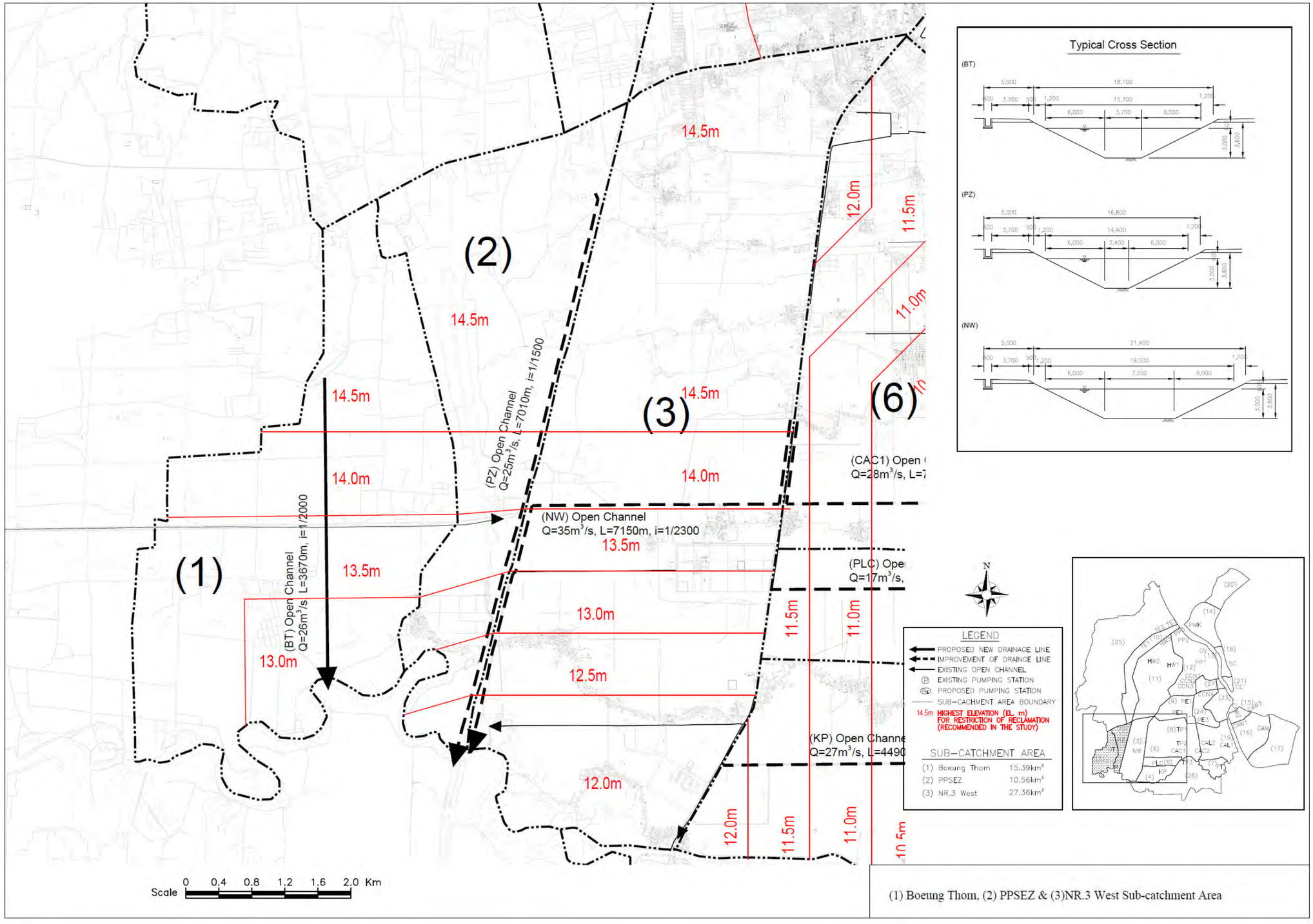
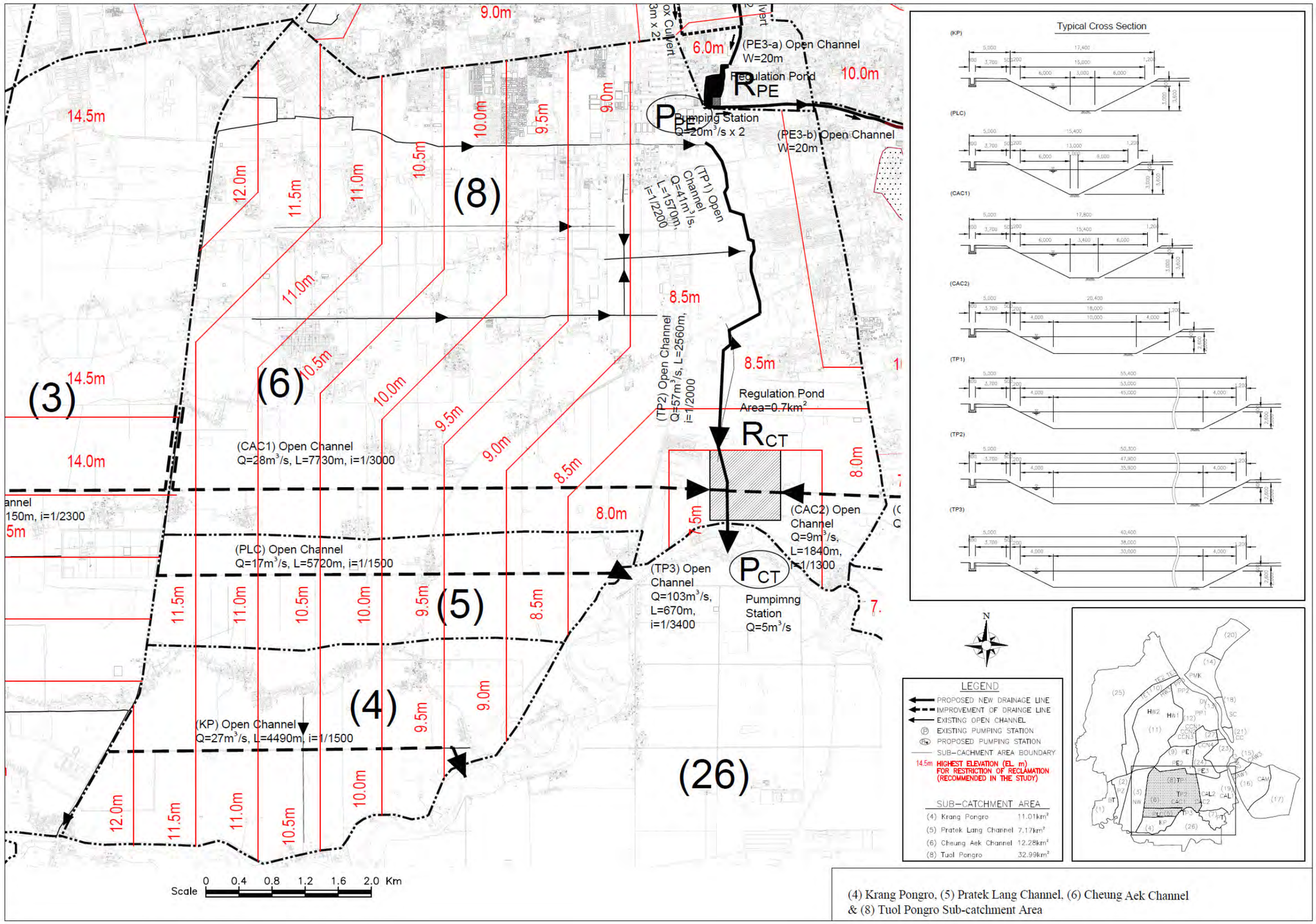
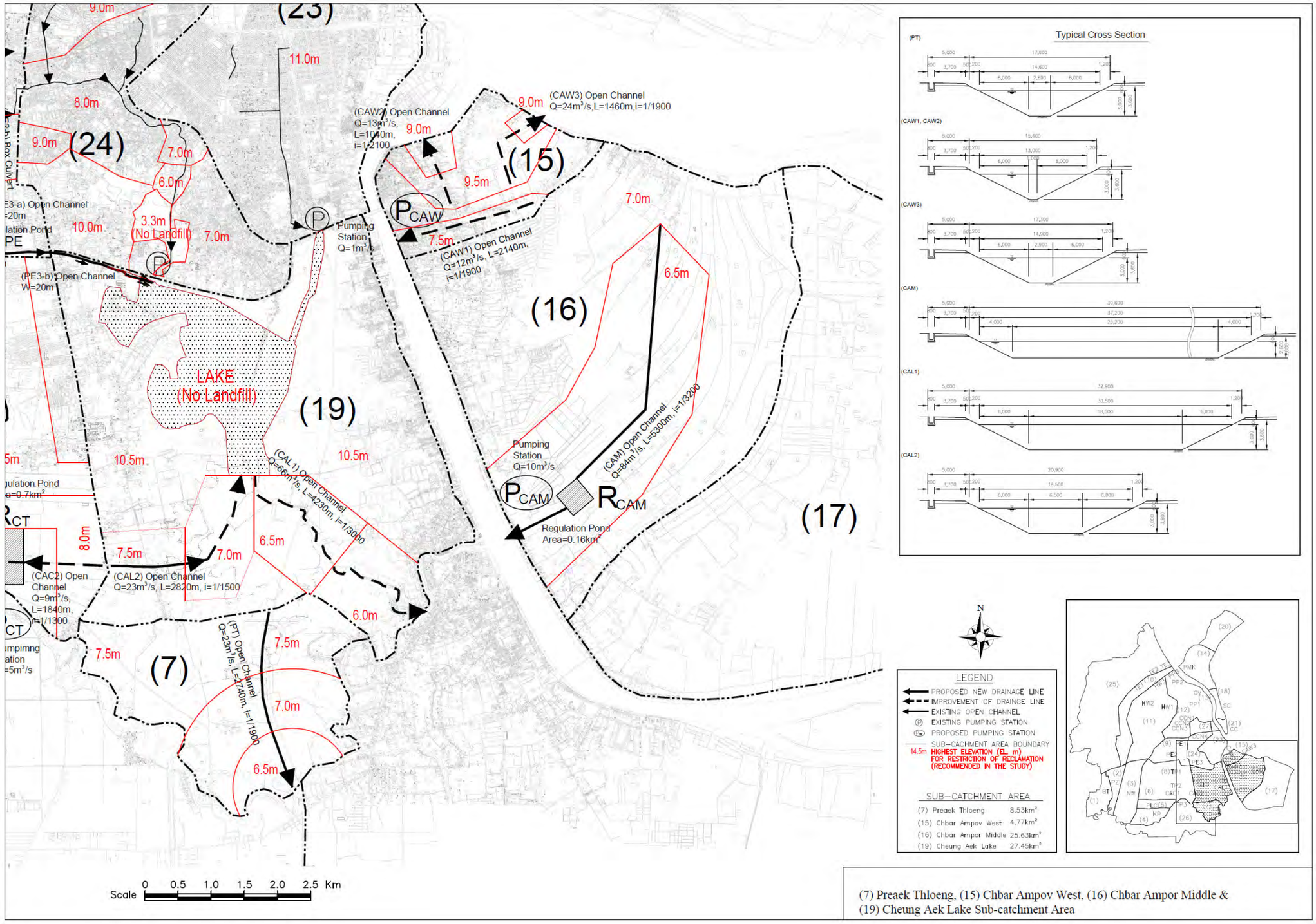
2. DRAINAGE MANAGEMENT



General Map of Drainage Improvement (1/7) (Boeung Thom/PPSEZ/NR. 3 West Drainage Areas) (Including High Elevation for Restriction of Reclamation)

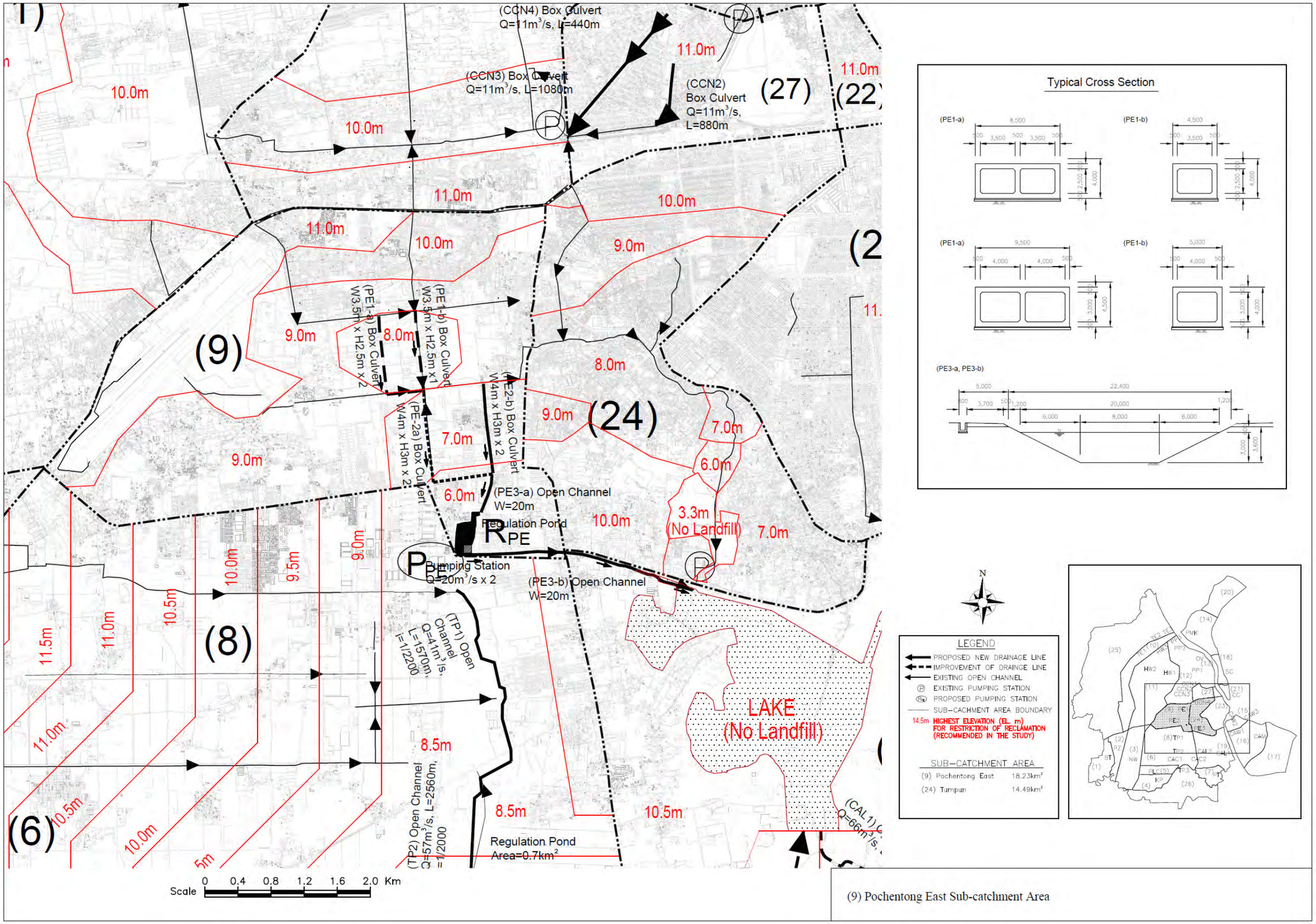


General Map of Drainage Improvement (2/7) (Krang Pongro/Pratek Lang Channel/Tuol Pongro Drainage Areas) (Including High Elevation for Restriction of Reclamation)

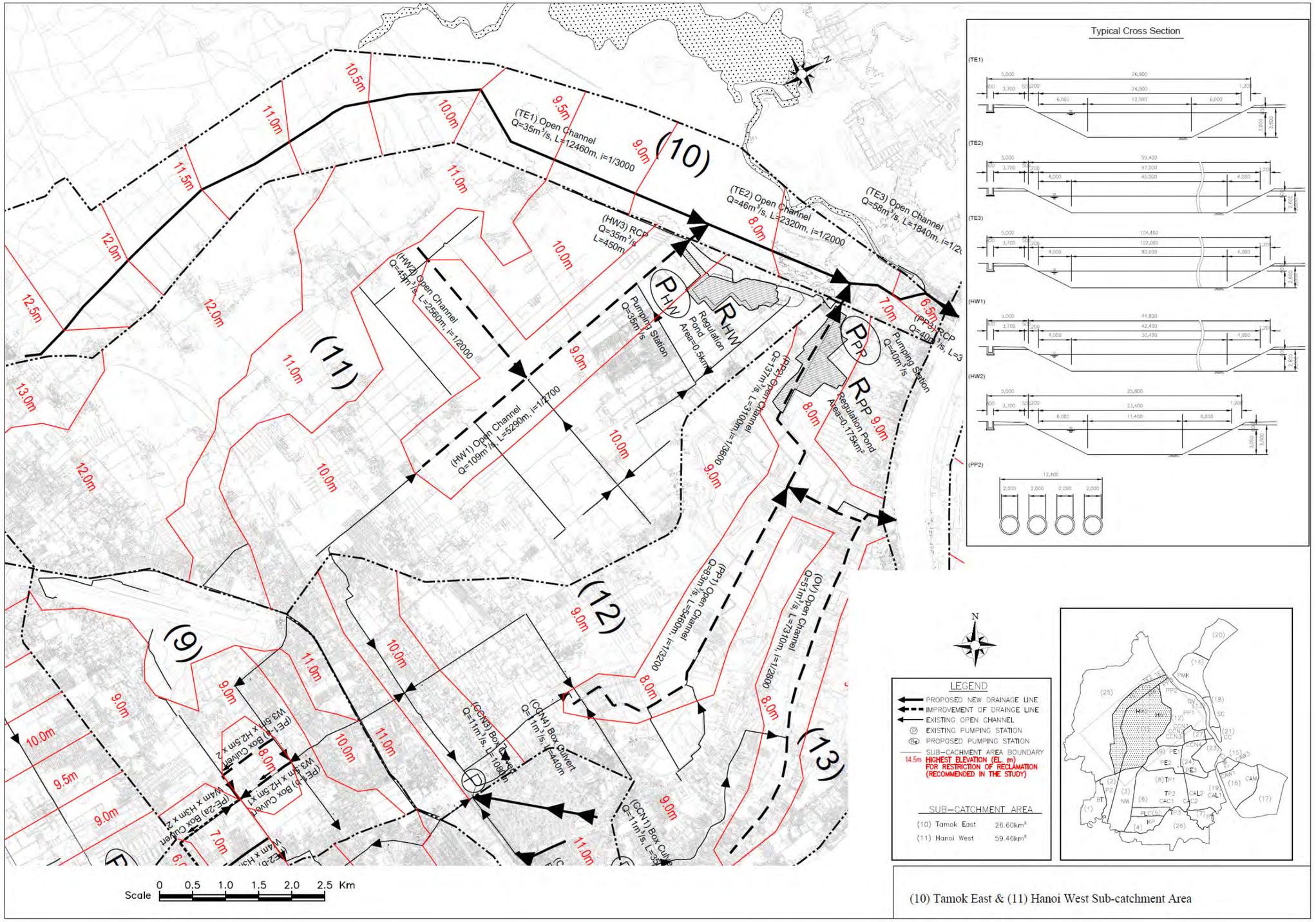


(7) Preaek Thloeng, (15) Chbar Ampov West, (16) Chbar Ampor Middle &
(19) Cheung Aek Lake Sub-catchment Area

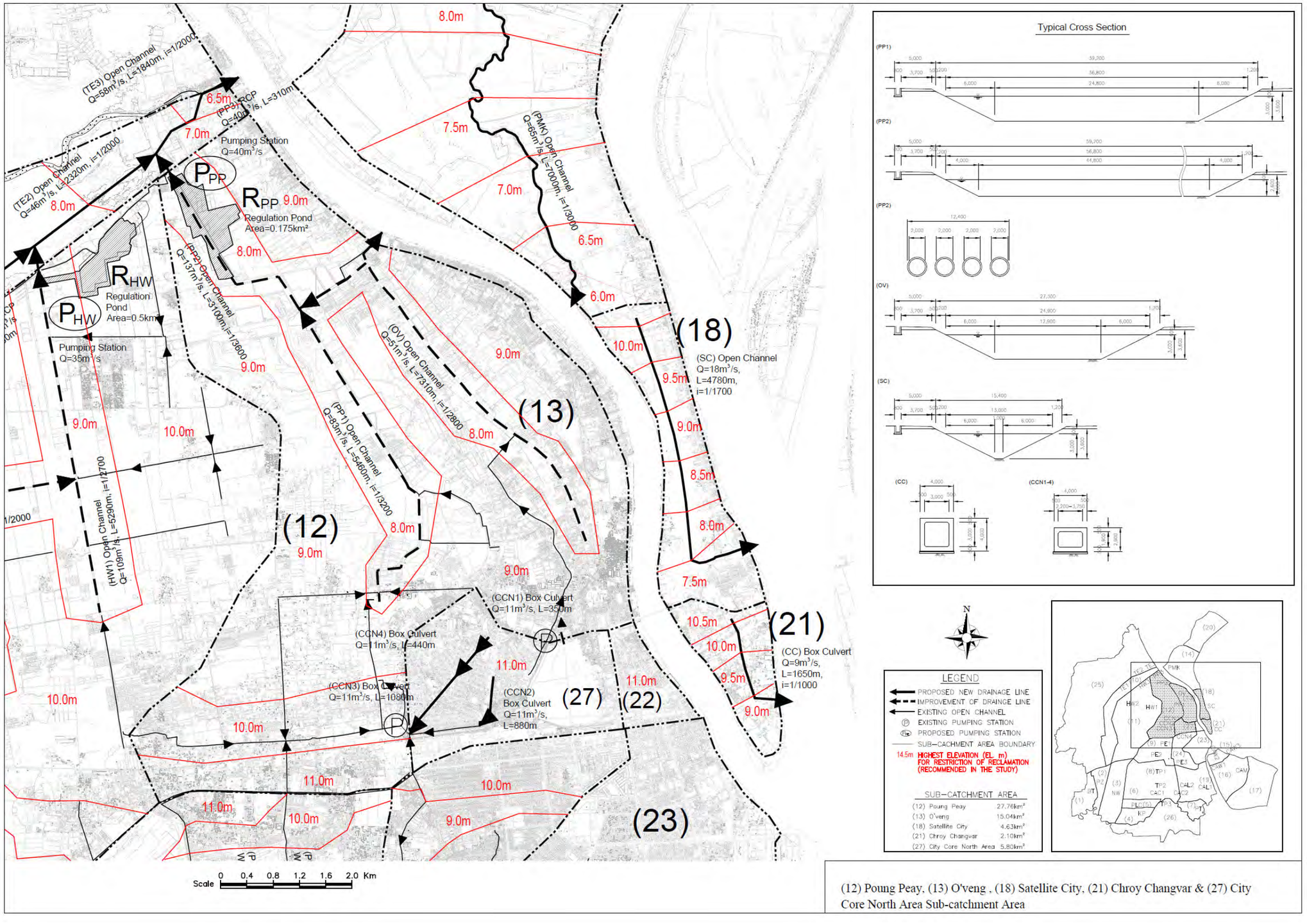
General Map of Drainage Improvement (3/7) (Preaek Thloeng/Chbar Ampov Middle/Cheung Aek Lake Drainage Areas) (Including High Elevation for Restriction of Reclamation)



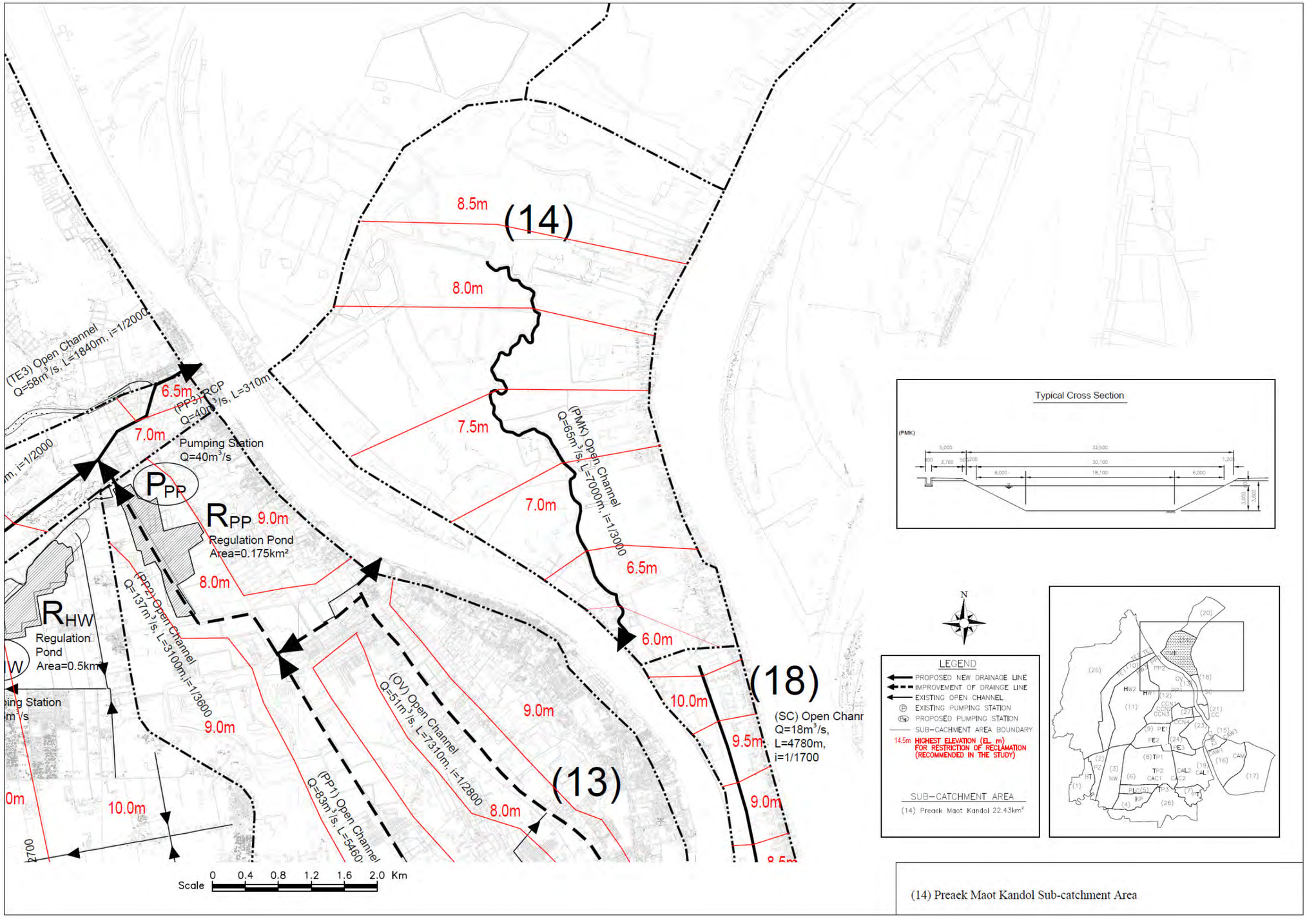
General Map of Drainage Improvement (4/7) (Pochentong East Drainage Area) (Including High Elevation for Restriction of Reclamation)



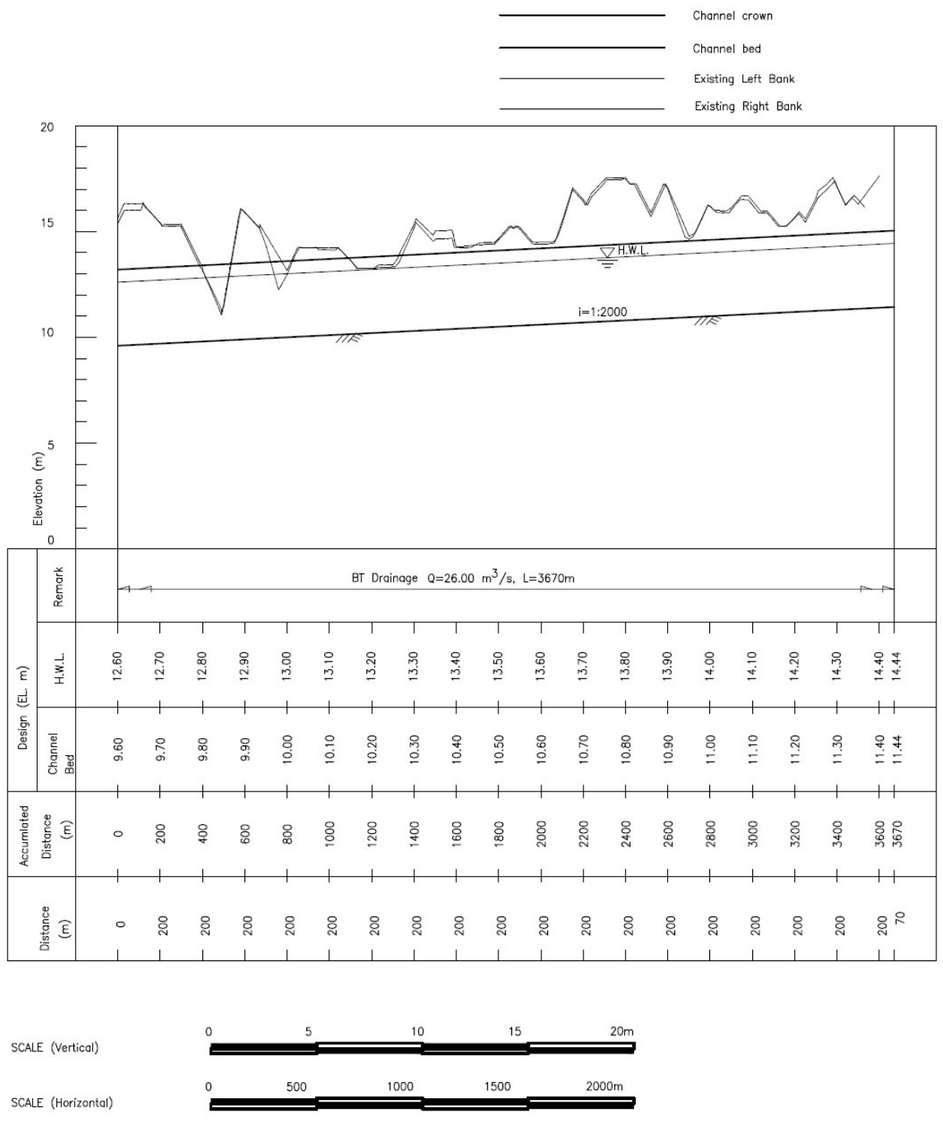
General Map of Drainage Improvement (5/7) (Tamok East/Hanoi West Drainage Areas) (Including High Elevation for Restriction of Reclamation)

