	No	DESCRIPTION OF STRATA	DEPTH and THICK.	LEGEND of SOIL	S P T (N) BLOWS/300MM	RECOVERY RATIO (MM)
15		D		13		15.50		15.00m to 15.45 = 10, 15, 30, N-45	270/450
16					8/ Very dense grey, yellow very clayey medium				
17		D		14	to coarse SAND(CS), with gravel.	(2.50)		16.50m to 16.95m 12, 26, 25, N-51	250/450
18		D		15		18.00		16.50m to 16.95m 6, 20, 30, N-50	270/450
19					End of borehole No T-1 at 18.00m depth.				
20									
21									
22									
23									
24									
25									
26									
27									
28									
29									
30									

consistency		RELATIVE DENSITY	
SPT(N),Blows/300mm		SPT(N),Blows/300mm	
Very soft	0 to 2	Very loose	0 to 4
Soft	2 to 4	Loose	4 to 10
Medium	4 to 8	Medium dense	10 to 30
Stiff	8 to 15		
Very stiff	15 to 30	Dense	30 to 50
Hard	30 to 50	Very dense	Over 50

TYPE OF SAMPLE

D-disturbed sample

U-Undisturbed sample

TYPE OF FIELD TEST

SPT	Standard penetration test
VT	Shear vane test
PT	pocket penetrometer test
q_u	=.....Kgf/cm^2
K	Permeability

Figure 5a

RESEARCH AND DESIGN ENTERPRISE — *FIELD BORING LOG* — SHEET 1

SOIL TESTING LABORATORY — *BOREHOLE No..T-2*

STANDARD PENETRATION TEST

Project: W.T. P	Date started..14/06/2000	Location:Phum prek W.T.P, khan toul kork, Phnom Penh
	Date finished 14/06/2000	Kingdom of Cambodia.
Owner :	Method :Rotary Auger	Size 120mm ,Elevation:. + 11.240
Contractor :	Depth to water flow : 3.20m.	On 14/06/2000 Time...06h30Am
sub contractor :	Depth to water level: 1.40m.	On 14/06/2000 Time. 12 h30pm

DEPTH and TYPE OF SAMPLE (M)	(M)	D	U	No	DESCRIPTION OF STRATA	DEPTH and THICK.	LEGEND of SOIL	S P T (N) BLOWS/300MM	RECOVERY RATIO (MM)
0 - 1					1/ Made ground (Brown clay, silt, sand and crushed brick, crushed stone, encountered from ground surface to 2.00m depth.	0.00 (2.00)			
- 2		D		1		2.00		1.50 to 1.95m = 2, 3 , 3 , N -6	200/450
			U	2	2/ Medium brown clay lean SILT(ML).	(1.00)			
- 3						3.00			
		D		3	3/ Soft brown silt, fat CLAY(CH).	(1.00)		3.00 to 3.45m = 1, 2, 2, N-4	350/450
- 4						4.00			
					4/ Very loose black peat, clay and fine SAND.	(1.00)			
- 5		D		4	(MS).	5.00		4.50m to 4.95m = 1, 0 , 1, N-1	400/450
					5/ Soft brown fat CLAY(CH).	(1.00)			
- 6			U	5		6.00			
					6/ Very loose dark-grey silty fine SAND(MS).	(1.00)			
- 7		D		6		7.00		6.50m to 6.95m = 1, 0, 0, N<1	400/450
			U	7	7/ Medium brownish-grey fat SILT(MH).	7.50			
- 8		D		8				7.50m to 7.95m = 4, 6, 9, N-15	250/450
- 9									
		D		9	8/ Medium dense yellow, grey very clayey	(4.50)		9.00m to 9.45m = 5,8,12, N-20	300/450
- 10					fine to coarse SAND(CS), with gravel.				
- 11		D		10				10.50m to 10.95m 5, 10,12, N-22	270/450
- 12						12.00			
		D		11				12.00m to 12.45m 11,16,17, N-33	300/450
- 13					9/ Dense yellow, grey very clayey medium to coarse SAND(CS), with gravel.	(1.50)			
- 14		D		12		13.50		13.50m to 13.95m 6, 12, 16, N-28	450/450
					10/ Medium dense greenish-grey very clayey	(1.50)			
- 15					fine to coarse SAND, with gravel.	15.00			

consistency		RELATIVE DENSITY		TYPE OF SAMPLE	TYPE OF FIELD TEST	
SPT(N),Blows/300mm		SPT(N),Blows/300mm		D-disturbed sample	SPT	Standard penetration test
Very soft	0 to 2	Very loose	0 to 4	U-Undisturbed sample	VT	Shear vane test
Soft	2 to 4	Loose	4 to 10		PT	pocket penetrometer test
Medium	4 to 8	Medium dense	10 to 30		q_u	=.....Kgf/cm^2
Stiff	8 to 15				K	Permeability
Very stiff	15 to 30	Dense	30 to 50			
Hard	30 to 60	Very dense	Over 60			

Figure 6

RESEARCH AND DESIGN ENTERPRISE — *FIELD BORING LOG* — SHEET 2

SOIL TESTING LABORATORY — *BOREHOLE No..T-2*

STANDARD PENETRATION TEST

Project: W.T. P	Date started..14/06/2000	Location:Phum prek W.T.P, khan toul kork, Phnom Penh
	Date finished 14/06/2000	Kingdom of Cambodia.
Owner :	Method :Rotary Auger	Size 120mm ,Elevation:. + 11.240
Contractor :	Depth to water flow : 3.20m.	On 14/06/2000 Time...06h30Am
sub contractor :	Depth to water level: 1.40m.	On 14/06/2000 Time. 12 h30pm

DEPTH and TYPE OF SAMPLE (M)	(M)	D	U	No	DESCRIPTION OF STRATA	DEPTH and THICK.	LEGEND of SOIL	S P T (N) BLOWS/300MM	RECOVERY RATIO (MM)
15 - 16		D		13	11/ Very dense grey and yellow very clayey medium to coarse SAND(CS), with gravel.	(1.00) 16.00		15.00m to 15.45= 14, 29, 21, N>50 1blow=5mm.	350/400
- 17		D		14	12/ Dense grey and yellow very clayey medium to coarse SAND(CS), with gravel.	(1.00) 17.00		16.50m to 16.95m 8, 19, 25, N-44	330/450
- 18 - 19 - 20 - 21 - 22 - 23 - 24 - 25 - 26 - 27 - 28 - 29 - 30					End of borehole No T-2 at 17.00m depth.				

consistency		RELATIVE DENSITY		TYPE OF SAMPLE
SPT(N),Blows/300mm		SPT(N),Blows/300mm		D-disturbed sample
Very soft	0 to 2	Very loose	0 to 4	U-Undisturbed sample
Soft	2 to 4	Loose	4 to 10	
Medium	4 to 8	Medium dense	10 to 30	
Stiff	8 to 15			
Very stiff	15 to 30	Dense	30 to 50	
Hard	30 to 50	Very dense	Over 50	

TYPE OF FIELD TEST	
SPT	Standard penetration test
VT	Shear vane test
PT	pocket penetrometer test
q_u	=.....Kgf/cm^2
K	Permeability

Figure 6a

RESEARCH AND DESIGN ENTERPRISE — *FIELD BORING LOG* — SHEET 1

SOIL TESTING LABORATORY — *BOREHOLE No..T-3*

STANDARD PENETRATION TEST

Project: W.T. P	Date started..14/06/2000	Location:Phum prek W.T.P, khan toul kork, Phnom Penh
	Date finished 14/06/2000	Kingdom of Cambodia.
Owner :	Method :Rotary Auger	Size 120mm ,Elevation:. + 11.390
Contractor :	Depth to water flow : 3.30m.	On 14/06/2000 Time...13h0pm
sub contractor :	Depth to water level: 2.60m.	On 14/06/2000 Time. 18 h30pm

DEPTH and TYPE OF SAMPLE (M)	(M)	D	U	No	DESCRIPTION OF STRATA	DEPTH and THICK.	LEGEND of SOIL	S P T (N) BLOWS/300MM	RECOVERY RATIO (MM)
0					1/ Made ground(reddish-brown clay, silt, sand	0.00			
- 1					, grevel(laterite) and crushed stone, encountered	(2.00)			
-					from ground surface to 0.50m depth.				
2		D		1	Brown silt, clay and sand from 0.50m to 2.00m.	2.00		1.50 to 1.95m = 2, 3 , 3 , N -6	370/450
-			U	2	2/ Medium brown, grey and yellow fat CLAY.	2.50			
3		D		3	3/ Soft brown silty lean CLAY(CL).	3.00			
		D		4	4/ Very loose dark-grey silty fine SAND(MS).	(1.00)		3.00 to 3.45m = 1, 3, 1, N-4	300/450
- 4						4.00			
-			U	5					
5		D		6				5.00m to 5.45m = 1, 2, 2, N-4	250/450
- 6					5/ Medium brown, dark-grey silty lean CLAY	(4.00)			
		D		7	(CL).			6.00m to 6.45m = 2, 3, 3, N-6	200/450
- 7									
- 8		D		8		8.00		7.50m to 7.95m = 2, 3, 3, N-6	350/450
- 9									
-		D		9				9.00m to 9.45m = 3,4,4, N-8	350/450
10					6/ Stiff yellow and grey fine to medium sandy	(3.50)			
- 11		D		10	lean CLAY(CL).			10.50m to 10.95m 4, 5,8, N-13	300/450
-						11.50			
12		D		11	7/ Medium dense greenish-grey very clayey fine	(2.00)		12.00m to 12.45m 6,10,16, N-26	350/450
- 13					to coarse SAND(CS), with gravel.				
-						13.50			
14		D		12				13.50m to 13.95m 8, 11, 15, N-26	450/450
- 15					8/ Dense greenish-grey, light-grey very clayey medium to coarse SAND(CS), with gravel.				

consistency		*RELATIVE DENSITY*		*TYPE OF SAMPLE*	*TYPE OF FIELD TEST*	
SPT(N),Blows/300mm		*SPT(N),Blows/300mm*		D-disturbed sample	SPT	Standard penetration test
Very soft	0 to 2	Very loose	0 to 4	U-Undisturbed sample	VT	Shear vane test
Soft	2 to 4	Loose	4 to 10		PT	pocket penetrometer test
Medium	4 to 8	Medium dense	10 to 30		q_u	=.....Kgf/cm^2
Stiff	8 to 15				K	Permeability
Very stiff	15 to 30	Dense	30 to 50			
Hard	30 to 50	Very dense	Over 50			Figure 7

RESEARCH AND DESIGN ENTERPRISE — *FIELD BORING LOG* — SHEET 2

SOIL TESTING LABORATORY — *BOREHOLE No..T-3*

STANDARD PENETRATION TEST

Project: W.T. P	Date started..14/06/2000	Location:Phum prek W.T.P, khan toul kork, Phnom Penh
	Date finished 14/06/2000	Kingdom of Cambodia.
Owner :	Method :Rotary Auger	Size 120mm ,Elevation:. + 11.390
Contractor :	Depth to water flow : 3.30m.	On 14/06/2000 Time...13h0pm
sub contractor :	Depth to water level: 2.60m.	On 14/06/2000 Time. 18 h30pm

DEPTH and TYPE OF SAMPLE (M)	(M)	D	U	No	DESCRIPTION OF STRATA	DEPTH and THICK.	LEGEND of SOIL	* S P T (N) BLOWS/300MM	RECOVERY RATIO (MM)
15 - 16		D		13	8/ Dense greenish-grey, light-grey very clayey	(4.50)		15.00m to 15.45 = 11, 16, 19, N-35	400/450
- 17		D		14	medium to coarse SAND(CS), with gravel.			16.50m to 16.95m 6, 13, 30, N-43	450/450
- 18		D		15		18.50		18.00m to 18.45m 13, 18, 24, N-42	370/450
- 19					9/ Very dense grey, yellow very clayey medium	(1.50)			
- 20		D		16	to coarse SAND(CS), with gravel.	20.00		19.50m to 19.95m 3, 17, 35, N-52	350/450
- 21					End of borehole No T-3 at 20.00m depth.				
- 22									
- 23									
- 24									
- 25									
- 26									
- 27									
- 28									
- 29									
- 30									

consistency		RELATIVE DENSITY		TYPE OF SAMPLE	TYPE OF FIELD TEST	
SPT(N),Blows/300mm		SPT(N),Blows/300mm		D-disturbed sample	SPT	Standard penetration test
Very soft	0 to 2	Very loose	0 to 4	U-Undisturbed sample	VT	Shear vane test
Soft	2 to 4	Loose	4 to 10		PT	pocket penetrometer test
Medium	4 to 8	Medium dense	10 to 30		q_u	=.....Kgf/cm^2
Stiff	8 to 15				K	Permeability
Very stiff	15 to 30	Dense	30 to 50			
Hard	30 to 50	Very dense	Over 50			