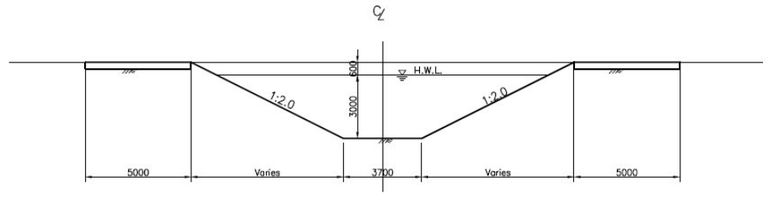


General Map of Drainage Improvement (6/7) (Poung Peay/O'veng/Satellite City/Chroy Changvar/City Core North Area Drainage Areas)
(Including High Elevation for Restriction of Reclamation)

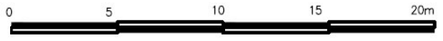


General Map of Drainage Improvement (7/7) (Preaek Moat Kandol DrainageArea) (Including High Elevation for Restriction of Reclamation)

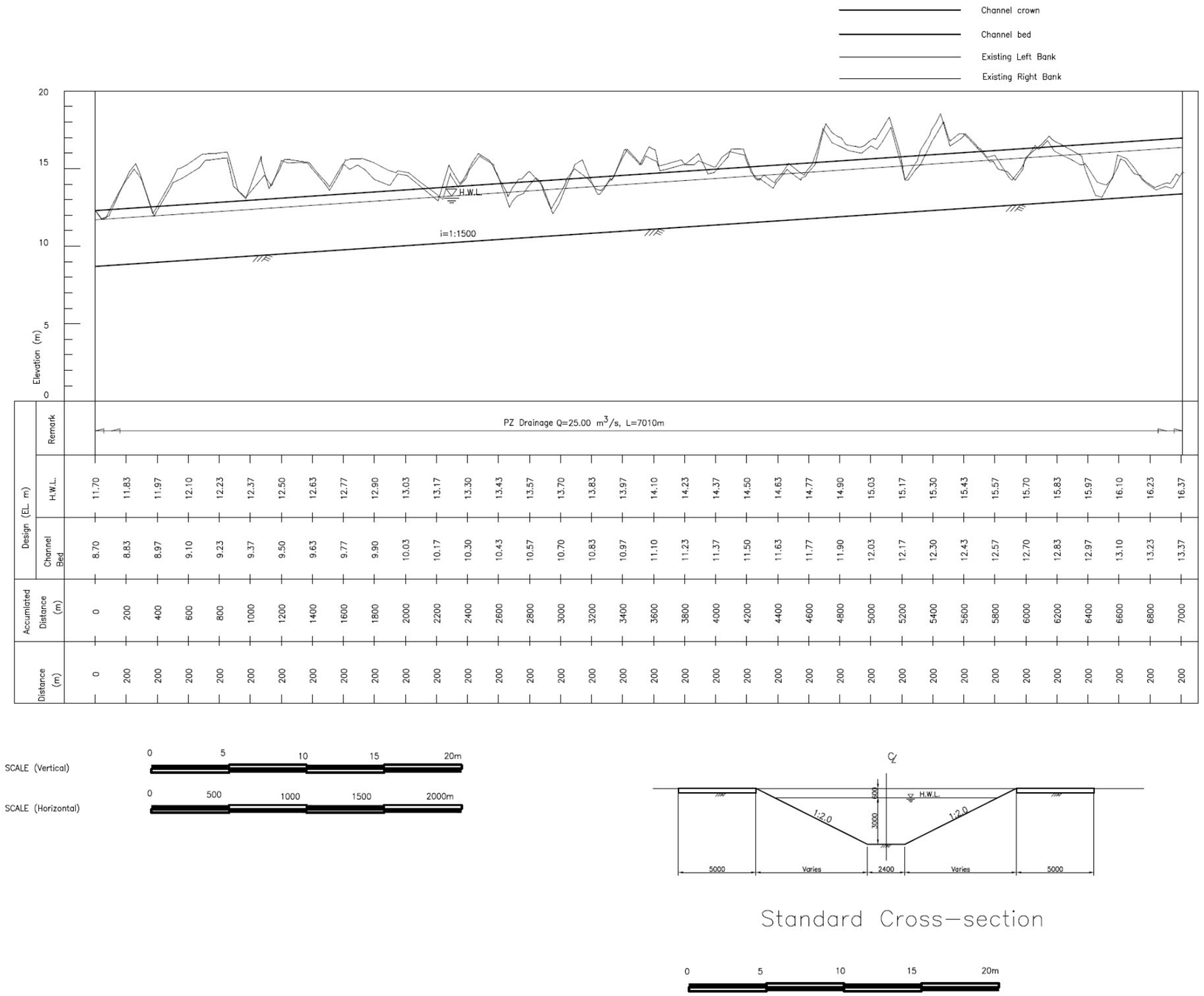




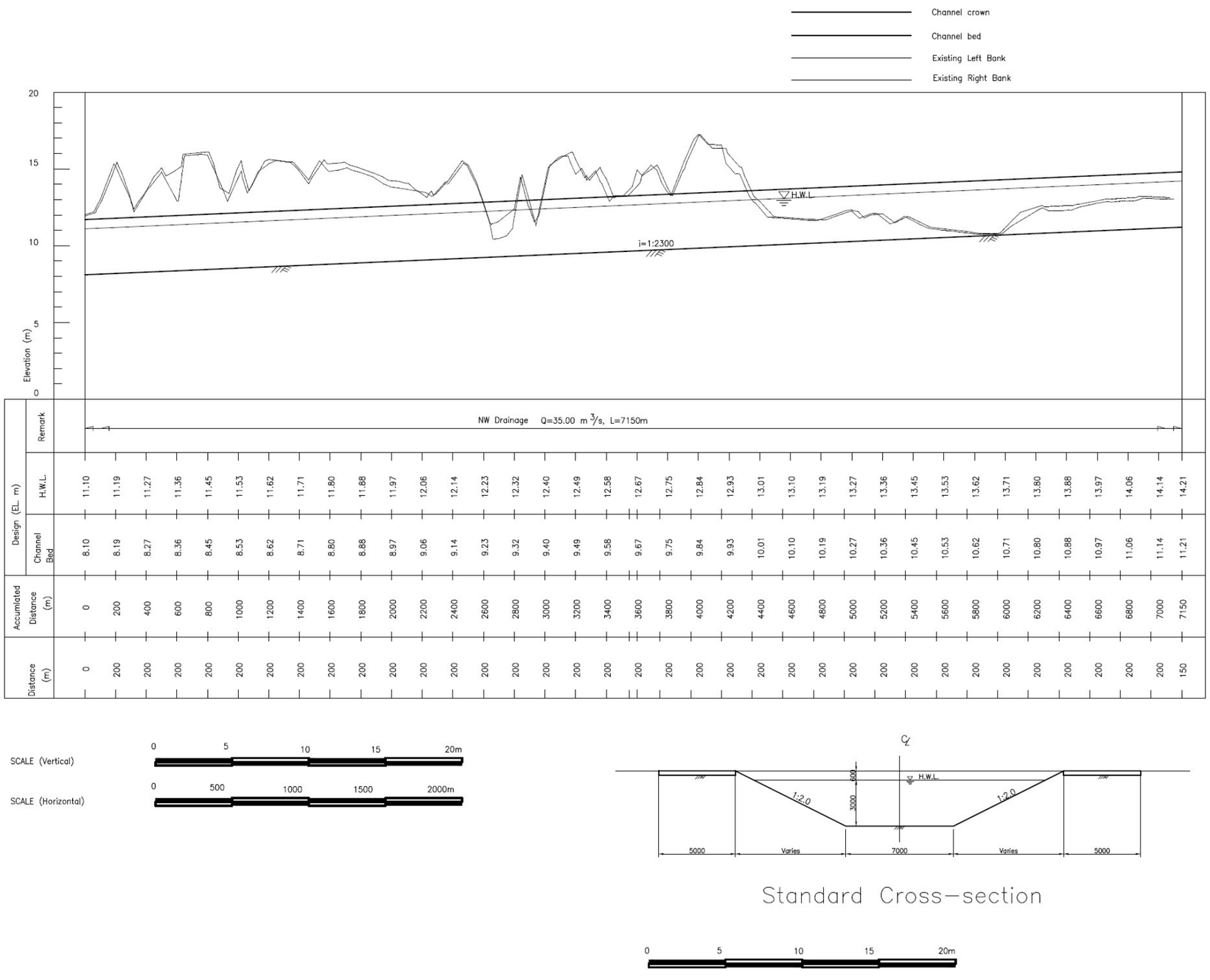
Standard Cross-section



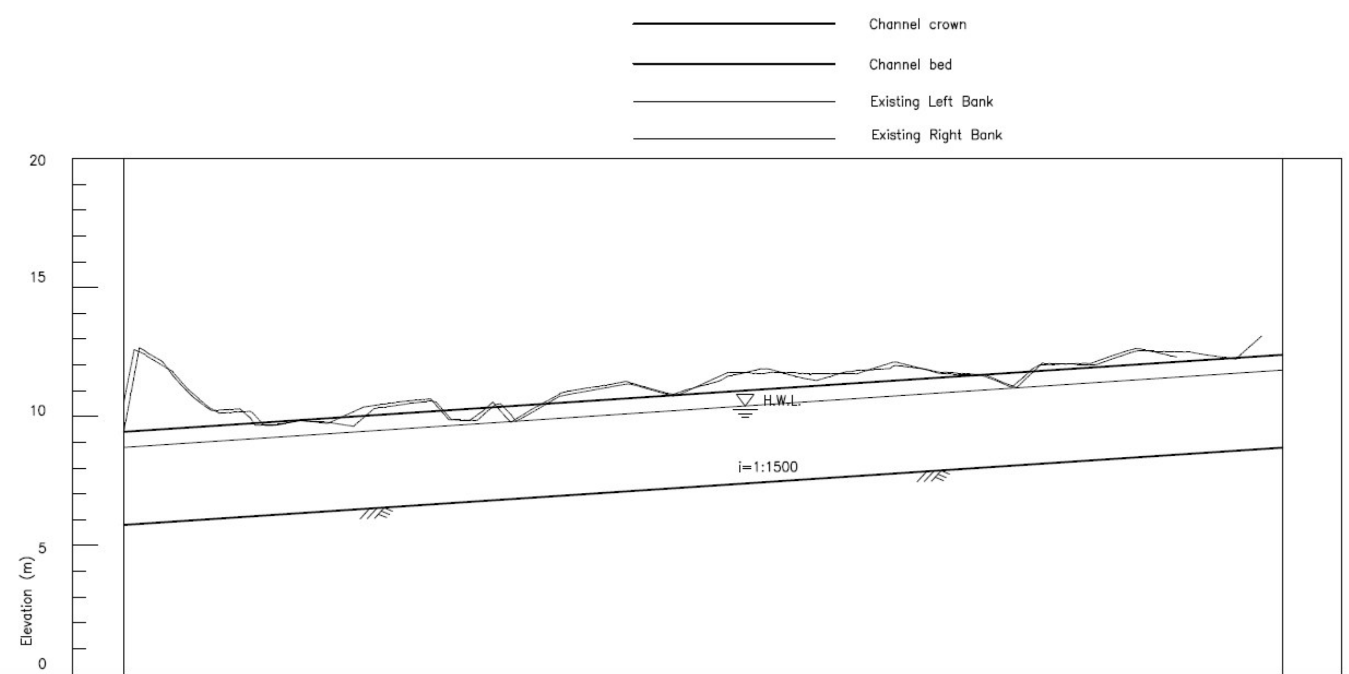
Profile of BT Drainage Channel in (1) Boeung Thom Sub-catchment Area



Profile of PZ Drainage Channel in (2) PPSEZ Sub-catchment Area



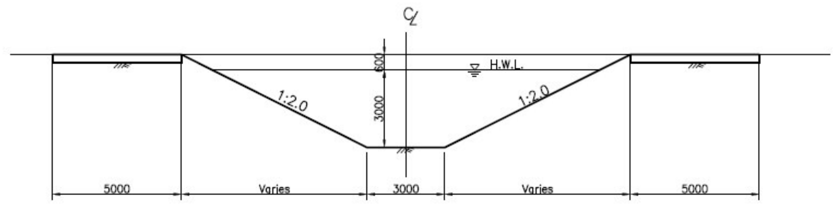
Profile of NW Drainage Channel in (3) NR.3 West Sub-catchment Area



Remark	KP Drainage Q=27.00 m^3/s, L=4490m																						
Design (EL. m) H.W.L.	8.80	8.93	9.07	9.20	9.33	9.47	9.60	9.73	9.87	10.00	10.13	10.27	10.40	10.53	10.67	10.80	10.93	11.07	11.20	11.33	11.47	11.60	11.79
Design (EL. m) Channel Bed	5.80	5.93	6.07	6.20	6.33	6.47	6.60	6.73	6.87	7.00	7.13	7.27	7.40	7.53	7.67	7.80	7.93	8.07	8.20	8.33	8.47	8.60	8.79
Accumlated Distance (m)	0	200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600	2800	3000	3200	3400	3600	3800	4000	4200	4490
Distance (m)	0	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	200	290

SCALE (Vertical) 0 5 10 15 20m

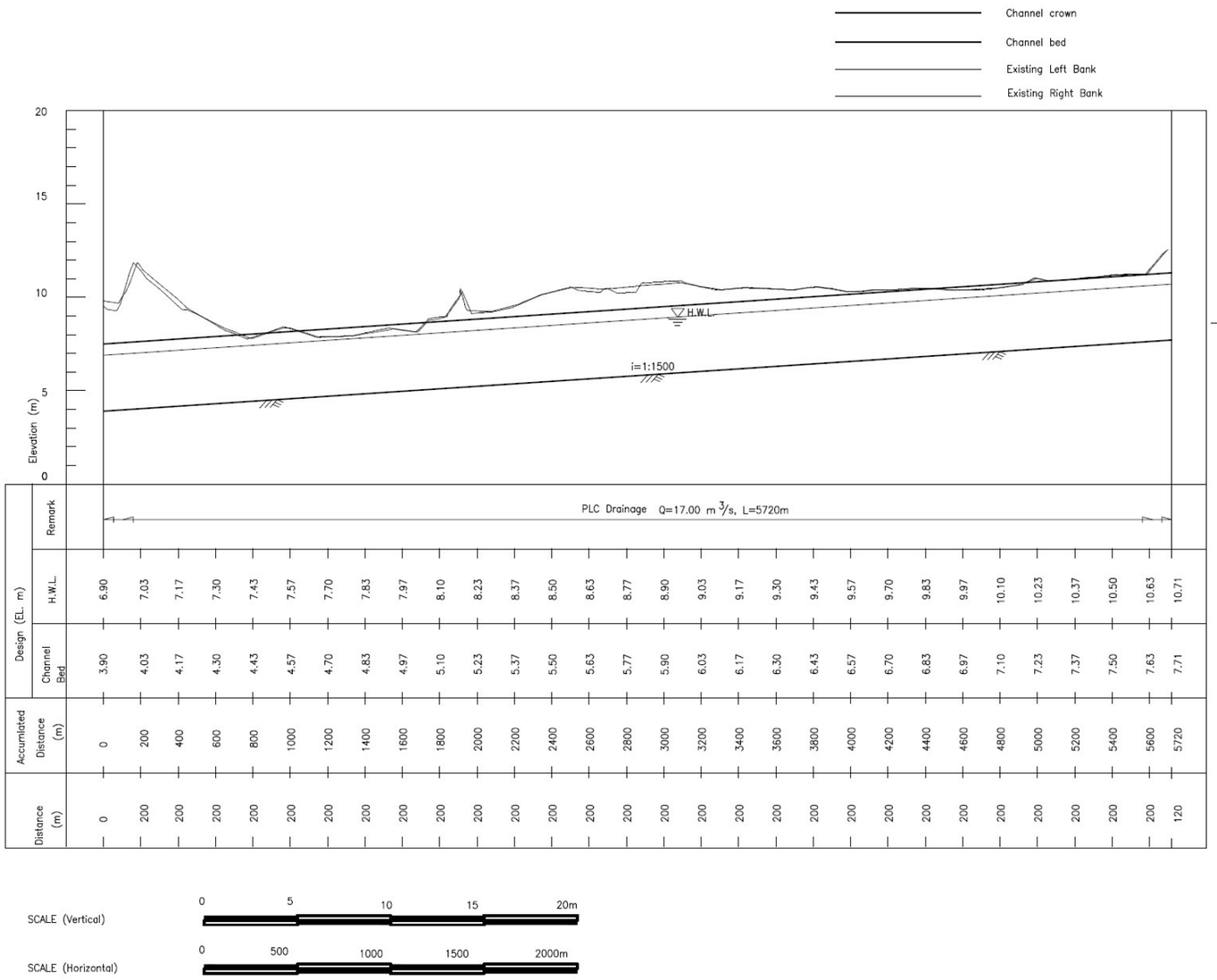
SCALE (Horizontal) 0 500 1000 1500 2000m