Figure 7a

Appendix 5- 7　Planned Facilities and Equipment

1) Facilities and Equipment

Facility and Equipment	Contents and Specifications
1.Intake Facility	
1.1 Intake pump（New）	3 sets Vertical mixed flow pump 36.7m^3／min×21.0 m×185 kW×50 Hz×3 kV
1.2 Intake gate（Rehab.）	4 sets Replacement of the operating rods of the gates Operating apparatus with bevel gear 4 sets φ50 mm×7.16 m 2 sets φ50 mm×13.42 m 2 sets
1.3 Overhead traveling crane（Rehab.）	1 set Replacement of trolley of the crane Hoisting Load ：6.0 ton Hoisting height ：8.0m Motor ：5.5 kW×380 V Traverse motion : 0.75 kW×380 V
1.4 Air valve (Rehab.)	1 set The existing valve shall be removed. A new Dia.75mm air exhaust valve shall be installed.
1.5 Air Vessel (Rehab.)	1 set 18 m3 × 2 vessels The existing vessels under the ground shall be abandoned. The new facility shall be constructed above the ground. Piping shall be connected with φ1,200 mm new raw water main and φ700 mm existing raw water main as standby.
2. Raw Water Mains	
2.1 Raw water valve chamber (New)	1 chamber New connecting pipes (φ900 mm × 2 pipes) shall be installed to the flanged branch of the existing header pipe of the raw water main. Raw water valve chamber (RC, W 5.10 m × L 3.90 m × H 3.33 m) Branch valve φ900 mm, Butterfly valve 2 sets
2.2 Raw water mains (New)	1,500 m Dia. 1,200 mm Ductile iron pipe with inner mortar lining, Class 3
2.3 Connecting pipe between raw water mains and receiving well (New)	Approx. 50 m φ1,200m Ductile iron pipe with inner mortar lining, Class 3
3. Receiving Well	
3.1 Receiving well (New)	1 chamber RC, W 5.30 m × L 15.90 m × H 6.60 m (Average depth of water 5.00m)
3.2 Raw water flow controlling valve (New)	1 set φ1,200 mm Butterfly valve with Baffle (incl. operating apparatus)
3.3 Raw water flow meter (New)	2 sets Weir (SUS316) and float type flow meter Weir length: 1.8 m for new WTP and 3.15 m for the existing WTP
4. Coagulation and Sedimentation Facility	
4.1 Rapid mixing basin (New)	2 basins for existing and new treatment facility Existing ； RC, W 3.15 m × L 5.00 m × Water depth 4.55 m New ； RC, W 1.80 m × L 5.00 m × Water depth 4.55m
4.2 Raid mixing method	No mechanical equipment (mixing using waterfall at the weir)

4.3 Connecting pipe (New)	2 sets Connecting pipe between the rapid mixing basin and raw water channel of flocculation basin • For existing treatment facility ; a φ1,350 mm ductile cast iron pipe with inner mortal lining, Class 3 • For new treatment facility ; a φ1,000 mm ductile cast iron pipe with inner mortal lining, Class 3
4.4 Flocculation basin (New)	8 basins RC, W 5.50 m × L 7.00 m × H 3.70 m (Average depth of water 3.46 m)
4.5 Flocculator (New)	8 sets Mechanical flocculator φ4.5 m × 3.7 kW × 380 V
4.6 Inlet gate of flocculation basin (New)	8 sets Manual operation rectangular gate 450 mm × 450 mm
4.7 Chemical sedimentation basin (New)	4 basins Horizontal flow type sedimentation basin ; RC, W 11.30 m × L 50.00 m × Average depth of water 2.54 m
4.8 Baffle wall at inlet, middle and outlet (New)	4 sets Baffle wall with a opening for cleaning the basin
4.9 Baffle wall at inlet of the existing basins (Improve.)	6 sets Installation of baffle wall at the inlet of the existing basin to reduce turbulence, short-circuit flow and dense flow
4.10 drain valve for settled sludge (New)	8 sets φ350mm Top Valve
4.11 Pressure water shooting device (New)	1 set φ75 mm ductile cast iron pipes with inner mortal lining, Class 3
4.12 Settled water collecting trough (New)	24 sets Orifice notch type
4.13 Drain valve in settled water channel (New)	3 sets φ100mm top valve
5. Rapid sand filter	
5.1 Rapid sand filter (New)	8 basins RC, W 4.50 m × L 10.85 m = 48.825 ㎡／basin
5.2 Inlet gate (New)	16 sets W 630 mm × H 380mm Outside screw type power-operated gate (SUS316)
5.3 Filter flow regulator (New)	8 sets Siphon type filter flow regulator (SUS316) Q(Normal) = 300 m^3／hour、Q(Max) = 399 m^3／hour connecting diameter 300 mm
5.4 Filtered water valve (New)	8 sets Flangeless butterfly valve with air type actuator φ300mm
5.5 Water backwash valve (New)	8 sets Flangeless butterfly valve with air type actuator φ450mm
5.6 Air scour valve (New)	8 sets Flangeless butterfly valve with air type actuator φ250mm
5.7 Drain valve (New)	8 sets Hand-operated sluice valve with handle φ150 mm
5.8 Drain valve in the adjusting equipment room (New)	8 sets Hand-operated sluice valve with handle φ75mm
5.9 Filter sand (New)	For 8 filters Sand type: Silica Effective diameter: 1.0mm Uniformity coefficient: below 1.5 Sand thickness 1.0 m
5.10 Filter underdrain device (New)	391 ㎡ for 8 basins Water and air backwash perforated device

5.11 Filter control desk (New)	4 sets 2 filters duo operated type
6. Chemical feeding facility	
6.1 Chemical building (New)	1 building Ground floor = 540 ㎡, 1st floor = 396 ㎡, mezzanine floor = 144 ㎡ The building consists of chemical feeding room, chlorine feeding room, water quality testing laboratory, chlorine neutralization room and chemicals/chlorine storage room.
6.2 Aluminum sulfate solution and feeding equipment (New)	4 solution tanks inner φ2.0 m × H 2.6 m, FRP
	4 mixers Vertical type power-operated mixer φ450 mm × 2 stages × 3.7 kW ×380 V × 50 Hz
	4 liquid level gauge Terminal type liquid level gauge (3 contact)
	2 feeding equipments W 0.8 m × L 1.5 m × H 0.7m, Triangular notch weir with flow display panel (an angle of 30 degrees)
6.3 Slaked lime feeding equipment (New)	2 mixing tanks W 2.0 × L 3.0 × H 2.5 m (effective depth 2.0), RC
	2 Mixers φ800mm × 1 stage × 5.5 kW × 0.4 kW × 50 Hz
	4 liquid level gauge Terminal type liquid level gauge (3 contact)
	1 mixer for saturator Vertical type power-operated mixer φ250 mm × 2 stages × 3.7 kW ×380 V × 50 Hz
	1 saturator for milky slaked lime tank φ350mm×φ950mm
	1 flow meter for service water φ100mm, Orifice type flow meter 20～100 m^3／hour
	Service water pipe: φ150mm ductile cast iron pipe with inner mortal lining, Class 3
6.4 Chlorine feeding equipment (New)	4 feeding equipments (2 for pre-chlorination and 2 for post-chlorination) Self standing cabinet type
	2 vacuum adjustment equipment (1 for pre-chlorination and 1 for post-chlorination) Wall mounted manifold pipe type Feeding quantity ； Max 40 kg／hour feeding pressure ； Max 1.0 Mpa
	4 ejectors (2 for pre-chlorination and 2 for post-chlorination) Working flow rate；400 L／min. Working pressure；0.6 Mpa Diameter；50 mm
	4 flow meters (2 for pre-chlorination and 2 for post-chlorination) built-in cabinet style Flow range ；0～40 kg／hour
	4 service water pump Discharge rate；0.4 m^3／min. Total head；23～25m Kind of pipe；φ100 mm ductile cast iron pipe with inner mortal lining, Class 3
	Chlorine gas cylinder; 30 cylinders

6.5 Chlorine gas neutralization equipment (New)	1 set Neutralization capacity； 1,000 kg Exhauster； FRP-made anti-corrosion turbo fan, Capacity of 60 m^3／min., Static pressure 250 mmAg 5.5KW×380V×50Hz Neutralization tower；PVC-made cylindrical vertical type dual filled tower φ1.05 mm×2 towers×H 1.2m Caustic soda；Steel rectangular tank with PVC lining 4.5m×2.0m×1.5m× 1 tank Caustic soda pump；PVC made pump 1.2 m^3／min.×10mAg×7.5KW×380V×50Hz× 1 set Detector of chlorine gas leak；6 sets (incl. transmitter and receiver) Detection range：0～3 ppm
7. Water Reservoir	
7.1 Distribution reservoir (New)	5,000 m^3, 1 basin, RC W 24.8m×L 66.8m×H 3.85m（effective depth 3.10 m）
7.2 Connecting pipe (New)	1 pipe, between filtered water channel and the new reservoir φ700mm ductile cast iron pipe with inner mortal lining, Class 3
7.3 Flow meter (New)	1 set Insertion type piezoelectric flow meter, φ700mm
7.4 Connecting pipe (New)	1 set, between the reservoir and distribution/transmission pump φ700mm ductile cast iron pipe with inner mortal lining, Class 3
7.5 Distribution pump (Rehav.)	3 sets Installation in the existing NO.1 pump room 35.0 m^3／min.×42m×320KW×3KV×50Hz Rehabilitation of suction pipe and delivery pipe
7.6 Distribution pump (New)	1 set Installation in the existing NO.2 pump room 17.5m^3/min ×42m×180kw×3kv×50Hz
7.7 Connecting pipe (Rehav.)	1 pipe One φ800mm existing distribution main shall be abandoned. Installation of a new connecting pipe between the distribution main (φ 1.350mm) and ADB financed transmission main φ1,000mm ductile cast iron pipe with inner mortal lining, Class 3
8. Water quality testing lab.	
8.1 Water quality testing lab. (New)	Establishment in the chemical feeding building
8.2 Water quality analysis equipment (New)	1 set Necessary equipment, glass installment and test reagent (see the next table)
8.3 Sampling pump (New)	2 sets of horizontal type pumps for sampling raw water (incl. standby) 2 sets of submerged motor pumps for sampling the settled water of the exiting sedimentation basin (incl. stadby) 2 sets of submerged motor pumps for sampling the settled water of new sedimentation basins (incl. stadby) 2 sets of submerged motor pumps for sampling the filtered water of exiting filters (incl. standby) 2 sets of submerged motor pumps for sampling the filtered water of new filters (incl. standby)
9. Electrical and metering instrumentation	
9.1 Activation panel for intake pump (New)	2 sets Installation in the existing intake electric room
9.2 Subsidiary relay panel for the activation panel (New)	1 set Installation in the existing electrical room
9.3 Control line (New)	1 line Installation with new raw water main between the intake and the treatment plant

9.4 Activation panel for distribution pump (New)	1 set Installation of a panel for the pump (Q = 17.5 m^3／min.) in the existing electric room of the treatment plant
9.5 Central control and monitoring panel (Remodeling)	1 set Modification of the mosaic and remodeling of the desk
9.6 Relay panel for central control and monitoring panel (Extension)	1 set Installation in the central control and monitoring room
9.7 Light for chemical building and lighting rod (New)	1 set
9.8 Water level gauge at intake (Rehab.)	1 set Ultra-sonic indicator
9.9 Raw water flow meter (New)	2 sets Float type flow meter and integrating meter for the existing and new water treatment facility
9.10 Head loss meter for filter (New)	8 sets Differential pressure type head loss indicator
9.11 Water level for distribution reservoir (New)	1 set Water level indicator for new distribution reservoir

2) Equipment in the Water Quality Monitoring Laboratory

Equipment	Number
1. Fume Hood (with Blower), Ceramitite	1
2. Center Table (with Sink)	1
3. Center Table with Reagent Shelf (with Glass Door)	2
4. Jar Tester, 6-Shafts	1
5 Digital Thermometer	1
6. Personal pH Meter (with Electrode)	1
7. Digital Temperature , Humidity and Dew Point Meter	1
8. Electrical Conductivity Meter	1
9. Direct Reading Type Turbidimeter	1
10. Drying Oven	1
11. Autoclave	1
12. Rack with Metal Fittings	1
13. Magnetic Mixer	1
14. Water Distillation Apparatus	1
15. Beaker, Glass, etc.	Necessary numbers
16. Testing Reagent	Necessary numbers

Appendix 5- 8　Operation and Maintenance Costs of Electricity and Chemicals

1．　Electricity Cost

(1) Electricity consumption of intake pump

185 kw×3 sets×24 hours/day×365 days/year = 4,861,800 kWh/year

(2) Electricity consumption of water treatment facility

① Flocculator

2 kW×12 sets×24hours/day×365days/year = 210,240 kWh/year

3.7 kW×8 sets×24 hours/day×365days /年 = 259,296 kWh/year

② Backwash pump

Assuming that: a filter is washed every 36 hours (1.5 days)　Total numbers of filter washing per day:　20 filters×24/36 = 13.4 filters/day

Assuming that water backwashing time per filter is 24 minute.

45kw×13.4filters/day×24/60×365das/year = 88,038 kWh/year

③ Air blower for backwashing

Assuming that air backwashing time per 1 filter is 5 minutes:

45kw×13.4filters/日 day×5/60×365days/year = 18,342 kWh/year

④ Agitator of dissolving aluminum sulfate

Assuming that the number of solution per day is 3 tanks and the operation time per tank is 1 hour.

3.7kw×3 times/day×1 hour/time×356days/year = 4,052 kWh/year

⑤ Agitator of dissolving slaked lime

24 hours/day operation to avoid settlement of slaked lime

5.5kw×2 sets×24hours/day×365days/year = 96,360 kWh/year

0.4kw×1 set×24hours/day×365days/year = 3,504 kWh/year

⑥ Feed water pump for chlorine

7.5kw×1set×24ours/day×365days/year = 65,700 kWh/year

⑦ Pump and blower for chlorine gas neutralization

The electricity consumption for this equipment is not estimated because of emergency use only.

⑧ Sampling ball

0.75kw×5sets×24hours/day×365days/year = 32,850 kWh/year

⑨ Others (Compressor, air conditioning apparatus, lights, ect)

Assuming that these electricity consumptions are 1 percent of the total consumption estimated above

5,640,182×0.01 = 55,818 kWh/year

Total： 834,200 kWh/year

(3) Electricity consumption of distribution and transmission pumps

The pump operation plan to distribute 150,000 m^3/day is as follows:

Distribution pump（2,100 m^3/hr、320kw）2 sets		4,200 m^3/hour＝100,800 m^3/day
Same as above （1,050 m^3/hr、180kw）2 sets		1,050 m^3/hr＝25,200 m^3/day
Transmission pump（1,050 m^3/hr、180kw）2 sets		1,050 m^3/hr＝25,200 m^3/day
	Total	6,300 m^3/hr＝151,200 m3/日

320kw×2sets×24hours/day×365days/year		= 5,606,400 kWh/Year
180kw×2sets×24hours/day×365days/year		= 3,153,600 kWh/Year
	Total	8,760,000 ｋWh／年

(2) Chemicals consumption for water treatment

① Aluminum Sulfate

Average optimum feeding rate is 23.5 mg/L based on the 1999 jar tester data.