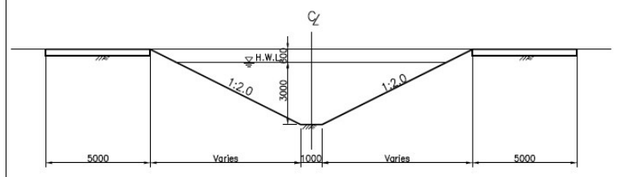


Standard Cross-section

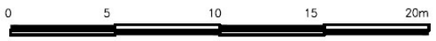
0 5 10 15 20m

Profile of KP Drainage Channel in (4) Krang Pongro Sub-catchment Area

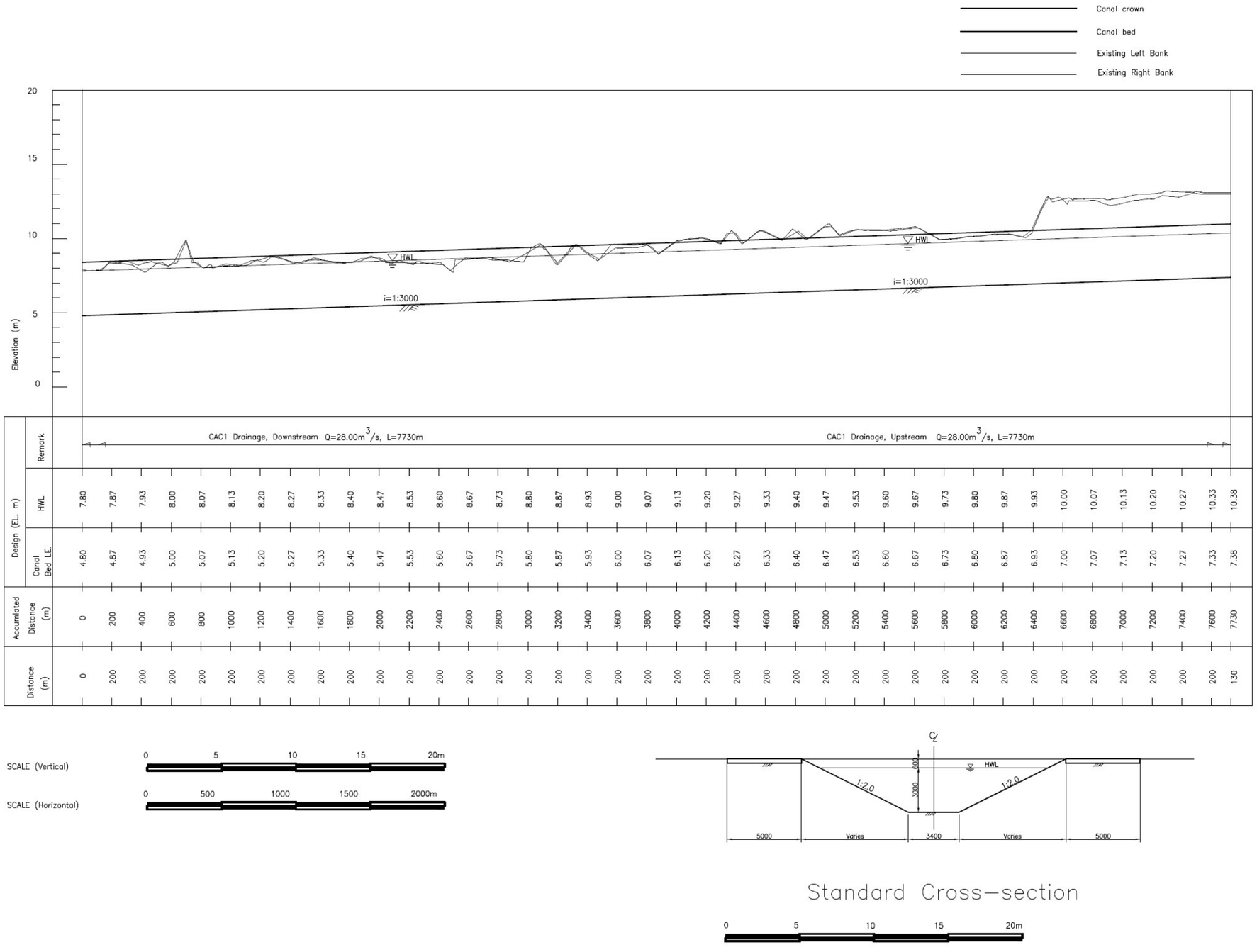




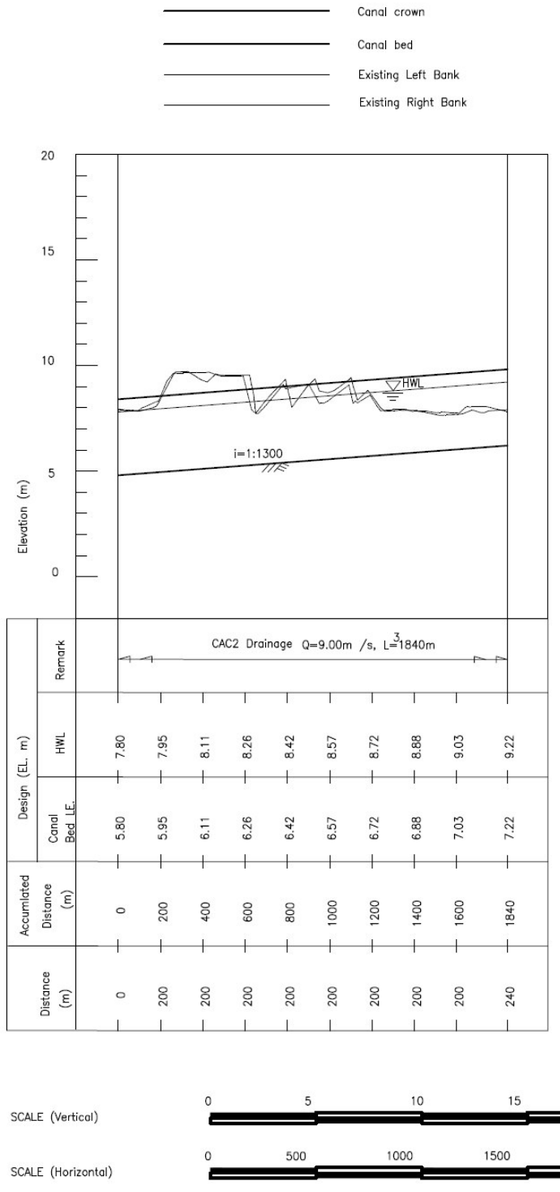
Standard Cross-section

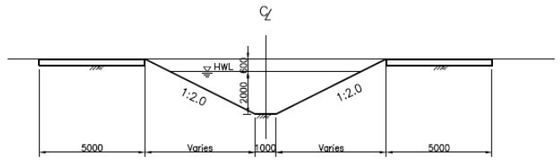


Profile of PLC Drainage Channel in (5) Pratek Lang Sub-catchment Area



Profile of CAC1 Drainage Channel in (6) Cheung Aek Channel Sub-catchment Area

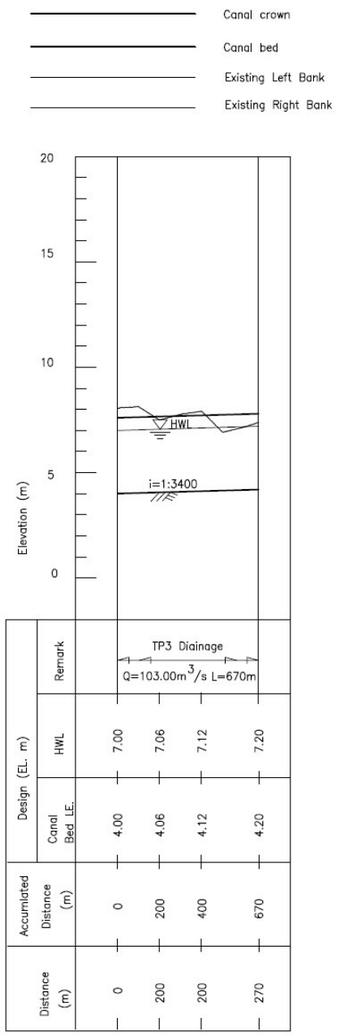


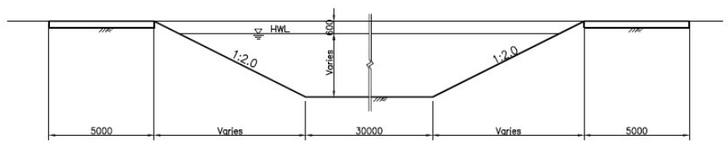


Standard Cross-section

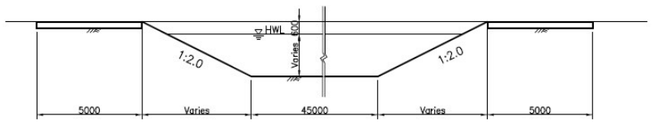
0 5 10 15 20m

Profile of CAC2 Drainage Channel in (6) Cheung Aek Channel Sub-catchment Area

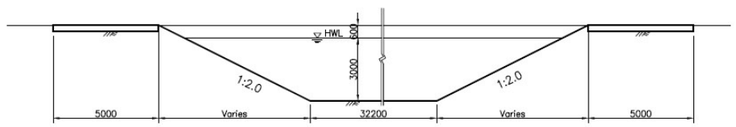




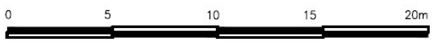
TP1 Standard Cross-section

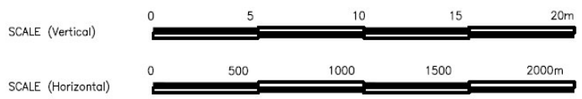


TP2 Standard Cross-section

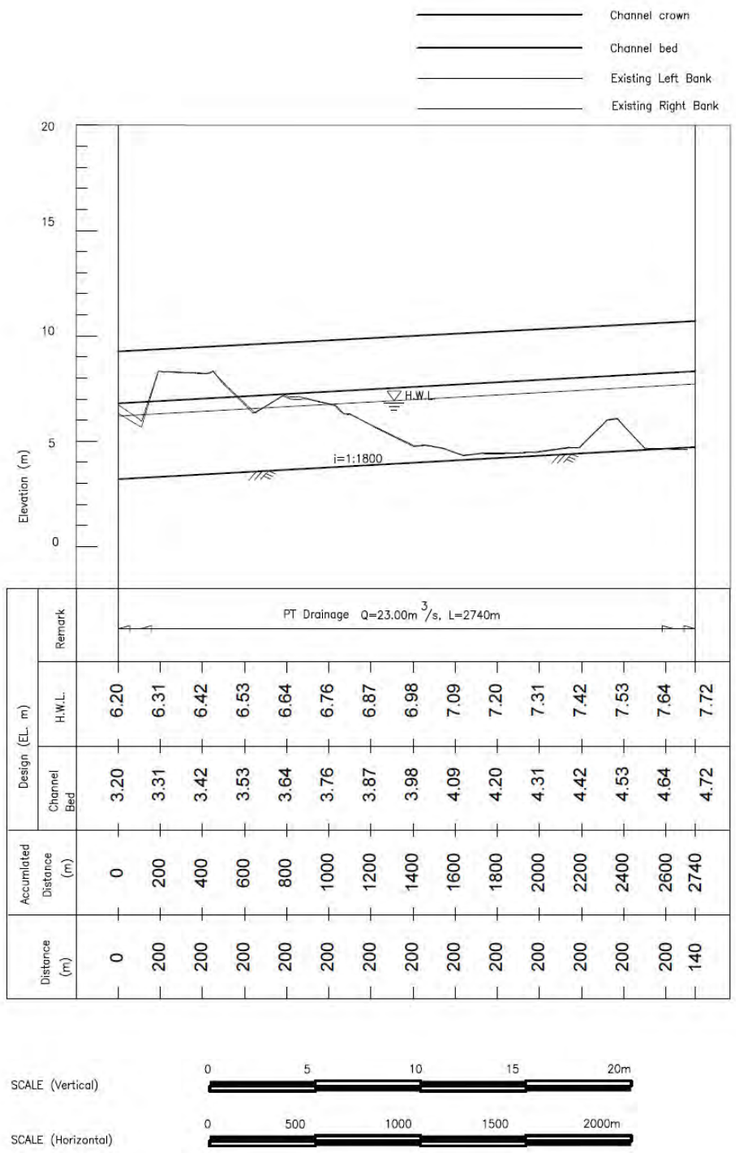


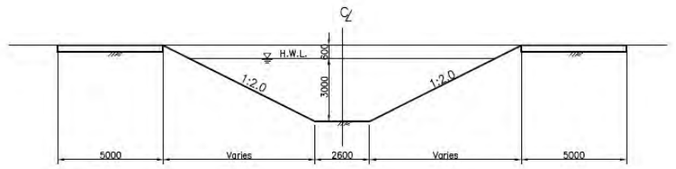
TP3 Standard Cross-section



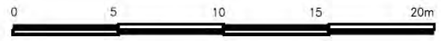


Profile of TP3 Drainage Channel in (8) Tuol Pongro Sub-Catchment Area

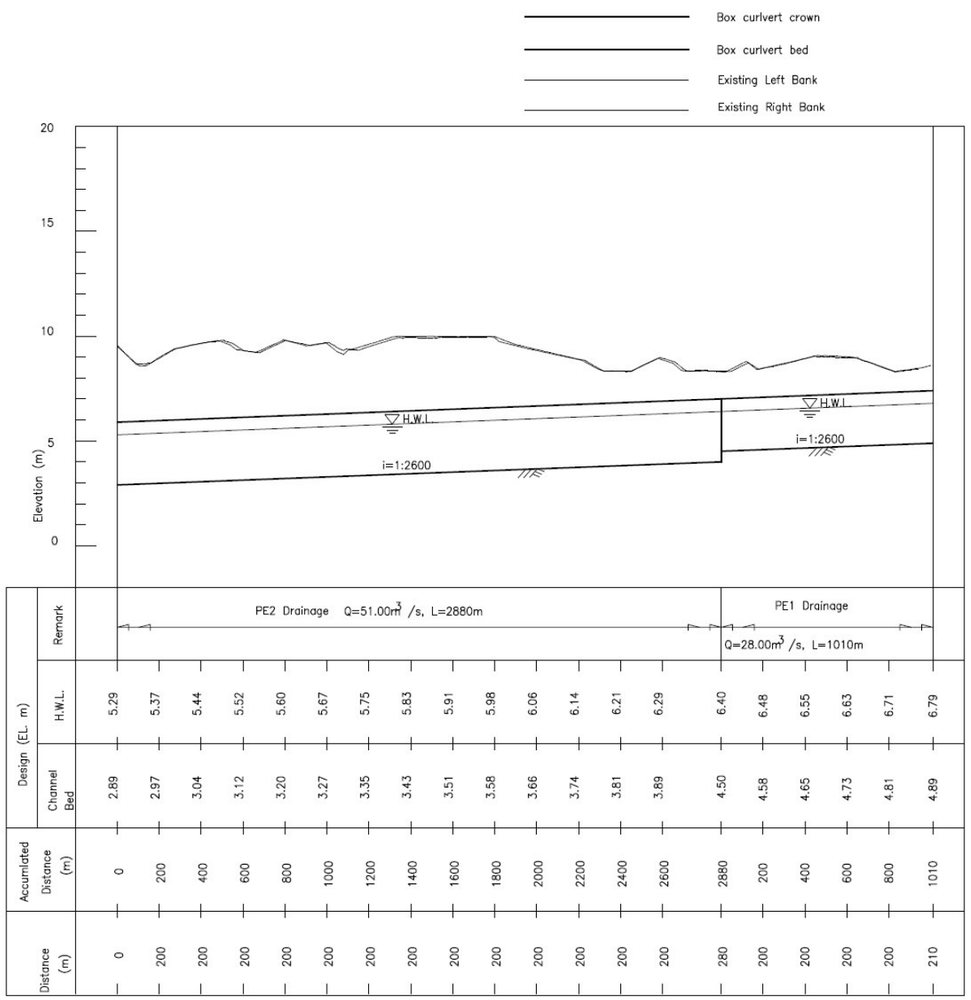


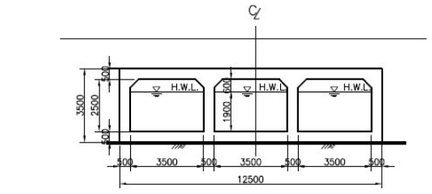


Standard Cross-section

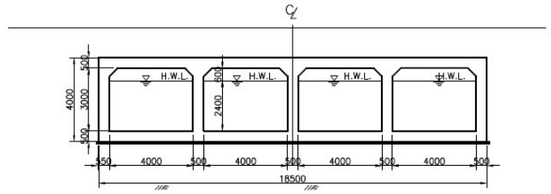


ProfileProfile of PT Drainage Channel in (7) Preaek Thloeung Sub-catchment Area



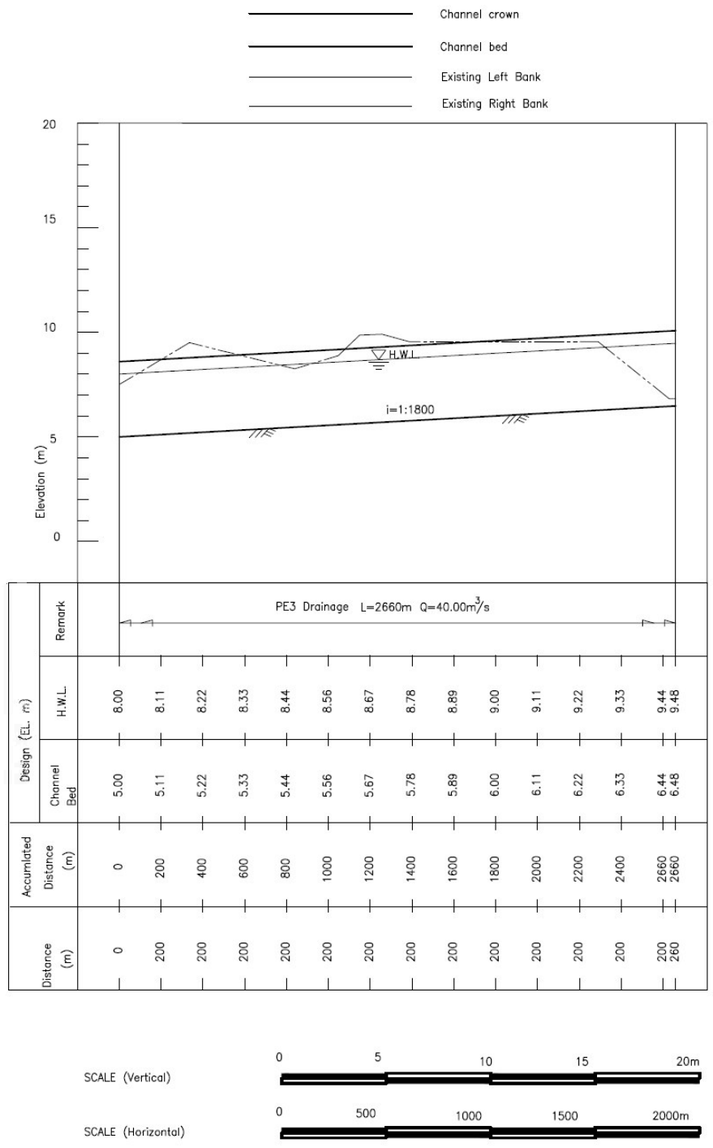


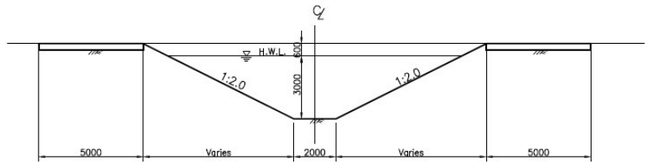
PE1 Standard Cross-section



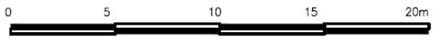
PE2 Standard Cross-section

Profile of PE1 &PE2 Drainage Box-Culvert in (9) Pochentong East Sub-catchment Area

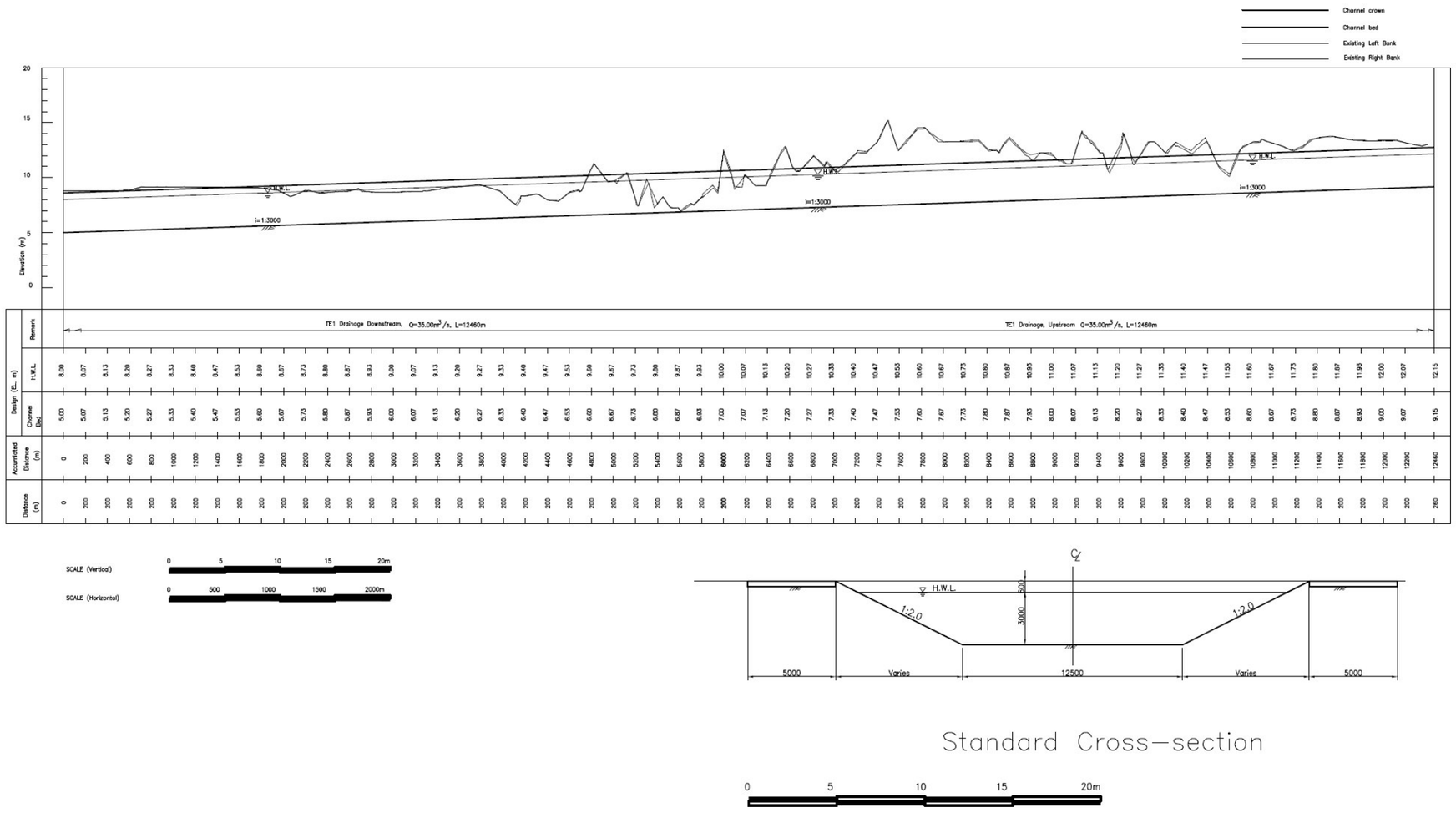




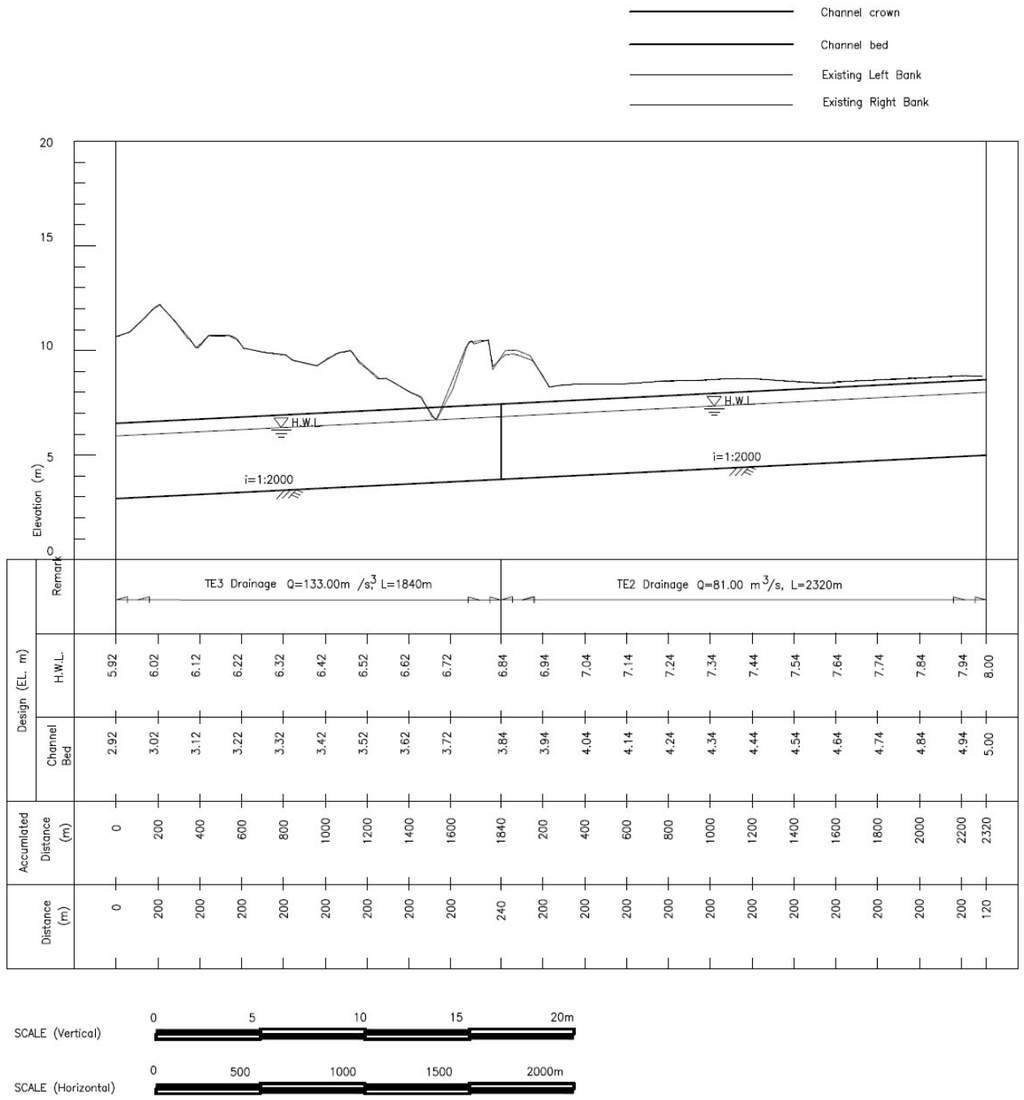
PE3 Standard Cross-section

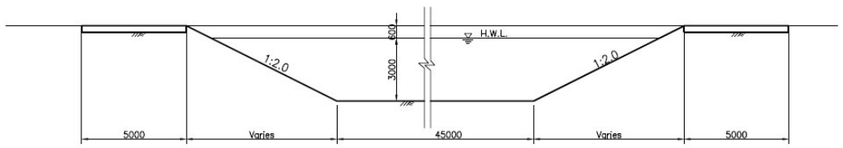


Profile of PE3 Drainage Channel in (9) Pochentong East Sub-catchment Area

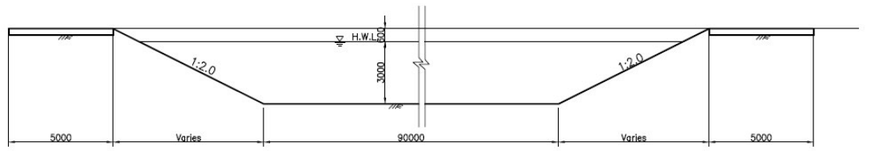


Profile of TE1 Drainage Channel in (10) Tamok East Sub-catchment Area

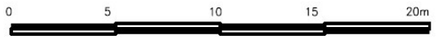




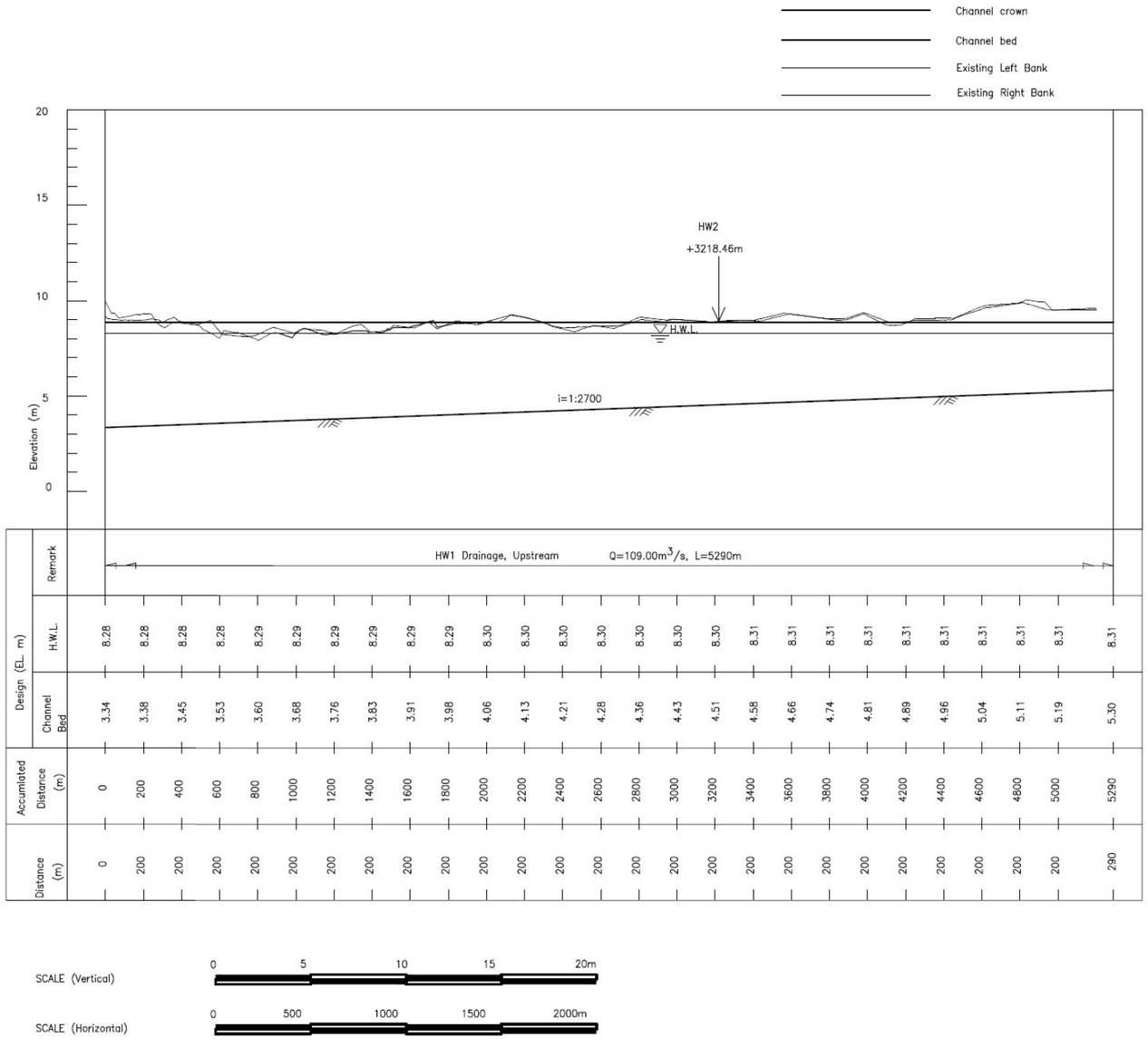
TE2 Standard Cross-section

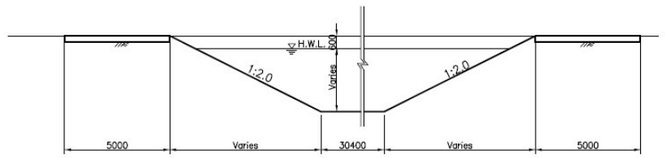


TE3 Standard Cross-section

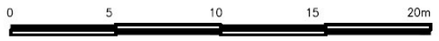


Profile of TE2 & TE3 Drainage Drainage in (10) Tamok East Sub-catchment Area

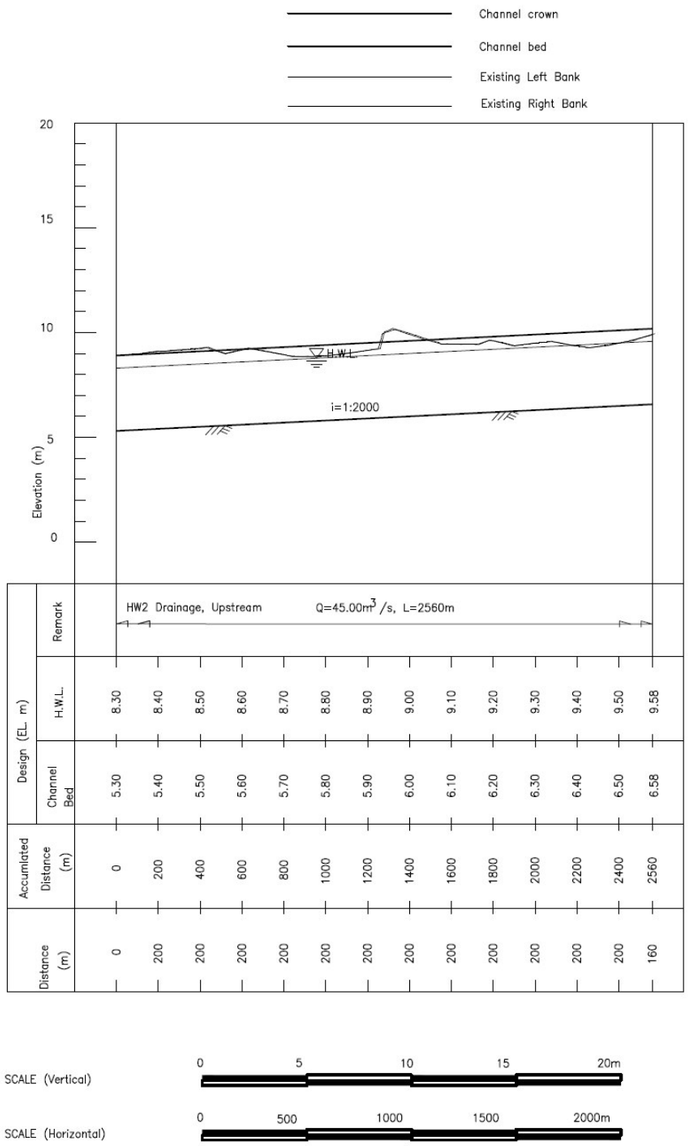


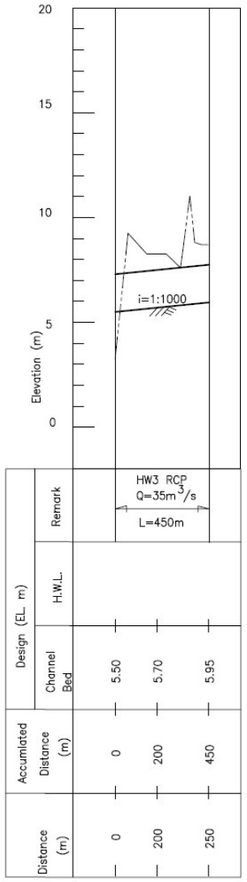


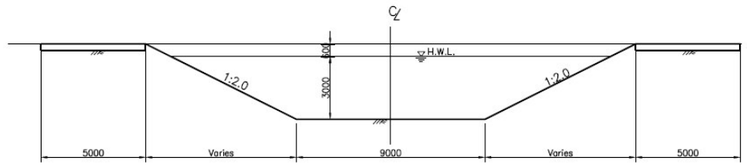
Standard Cross-section



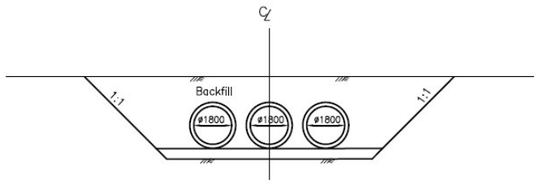
Profile of HW1 Drainage Channel in (11) Hanoi West Sub-catchment Area