158,400m^3/day×23.5mg/L×10^{-3}×365days/year = 1.359 ton/year

② Slaked lime

Average feeding rate is 10 mg/L and half a year is required feeding to adjust pH value

158,400m^3/day×10mg/L×10^{-3}×365days/year×1/2 year = 579 ton/year

③ Chlorination

Pre-Chlorination (2 mg/L feeding during the period December to May 6 months when algae generation occurs)

158,400m^3/day×2mg/L×10^{-3}×180days/year = 57 ton/year

Post-Chlorination

158,400m^3/day×1.5mg/L×10^{-3}×365day/year = 87 ton/year

Total quantity of Chlorine gas: 144ton/年

Table 1 Operation and maintenance cost estimation (Electricity and chemicals)

		Annual Consumption	Annual Cost Estimate
Electricity	Water treatment	834,000 kWh/year	400 million Riel
	Water intake	4,862,000 kWh/year	2,334 million Riel
	Water transmission and distribution	8,760,000 kWh/year	4,205 million Riel
	Subtotal	14,456,000 kWh/year	6,46 million Riel
Chemicals	Aluminum Sulfate	1,359 tons/year	326,000 US $
	Slaked lime	289 tons/yea	35,000 US $
	Chlorine gas	144 tons/year	158,000 US $
	Subtotal	–	519,000 US $ = 1,998 million Riel
Total		–	8,937 million Riel

(Estimation conditions)

1 US $ = 3,850 riel

Power tariff : 480 Riel/kWh = 0.09 US $/kWh (for Phum Prek WTP)

Aluminum Sulfate : 240 US $/ton (including transportation cost)

Slaked lime : 120 US $/ton (including transportation cost)

Chlorine gas : 1,100 US $/ton (including transportation cost)

Appendix 5- 9 Permission of Installation of Raw Water Mains

KINGDOM OF CAMBODIA
NATION RELIGION KING
****

Phnom Penh, Dated: 22nd June, 2000

PHNOM PENH WATER SUPPLY AUTHORITY
(PPWSA)
No: _____

To:
GOVERNOR OF PHNOM PENH MUNICIPALITY

Objective: Request for Installation of Transmission Pipe sized 1,200mm from Raw Water Pumping Station to Phum Prek Water Treatment Plant.

References:
- Minutes of Discussion on the Basic Design Study on the Project for Expansion of Phum Prek Water Treatment Plant in the Kingdom of Cambodia between Japan International Cooperation Agency and Phnom Penh Water Supply Authority dated on 23 June 2000.
- Letter of Japan International Cooperation Agency to Kingdom of Cambodia No. JC 11-177 on Basic Design Study on the Project for Expansion of Phum Prek Water Treatment Plant in the Kingdom of Cambodia.

Refer to the mentioning in the above objective and references, Phnom Penh Water Supply Authority has the honor to inform the Governor that Government of Japan has entrusted to Japan International Cooperation Agency for Basic Design Study on the Project for Expansion of Phum Prek Water Treatment Plant which has been requested the Grant from Government of Japan in 1997. Japan International Cooperation Agency has revealed that for this basic design, it is necessary that the Transmission Pipe sized 1,200mm from Raw Water Pumping Station in front of Council for Development of Cambodia to Phum Prek Water Treatment Plant should be installed as mentioned in attached Drawing.

To smoothly implement the Grant, Phnom Penh Water Supply Authority request to Governor of Phnom Penh Municipality's kind cooperation to officially permit as above request.

Yours faithfully
General Director of Phnom Penh Water Supply Authority
EK SONN CHAN

Response from Governor of Phnom Penh Municipality

Agreed to install pipe crossing the Garden except two places can be escaped.

Signature of Governor
23-June-2000

ព្រះរាជាណាចក្រកម្ពុជា

ជាតិ សាសនា ព្រះមហាក្សត្រ

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ភ្នំពេញ , ថ្ងៃទី ២២.. ខែ មិថុនា ឆ្នាំ ២០០០

រដ្ឋាករទឹកស្វយ័តក្រុងភ្នំពេញ

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លេខ: ២២២ ណ.ស

367

28.6.00

<u>សូមគោរពជូន</u>

ឯកឧត្តមប្រតិភូរាជរដ្ឋាភិបាលទទួលបន្ទុកអភិបាលរាជធានីភ្នំពេញ

<u>កម្មវត្ថុ</u>: សំណើសុំអនុញ្ញាតជីកដាក់បំពង់ទឹក ទំហំ ១.២០០មម ប្រវែង ១.៥០០ម ចេញពីស្ថានីយ៍បូមទឹកល្អក់ មកទល់ និងអាងទទួលទឹករោងចក្រភូមិព្រែក ។

<u>យោង</u>: - កិច្ចពិភាក្សា នៃការសិក្សាគំរោងពង្រីករោងចក្រផលិតទឹកស្អាតភូមិព្រែក រវាងភាគីភ្នាក់ងារសហប្រតិបត្តិការអន្តរជាតិ នៃប្រទេសជប៉ុន និងរដ្ឋាករទឹកស្វយ័តក្រុងភ្នំពេញ ចុះថ្ងៃទី ២៣ ខែកក្កដា ឆ្នាំ ២០០០ ។

- សារលិខិតរបស់ទីភ្នាក់ងារសហប្រតិបត្តិការអន្តរជាតិ នៃប្រទេសជប៉ុន ប្រចាំព្រះរាជាណាចក្រកម្ពុជា លេខ JC 11-177 ចុះថ្ងៃទី ១២ ខែ កក្កដា ឆ្នាំ ២០០០ ស្តីពីការមកដល់របស់គណៈប្រតិភូជប៉ុន លើការសិក្សាគំរោងពង្រីកសមត្ថភាពរោងចក្រផលិតទឹកស្អាតភូមិព្រែក ។

សេចក្តីដូចមានចែងក្នុងកម្មវត្ថុខាងលើ រដ្ឋាករទឹកស្វយ័តក្រុងភ្នំពេញ សូមជំរាបជូនឯកឧត្តមប្រតិភូ មេត្តាជ្រាបថា ÷ រដ្ឋាភិបាលជប៉ុន បានបញ្ជូនប្រតិភូរបស់ទីភ្នាក់ងារសហប្រតិបត្តិការអន្តរជាតិ នៃប្រទេសជប៉ុន ដើម្បីធ្វើការសិក្សាអំពីលទ្ធភាពធ្វើបាន (Basic Design) ទៅលើគំរោងពង្រីកសមត្ថភាពផលិតទឹកស្អាតរោងចក្រភូមិព្រែក ដែលភាគីកម្ពុជាបានស្នើសុំជំនួយឥតសំណងពីរាជរដ្ឋាភិបាលជប៉ុន នាឆ្នាំ ១៩៩៧ ។ ក្នុងការសិក្សានេះ ភាគីជប៉ុនបានអោយដឹងថា ចាំបាច់ត្រូវដាក់បំពង់មួយទំហំ ១.២០០មម ប្រវែង ១.៥០០ម ពីស្ថានីយ៍បូមទឹកល្អក់នៅមុខទីស្នាក់ការក្រុមប្រឹក្សាអភិវឌ្ឍន៍កម្ពុជាមករោងចក្រភូមិព្រែកដូចដែលមានប្លង់គំនូសបំព្រួញភ្ជាប់ជាមួយនេះ ។

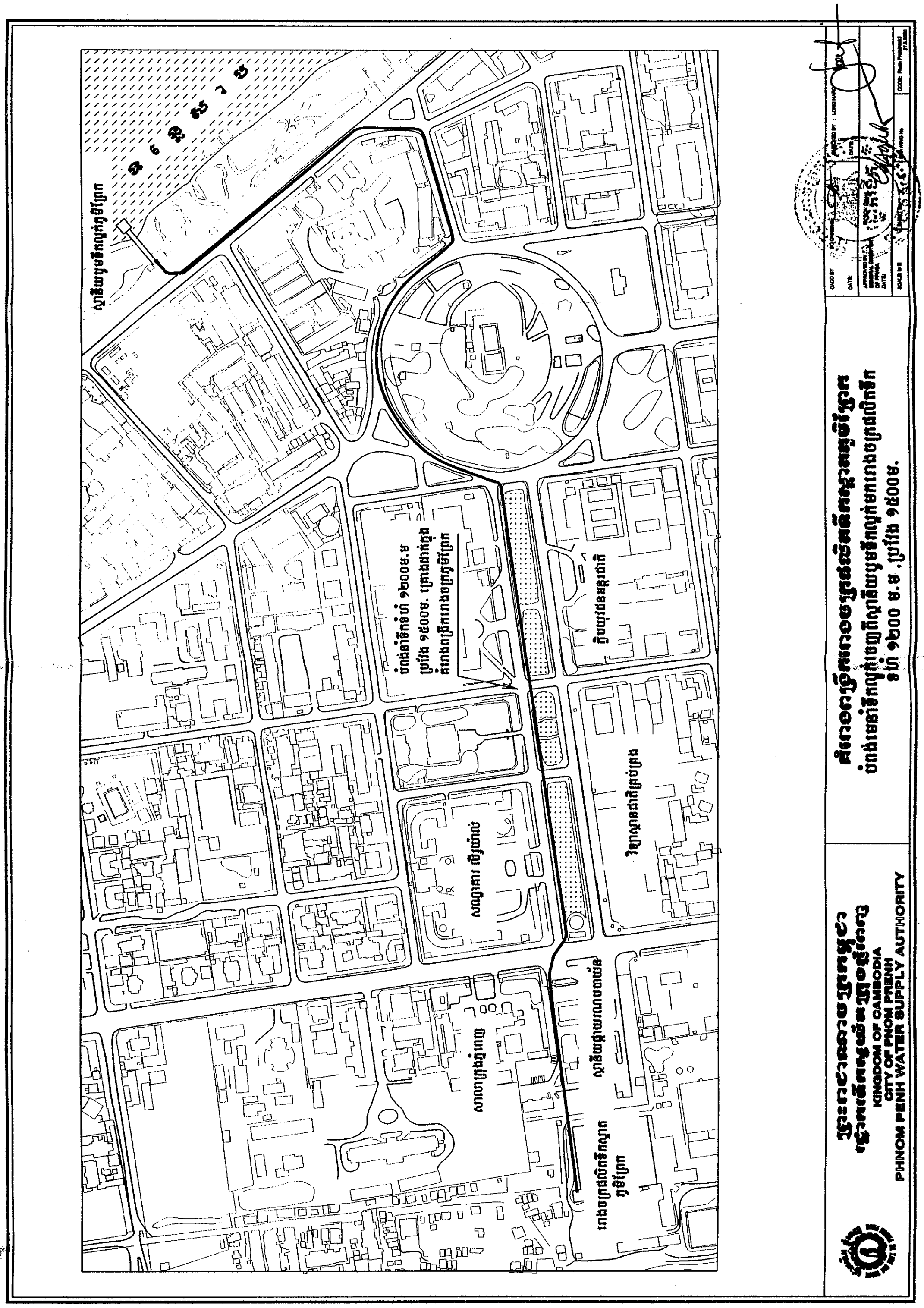
ដើម្បីអនុវត្តបាននូវគំរោងជំនួយឥតសំណងនេះ យើងខ្ញុំសូមឯកឧត្តមប្រតិភូ រាជរដ្ឋាភិបាលទទួលបន្ទុកអភិបាលរាជធានីភ្នំពេញ មេត្តាអនុញ្ញាត ដោយក្តីអនុគ្រោះ ។

សូមឯកឧត្តមប្រតិភូ មេត្តាទទួលនូវការគោរពដ៏ខ្ពង់ខ្ពស់អំពីយើងខ្ញុំ ។

អគ្គនាយក

ឯក សុនចាន់

ទីស្នាក់ការ : ខាងជើងស្ថានីយ៍រថភ្លើងកម្ពុជា ទូរស័ព្ទ : ០២៣-៧២៤ ០៤៦ ទូរស័ព្ទ-ទូរសារ : ៨៥៥ - ២៣-៤២៨ ៩៦៩


KINGDOM OF CAMBODIA
CITY OF PHNOM PENH
PHNOM PENH WATER SUPPLY AUTHORITY

Appendix 5- 10 Permission of Installation of Raw Water Mains (Telecommunication building site)

KINGDOM OF CAMBODIA
NATION-RELIGION-KING

PHNOM PENH WATER SUPPLY AUTHORITY
PROJECT MANAGEMENT UNIT

ADDRESS: North of Cambodia Railway Station
PHNOM PENH
TEL: 855-23 427 657, Fax: 855-23 427 657

Date: 23 August 2000 Message No.: 093 - PMU-GR/00
Total Page: 3 including this cover sheet

To: Tokyo Engineering Consultants Co. Ltd.
Fuji Building, 3-7-4 Kasmigasaki
Chiyoda-Ku, Tokyo, Japan

Attention: Mr. Hirotaka SATO
M.E (Environment & Sanitary)
M.W.R.A (Water Resources Administration)
Overseas Department
Fax: 813-3580-2793

Subject: Request for the installation of 1,200mm water pipe crossing Bayon Satellite Station

Dear Sir,

Please find the attached letter from Ministry of Posts and Telecommunications on the approval of pipe installation crossing Bayon Satellite Station together with its translation into English.

Best regards,

Long Naro
Director of Technical and Project DPT
PPWSA

ព្រះរាជាណាចក្រកម្ពុជា
Kingdom of Cambodia
ជាតិ សាសនា ព្រះមហាក្សត្រ
Nation - Religion - King

ដីស្តីការ
ក្រសួងប្រៃសណីយ៍ និង ទូរគមនាគមន៍
Ministry of Posts and Telecommunications

ភ្នំពេញ ថ្ងៃទី ..15.. ខែ 08 ..... ឆ្នាំ 2000

លេខ : 1391 ប.ទ.ព.ន

រដ្ឋាករទឹកស្វយ័តក្រុងភ្នំពេញ
លេខចូលការិយាល័យ
លេខ 1150
ថ្ងៃទី 16.08.00 ម៉ោង 11:30

រដ្ឋាករទឹកស្វយ័តក្រុងភ្នំពេញ
លេខ 431
ថ្ងៃទី 15-8-00
ហត្ថលេខា

រដ្ឋមន្ត្រី ក្រសួងប្រៃសណីយ៍និងទូរគមនាគមន៍
ជំរាបមក
លោកអគ្គនាយករដ្ឋាករទឹកស្វយ័តក្រុងភ្នំពេញ

កម្មវត្ថុ: អំពីការសំណើសុំអនុញ្ញាតដាក់បំពង់ទឹកទំហំ 1.200មម ឆ្លងកាត់ស្ថានីយ៍ផ្ការណាបចាយ័ន ។

យោង: លិខិតលេខ 223ល.ស ចុះថ្ងៃទី 10.07.2000 របស់រដ្ឋាករទឹកក្រុងភ្នំពេញ.