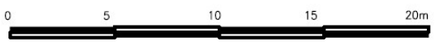




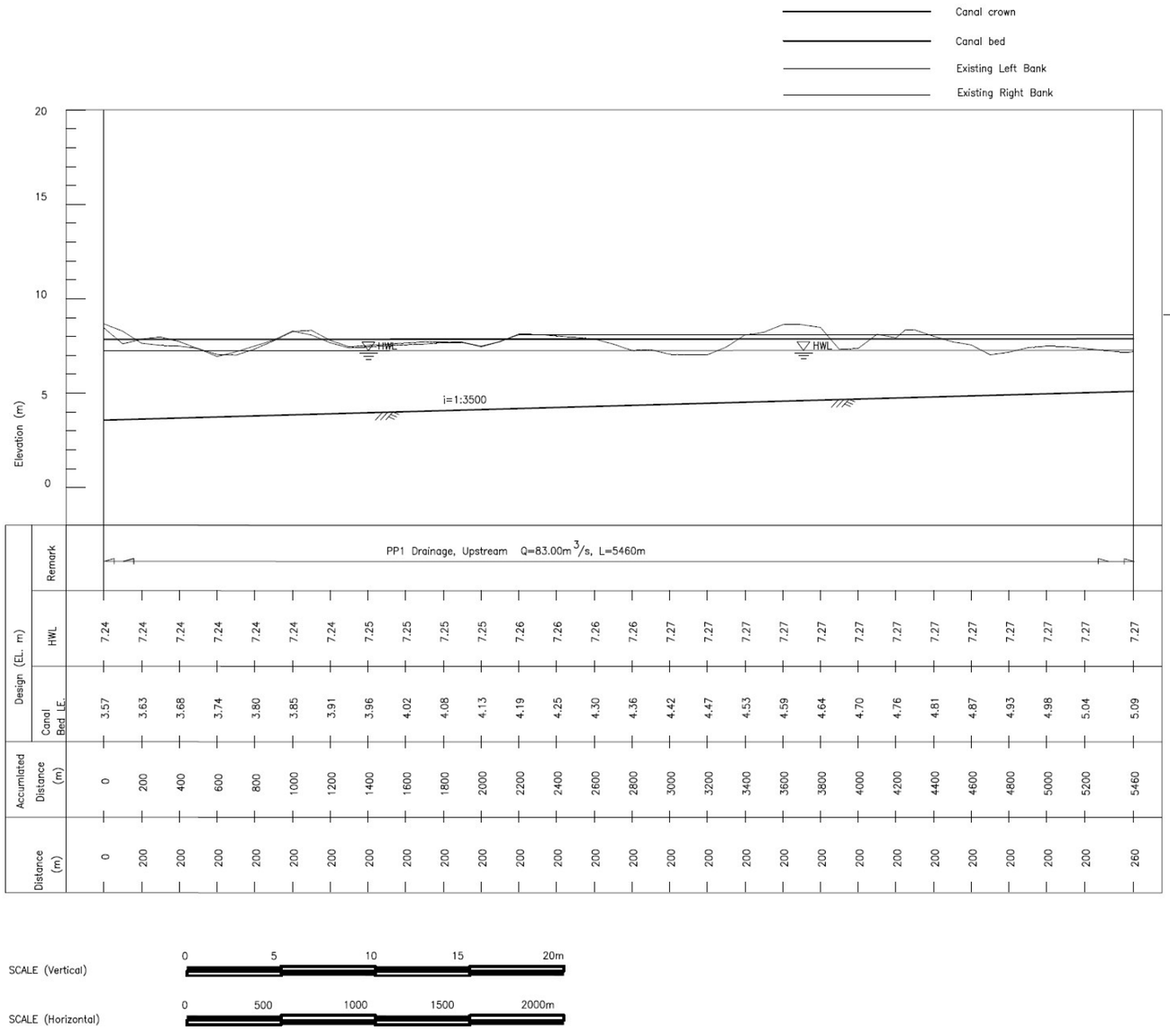
HW2 Standard Cross-section

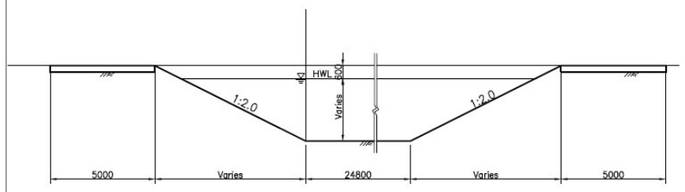


HW3 Standard Cross-section

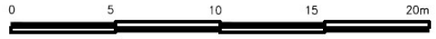


Profile of HW2 & HW3 Drainage Channel in (11) Hanoi West Sub-catchment Area

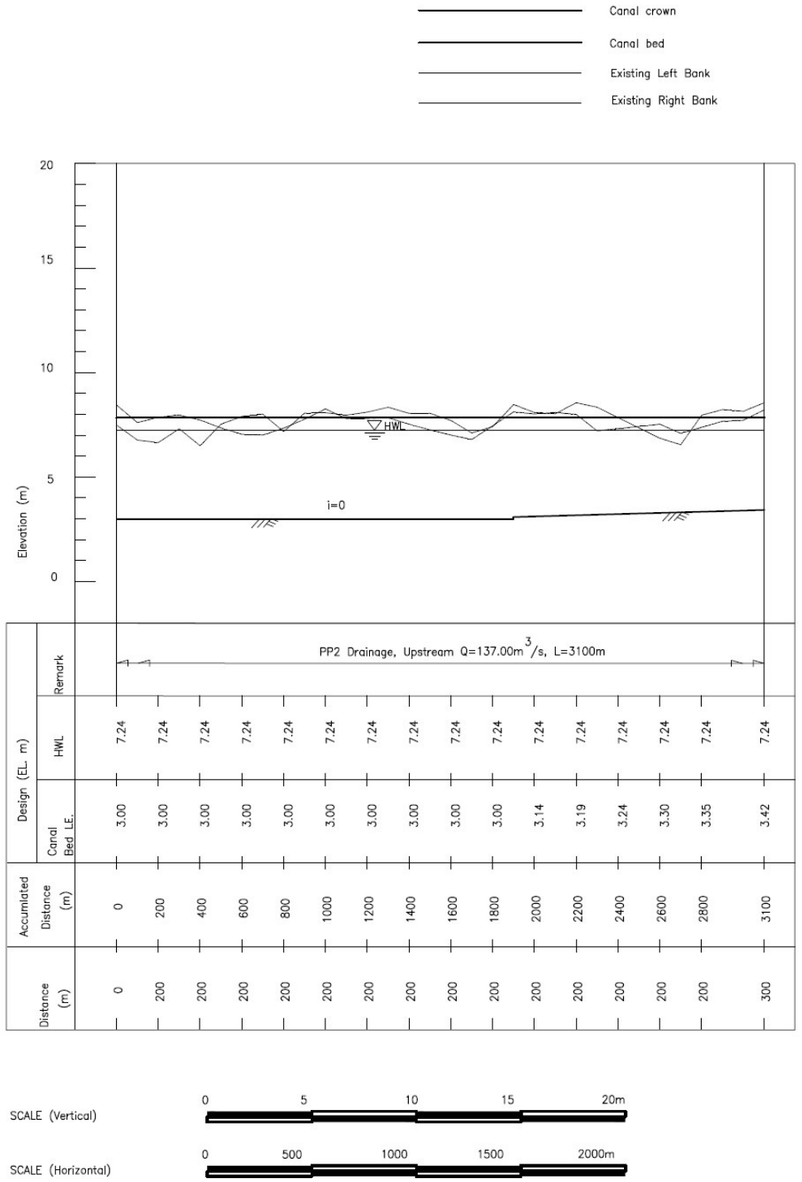


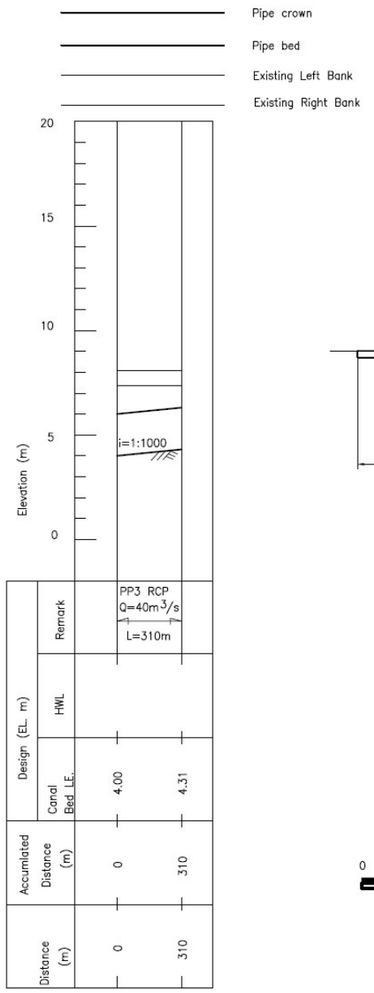


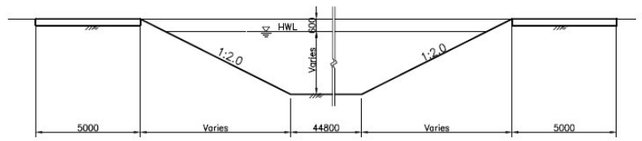
Standard Cross–section



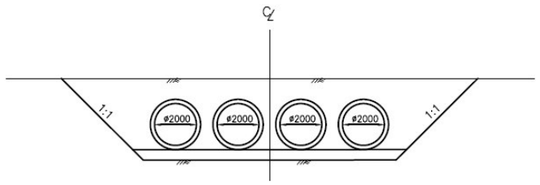
Profile of PP1 Drainage Channel in (12) Poung Peay Sub-catchment Area



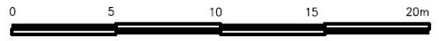




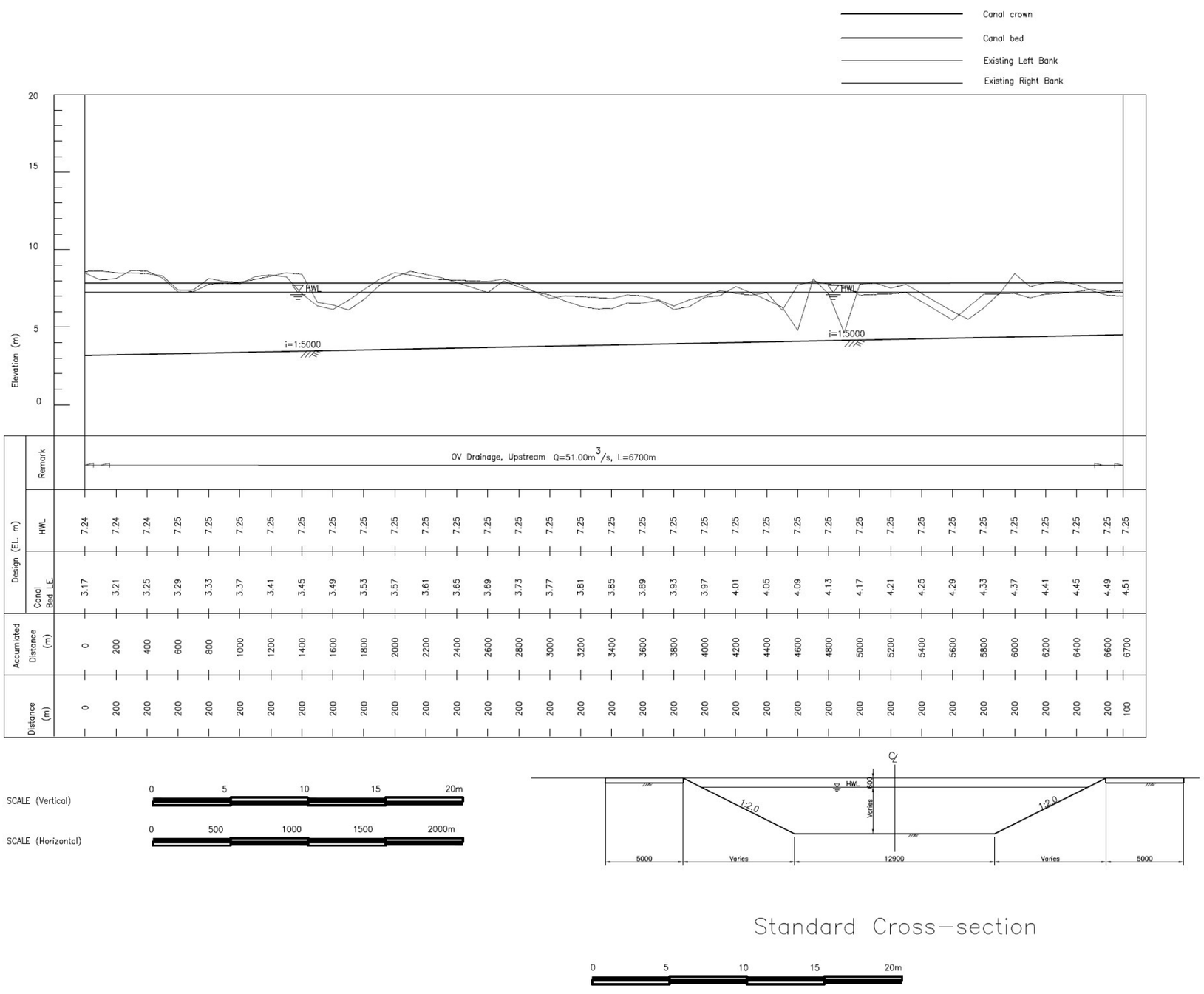
PP2 Standard Cross-section



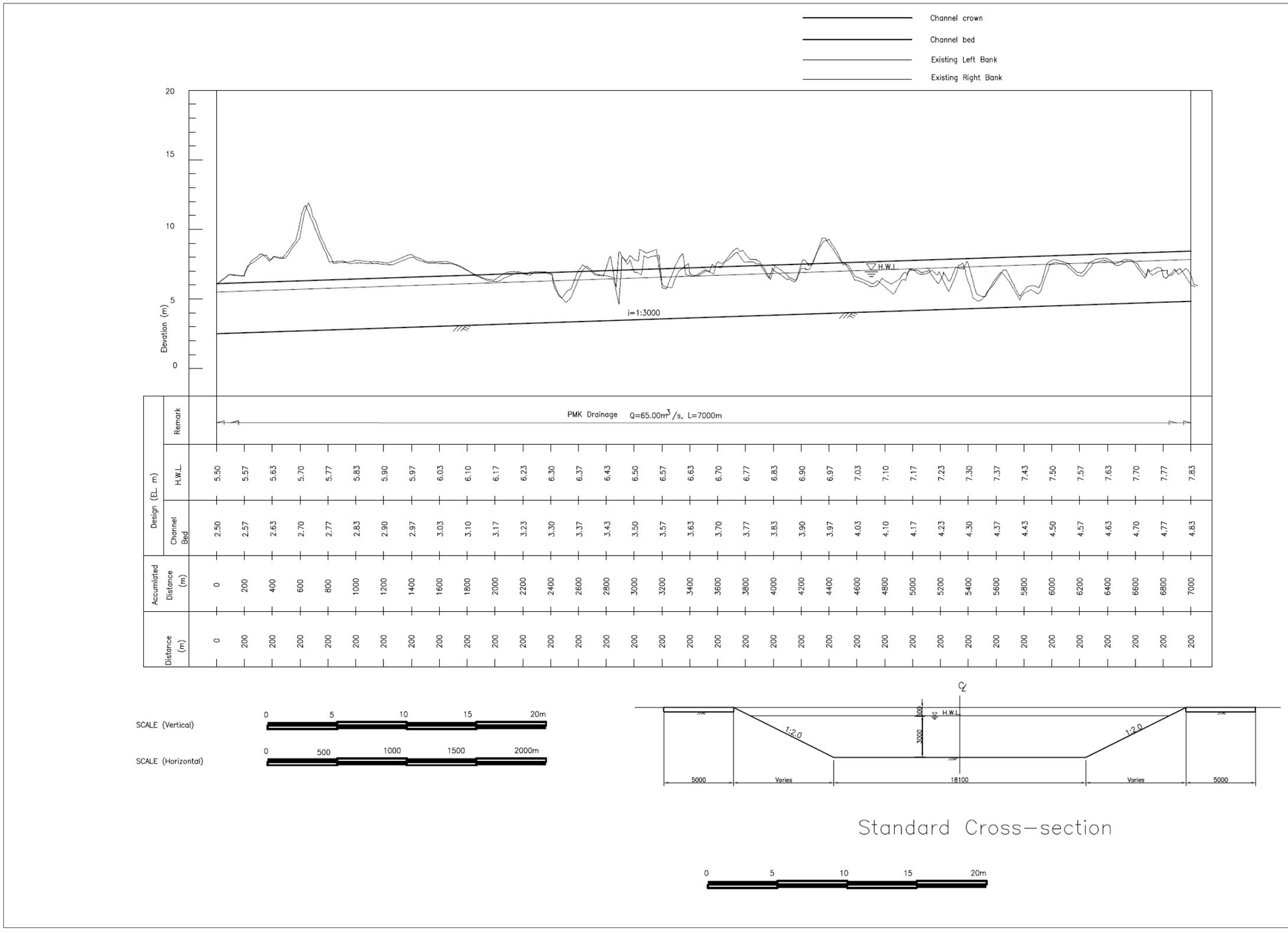
PP3 Standard Cross-section



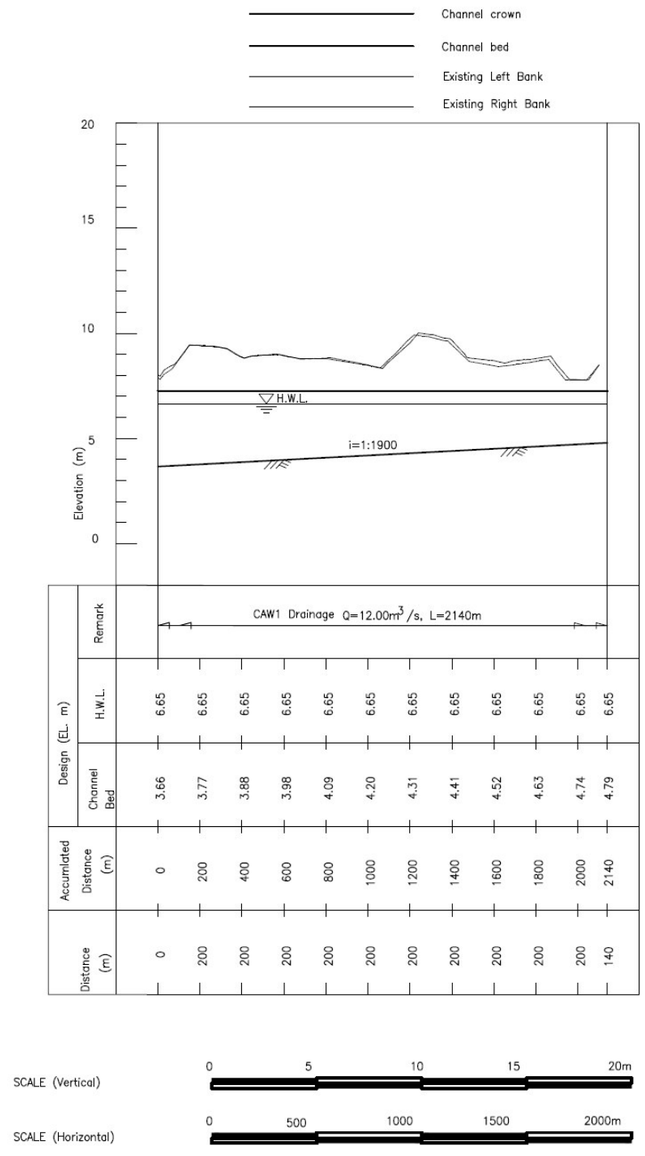
Profile of PP2 & PP3 Drainage Channel in (12) Poung Peay Sub-catchment Area



Profile of OV Drainage Channel in (13) O'veng Sub-catchment Area



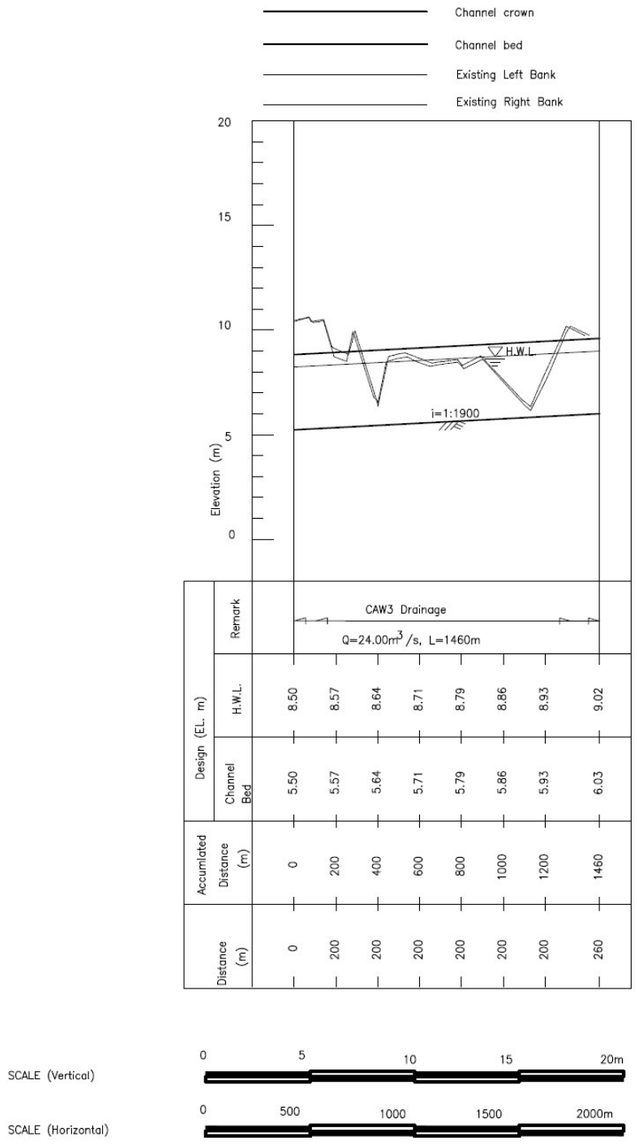
Profile of PMK Drainage Channel in (14) Preak Maot Kandol Sub-catchment Area

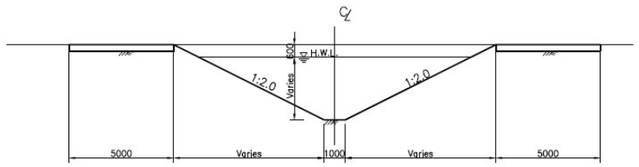


Distance (m)		0	200	200	200	200	200	200	200	200	200	200	200	140
Accumulated Distance (m)		0	200	400	600	800	1000	1200	1400	1600	1800	2000	2140	
Design (EL. m)	Channel Bed	3.66	3.77	3.88	3.98	4.09	4.20	4.31	4.41	4.52	4.63	4.74	4.79	
	H.W.L.	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	6.65	
Remark														

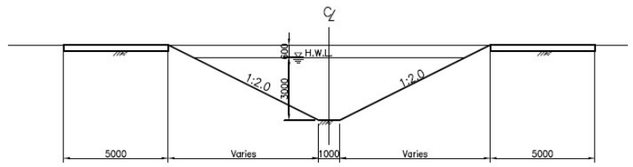
Distance (m)		0	200	200	200	200	200	240
Accumulated Distance (m)		0	200	400	600	800	1040	
Design (EL. m)	Channel Bed	5.50	5.60	5.69	5.79	5.88	6.00	
	H.W.L.	8.50	8.60	8.69	8.79	8.88	9.00	
Remark								

Profile of CAW1 & CAW2 Drainage Channel in (15) Chbar Ampov West Sub-catchment Area





CAW1 Standard Cross-section



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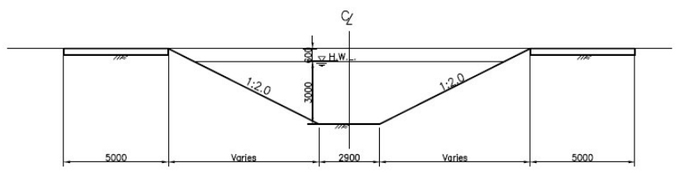
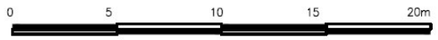
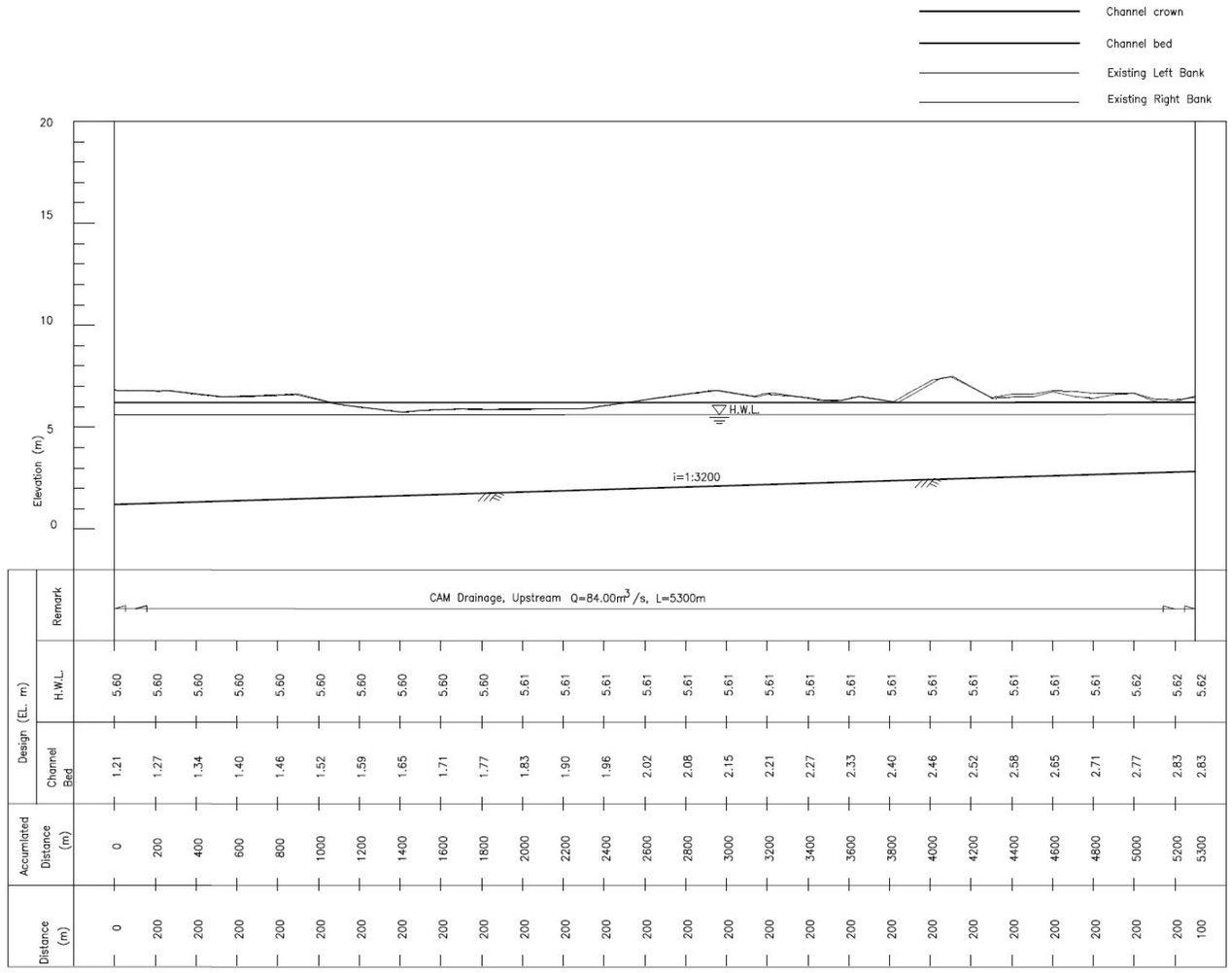
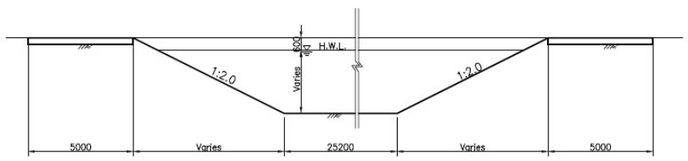


CAW3 Standard Cross-section



Profile of CAW3 Drainage Channel in (15) Chbar Ampov West Sub-catchment Area





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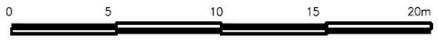
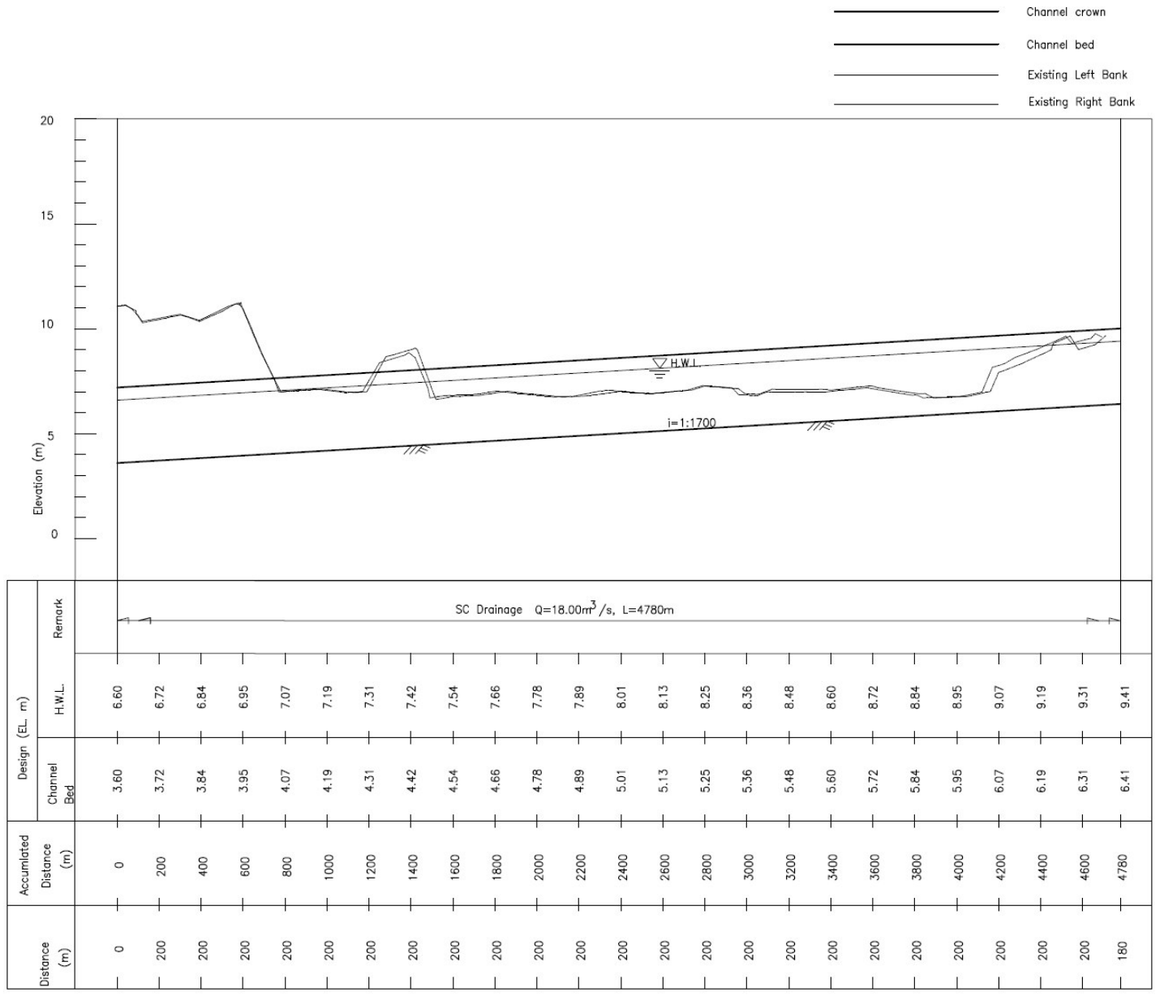
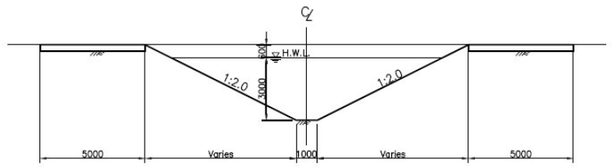


Profile of CAM Drainage Channel in (16) Chbar Ampov Middle Sub-catchment Area





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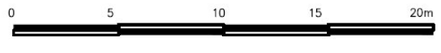
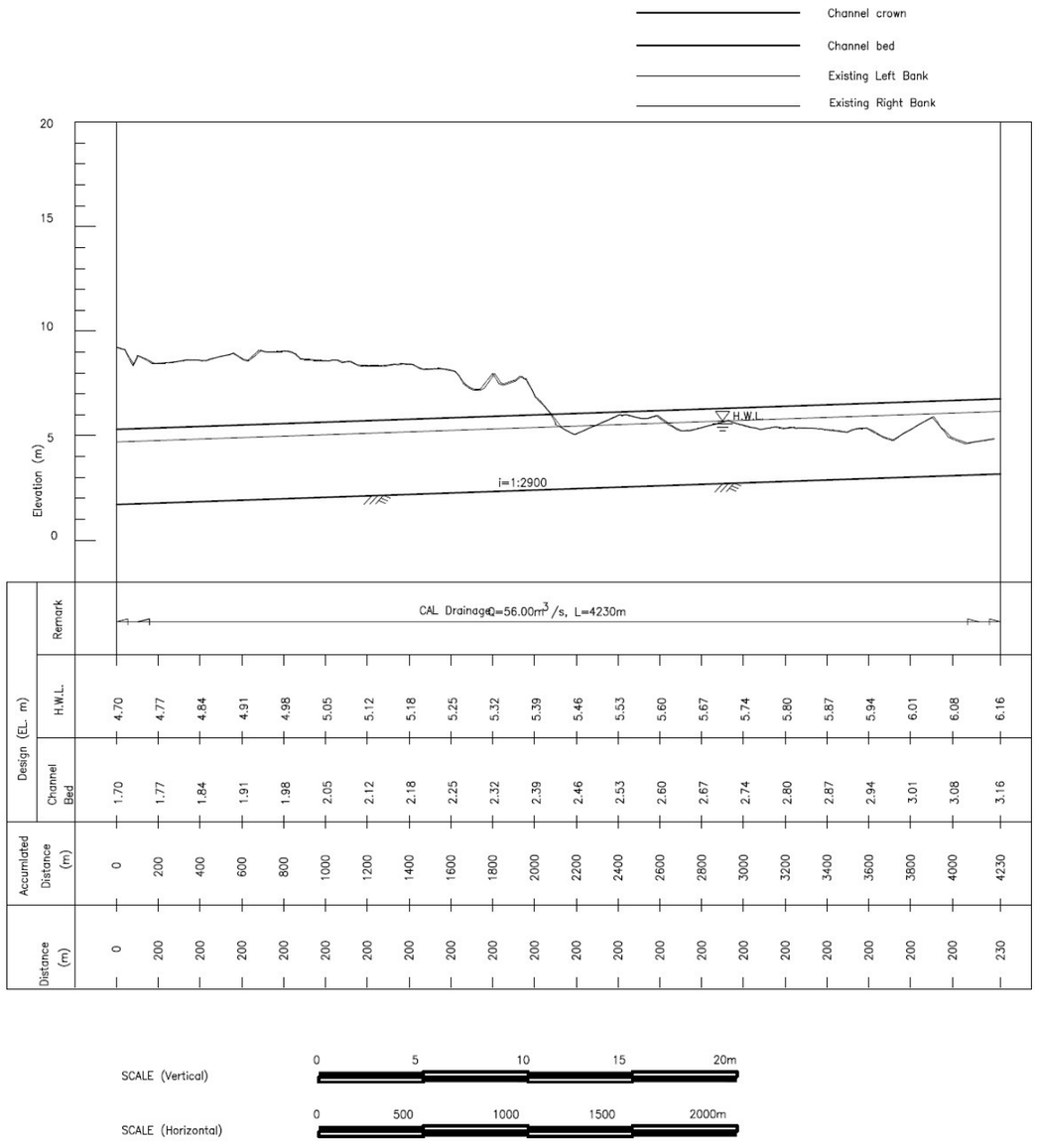
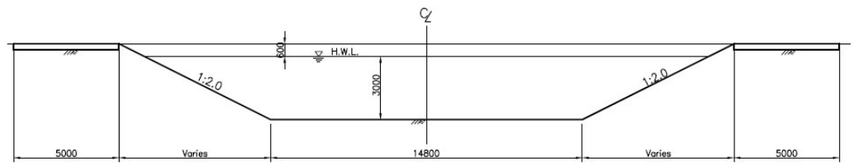


Profile of SC Drainage Channel in (18) Satellite City Sub-catchment Area





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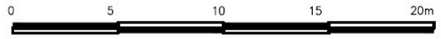
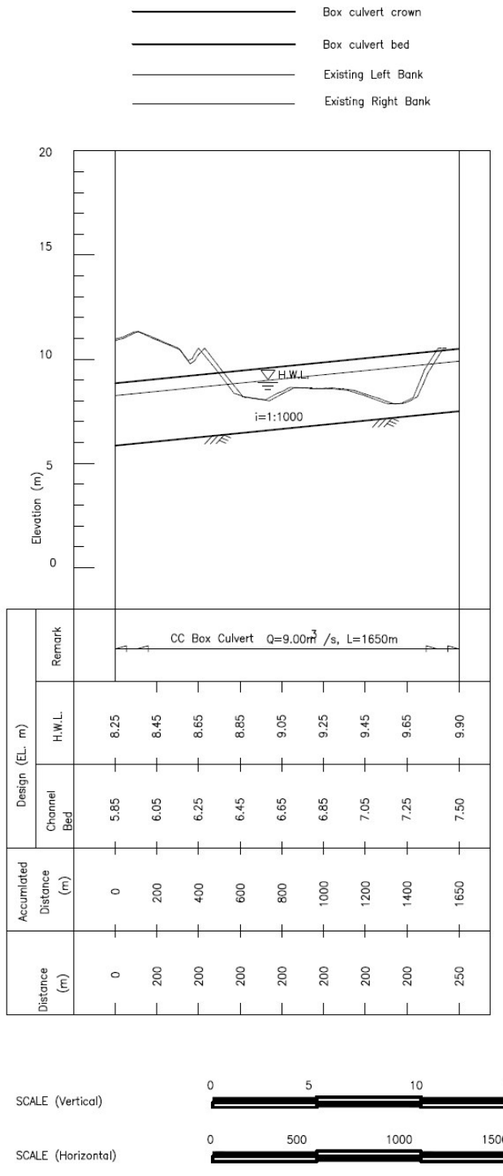
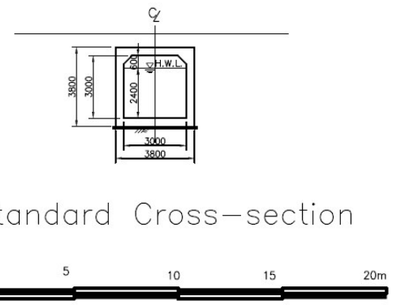


Profile of CAL Drainage Channel in (19) Cheung Aek Lake Sub-catchment Area





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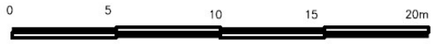
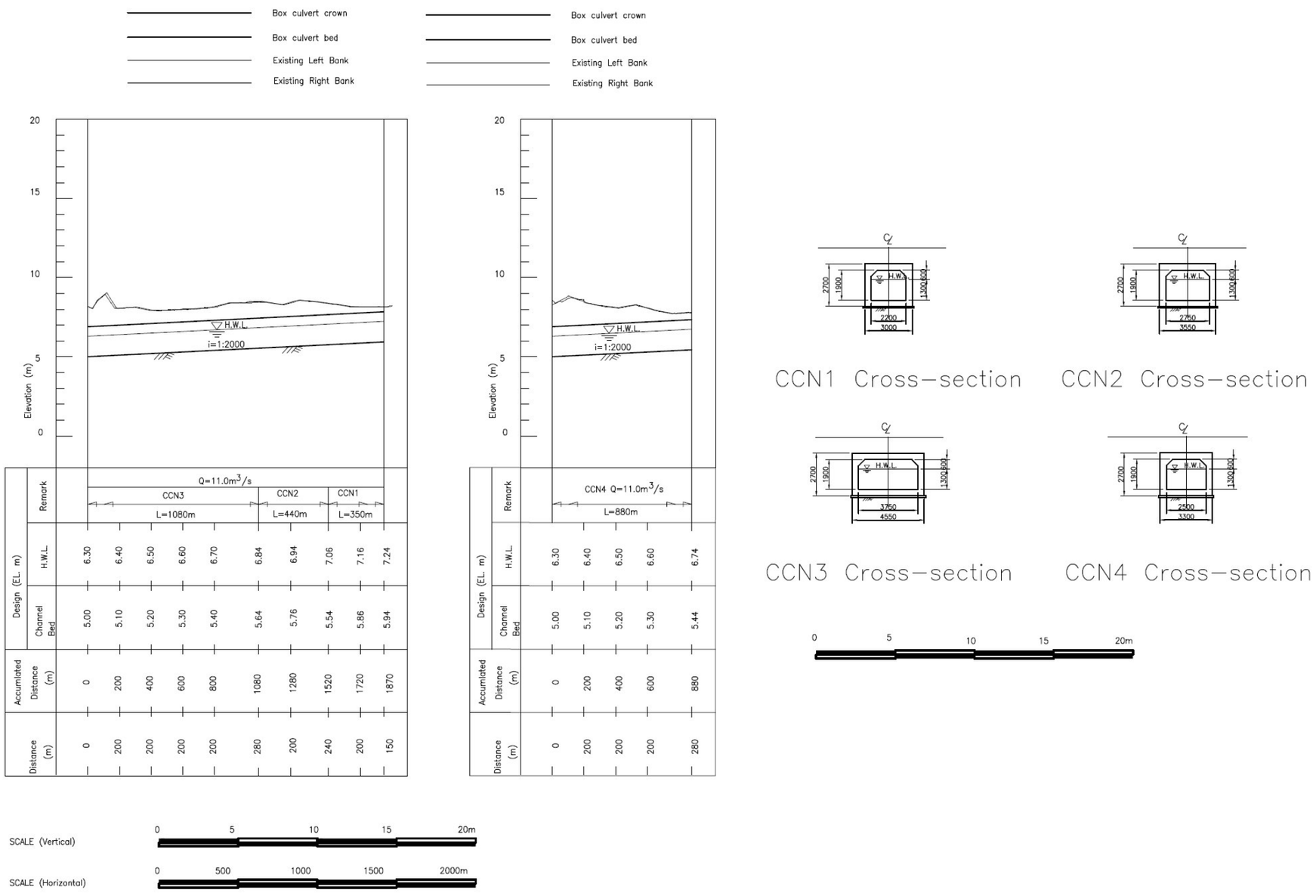
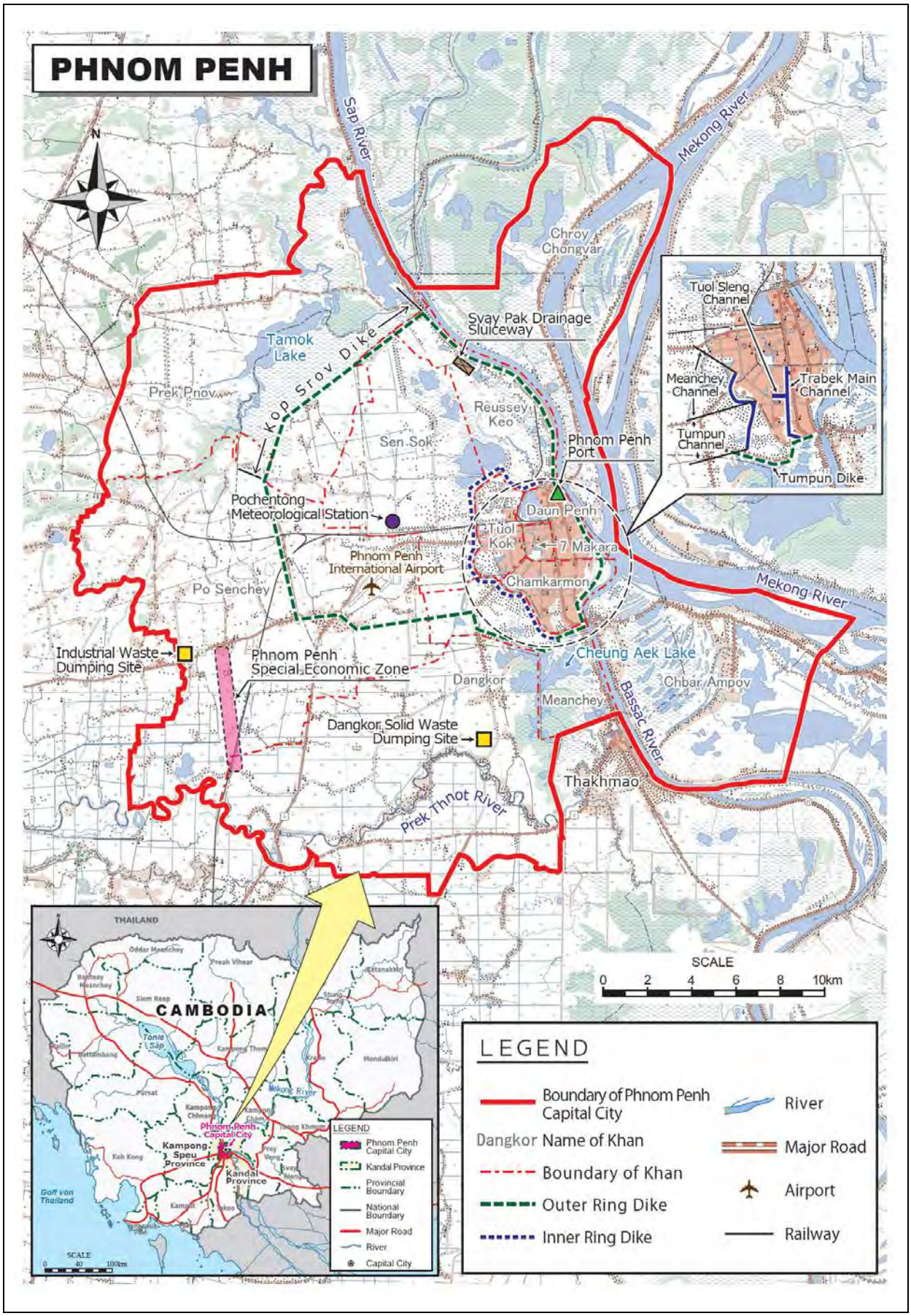


Profile of CC Drainage Channel in (21) Chroy Changvar Sub-catchment Area



Profile of CCN1~CCN4 Drainage Box-Culvert in (27) City Core North Sub-catchment Area

3. PRELIMINARY ENVIRONMENTAL STUDY FOR PRIORITY PROJECTS OF DRAINAGE AND SEWERAGE IMPROVEMENT IN PHNOM PENH METROPOLITAN AREA (DRAFT)



LOCATION MAP

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ABBREVIATIONS

1. Organization/Program/Project

ADB	Asian Development Bank
CIA	Central Intelligence Agency
DPWT	Department of Public Works and Transport
DOE	Department of Environment
EDC	Electricite du Cambodia
FAO	Food and Agriculture Organization
GOC	Government of Cambodia
GOJ	Government of Japan
IRC	Inter-Ministerial Resettlement Committee
IUCN	International Union for Conservation of Nature and Natural Resources
JICA	Japan International Cooperation Agency
MAFF	Ministry of Agriculture, Forest and Fisheries
MEF	Ministry of Economy and Finance
MLMUPC	Ministry of Land Management, Urban Planning and Construction
MOE	Ministry of Environment
MOWRAM	Ministry of Water Resources and Meteorology
MPWT	Ministry of Public Works and Transport
NSDP	National Strategic Development Plan
PPCC	Phnom Penh Capital City
RD	Department of Resettlement
RGC	Royal Government of Cambodia

2. Technical Terms

BOD	Biochemical Oxygen Demand
CASP	Conventional Activated Sludge Process
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CR	Critically Endangered
DO	Dissolved Oxygen
EIA	Environmental Impact Assessment
EN	Endangered
FEIA	Final Environmental Impact Assessment
GDP	Gross Domestic Product
IEIA	Initial Environmental Impact Assessment
NO_2	Nitrogen Dioxide
pH	Potential Hydrogen
T-N	Total Nitrogen
T-P	Total Phosphorus
TOR	Terms of Reference
TSP	Total Suspended Particles
TSS	Total Suspended Solid
VU	Vulnerable

3. Others

CSES	Cambodia Socio-Economic Survey
ELC	Economic Land Concessions
F/S	Feasibility Study
IPP	Independent Power Producer
M/P	Master Plan
NGO	Non-Governmental Organization

LARAP	Land Acquisition and Resettlement Action Plan
PAP	Project-Affected People
R/D	Record of Discussions
ROW	Right-of-Way
SLC	Social Land Concessions
STP	Sewage Treatment Plant
USD	United States Dollar

CHAPTER 1 INTRODUCTION

1.1 Background

This environmental study was conducted to identify the critical environmental and social conditions at the early stage of project establishment, i.e.; the pre-feasibility stage of the priority project proposed in THE STUDY ON DRAINAGE AND SEWERAGE IMPROVEMENT PROJECT IN PHNOM PENH METROPOLITAN AREA, and to provide the basic information for considering environmental and social conditions in relation to the project.

The administrative area of Phnom Penh Capital City (hereinafter referred to as "PPCC") has been expanding since 2008 to 678.46 km^2 in 2011 and its population has increased from about 1.0 million in 1998 to 1.5 million in 2010. PPCC is often threatened by floods from the Mekong River due to the insufficient protection from the flood dikes. Urban drainage facilities constructed from the beginning of the 1960's are not functioning well since they are superannuated, and poor maintenance during the civil war in the 1970's has aggravated the situation. As a result, the capital city suffers from habitual inundation by local rainfall, especially, in the rainy season.

The Japan International Cooperation Agency (hereinafter referred to as "JICA"), in response to the request from the Royal Government of Cambodia (hereinafter referred to as "RGC"), conducted the "Study on Drainage Improvement and Flood Control in the Municipality of Phnom Penh" in 1999. Based on the Master Plan formulated in the Study, the Government of Japan (hereinafter referred to as "GOJ") conducted Grant Aid projects (Phase I, II and III) for the purpose of strengthening drainage capacity in the city area and to protect the city from flooding. In spite of these efforts, drainage problems have been generated in areas other than the areas of Phases I, II and III, due to rapid urbanization and changes in land use.

As for sewage management in PPCC, only human excreta are held in septic tanks. Seepage from the septic tanks and domestic wastewater flows directly into the drainage pipes or open channels, and run into the ponds/swamps located in the downstream of watersheds where they may be purified by the natural purification function to some extent.

However, houses, factories and other activities have proliferated in these ponds/swamps and hence their natural purification function is no longer felt. Due to rapid population growth and city development the amount of stagnating wastewater have increased causing the foul smell. Outbreak of insects and waterborne diseases is thus anticipated, and since Mekong River, Sap River and Bassac River are the final disposal sites of wastewater, these water bodies are also polluted.

Taking the above conditions into consideration, revision of the master plan of urban drainage improvement as well as consideration of wastewater treatment is necessary. Thus, the RGC has officially requested assistance from the GOJ and, in response to the request, the GOJ decided to conduct the "Study on Drainage and Sewerage Improvement Project in Phnom Penh Metropolitan Area" (the Study). Accordingly, JICA, which is the official agency responsible for the implementation of technical cooperation programs of the GOJ, dispatched the Detailed Planning Survey Team to Cambodia from March to April, 2014 and the Records of Discussion (R/D) was signed with the Cambodian side in May 2014.

1.2 Objectives of the Study

The objective of the Study is to grasp the current situation of environment in the target area at the planning stage.

1.3 Study Area

The Study covers the entire area of Phnom Penh Capital City (PPCC).

1.4 Name of Project

The whole Project is: “THE DRAINAGE AND SEWERAGE IMPROVEMENT PROJECT IN PHNOM PENH METROPOLITAN AREA”.

1.5 Methodology

The Preliminary IEE study was to be conducted through the review of available information and conditions currently available for the Project.

CHAPTER 2 LEGAL FRAMEWORK

2.1 Legislations related to Environment

In Cambodia, the Law on Environmental Protection and Natural Resource Management, 1996 (Kram/NS-PKM-1296/36, 1996, 24 Dec.) provides the general policy on environmental protection as the principal environmental law. Based on the law, the Royal Government of Cambodia (RGC) manages the environment deliberately under the periodical National and Regional Management Plan which is supposed to be prepared and revised every 5 years. The requirement of the Environmental Assessment in the project is also included in the law. Private and public projects should refer to the law when conducting the required study depending on the scale and location of project **(Table 2.1.1)**.

In the law, the Sub-Decree on Environmental Impact Assessment (EIA) Process, 1999 (No. 72 ANRK.BK, 1999) and the declaration on General Guideline for conducting IEIA/EIA Reports, 2009 (No. 376 BRK.BST, 2009) provide details of the procedure of environmental assessment. The Sub-Decree stipulates the institutional responsibilities, the projects that require EIA, procedures of EIA, conditions necessary for approving project(s), and penalties. The projects which require environmental assessment are listed in the Annex to the Sub-Decree. The declaration also stipulates the timeframe and required documents for submission at the approval process in IEIA and EIA in detail. Annex-1 in the declaration specifies the basic contents of IEIA/EIA reports. The declaration also stipulates the demarcation of responsibilities between environmental authorities in the national level and provincial level, which are the Ministry of Environment (MOE) in the national level and the Department of Environment (DOE) in the provincial/municipal level.

In relation to pollution control, several standards have been issued by the government. The Sub-Decree (Anukret) on Water Pollution Control, 1999 (No. 27 ANRK. BK, 1999) stipulate the standards of water quality. The Sub-Decree on Solid Waste Management, 1999 (No. 36 ANRK.BK, 1999), stipulate the general standards of solid waste while No. 42 in 2000, Sub-Decree on the Control of Air Pollution and Noise Disturbance, provides for the regulation of environmental air condition and noise level.

With regard to environmental protection, the protected area is prescribed in the law of protected area (Royal Decree No. NS/RKM/0208/007). Based on the law, the important natural features are protected under the responsibility of the MOE.

Table 2.1.1 Legislations related to Environmental Assessment and Protection

No.	Legislation	Description
1	Preah Reach Kram/NS-PKM-1296/36, 1996, Law on Environmental Protection and Natural Resource Management,1996 (18 November 1996)	As the principal law on environmental protection, the law provides for the national environment policy, national and regional environment plans, assessment of impact on the environment of projects and activities, management of natural resources, monitoring, data collection and inspection, and participation of the public in relation to environment. It also prescribes penalties for offences defined in this law. Regarding environmental assessment, the requirement of environmental impact assessment on every private and public project is prescribed in Article 6 and public participation is described in the Chapter VII about information provision to the public and dissemination by the government.
2	No. 72 ANRK.BK, 1999, Anukret (Sub-Decree) on Environmental Impact Assessment (EIA) Process (11 August 1999)	This Sub-Decree provides the detailed guidelines for implementation of the IEIA/EIA Process. The projects which require environmental assessment are listed in the Annex. The Sub-Decree stipulates the Institutional Responsibilities, Projects that require EIA, procedures of EIA, condition for Approving Project(s), and Penalties. Its Annex requires the conduct of IEIA/EIA on the following activities under the Project: (i) waste processing, burning activities,

No.	Legislation	Description
		all sizes; (ii) wastewater treatment plants, all sizes; and (iii) drainage systems, >5,000 ha. The Sub-Decree has no stipulation on environmental assessment requirements for flood protection dykes, riverbank protection and local roads.
3	No. 376 BRK.BST, 2009 Prakas (Declaration) on General Guideline for conducting IEIA1/EIA Reports,2009	The Declaration on the General Guideline for Preparing Initial Environmental Impact Assessment (IEIA) and EIA Reports, was issued by the Ministry of Environment (MOE) in 2009. The declaration also stipulates the timeframe and documents required for submission at the approval process in IEIA and EIA. Annex-1 specify the basic contents of IEIA/EIA Reports: (i) introduction; (ii) legal framework; (iii) project description; (iv) description of the existing environment; (v) public participation; (vi) assessment of, and mitigation measures for, significant environmental impacts; (vii) environmental management plan; (viii) cost-benefit analysis; and (ix) conclusion and recommendation. The format for the environmental checklist is provided in Annex-2.
4	No. 27 ANRK/BK/1999, Anukret (Sub-Decree) on Water Pollution Control, 1999 (April 6, 1999)	This Sub-decree regulate activities that cause pollution in public water areas in order to sustain good water quality so that the protection of human health and the conservation of biodiversity are ensured. This consists of 39 articles in 8 chapters with 5 annexes regarding general definition, permission, monitoring, inspection and penalties. Annexes 2, 4 & 5 provide the industrial effluent standards, including effluent from wastewater stabilization ponds, water quality standards for public waters for the purpose of biodiversity conservation, and water quality standards for public waters and health, respectively.
5	No. 36 ANRK.BK. in 1999, Anukret (Sub-decree) on Solid Waste Management, 1999	This Sub-decree regulates solid waste management to ensure the protection of human health and the conservation of biodiversity. It consists of 32 articles in 6 chapters with Annex regarding general definition, house waste and hazardous waste management and those for monitoring, inspection and penalty for offence. Responsibilities of the ministry and the province on house waste management and also responsibilities of the owner of hazardous waste including storage and transport which should be strictly handled separately from house waste are provided.
6	No. 42 in 2000, Anukret (Sub-Decree) on the Control of Air Pollution and Noise Disturbance, 2000 (July 10, 2000)	This Sub-Decree provides for the management, prevention and control of air and noise pollution, detailing in the Annexes the threshold values for emissions, outlaying the procedures and legal requirements to limit and provide for the pollutants. Following standards are included: Annex 1, Ambient Air Quality Standard; Annex 2, Maximum Allowable Concentration of Hazardous Substance in Ambient Air; Annex 3, Maximum Allowable Standard of Pollution Substance for Immovable Sources in Ambient Air; Annex 4, Gas Emission Standard of Mobile Source; Annex 5, Maximum Standard of Noise Emission Level Allowable for Vehicles on Public Roads; Annex 6, Maximum Standard of Noise Level Allowable in the Public and Residential Areas (dB(A)); Annex 7, Noise Control Standard at Workshop, Factory and Industry; Annex 8, Standard of Sulfur, Lead, Benzene, and Hydrocarbon Permitted in Fuel and Coal.
7	No. 745 MEF/MOE 2000, Prakas (Joint Declaration) between MOE and MEF on Determination of Service Fee for EIA reviewing and Monitoring (20 Oct. 2000)	This declaration provides the fee for the environmental services. The fees are determined depending on the categories. The categories are Industrial, Agriculture, Tourism, infrastructure. In case of Wastewater Treatment Plants 2,000,000Riel is charged for all size of the project.
8	No. 07 NS/RKM/2008, Protected Areas Law (Royal Decree No. NS/RKM/2008/007)	This Law provides for the management, conservation and development of natural protected areas to ensure the conservation of biodiversity and guarantee the use of natural resources in a sustainable manner and consists of 11 Chapters divided into 66 articles The Law classifies natural protected areas into eight categories as follows: 1) National Parks; 2) Wildlife Sanctuaries; 3) Protected

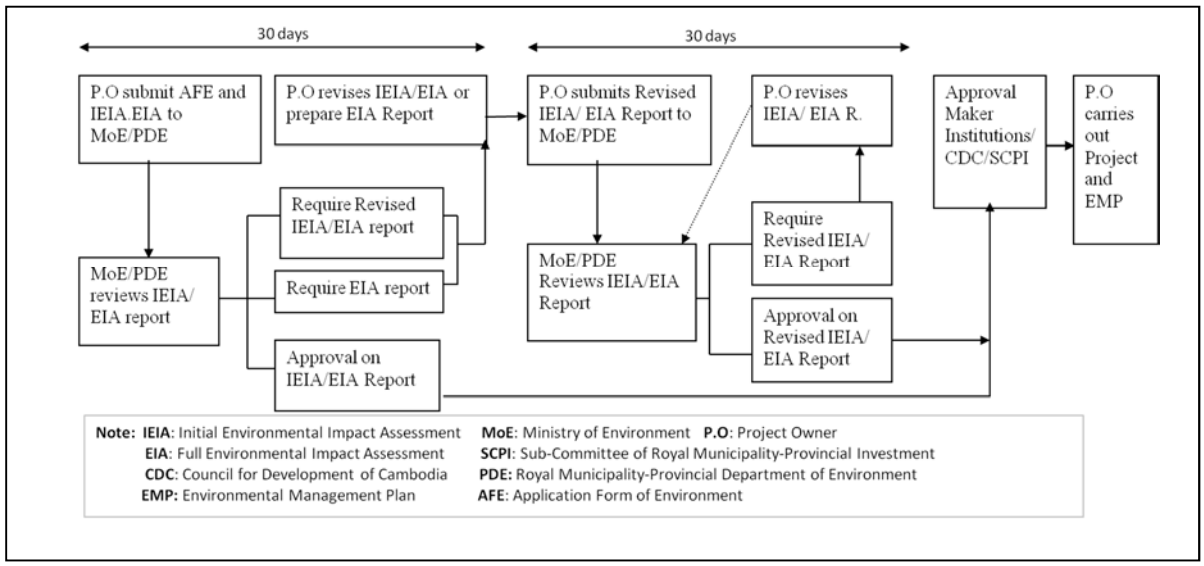
No.	Legislation	Description
		Landscapes; 4) Multi Use Areas; 5) Ramsar Sites; 6) Biosphere Reserves; 7) Natural Heritage Sites; and 8) Marine Parks. Each natural protected area shall be divided into four management zoning systems: 1) Core zone; 2) Conservation zone; 3) Sustainable use zone; and 4) Community zone. The Law recognizes the power of the Ministry of Environment to manage natural protected areas developing a National Protected Area Strategic Management Plan.
9	No. 1033, 1994, Prakas (Declaration) on Protected Areas, 1994	This "Prakas" (Declaration) of the Ministry of Environment prohibits a series of acts in natural protected areas in the sense of Royal Decree of 1 November, 1993 on the Protection of Natural Areas. Prohibited activities include construction of sawmills, hunting, placing of traps, fishing of mammals, amphibians, reptiles and aquatic animals for specified purposes, deforestation for land use, water pollution and other forms of pollution of the environment, etc. Research and experimenting requires approval of the Secretariat of the Environment. The Nature Conservation Department of the Secretariat shall implement this Declaration.
10	No. 230 in 2005, Prakas (Declaration) on the Delegation of Power of Decision-Making on Project Development to the Provincial Department of Environment, 2005	The Declaration on the Delegation of Power of Decision-Making on Project Development to the Provincial Department of Environment (PDOE), 2005, provides for the PDOE to be the reviewing and approving authority of IEIA/EIA reports of projects costing below USD 2 Million.