សេចក្តីដូចមានចែងក្នុងកម្មវត្ថុនិងយោងខាងលើ ខ្ញុំមានកិត្តិយសសូមជំរាបលោកអគ្គនាយកជ្រាបថា : ផ្អែកតាមលទ្ធផលនៃការពិភាក្សារវាងមន្ត្រីនាយកដ្ឋានទូរគមនាគមន៍អន្តរជាតិនៃក្រសួងប្រៃសណីយ៍និងទូរគមនាគមន៍ និងតំណាងរដ្ឋាករទឹកស្វយ័តក្រុងភ្នំពេញរួមជាមួយជំនាញបច្ចេកទេសជប៉ុន ក្រសួងប្រៃសណីយ៍និងទូរគមនាគមន៍បានឯកភាពអនុញ្ញាតជាគោលការណ៍ក្នុងការស្នាបនាដាក់បំពង់ទឹកតាមបណ្តោយផ្លូវក្នុងស្ថានីយ៍ផ្ការណាបចាយ័នខាងជើងអាគារផ្ទុកថាស ដោយកំរិតអោយមានវិធានការណ៍ដូចខាងក្រោមនៅមុនពេលសំរេចបើកការដ្ឋាន :

1- រដ្ឋាករទឹកស្វយ័តក្រុងសិក្សាលទ្ធភាពនៃតំរោងនិងបង្ហាញលទ្ធផលថាមិនប៉ះពាល់ដល់ដំណើរការនៃស្ថានីយ៍ផ្ការណាប ។

2- ត្រូវធ្វើកិច្ចសន្យាធានារ៉ាប់រងសុវត្ថិភាពនិងជួសជុលការខូចខាតក្នុងស្ថានីយ៍ដែលបង្កឡើងដោយការដ្ឋានដាក់បំពង់ទឹកនេះ ។

អាស្រ័យហេតុដូចបានជំរាបជូនខាងលើ សូមលោកអគ្គនាយកជ្រាបនិងចាត់ចែងអនុវត្តន៍អោយទទួលបានជោគជ័យ ។

សូម **លោកអគ្គនាយក** ទទួលនូវសេចក្តីគោរពដ៏ខ្ពង់ខ្ពស់ ។

ចម្លងជូន:
- *សាលាក្រុងភ្នំពេញ * ដើម្បីជ្រាប *
- *នាយកដ្ឋានវិនិយោគវិស្វកម្ម * ដើម្បីមុខការ *
- *នាយកដ្ឋានទូរគមនាគមន៍អន្តរជាតិ * ដើម្បីមុខការ *
- *ឯកសារ កាលប្បវត្តិ.*

ស.ឃុន

ការិយាល័យលេខ ១៣ និង ១០២ សង្កាត់វត្តភ្នំ ខណ្ឌដូនពេញ
ទូរស័ព្ទ : 855-23.426993 / 426510
ទូរសារ : 855-23.426992 / 426011

Corner street 13 and 102 Wat Phnom
Section - Daun Penh District P.Penh
Tel : 855-23.426993 / 426510
Fax : 855-23.426992 / 426011

KINGDOM OF CAMBODIA
NATION RELIGION KING
****

Phnom Penh, Dated: 15 August, 2000

Cabinet
Ministry of Posts and Telecommunications
No.:_____

Minister of Posts and Telecommunications

officially informs

General Director of Phnom Penh Water Supply Authority

Objective: The request for the installation of 1,200mm water pipe crossing Bayon Satellite Station

Reference: Letter No. 223_____ of Phnom Penh Water Supply Authority dated on 10 July 2000

In accordance with the objective and reference mentioned above, we have the honor to inform General Director that based on the results of the discussion between International Telecommunication Department of Ministry of Posts and Telecommunications and representative of Phnom Penh Water Supply Authority including Japanese expert, Minister of Posts and Telecommunications has officially permitted for the installation of water pipe along the road at the north of Administration Building in Bayon Satellite Station. Some below measures shall be taken prior opening the site:

1. Phnom Penh Water Supply Authority shall study on the feasibility of the project indicating that there is no any bad affect to the operation of Satellite Station.

2. Phnom Penh Water Supply Authority shall ensure the safety and repair all the damage parts in the station resulting from the installation of water pipe.

This above description is informative to General Director and we wish you implementing it successfully.