Source: JICA Study Team based on English Translation supplemented by JICA env. Profile 2013, Faolex, ADB (2014) Integrated Urban Environmental Management in the Tonle Sap Basin Project – Kampong Chhnang Urban Area Environment Improvements.

2.2 EIA Process

2.2.1 EIA Process in Cambodia

As shown in the flowchart below (**Fig. 2.2.1**), the project owner firstly submits the Environment Application Form with the report to the authority, i.e., the MOE or Provincial Department of Environment (DOE). After the authority has reviewed the report, it may require the project owner to revise it or implement further study as EIA. When the environmental study fulfils the requirement of the authority, the report is forwarded to the Council for Development/Sub-committee of Royal Municipality-Provincial Department of Environment for approval.



Source: Declaration on General Guideline for Conducting Initial and Full Environmental Impact Assessment Reports

Fig. 2.2.1 Flowchart of IEIA/EIA Process for National-Level Projects

2.2.2 Organization for Environmental Matters

The MOE is the competent authority on environmental assessment in the country. Within the MOE, the Department of the Environmental Impact Assessment Review is in charge of the process.

Under supervision of the MOE, the Department of Environment (DOE), as one of the specialized departments in PPCC, is in charge of the environmental assessment process. The organizational structure is slightly different in each province.

Based on the "Declaration on the Decentralization for Environmental Municipal/Provincial Department and the Declaration on the Power of the Delegation to the Decision Making on Project Development for Environmental Municipal/Provincial Department 2005", projects of less than USD 2,000,000 of capital investment is under the responsibility of the municipal/provincial authority and projects of USD 2,000,000 or more is under the responsibility of the MOE. The DOE has approximately 70 personnel and 8 of them are assigned at the EIA office for the EIA related works.

2.2.3 Difference between Cambodian Legislation and International Standards

There is no large difference between the Cambodian government's environmental framework and the JICA guidelines in terms of contents and items to be referred. However, in terms of timeframe, the Cambodian legislation allows special cases which are specially approved by the government to be excluded as described in Article 2 of the Sub-Decree. Some priority cases are allowed to be processed without following the established procedure.

As information disclosure, public participation is described in the Sub-Decree to be involved at the EIA process as an objective in Arfticle-1 (No. 72 ANRK.BK Phnom Penh, August 11, 1999). However, details of the procedure such as number of meetings are not particularly provided in any Sub-Decree or guideline. In Annex 1 of the declaration on general guidelines for EIA (No. 376 BRK.BST. 2009), public participation is defined to involve all concerned stakeholders; namely, concerned ministries/institutions, local authorities, concerned departments, project owners, consulting companies, representatives of affected people and non-governmental organizations (NGOs). The report should include introduction, conducting the public consultation dissemination for the authorities and local communities about development projects, comments from relevant ministries/institutions/departments and local authorities, comments from relevant NGOs and local people, and conclusion on the results of public consultation.

2.2.4 Legislation and Procedure of Environmental Study on Sewerage and Drainage Project Development

As described in the previous section, the projects require environmental assessment are prescribed in the Annex to the Sub-Decree, No. 72 ANRK.BK, 1999. The present study aims to develop physical countermeasures for the sewerage and drainage issues in PPCC. According to the Sub-Decree, the expected activities within the current project may be related to: (1) all sizes of waste processing and burning activities; (2) all sizes of wastewater treatment plants; and (3) drainage systems of more than 5,000 ha as defined in the Annex.

2.3 Legislation and Legal Procedure of Resettlement and Land Acquisition for Development

2.3.1 Legislation on Resettlement and Land Acquisition

There is no major change of legislation related to the resettlement and land acquisition after the preparatory survey in 2014. The resettlement process in the country follows different legislations depending on the land status, private land or public land. The legal framework for resettlement and land acquisition are as explained below **(Table 2.3.1)**.

Table 2.3.1 Legislations related to Resettlement and Land Acquisition

No.	Legislation	Description
1	NS/RKM/0801/14, 2001, Land Law (2001), (August 30, 2001)	The law provides for the distribution and management of land in Cambodia as well as the protection of property rights. This basic land legislation consists of 8 Titles: Private and public ownership (I); Acquisition of ownership (II); The regime of private ownership (III); Forms of ownership (IV); Immovable property used as surety (V); Cadastre (VI); Penalty provisions (VII); and Final provisions (VIII). Besides ownership of public property, private ownership such as individual and collective private ownership, are defined.
2	No. 224 in 1996 Ministry of Economy and Finance, Prakas (Declaration) on Collection of Tax on Unused Land (1996)	The declaration defines the taxable unused land not falling under the following characteristics: 1) Land with construction located in residential area where the owner has his principal place of residence for 183 days or more. 2) Possessed land rented with construction that generates a monthly income of more than 80% of one-twelfth of the land value. 3) Land of legitimate economic activities as determined by the state with monthly revenue from such activities of more than 80% of one-twelfth of the land value in a tax collection year. 4) Land belongs to the state which is leased to a legal entity or physical person. 5) Land under an investment contract in which the performance has not been started due to force majeure or disaster.
3	No.118 in 2005, Anukret (Sub-Decree) on State Land Management (2005)	The Sub-Decree provides the framework for state land management and consists of 11 chapters and 33 articles in total. It provides legal definition of state land and the differences between public and private state lands, processes of state land identification and mapping, and the roles of corresponding responsible actors, processes to classify/reclassify the land, procedures to maintain/update the State Land Map and Database as well as the access rights to the database, Trustee's mandate and administration of the land.

No.	Legislation	Description
4	Royal Decree NS/RKT/0806/339 , 2006, on Provisional Guidelines and Principles Regarding the Re-classification of State Public Properties and of Public Entities, (8 August 2006)	The Royal Decree determines the principles and transitional provisions involving transfer of public properties of the state and legal public entities. The Royal Decree requires that state public land may only be reclassified if certain conditions are met, principally, that the land no longer serves the public interest, has lost its originally intended function, or is no longer used directly by the public.
5	Anukret (Sub-Decree) No. 129/ANK.BK, 2006 on Rules and Procedures for Reclassification of State Public Properties and Public Entities (2006)	This sub-decree was signed by the Prime Minister and states that any reclassification of state public land must comply with the Royal Decree (2006).
6	No. NS/RKM/0210/003, Expropriation Law (2010) (February 26, 2010)	This Law defines the principles, mechanisms, compensation and procedure for expropriation relating to construction, rehabilitation and expansion of public physical infrastructure in Cambodia. The Law stipulates that only the state may expropriate property for the public benefit or state interest. The Law also requires an expropriation committee to be managed by a representative of the Ministry of Economy and Finance, with representatives from other government bodies. The Expropriation Committee shall prepare an "expropriation project proposal" subject to be reviewed and approved by the Royal Government. The amount of compensation is determined based on the market price or replacement cost as of the date of issuance of the declaration on the expropriation project provided in Article 22. The market price or the replacement cost is supposed to be determined by an independent committee or agent appointed by the Expropriation Committee.
7	Circular (Letter) No. 02 S.R 2007, Related to illegal occupation of State Land (February 22, 2007)	Supplementing the Land Law (2001), this circular provides policy principles for dealing with illegal occupants of state land. People occupying state land illegally have no right to ask for compensation, but possibly guilty as stated in the Land Law of 2001(6.2); however, in case of poor families who have no land, etc., the Royal Government (RGC) provide land with appropriate dimensions so that they can exploit it for for living or building a house under condition of Item 7 of the Circular.
8	Circular (Letter) No. 03 SR 2010, Circular on the settlement of illegal construction on state land in cities and urban areas	The circular aims to provide solution on illegal constructions in state land. The works are supposed to be done through the Capital/Provincial State Land Management Committee with the state land working groups in the municipalities, districts/khans. The provided work steps are: 1) Collecting data and information about the specific location of illegal construction. 2) Identifying, mapping and classifying the location of illegal construction. 3) Conducting census of households and population living in the location of illegal construction. 4) Providing solutions such as resettlement, on-site development, and other realistic policy options. 5) Coordinated consultation to define the policy measure. 6) The physical infrastructures and basic services must be prepared in advance. 7) Participation by the relevant development stakeholders.
9	Sechkdey Prakas (Declaration) No. 06 BRK 1999 on the Measure of Eliminating Anarchical land Encroachment	This provides the required measures to be taken by the government on anarchical land encroachment; 1) No provision of private rights on state land. 2) Prohibition of issuance of application form for land possession.

No.	Legislation	Description
		3) Investigation of illegal land encroachment by the authorities. 4) Responsibility of the local government. 5) Cooperation of the National Police, Royal Armed Force and Military Region. 6) Ban illegal encroachment activities. 7) Investigation by the ministries. 8) ROW for National Road and Railway. 9) Role of the Ministry of Interior in collaboration with the Ministry of Public Works and Transport, the Ministry of LMUPC, the Ministry of National Defense and the Ministry of Economy and Finance. 10) Immediate action by the National Road and Railway authorities. 11) The Provincial/Municipal Land Dispute Settlement Commission throughout the country shall monitor the implementation of the measure.
10	Circular No. 006 MEF 2014 on Procedure to Implement Resettlement of Development Projects	The circular was made: 1) to ensure effective and efficient implementation of resettlement of each development project; 2) to avoid moral impact in addition to impact on property of Project-Affected People; 3) to avoid barriers to the construction of public physical infrastructure development project for public and national interests; and 4) to gain full support from the public. Required actions by the implementation agency at Project Feasibility Study Stage, Resettlement Plan Implementation Stage and Post Resettlement Plan Implementation Stage are described along with their responsibilities.

Source: JICA Study Team based on English Translation supplemented by JICA env. Profile 2013, Faolex, ADB (2014)Integrated Urban Environmental Management in the Tonle Sap Basin Project – Kampong Chhnang Urban Area Environment Improvements and UN Human Rights Council(2012) Report of the Special Rapporteur on the situation of human rights in Cambodia, Surya P. Subedi.

2.3.2 Land Tenure in Cambodia

The Land Law (2001) NS/RKM/0801/14, August 30, 2001 provides rules for land possession in the country including private and public immovable properties. The law replaced the land law of 1993 considering officially denying land ownership prior to 1979. Land in the country is defined as private and state properties, i.e., private land and state land. Private property in the country is allowed for individual and collective ownership, exclusively for Cambodian citizens and entities defined in the law. Ownership and Extraordinary Acquisitive Possession are legally recognized as land title for private land. State land is divided into state private land and state public land as described later.

Under the Land Law (2001), Sub-Decree No. 118: State Land Management (2005) provides the principles, procedures, mechanisms and mapping of state land; registration and classification of state land; creation and maintenance of a State Land Database; allocation and management of state land; and reclassification of state land (Article 1). The sub-decree defines the land in the country state land and private land. The state land is classified into two categories; namely, State Public Land and State Private Land. State Public Land is designated for the public purpose and State Private Land is used for concession lease such as Social Land Concessions (SLC) and Economic Land Concessions (ELC).

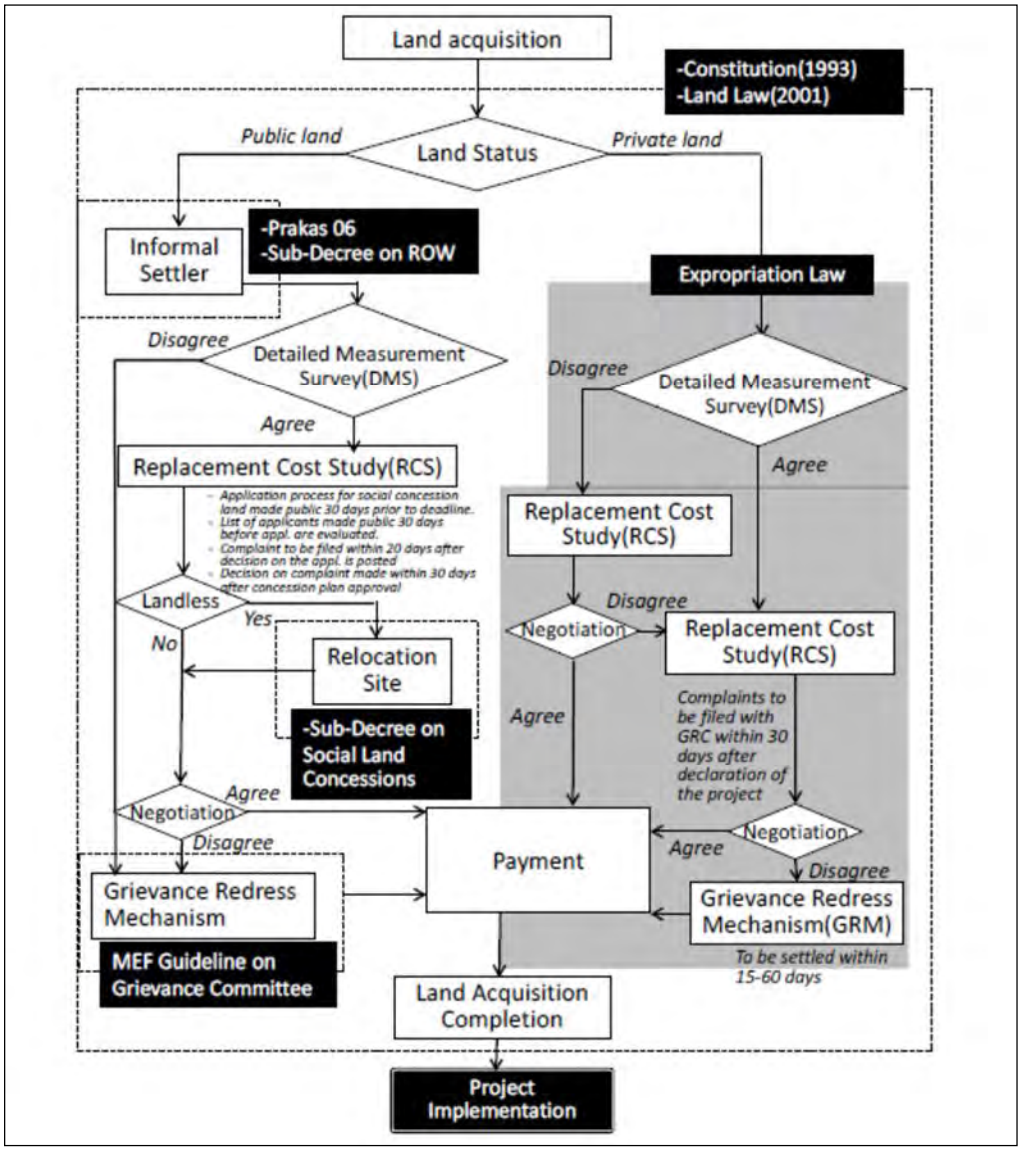
2.3.3 Procedure of Land Acquisition

The acquisition of private land to be used for the public interest shall follow the land expropriation law (2010). On the other hand, the state land should be processed within the government shall follow the Sub-Decree on State Land Management and may follow the Prakas (Declaration) No. 6, 1999 on measures to crack down on anarchic land grabbing and encroachment if the area is occupied in illegal

way, or Circular No. 2 2007 on "Related to illegal occupation of state land" and Circular No. 3 2010 on "Settlement of illegal construction on state land in cities and urban areas". In any case, survey should be conducted to identify the situation (**Fig. 2.3.1**).

The Expropriation Law (2010) defines the principles, mechanisms, compensation and procedures for expropriation of private properties relating to construction, rehabilitation and expansion of public physical infrastructure in Cambodia. The Expropriation Committee shall prepare an "expropriation project proposal" subject to review and approval by the Royal Government. The amount of compensation is determined based on the market price or replacement cost as of the date of issuance of declaration on the expropriation project as provided in Article 22. The market price or the replacement cost is supposed to be determined by an independent committee or agent appointed by the Expropriation Committee.

In the case of a government project, expropriation is implemented following the law. An Expropriation Committee is headed by a representative from the MEF and other representatives from concerned ministries/institutions. The Expropriation Sub-Committee is headed by the provincial/municipal governor and is composed of representatives from relevant specialized provincial departments and authorities.



Source: MEF, Basic Resettlement Procedure, 2012

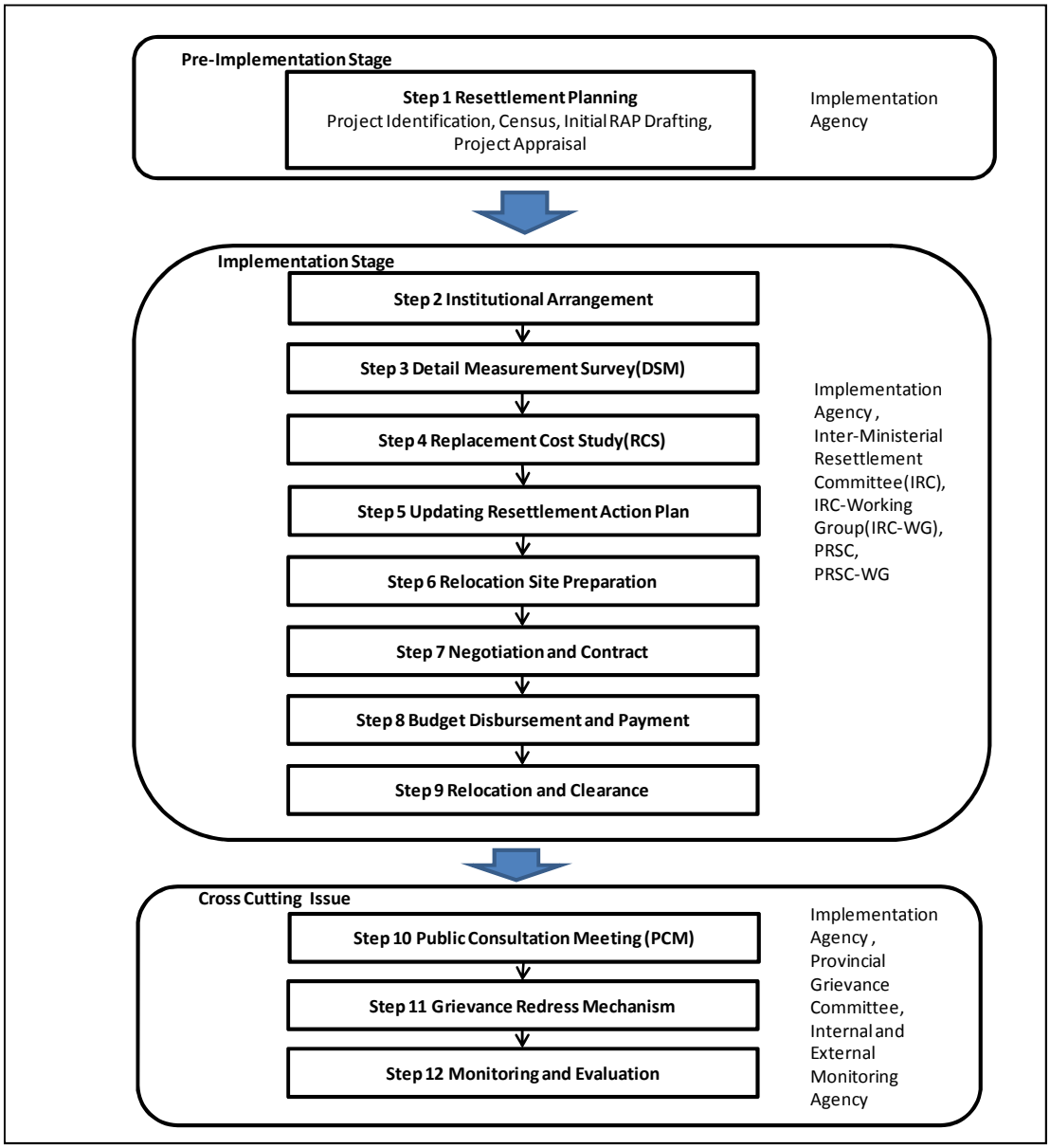
Fig. 2.3.1 Flowchart of Land Acquisition

2.3.4 Resettlement Framework in the Country

The resettlement framework is explained in the Standard Operating Procedures for All Externally Financed Projects/Programs in Cambodia (MEF, 2012), as shown in **Fig. 2.3.2**.

The Inter-Ministerial Committee (IRC) was established by the Royal Cambodian Government (RCG) with permanent members from MEF in 2007 to deal with the resettlement issue. The IRC is supported by the newly created Resettlement Department (RD) in MEF, which is staffed by well-qualified and trained personnel with JICA and ADB support. The RD assists line ministries to prepare resettlement plans and to have these plans funded and executed, especially, for the ministries and agencies which do not currently have resettlement units.

All resettlement matters are handled on the central government level, i.e., the Inter-Ministerial Committee. In case of resettlement in the project by PPCC, the DPWT will work for the land investigation based on the Aerial Photo. Then, the result of the investigation is submitted to PPCC. PPCC (Governor) requests the central government to establish the Inter-Ministerial Committee.



Source: JICA Study Team, based on the MEF (2012), Basic Resettlement Procedure

Fig. 2.3.2 Workflow of Resettlement Process

2.4 Environmental Standard

2.4.1 Water Quality and Effluent Standard

The "Sub-Decree on Water Pollution Control, No. 27, 1999" was enacted on 6 April 1999, aiming to prevent water pollution in Cambodia. This Sub-Decree defines 'Classification of waste and hazard discharge', 'Water Quality Standard', 'Effluent Standard', 'Responsibility of polluter', 'Monitoring', 'Discharge Permit', ' Inspection' and 'Penalty', etc.

Water quality standard in public water areas such as river, lakes, reservoirs and coastal water is set for bio-diversity conservation (**Table 2.4.1**). In addition, 25 parameters are set as water quality standard in public water areas for public health protection (**Table 2.4.2**).

Table 2.4.1 Water Quality Standard for Bio-Diversity Conservation

	No	Parameter	Unit	Standard Value
1. River	1	pH	-	6.5 – 8.5
	2	BOD_5	mg/l	1 – 10
	3	Suspended Solid	mg/l	2.4 – 100
	4	Dissolved Oxygen	mg/l	2.0 – 7.5
	5	Coliform	MPN/100ml	< 5,000
2. Lakes and Reservoirs	1	pH	-	6.5 – 8.5
	2	COD_{Mn}	mg/l	1 – 8
	3	Suspended Solid	mg/l	1 – 15
	4	Dissolved Oxygen	mg/l	2.0 – 7.5
	5	Coliform	MPN/100ml	< 1,000
	6	Total Nitrogen	mg/l	1.0 – 0.6
	7	Total Phosphorus	mg/l	0.005 – 0.05
3. Coastal Water	1	pH	-	7.0 – 8.3
	2	COD_{Mn}	mg/l	2 – 8
	3	Suspended Solid	mg/l	2 – 7.5
	4	Coliform	MPN/100ml	< 1,000
	5	Oil Content	mg/l	0
	6	Total Nitrogen	mg/l	0.2 – 1.0
	7	Total Phosphorus	mg/l	0.02 – 0.09

* Some parameters have 'lower limit' and 'upper limit'. As the result of inquiry to MOE about 'lower limit', setting up of the 'lower limit' (excluding pH) is not correct and those should be revised but the schedule of the revision is not fixed.

Source: Sub-Decree on Water Pollution Control, Annex 4: Water Quality Standard in public water areas for bio-diversity conservation.

Table 2.4.2 Water Quality Standard for Public Health Protection

No.	Parameter	Standard Value (µg/l)
1	Carbon tetrachloride	< 12
2	Hexachloro-benzene	< 0.03
3	DDT	< 10
4	Endrin	< 0.01
5	Diedrin	< 0.01
6	Aldrin	< 0.005
7	Isodrin	< 0.005
8	Perchloroethylene	< 10
9	Hexachlorobutadiene	< 0.1
10	Chloroform	< 12
11	1,2 Trichloroethylene	< 10
12	Trichloroethylene	< 10
13	Trichlorobenzene	< 0.4
14	Hexachloroethylene	< 0.05
15	Benzene	< 10

No.	Parameter	Standard Value (µg/l)
16	Tetrachloroethylene	< 10
17	Cadmium	< 1
18	Total mercury	< 0.5
19	Organic mercury	0
20	Lead	< 10
21	Chromium, valent 6	< 50
22	Arsenic	< 10
23	Selenium	< 10
24	Polychlorobiohenyl	0
25	Cyanide	< 0.005

Source: Sub-Decree on Water Pollution Control, Annex 5: Water Quality Standard in Public Water Areas for Public Health Protection

"Effluent standard for pollution sources discharging wastewater to public water areas or sewer" is defined in this sub-decree **(Table 2.4.3)**. "Protected public water area" is set in this standard. All effluent including industries should comply with standard of "Public water area and sewer" since the protected area is not specified yet currently.

Table 2.4.3 Effluent Standard to Public Water Areas or Sewers

No	Parameter	Unit	Standard	
			Protected Public Water Area	Public Water Area and Sewer
1	Temperature	^{0}C	< 45	< 45
2	pH		6 – 9	5 – 9
3	BOD_5 (5 days at 20℃)	mg/l	< 30	< 80
4	COD_{Cr}	mg/l	< 50	< 100
5	Total Suspended Solids	mg/l	< 60	< 120
6	Total Dissolved Solids	mg/l	< 1,000	< 2,000
7	Grease and Oil	mg/l	< 5.0	< 15
8	Detergents	mg/l	< 5.0	< 15
9	Phenols	mg/l	< 0.1	< 1.2
10	Nitrate (NO_3)	mg/l	< 10	< 20
11	Chlorine (free)	mg/l	< 1.0	< 2.0
12	Chloride (ion)	mg/l	< 500	< 700
13	Sulphate (as SO_4)	mg/l	< 300	< 500
14	Sulphate (as Sulphur)	mg/l	< 0.2	< 1.0
15	Phosphate (PO_4)	mg/l	< 3.0	< 6.0
16	Cyanide (CN)	mg/l	< 0.2	< 1.5
17	Barium (Ba)	mg/l	< 4.0	< 7.0
18	Arsenic (As)	mg/l	< 0.10	< 1.0
19	Tin (Sn)	mg/l	< 2.0	< 8.0
20	Iron (Fe)	mg/l	< 1.0	< 20
21	Boron (B)	mg/l	< 1.0	< 5.0
22	Manganese (Mn)	mg/l	< 1.0	< 5.0
23	Cadmium (Cd)	mg/l	< 0.1	< 0.5
24	Chromium (Cr^{+3})	mg/l	< 0.2	< 1.0
25	Chromium (Cr^{+6})	mg/l	< 0.05	< 0.5
26	Copper (Cu)	mg/l	< 0.2	< 1.0
27	Lead (Pb)	mg/l	< 0.1	< 1.0
28	Mercury (Hg)	mg/l	< 0.002	< 0.05
29	Nickel (Ni)	mg/l	< 0.2	< 1.0
30	Selenium (Se)	mg/l	< 0.05	< 0.5
31	Silver (Ag)	mg/l	< 0.1	< 0.5
32	Zinc (Zn)	mg/l	< 1.0	< 3.0
33	Molybdenum (Mo)	mg/l	< 0.1	< 1.0
34	Ammonia (NH_3)	mg/l	< 5.0	< 7.0
35	DO	mg/l	>2.0	>1.0
36	Polychlorinated Byphenyl	mg/l	<0.003	<0.003
37	Calcium	mg/l	<150	<200

No	Parameter	Unit	Standard	
			Protected Public Water Area	Public Water Area and Sewer
38	Magnesium	mg/l	<150	<200
39	Carbon tetrachloride	mg/l	<3	<3
40	Hexachloro benzene	mg/l	<2	<2
41	DTT (Dithiothreitol)	mg/l	<1.3	<1.3
42	Endrin	mg/l	<0.01	<0.01
43	Dieldrin	mg/l	<0.01	<0.01
44	Aldrin	mg/l	<0.01	<0.01
45	Isodrin	mg/l	<0.01	<0.01
46	Perchloro ethylene	mg/l	<2.4	<2.4
47	Hexachloro butadiene	mg/l	<3	<3
48	Chloroform	mg/l	<1	<1
49	1,2 Dichloro ethylene	mg/l	<2.4	<2.4
50	Trichloro ethylene	mg/l	<1	<1
51	Trichloro benzene	mg/l	<2	<2
52	Hexaxhloro cyclohexene	mg/l	<2	<2

* "Protected public water area" is set in this standard. All effluent including industries should be applied to standard of "Public water area and sewer" since the protected area is not specified yet currently.

Source: Sub-Decree on Water Pollution Control, Annex 2: Effluent standard for pollution sources discharging wastewater to public water areas or sewer.

2.4.2 Air Quality Standard

Air quality standards are prescribed in the Sub-Decree, Anukret No. 42/ANK/BK of July 10, 2000, "ANUKRET on The Control of Air Pollution and Noise Disturbance". The standard values are shown in **Table 2.4.4**.

Table 2.4.4 Ambient Air Quality Standard

No.	Parameter	1 Hour Average mg/m3	8 Hours Average mg/m^3	24 Hours Average mg/m^3	1 Year Average mg/m^3
1	Carbon Monoxide (CO)	40	20		
2	Nitrogen Dioxide (NO_2)	0.3		0.10	
3	Sulfur Dioxide (SO_2)	0.5		0.30	0.10
4	Ozone (O_3)	0.2			
5	Lead (Pb)			0.005	
6	Total Suspended Particulate (TSP)			0.33	0.10

Note: This standard applies to ambient of air quality and to monitoring of air pollution status. Method for analysis of ambient air quality is specified in the guideline of the MOE.

Source: Annex to Anukret No. 42/ANK/BK of July 10, 2000, ANUKRET on the Control of Air Pollution and Noise Disturbance

2.4.3 Noise Standard

Noise standard is prescribed in the Sub-Decree, Anukret No. 42/ANK/BK of July 10, 2000, "ANUKRET on The Control of Air Pollution and Noise Disturbance" as well as air quality. The standard values are shown in **Tables 2.4.5 to 2.4.7**.

Table 2.4.5 Maximum Standard of Noise Emission Level Allowable for Vehicles on Public Roads

No.	Category of Vehicles	Maximum Noise Level Permitted [dB (A)]
1	Motorcycles, cylinder capacity (cc) of engine <125cm3	85
2	Motorcycles, cylinder capacity (cc) of engine >125cm3	90
3	Motorize Tricycles	90
4	*Cars, taxi, bus with capacity of < 12 passengers*	80
5	Bus with capacity of > 12 passengers	85

No.	Category of Vehicles	Maximum Noise Level Permitted [dB (A)]
6	Truck with loading capacity of <3.5 tons	85
7	Truck with loading capacity of > 3.5 tons	88
8	Truck with engine capacity of > 150 kw	89
9	Other machinery (tractors/trucks) that are not listed above	91

Note: This standard is applied to control noise emission for all kinds of vehicles when operating on public roads.
Source: ANNEX 5 in Anukret No. 42/ANK/BK of July 10, 2000

Table 2.4.6 Maximum Standard of Noise Level Allowable in Public and Residential Areas [dB(A)]

No.	Areas	Period of Time		
		From 6AM Onwards	18PM	From 18PM Onwards
1	Quiet Areas - Hospitals - Libraries - School - Kindergarten	45	40	35
2	Residential Areas - Hotels - Administrative office - Villa, Flat	60	50	45
3	Commercial and Service Areas and Area of multiple businesses	70	65	50
4	Small industrial factories mingling in residential area	75	70	50

Note: This standard is applied to control noise level of any source or activity that emit noise into public and residential areas.
Source: ANNEX 6, in Anukret No. 42/ANK/BK of July 10, 2000

Table 2.4.7 Noise Control Standard at Workshop, Factory and Industry

Noise Level [dB (A)]	Maximum Period of Time	Level
75	32	Ear protection equipment must be provided to workers who work at a location with a noise level over 80dB(A)
80	16	
85	8	
90	4	
95	2	
100	1	
105	0.5	
110	0.25	
115	0.125	

Note: This standard is applied to control of noise level in location of workshop, industries and factories.
Source: ANNEX 7 in Anukret No. 42/ANK/BK of July 10, 2000

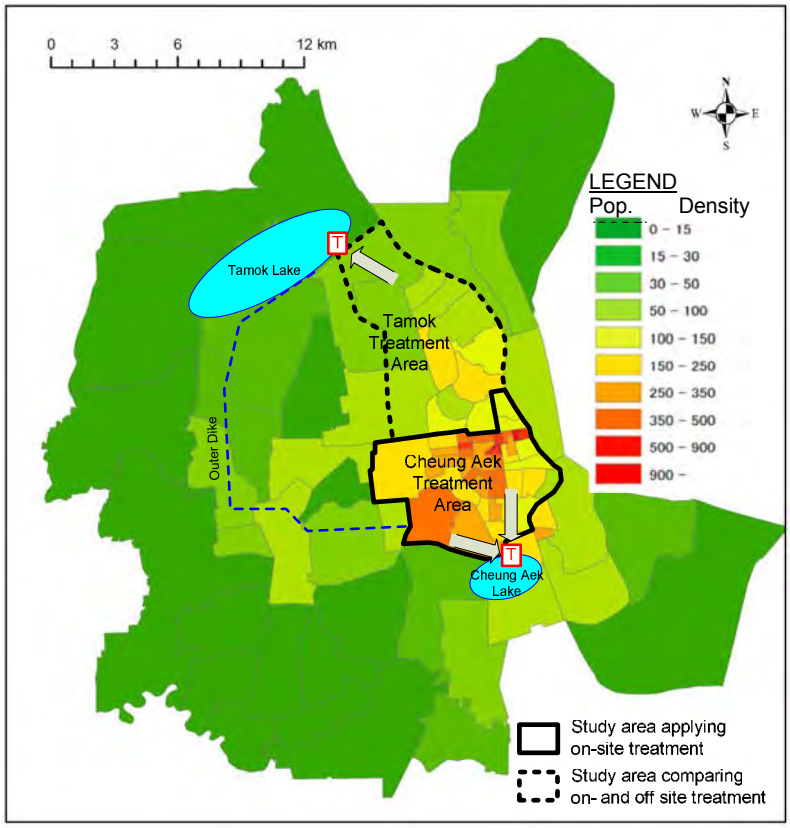
CHAPTER 3 DESCRIPTION OF PRIORITY PROJECT

3.1 Priority Project for Pre-Feasibility Study in the Sewerage Management

The priority project proposed for pre-feasibility study in the Sewerage Management Master Plan is located adjacent to the Cheung Aek Treatment Area (see **Fig. 3.1.1**), The pre-F/S is to achieve technical skill and accumulate experience in construction, operation and maintenance work in preparation for the full-scale construction and operation of sewerage facilities in parallel with the establishment of institutional and legal framework, considering the current lack of institutional and legal provisions for sewerage management in Phnom Penh. The Priority project is to be subject to the required preliminary environmental study.

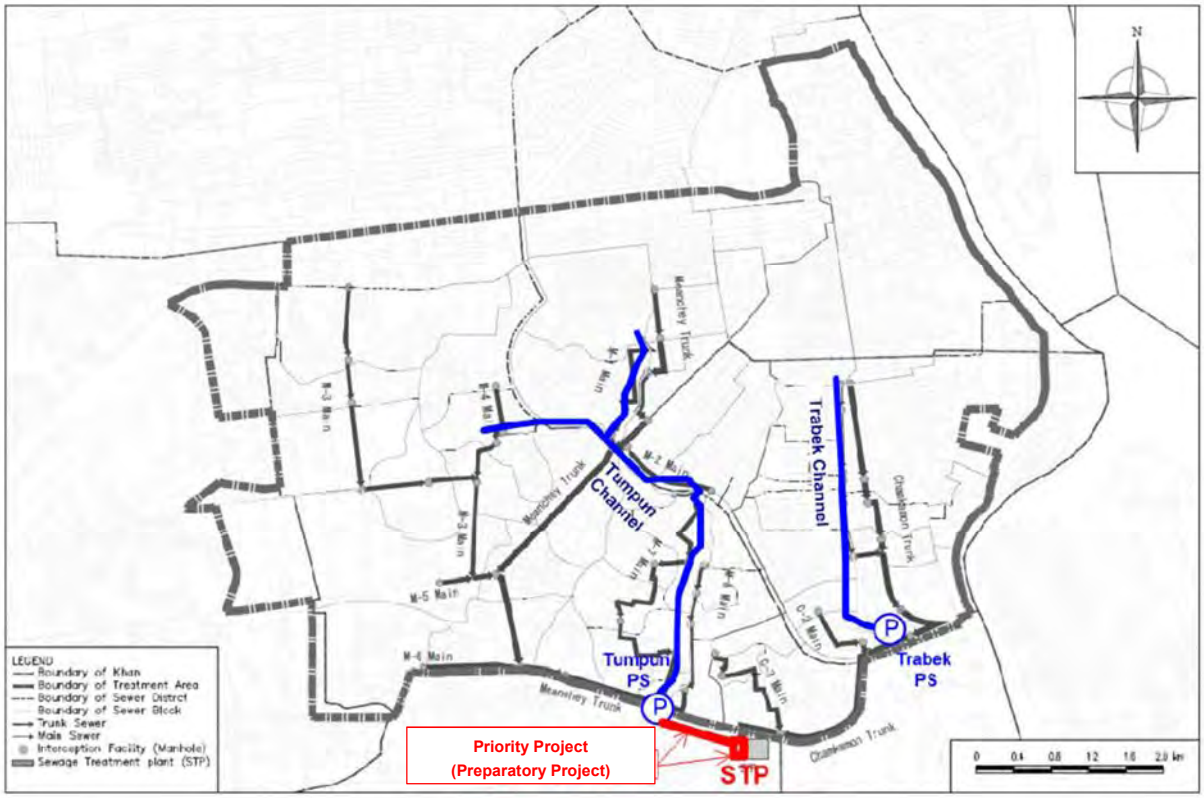
The priority project covers "Preparatory Project" consisting of a small-scale sewage treatment plant (STP) and sewer pipes to collect and convey wastewater from the STP. The STP has the capacity of 5,000 m^3/day which is deemed as the minimum to demonstrate its performance, as well as the effectiveness of treatment method. The sewer pipe is to collect wastewater from the Tumpun Pumping Station which is located in the west of the STP construction site, as shown in **Fig. 3.1.2** and **Table 3.1.1**, The STP applies the Conventional Activated Sludge Process (CASP) as the wastewater treatment method as shown in **Table 3.1.2**.

Along with the sewage treatment facilities, some measures such as landscaped pond for the people are to be proposed in the Pre-F/S to visualize accomplishments and enhance public relations.



Source: JICA Study Team

Fig. 3.1.1 Target Area for Off-Site Sewage Treatment



Source: JICA Study Team

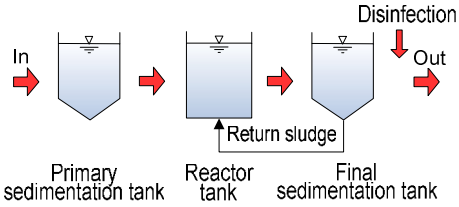
Fig. 3.1.2 Location Map of Priority Project in Cheung Aek Treatment Area

Table 3.1.1 Components of Priority Project in Cheung Aek Treatment Area

Component	Contents
Sewer Pipe	Diameter : φ500 mm Length :about1,300 m
STP	Capacity: 5,000 m^3/dairy maximum Conventional Activated Sludge Process (CASP): Approximately 3.5 ha (total area in Cheung Aek Lake)

Source: JICA Study Team

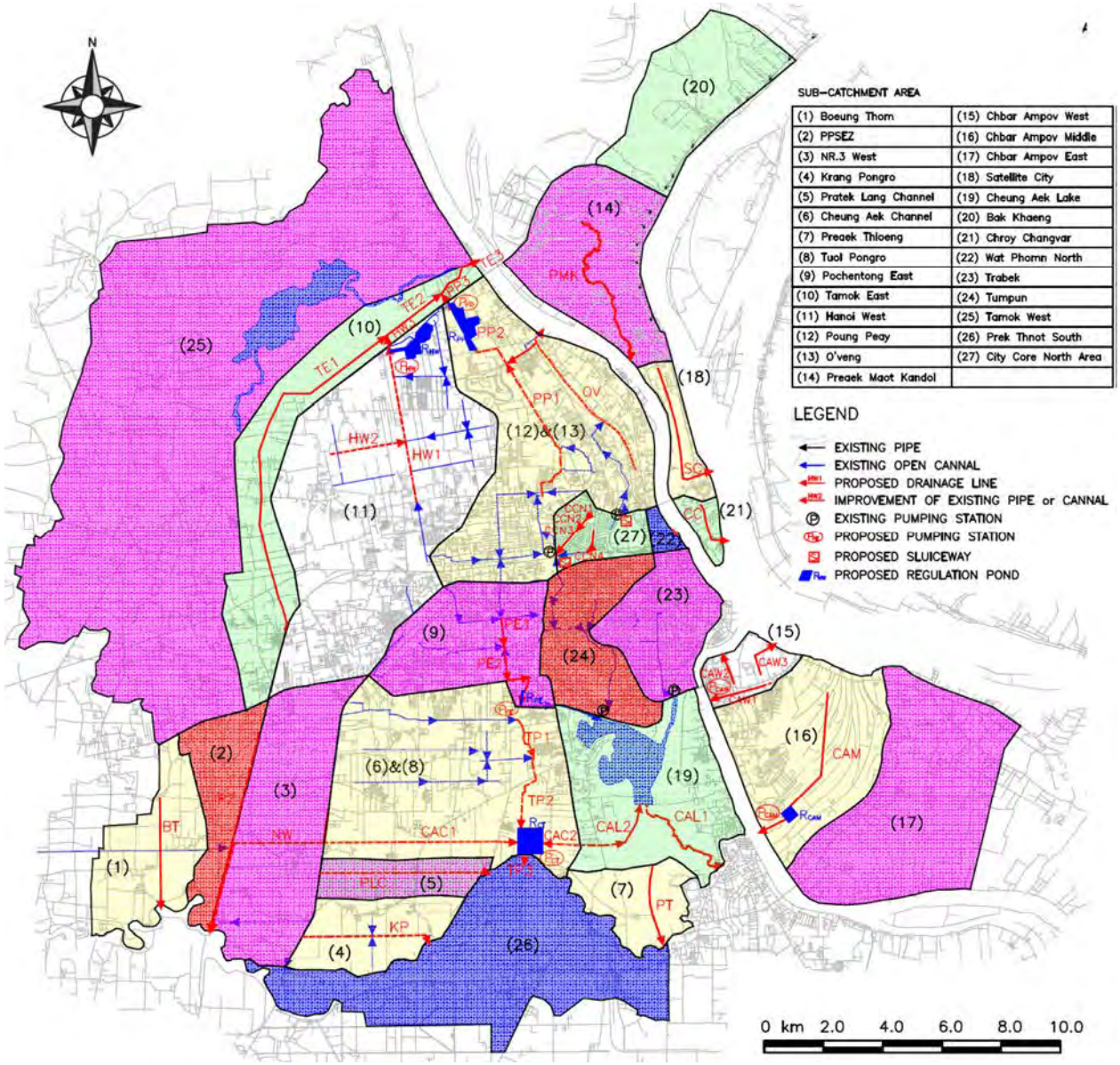
Table 3.1.2 Characteristics of the Treatment Method (CASP: Conventional Activated Sludge Process)

Method	Flow	Salient Features
Conventional Activated sludge process (CASP)		• Pro: High efficiency in pollution load reduction and the small land requirement. • Con: Equipment is large in number and unit cost of treatment is the highest. Further, sophisticated technique is required.

Source: JICA Study Team

3.2 Priority Project for Pre-Feasibility Study in the Drainage Management

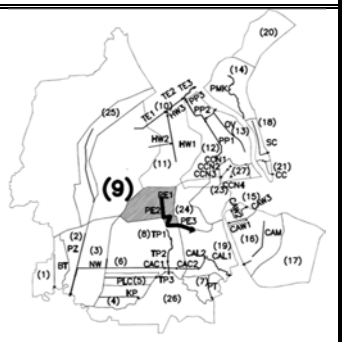
The priority project proposed for Pre-F/S in the Drainage Management Master Plan (see **Fig. 3.2.1**) shall also be subject to Preliminary Environmental Study. The priority project is proposed in Pochentong East Drainage Area (Drainage Area No. 9). Outline of the Pochentong East Drainage Area and components of the priority project are summarised in **Tables 3.2.1** and **3.2.2**, respectively.



Source : JICA Study Team

Fig. 3.2.1 General Layout of Proposed Drainage Management Master Plan

Table 3.2.1 Outline of Pochentong East Drainage Area (Drainage Area No. 9)

Item	Description	
Location	The area includes Phnom Penh International Airport (former Pochentong International Airport) and its adjacent area in the east and southeast, bordered by National Road No. 4 on the north and west, Veng Sreng Road (former BOT road) on the south, and catchment boundary of Tumpun Drainage area on the east.	
Land-use	Present: high density residential area, commercial and industrial area (factory, shop). Future: high density residential areas, commercial and industrial area, economic development zone.	
Salient features of drainage area	This area is topographically flat and is in most urbanized area of Phnom Penh. Urbanization is to the west in recent years.	
Issues	Installation of drainage facilities have not been catching up with rapid urbanization. Inundation occurs especially in the southern part of the area. With the progress of urbanization, inundation damage will be bigger.	
Strategy for improvement	Installation of new box culvert is proposed to connect existing drainage channels/pipes, and drain stormwater to Cheung Aek Lake through Veng Sreng road (former BOT road) and new pumping station and Moul drainage channel.	
Structural measures	Box culvert, Pumping station, Regulation pond and Drainage channel.	

Source: JICA Study Team

Table 3.2.2 Components of Priority Project in Drainage Management

Name of project	Facilities	Specification/Capacity
Construction of drainage facilities in Pochentong East, Drainage Area (Drainage Area No. 9)	Drainage channel	・Construction of box culvert: 5,220 m ・Construction of inlet channel: 480 m ・Rehabilitation of existing channel：2,660 m
	Pumping station	・ 1 location: Capacity 40 m^3/s
	Regulation pond	・ 1 location :Area required: 25,000 m^2

Source：JICA Study Team

CHAPTER 4 DESCRIPTION OF ENVIRONMENTAL RESOURCES

4.1 Natural Environmental Resources

4.1.1 Physical Resources

The Royal Government of Cambodia has 181,035 km^2 of the land. The country borders with Thailand to the north and west, Laos to the northeast, and Vietnam to the east and southeast. The country area is surrounded by the Cardamom Mountains and the Dângrêk Mountains at the west to north bordering with the Thailand and Mondorukiri Plateau at the border with the Vietnam. Most of the country area is below 100 m and the Mekong River and its tributaries flow in the middle of the country. All the area in the country falls into the tropical monsoon climate zone having about 27.7ºC of the average temperature and about 1,500 mm of annual rainfall, with the dry season from May to November and the rainy season from December to April.

Phnom Penh is located in alluvial lowland at the right bank of the confluence of Mekong and Sap Rivers, and at the fork of Mekong and Bassac Rivers. Old Phnom Penh City is located on natural levee, and the suburban residential area is in swampy plain, which is prone to inundation. The area is relatively topographically flat and its elevation is lower than the maximum water level of the Mekong River that reaches more than 10 m in the rainy season. Therefore, the urban and suburban areas of Phnom Penh are highly prone to flooding, despite being surrounded by dikes. The urbanization in the outskirts has been progressing in recent years, and lots of lakes and swamps in and around Phnom Penh have been reclaimed, resulting in inundation.

(1) Geology

In terms of geological conditions of Cambodia, almost all of the land is situated on relatively-new ground, such as quaternary sedimentary rocks and unconsolidated sediments. Relatively old soil such as the upper Jurassic-cretaceous sedimentary unit, exists in the northeast area. Lower-middle Jurassic sedimentary units are situated in the southwest part of Cambodia. Phnom Penh is mainly located on quaternary sedimentary rocks.

(2) Topography

In the administrative area of PPCC, the topography is relatively flat and its elevation is lower than the maximum water level of the Mekong River during the rainy season. The maximum water level of the Mekong River is more than 10 m, while the ground elevation in the east of Phnom Penh is lower than 7.5 m. Therefore, the urban and suburban areas of Phnom Penh are highly prone to flooding, despite being surrounded by dikes.

(3) Soil Erosion and Sedimentation

Geologic structure of the Mekong Delta region, where the Study Area is situated, had been formed in Precambrian to Holocene ages. Old Alluvium was formed in deltaic shape between the Pliocene and Pleistocene by the Mekong and its tributaries and then Holocene deltaic alluvium was formed. The Holocene Alluvium, mainly consisting of unconsolidated silt and clay with some lenses of sand, virtually blankets the entire delta. The Holocene Alluvium in and around the Study Area generally has a thickness of less than 25 m.

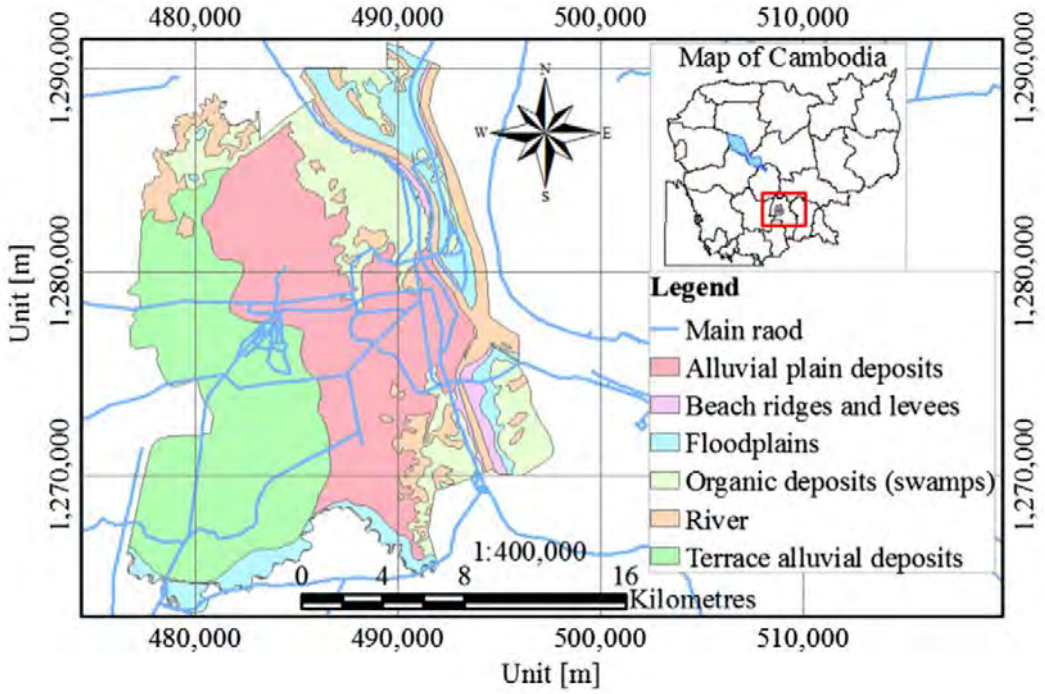
The Holocene Alluvium differs from the Old Alluvium in having a generally finer texture, almost no laterite, and a relative abundance of shell and lignite layers. The surface geological condition of PPCC is characterised by the sandy mud covered on base terrane inclined from west to east, as well as soft clay layer at some places.

The ground mainly consists of sand up to about 44 m depth in the underground and the gravel appears in some places, according to a boring data of Mekong Bridge at Kampong Cham where the low lands spread out in the northeast of Phnom Penh. Near the National Route 6A at about 40 km north of Phnom Penh, wetlands spread out and the clay layer reaches to 24 m depth and N value become high in more than 10 m depth, which indicate the layer was formed in old age, according to the boring data around the area. There is the hill and alluvial fan of Prek Thnot in the west of Phnom Penh plain, and there exists base rock around 30 m as well as clay and sand which includes coarse sand and gravel, according to a deep well survey in the alluvial fan.

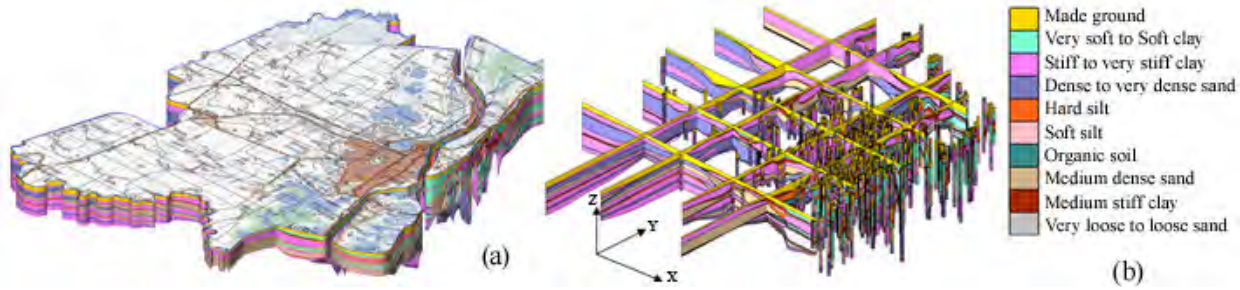
In the central area of Phnom Penh, monadnock of basic rock is found under Wat Phnom area, and basic rock is found in relatively shallow depth under Chroy Changvar bridge (about 7 m depth) and Phnom Penh port (about 17 m). No basic rock is found up to 36 m in the southern area where the Japanese Embassy is located, and thick organic clay is found in some places.

Soft clay continues up to 27 m in depth, according to the boring data of irrigation facilities project at the Mekong River banks. Deep well data of Svay Rieng Province at left bank of Mekong at southeast of Phnom Penh plain, shows that basic rock is not found up to 130 m in depth and all sediment are formed in Quaternary Age. The results of geophysical prospecting shows that the structure stretches in north and south and fall down to east. On the other hand, there is a monadnock named Ba Phnom on the left bank side, which shows that the geographical structure of the base layer is complex. (Source: KUBO, 2001, Abstracts, 5thICG.Kubo, 2002, Japan Geography Society summary collection No. 61)

Two-Dimensional and Three-Dimensional Phnom Penh Geological Maps are shown in **Fig. 4.1.1**.



Source: Geological Map of Phnom Penh City (reproduced form JICA and MPWT, 2003)



Source: Engineering Geology, 178, and 3D geological modeling and geotechnical characteristics of Phnom Penh Sub-soils in Cambodia (58-69(2014)

Fig. 4.1.1 Two-Dimensional and Three-Dimensional Phnom Penh Geological Maps

(4) Climate

Phnom Penh has a tropical monsoon climate. The average annual rainfall recorded between 2000 and 2010 was 1,500 mm. The minimum annual rainfall was 1,171 mm (in 2006) while the maximum was 2,147 mm (in 2000). The dry season, from December to April, has few rainy days between January and March. On the other hand, the rainy season, from May to November, records more than 80% of the annual rainfall.

(a) Temperature

Phnom Penh experiences high temperature and high humidity. The maximum and lowest monthly average temperatures in Phnom Penh between 2000 and 2010 are 35.4°C and 22°C, respectively, and the seasonal fluctuation of temperature is not large. The temperature from March to May is relatively high, and the highest temperature recorded in the past 11 years was 40°C in May 2010. The annual average humidity between 2000 and 2010 was 76.3%.

(b) Wind Direction and Speeds

Wind speed tends to be stronger in the dry season than that in the rainy season. The maximum wind speed between 2001 and 2010 was 20 m/s, which was recorded in June 2006. Generally, the wind flows to the northern direction from October to January, south-eastern from February to April, and western to south-western from May to September.

(c) Evaporation

The daily average evaporation between 2000 and 2010 is 4.6 mm. The daily maximum evaporation in the rainy and dry seasons is 9.5 mm and 43.8 mm, respectively. The seasonal variation of evaporation in the dry season is five times of that in the rainy season.