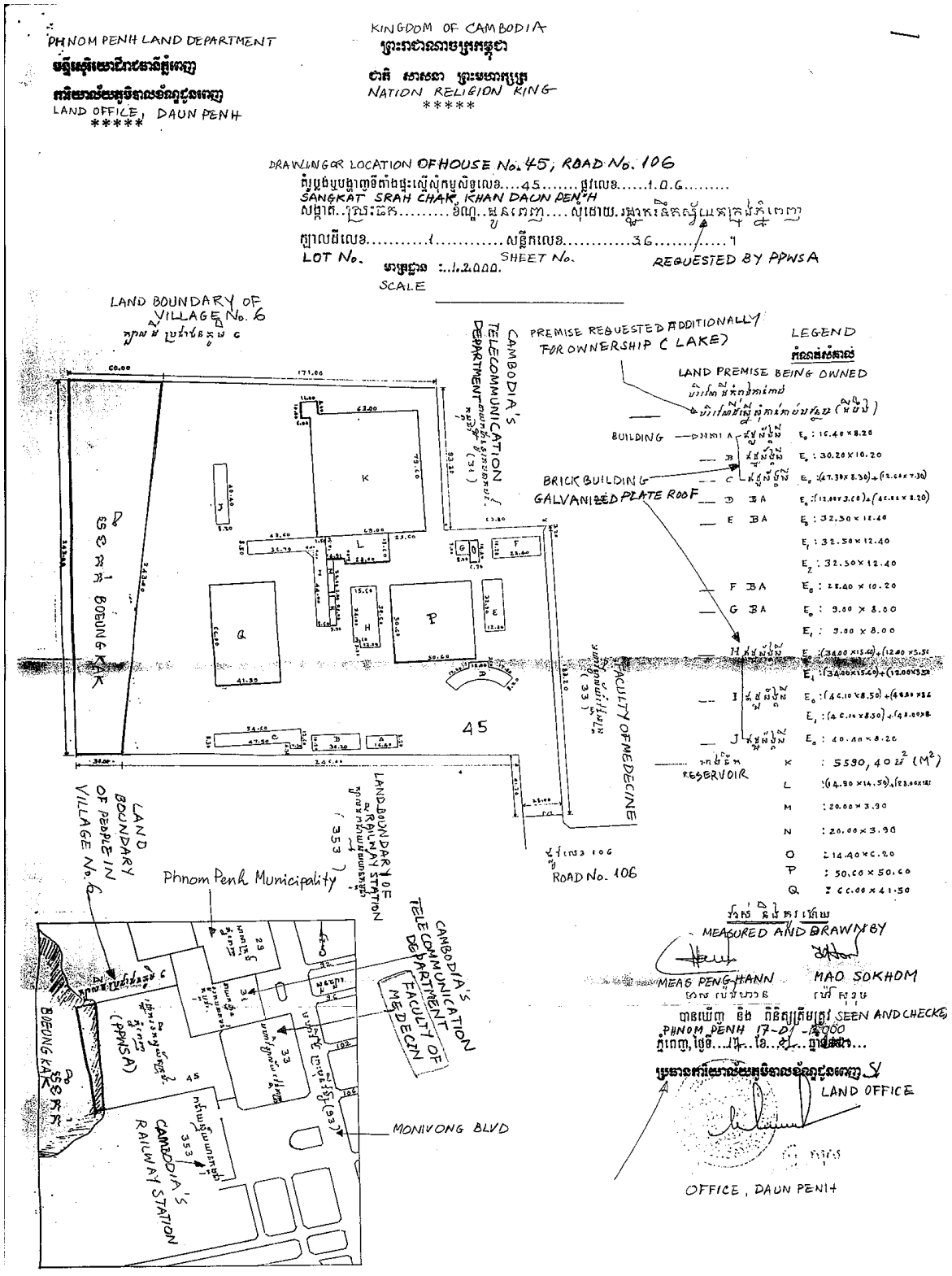
Best regards,

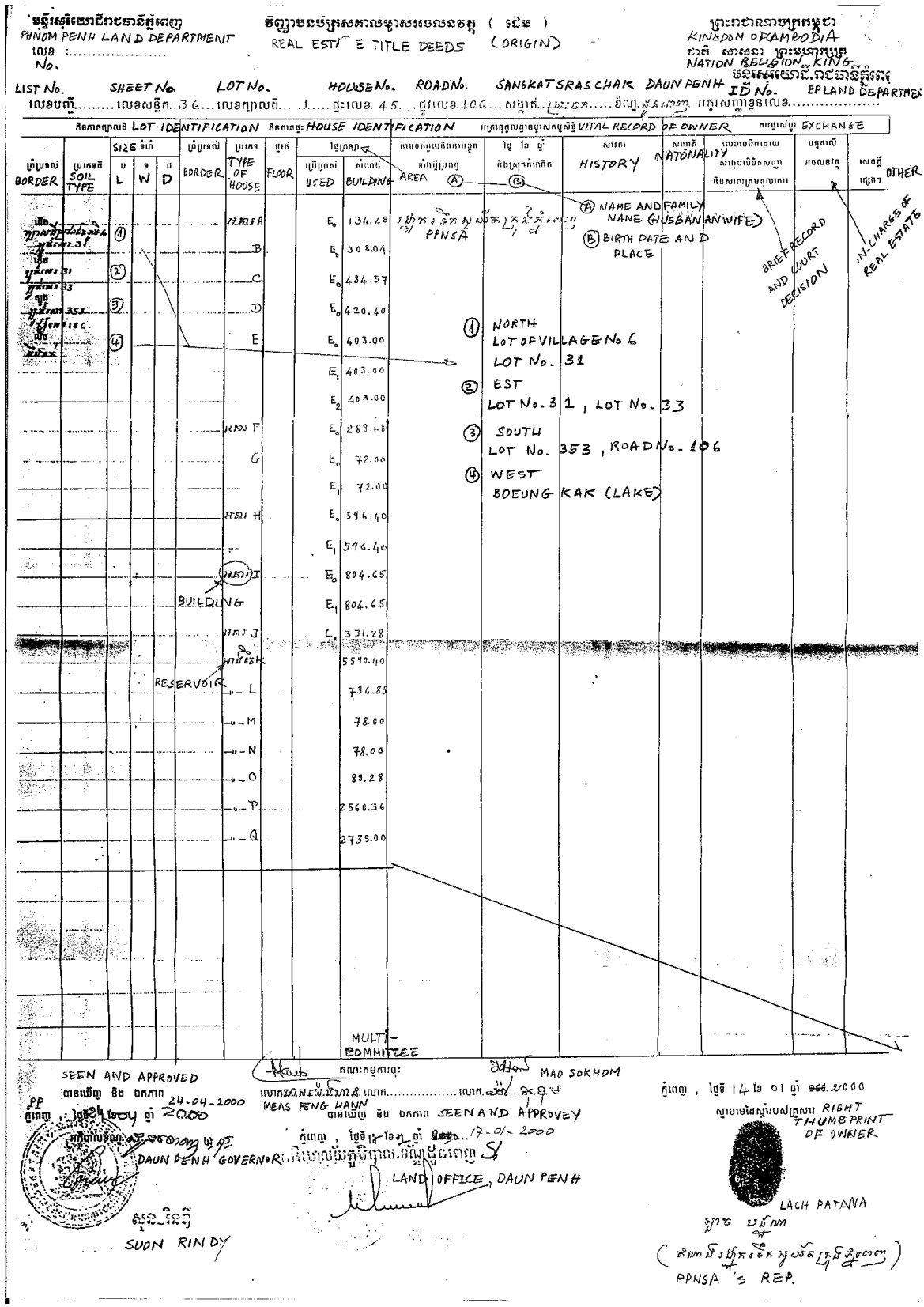
Copied to:
- Phnom Penh Municipality
- Financial Planning Department "Official"
- International Telecommunication Department "Official"
- Document, file

MINISTER

SO KHUN

Appendix 5- 11 Registration of Landfill Land of Phum Prek Water Treatment Plant




PHNOM PENH LAND DEPARTMENT
REAL ESTATE TITLE DEEDS (ORIGIN)
KINGDOM OF CAMBODIA
NATION RELIGION KING
LIST No. SHEET No. LOT No. HOUSE No. ROAD No. SANGKAT SRAS CHAK DAUN PENH ID No.
LOT IDENTIFICATION
HOUSE IDENTIFICATION
VITAL RECORD OF OWNER
EXCHANGE
SIZE
BORDER
SOIL TYPE
L
W
D
TYPE OF HOUSE
FLOOR
USED
BUILDING
AREA
HISTORY
NATIONALITY
OTHER
(A) NAME AND FAMILY NANE (HUSBAN AN WIFE)
(B) BIRTH DATE AND PLACE
BRIEF RECORD AND COURT DECISION
IN-CHARGE OF REAL ESTATE
PPNSA
1 NORTH LOT OF VILLAGE No 6 LOT No. 31
2 EST LOT No. 31 , LOT No. 33
3 SOUTH LOT No. 353 , ROAD No. 106
4 WEST BOEUNG KAK (LAKE)
BUILDING
RESERVOIR
MULTI-COMMITTEE
SEEN AND APPROVED
24-04-2000
DAUN PENH GOVERNOR
SUON RINDY
MEAS PENG HANN
SEEN AND APPROVEY
17-01-2000
LAND OFFICE, DAUN PENH
MAO SOKHOM
RIGHT THUMB PRINT OF OWNER
LACH PATANA
PPNSA 's REP.