(5) Hydrology

The water level of the Mekong River is measured at Chrauy Changva Station, while that of the Sap River is measured at Chaktmuk and Phnom Penh Port stations by MOWRAM. The highest water level of Bassac and Sap rivers is generally recorded during August to October. Among annual highest water level in recent 5 years (2009-2013), the highest water level of Bassac River is 9.84 m (2011) and lowest level is 7.47 m (2010). On the other hand, water level during March to May is very low (1.2 m). Annual variation of the river water levels sometimes reaches approximately 8.0 m.

The river flows have seasonal fluctuations: the maximum flow of the Mekong River is more than 30,000 m^3/s during the rainy season when it counter-flows towards Sap River.

(6) Water Quality

The JICA study, Drainage and Sewerage Improvement Project in Phnom Penh Metropolitan Area, conducted a range of water quality monitoring in 2014 as their baseline survey, in rivers, lakes and some effluent in 3 times respectively in the dry and rainy season. The result shows water pollution at the surrounding area of the capital, having low concentration of DO, and high concentration of TSS, BOD, COD, T-N and T-P. The monitoring results are detailed below.

(a) Monitoring Locations and Parameters

Water monitoring and analysis was implemented by the JICA Study Team. The survey was independent from MOE's monitoring survey. Locations of monitoring are shown in **Table 4.1.1**. Sixteen monitoring locations in total include river, lake/swamp, small channel, factory and commercial facilities. Samplings were conducted 6 times (3 times in the dry season and 3 times in the rainy season).

Table 4.1.1 Monitoring Points and Parameters in the Study

No.	Category	Monitoring Point	Parameters	Remarks
1	River	Sap River (Phnom Penh Port)	pH, DO, BOD_5, COD_{Cr}, COD_{Mn}, TSS, T-N, T-P, Total Coliform (9 parameters)	Surface water is taken from the riverside
2		Mekong River (Kien Svay)		
3		Bassac River (Thakhmao)		
4	Lake/swamp	Tamok Lake (Discharge Point)		Water is taken at discharge point of the lake/swamp
5		Cheung Aek Lake (Discharge Point)		
6	Small Channel	Kop Slov Pumping Station	pH, DO, BOD_5, COD_{Cr}, TSS, T-N, T-P, Total Coliform (8 parameters)	Surface water is taken at the middle of channels. The points of factory and commercial facilities are selected in collaboration with DOE/PPCC.
7		Svay Pak Sluiceway		
8		Trabek Pumping Station		
9		Tumpun Pumping Station		
10		Prek Thnot River (Thakhmao Bridge)		<Treatment Facility>
11	Factory	Men Sarun (Noodle Factory)		Septic Tank
12		SKD (Liquor Factory)		Digestion Tank+Lagoon
13		SL (Garment and Washing)		Activated sludge process+Chemical

No.	Category	Monitoring Point	Parameters	Remarks
				treatment
14	Commercial Facilities	Phnom Penh Tower (Office Building)		Activated sludge process
15		Intercontinental Hotel		Septic tank+Aeration
16		Central Market		Septic tank

Note: COD_{Mn} is monitored at rivers to compare the COD_{Mn} of lake and swamp, at which COD_{Mn} is regulated.
Source: JICA Study Team

(b) Survey Result

Monitoring results in total 6 times are enumerated below. Minimum, maximum and average at each monitoring point, are summarised in **Table 4.1.2.**

- *pH;* Most of pH met the standard. At 2nd monitoring in the rainy season at Mekong River (Point No. 2, Time monitored: 11 o'clock) and 3rd monitoring in the rainy season at SKD (Point No.12, Time monitored: 8 o'clock), the pH exceeded the standard to a large extent.

- *DO;* At Trabek Pumping Station (Point No. 8) and Tumpun Pumping Station (Point No. 9), receiving wastewater from the Cheung Aek Lake Basin, DO were extremely low. In particular, at point No.8, almost all values were 0.0 mg/L, showing high contamination.

- *TSS;* Maximum TSS was recorded at Trabek Pumping Station (Point No. 8, Time monitored: 11 o'clock) with 740 mg/L in 2nd monitoring in the dry season, followed by 640 mg/L recorded at Svay Pak Sluiceway (Point No. 7, Time monitored: 11 o'clock) in 2nd monitoring in the dry season. High TSS at Point No. 7 is due to solids and sand, and is due to wastewater at Point No. 8.

- *BOD_5;* BOD_5 at Trabek Pumping Station (Point No. 8) were as a whole very high and the BOD_5 intensively increases from the end of the rainy season to the dry season. The maximum at the point was 299.9 mg/L recorded in 2nd monitoring (Time monitored: 11 o'clock) in the dry season. At Tumpun Pumping Station (Point No. 9), similar trend was observed. The maximum at the point was 249.5 mg/L in 2nd monitoring (Time monitored: 12 o'clock) in the dry season. Among the factories and commercial facilities, only the value at Central Market (Point No. 16) exceeded the effluent standard, with maximum value of 292.5 mg/L (Time monitored: 13 o'clock).

- *COD_{Mn} and* COD_{Cr}*;* COD_{Mn} at Tamok Lake (Point No. 4) and Cheung Aek Lake (Point No. 5) exceeded the standard of 8.0 mg/L, except for 1st monitoring in the rainy season. The maximum COD_{Cr} was 595.8 mg/L recorded at Men Sarun (Point No. 11) in 2nd monitoring (Time monitored: 10 o'clock) in the dry season.

- *T-N and T-P;* The maximum T-N was 26.3 mg/L recorded at Trabek Pumping Station (Point No. 8) in 2nd monitoring (Time monitored: 8 o'clock) in the rainy season, followed by 26.1 mg/L recorded at Intercontinental Hotel (Point No. 15) in 2nd monitoring (Time monitored: 15 o'clock) in the rainy season. The maximum T-P was 5.81 mg/L recorded (Time monitored: 14 o'clock) at Central Market (Point No. 16) followed by 4.95 mg/L recorded (Time monitored: 12 o'clock) at Tumpun Pumping Station (Point No. 9) and 4.50 mg/L (Time monitored: 11 o'clock) at Trabek Pumping Station (Point No. 8), which were all recorded in 2nd monitoring in the dry season.

- *Total Coliform;* Most of the values recorded at Sap River (Point No. 1), Mekong River (Point No. 2), Bassac River (Point No. 3) and Prek Thnot River (Point No. 10) exceeded the standard for river (5.0×10^3 MPN/100ml). Similarly, values measured at Tamok Lake (Point No. 4) and Cheung Aek Lake (Point No. 5) also exceeded the standard for lake (1.0×10^3 MPN/100ml).

Table 4.1.2 Minimum, Maximum and Average at Monitoring Points in the Study

No.	Location		pH (-)	DO (mg/L)	TSS (mg/L)	BOD_5 (mg/L)	COD_{Mn} (mg/L)	COD_{Cr} (mg/L)	T-N (mg/L)	T-P (mg/L)	Total Coliform (MPN/100 ml)
1	Tonle River	Min	6.17	3.44	72.0	2.79	3.98	22.64	0.09	0.01	1.1E+04
		Max	7.73	5.51	214.0	5.18	8.14	43.12	0.91	0.06	9.3E+05
		Average	6.91	4.47	124.3	4.05	6.04	32.40	0.43	0.04	2.2E+05
2	Mekong River	Min	4.20	4.37	98.0	0.90	2.79	19.60	0.13	0.04	2.9E+03
		Max	7.54	5.82	364.0	3.06	6.20	37.50	1.67	0.28	7.5E+05
		Average	6.41	5.15	179.5	2.04	4.51	27.67	0.54	0.09	1.8E+05
3	Bassac River	Min	5.83	4.18	95.0	0.50	3.05	15.68	0.48	0.05	4.6E+03
		Max	7.40	5.71	332.0	3.75	6.80	27.44	1.67	0.28	2.4E+06
		Average	6.71	4.83	165.2	2.06	4.38	22.30	0.84	0.14	4.4E+05
4	Tamok Lake	Min	6.61	4.72	59.0	2.90	4.31	33.80	0.66	0.12	2.3E+04
		Max	9.16	7.59	102.0	6.44	12.29	62.40	4.86	0.51	2.4E+05
		Average	7.64	6.06	85.8	5.17	9.76	49.43	1.74	0.30	9.8E+04
5	Cheung Aek Lake	Min	6.37	0.64	26.0	3.60	6.95	35.27	1.78	0.31	2.3E+04
		Max	7.38	4.85	164.0	9.69	18.24	74.16	4.76	0.76	7.5E+05
		Average	6.85	2.06	95.7	7.13	13.11	54.48	3.45	0.53	2.3E+05
6	Kop Slov Pumping Station	Min	6.10	0.13	84.0	10.80	-	36.84	2.23	0.99	1.5E+04
		Max	7.42	6.10	154.0	26.73	-	59.00	6.65	2.17	1.1E+06
		Average	6.92	2.82	106.5	18.05	-	46.00	3.49	1.47	3.2E+05
7	Svay Pak Sluiceway	Min	5.82	0.00	134.0	88.00	-	50.96	3.44	0.36	2.1E+04
		Max	7.23	3.57	640.0	156.62	-	90.16	8.80	2.10	2.4E+07
		Average	6.73	1.59	315.0	121.35	-	74.21	5.75	1.19	4.2E+06
8	Trabek Pumping Station	Min	6.66	0.00	72.0	89.00	-	116.52	2.74	1.17	2.1E+04
		Max	7.06	0.07	740.0	299.85	-	247.61	26.31	4.01	9.3E+06
		Average	6.85	0.03	254.5	243.05	-	195.71	11.13	2.18	1.8E+06
9	Tumpun Pumping Station	Min	6.09	0.00	142.0	112.00	-	92.18	3.32	0.59	2.3E+04
		Max	7.27	0.73	480.0	249.50	-	196.37	21.90	4.95	1.5E+07
		Average	6.79	0.13	237.5	164.09	-	132.06	10.62	2.01	2.7E+06
10	Prek Thnot River	Min	6.18	0.98	170.0	7.38	-	31.32	1.84	0.19	3.5E+03
		Max	7.39	5.10	474.0	20.69	-	48.12	6.96	1.83	9.3E+06
		Average	6.77	3.02	248.5	12.84	-	41.32	4.06	0.77	1.6E+06
11	Men Sarun (Noodle Factory)	Min	4.30	2.60	108.0	36.40	-	48.80	0.75	0.16	2.8E+04
		Max	7.25	6.12	478.0	127.50	-	595.84	4.10	1.04	1.1E+06
		Average	6.15	4.83	218.8	79.70	-	251.24	2.91	0.56	6.1E+05
12	SKD (Liquor Factory)	Min	3.35	1.03	52.0	30.75	-	48.76	0.59	0.14	7.5E+03
		Max	7.32	6.78	98.0	47.06	-	104.16	5.96	1.58	2.4E+05
		Average	6.34	3.09	79.2	39.34	-	71.36	2.33	0.54	1.4E+05
13	SL (Garment and Washing Factory)	Min	6.30	2.60	52.0	36.95	-	70.68	4.87	0.18	1.5E+03
		Max	7.51	6.35	128.0	65.52	-	160.72	14.75	2.18	7.5E+05
		Average	6.96	4.38	80.8	45.17	-	112.29	8.61	0.57	1.9E+05
14	Phnom Penh Tower (Office Building)	Min	5.48	0.00	86.0	15.70	-	49.60	4.08	2.55	2.3E+04
		Max	7.21	3.10	302.0	72.54	-	101.40	10.88	3.63	7.5E+05
		Average	6.63	1.67	201.7	37.37	-	79.90	7.56	3.01	1.7E+05
15	Intercontinental Hotel	Min	5.38	4.70	64.0	21.06	-	58.82	7.92	1.09	2.1E+04
		Max	7.83	5.72	268.0	75.58	-	84.88	26.14	2.96	2.1E+07
		Average	7.03	5.10	149.2	41.41	-	74.37	13.10	2.13	3.6E+06
16	Central Market	Min	4.70	0.00	144.0	135.62	-	202.80	7.21	2.24	2.3E+04
		Max	6.95	0.34	276.0	292.50	-	356.72	22.08	5.81	7.5E+07
		Average	6.17	0.07	190.0	212.91	-	283.35	11.19	3.38	1.3E+07
Standard for Monitoring Point											
	No. 1 to 3		6.5-8.5	>2.0	<100	<10	-	-	-	-	5.0E+03
	No. 4 to 5		6.5-8.5	>2.0	<15	-	<8	-	<1.0	<0.05	1.0E+03
	No. 6 to 16		5.0-9.0	>2.0	<120	<80	-	<100	-	-	-

Source: JICA Study Team

(7) Air Quality

Available air quality monitoring as secondary information is still limited in Cambodia. Results of the monitoring of ambient air pollution (Project for Comprehensive Urban Transport Plan in Phnom

Penh Capital City, 2014,) are shown in **Tables 4.1.3** to **4.1.5**. As shown in the tables, CO, NO_2 and SO_2 values are within the standard. However, the dust parameters of particulate matters (PM 2.5, PM 10) are very high. The trend also found in the record in 2001 was high Total Suspended Particles (TSP).

Table 4.1.3 Air Quality Monitoring in Phnom Penh

No.	Parameter	2008	2009	2010	2011	2012
1	Carbon Monoxide (CO ppm)					
	Kbarl Thnol Fly Over	7.12	8.78	9.03	7.72	7.22
	Olympic Stadium Roudabout	8.09	8.75	10.15	8.59	7.08
	Tuol Kok Intersection	7.15	9.27	8.62	7.65	7.39
2	Nitrogen Dioxide (NO_2 ppm)					
	Kbarl Thnol Fly Over	0.028	0.031	0.022	0.022	0.030
	Olympic Stadium Roudabout	0.030	0.037	0.024	0.029	0.034
	Tuol Kok Intersection	0.025	0.035	0.029	0.031	0.036

Note: 24hr survey
Source: MOE, Project for Comprehensive Urban Transport Plan in Phnom Penh Capital City, 2014

Table 4.1.4 Air Quality along Road National Road No. 4 in Phnom Penh

Type	Unit	Point 1 (7 Makara)	Point 2 (Sen sok)	Point 3 (near Hanoi Road Junction)	Point 4 (Airport)	Point 5 (near Junction with NH3)	Cambodian Standard	WHO Standard
CO	mg/m^3	2.86	1.79	2.86	3.58	3.58	20	
NO_2	mg/m^3	0.057	0.029	0.045	0.056	0.058	0.1	
SO_2	mg/m^3	0.033	0.027	0.027	0.025	0.033	0.3	
PM2.5	$\mu g/m^3$	128	107	284	186	248	n.a.	25
PM10	$\mu g/m^3$	93	68	150	71	169	n.a.	50

Note: The results are average of 24 hours continuous survey
Source: Project for Comprehensive Urban Transport Plan in Phnom Penh Capital City, 2014

Table 4.1.5 Ambient Air Pollution in Phnom Penh

Parameters	2000		2001		2002		2014	
	Mean	Max	Mean	Max	Mean	Max	Mean	Max
CO (mg/m^3)	3.06	7.12	1.98	2.42	3.50	5.71	3.02	3.87
NO_2 ($\mu g/m^3$)	32.08	47.17	2.45	3.77	30.19	56.60	24	71
SO_2 ($\mu g/m^3$)	-	-	2.60	7.80	7.80	13.00	10	27
TSP (mg/m^3)	-	-	0.63	0.84	0.41	1.00	0.128	0.169

CO=Carbon Monoxide: mg/m^3=milligrams per cubic meter; $\mu g/m^3$=micrograms per cubic meter; NO_2=Nitrogen Dioxide; TSP=Total Suspended Particles. Mean Value in the 2014 were received as tentative values.
Source: MOE (2014), ADB 2006 Country Synthesis Report on Urban Air Quality Management, "Research collaboration with Yokohama University from 2000-2002.
Quoted in MOE and Ministry of Health (2006). Country Report: Cambodia, Hang Dara, Chin Chamroeun, Sourn Pun Lork, and Chim Sophan, Paper presented at the Clean Air for Asia Training Course for Developing Countries, Thailand, 24 May-02 from ADB

4.1.2 Biological Resources

(1) Forest

Although there are some patches of tree vegetation remaining in the capital in a private garden or a city park, there is no legally recognized forest area in Phnom Penh capital.

The forest area in the country was managed by the Ministry of Agriculture, Forest and Fisheries (MAFF). According to the FAO (2010), the total forest area in Cambodia in 2010 was estimated at 10,094,000 hectares (ha), which covers 57% of the land area. As a general trend in Cambodia, the extent of forest area has been declining and around 127,000 ha of forest have been converted to

other uses or lost through natural causes every year from 2005 to 2010 with the annual deforestation rate of 1.2%.

(2) Biodiversity and Ecology System

Cambodia accommodates more than 135 species of mammals, 599 species of birds, 173 species of reptiles, 72 species of amphibians, 350 species of moths and butterflies, 955 fresh and marine fish and aquatic species, and more than 4,500 vascular plant species (2014, The Fifth National Report to the Convention on Biological Diversity). Located at the middle Cambodia, Phnom Penh also has similar potential for biodiversity. Among the species, 74 vertebrate animal and 23 plant species were listed as endangered species in the Red List in the IUCN at 2011. The status is shown in **Table 4.1.6**.

Table 4.1.6 Status of Endangered Species in Cambodia

Red List Species		Red List Status	
Taxon	Total	Type	Total
Mammal	26	VU	18
		EN	6
		CR	2
Bird	26	VU	9
		EN	10
		CR	7
Reptile	11	VU	7
		EN	3
		CR	2
Amphibians	2	VU	2
		EN	0
		CR	0
Fish	9	VU	0
		EN	6
		CR	3
Plant	23	VU	0
		EN	13
		CR	10

Source: National Biodiversity Steering Committee in Kingdom of Cambodia (2014) 5th National Report to the Convention of Biological Diversity based on the IUCN 2011 and Bird Life International Cambodian Program 2013

(3) Protected Area

There is no protected area in Phnom Penh Capital. In Cambodia, naturally important environmental features are protected under No. 07 NS/RKM/2008, Protected Areas Law (Royal Decree No. NS/RKM/2008/007). The protected areas are classified into four types depending on the purpose: 1) Natural Park: Areas reserved for nature and scenic views and to be protected for scientific, educational and entertainment purposes; 2) Wildlife Preserves: Areas preserved in their natural condition to protect wildlife, vegetation and ecological balance; 3) Protected scenic view areas: Areas to be maintained as scenic spots for leisure and tourism; and 4) Multi-purposes areas: Areas necessary for the stability of the water, forestry, wildlife, and fisheries resource, for pleasure, and for the conservation of nature with a view of assuring economic development. Name of protected areas in the country are shown in **Table 4.1.7**.

Table 4.1.7 Protected Areas in Cambodia

National Parks in Cambodia			
	Name	Province	Area (ha)
1	Kirirom	Kampong Speu and Koh Kong	35,000
2	Bokor	Kampot	140,000
3	Kep	Kampot	Originally 5,000 Later amended to 1,152
4	Ream	Kampong Som	150,000

5	Botum Sakor	Koh Kong	171,250
6	Phnom Koulen	Siem Reap	37,500
7	Virachey	Stung Treng and Ratanik Kiri	332,500
Wildlife preserves in Cambodia			
	Name	Province	Area (ha)
1	Phnom Aural	Koh Kong, Pursat, Kampong Chhnang	253,750
2	Peam Krasop	Koh Kong	23,750
3	Phnom Samkos	Koh Kong	333,750
4	Roneam Donsam	Battambang	178,750
5	Koulen Prum Tep	Siem Reap and Preah Vihear	402,500
6	Beng Per	Kampong Thom	242,500
7	Lumphat	Ratanak Kiri and Mondul Kiri	250,000
8	Phnom Prich	Mondul Kiri and Kratie	222,500
9	Phnom Namlear	Mondul Kiri	47,500
10	Snuol	Kratie	75,000
Protected scenic view areas			
	Name	Province	Area (ha)
1	Angkor	Siem Reap	10,800
2	Banteay Chhmar	Banteay Meanchey	81,200
3	Preah Vihear	Preah Vihear	5,000
Multi-purpose areas in Cambodia			
	Name	Province	Area (ha)
1	Dung Peng	Koh Kong	27,700
2	Samlot	Battambang	60,000
3	Tonle Sap	Kampong Chhnang, Kampong Thom, Siem Reap, Battambang and Pursat	316,250

Source: http://www.opendevelopmentcambodia.net/briefing/protected-areas/#1

4.2 Socio-economic Resources

About 15 million people consisting of Khmer (90%), Vietnamese (5%), Chinese (1%) and other (4%) of ethnic groups live in the Mekong River basin at the southwestern part of Indochina peninsula. More than 96% of them are Buddhists. The country experienced long politically instable period through civil wars even after independence in 1945 and those ended in 1999. High annual growth rate of the economy in the country keeping more than 7% of GDP growth rate were achieved in recent years. The main industries are garments, construction, agriculture, and tourism. Poverty rate in 2011 was 10.1% (Number of people living below 1.25 USD/day of the international poverty line). The official language is Khmer. The adult literacy rates in 2008 were 75.6% in total, 84.6% for males, and 67.7% for females.

Phnom Penh, located in the middle of the country, currently consists 12 khans (districts). Approximately 1.5 million people live in the area of 678.5 km^2. Poverty rate (which is calculated by the cost of purchasing food equivalent to 2,200 kilocalories, NSDP) in the whole nation is 17.9% and that in Phnom Penh is 15.3%. Adult literature rate in the capital is 93.8% in the estimation in 2012 and it is higher than those in other urban area (86.4%) and country (79.7%). Household's monthly average income in the capital is approximately 629 USD. It is more than two times higher than the national household's monthly income of approximately 309 USD.

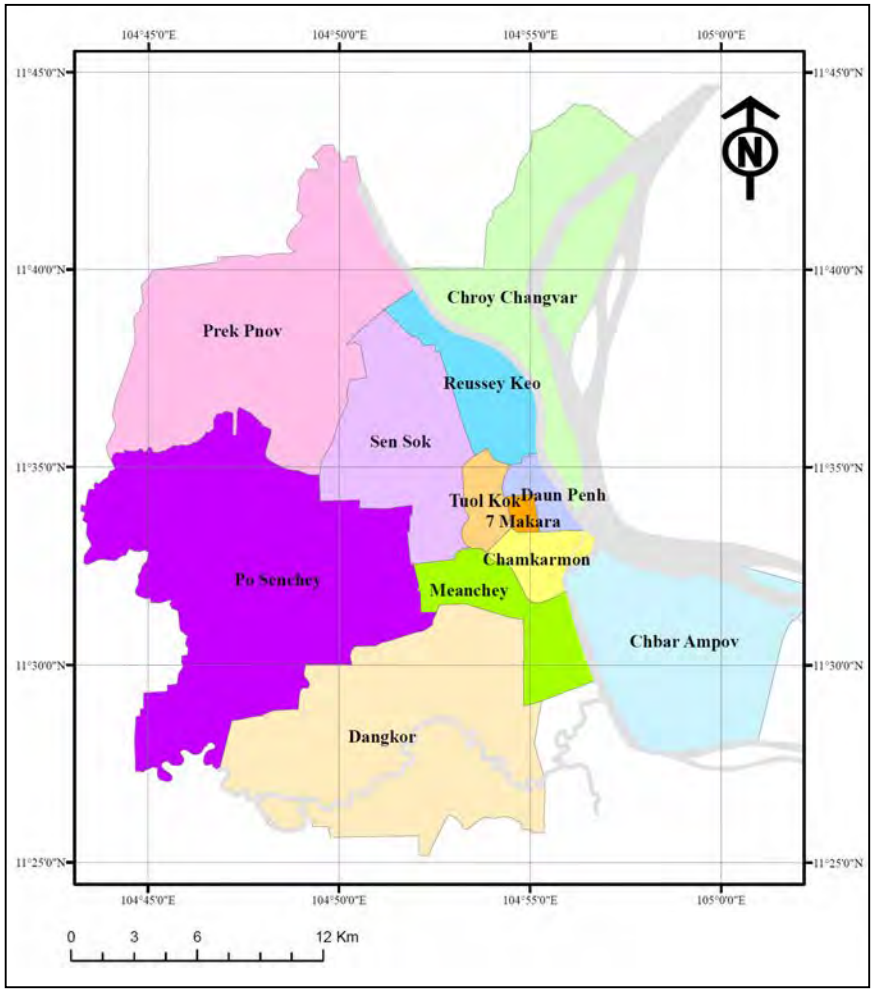
(1) Demography and Settlement

The demographic situation of each khan in Phnom Penh is shown in **Table 4.2.1**. Out of 12 khans, Chamkarmon, Daun Penh, 7 Makara and Tuol Kok are located in the city center (**Fig. 4.2.1**) having higher population densities of more than 160 persons/ha. Dangkor, Chroy Changvar, Prek Pnov and Chbar Ampov which have been recently incorporated from Kandal Province, have comparatively lower population densities.

Table 4.2.1 Administrative Division and Population of District in PPCC (2008)

	District (Khan)	No. of Sangkats	Area (km^2)	Population (person)	Population Density (person/ha)
1	Chamkarmon	12	11.1	182,004	164.0
2	Daun Penh	11	7.5	126,550	168.7
3	7 Makara	8	2.2	91,895	417.7
4	Tuol Kok	10	8.2	171,200	208.8
5	Dangkor	13	117.8	73,287	6.2
6	Po Senchey	10	150.0	159,455	10.6
7	Meanchey	4	25.0	194,636	77.9
8	Chbar Ampov	8	80.5	133,165	16.5
9	Reussey Keo	6	24.9	115,740	46.5
10	Chroy Changvar	5	84.0	68,708	8.2
11	Sen Sok	4	51.9	137,772	26.5
12	Prek Pnov	5	115.4	47,313	4.1
	Total	96	678.5	1,501,725	22.1

Source: PPCC, JICA Study Team



Source: JICA Study Team

Fig. 4.2.1 Administrative Division Map of Phnom Penh

(2) Economic Status: Employment and Income

The National Institute of Statistics, Ministry of Planning, publishes the socio-economic research results every year. Household income is shown in **Tables 4.2.2** and **4.2.3**.

Total income and disposable income in total Cambodia increased from 2009 to 2013 except in 2011. In 2011, self-employment income, in particular, non-agriculture decreased so that total and disposable incomes decreased.

Table 4.2.2 Household Income Composition, Average per Month in Cambodia

Source of Income	Value in thousand Riels				
	2009	2010	2011*	2012*	2013*
Cambodia					
Primary income	727	877	862	984	1,183
Wage and Salary	241	292	340	403	505
Self-employment Income	482	582	520	576	675
Agriculture	162	205	209	229	195
Non Agriculture	250	290	224	249	369
Owner occupied house	70	88	86	98	111
Property income	4	3	2	5	3
Total transfers received	19	24	26	35	53
Total Income	**747**	**901**	**888**	**1,019**	**1,236**
Total transfers paid	11	24	17	5	95
Disposable Income	**736**	**877**	**871**	**1,014**	**1,141**

Note: * Preliminary results
Source: National Institute of Statistics
(http://www.nis.gov.kh/index.php/en/find-statistic/social-statistics/cses/cses-tables.html)

Table 4.2.3 Household Income Composition, Average per Month in Phnom Penh

Source of Income	Value in thousand Riels				
	2009	2010	2011*	2012*	2013*
Phnom Penh					
Primary income	1,986	1,940	1,770	1,847	2,478
Wage and Salary	765	910	991	930	1,135
Self-employment Income	1,203	1,023	769	909	1,326
Agriculture	22	20	8	22	11
Non Agriculture	878	650	423	560	935
Owner occupied house			338	327	381
Property income	17	7	10	8	17
Total transfers received	54	47	50	40	38
Total Income	**2,039**	**1,987**	**1,819**	**1,886**	**2,517**
Total transfers paid	24	44	26	17	138
Disposable Income	**2,016**	**1,944**	**1,793**	**1,870**	**2,378**

Note: * Preliminary results
Source: National Institute of Statistics
(http://www.nis.gov.kh/index.php/en/find-statistic/social-statistics/cses/cses-tables.html)

However, total and disposable incomes in Phnom Penh decreased in not only 2011 but also 2010. The reason of decrease in 2010 is not clear, but it can be guessed that it might be due to the expansion of the PPCC area in 2010. Perhaps, peripheral low self-employed non-agriculture income households were integrated into Phnom Penh or it may be an omen of the nationwide decrease in the following year. The decrease in 2011 seems to follow the national trend. Household incomes in Phnom Penh are approximately twice of that in total Cambodia average.

Disposable incomes per capita by quintile group in Cambodia and Phnom Penh are shown in **Table 4.2.4** (quintile group is formed by dividing five equal numbers arranging all households from the lowest annual income to the highest and groups 1 to 5 are from the lowest to the highest). Poorer stratum income increased more from 2009 to 2013 in total Cambodia and Phnom Penh and the increase rates in Cambodia are larger than those in Phnom Penh. At least during the period from 2009 to 2013, divides or gaps between the poor and the rich and between Cambodia and Phnom Penh were reduced from the viewpoint of household income.

Table 4.2.4 Disposable Incomes per capita by Quintile Group

Year	Value in thousand Riels					Increase
	2009	2010	2011*	2012*	2013*	'13/'09
Cambodia						
Quintile group						
1	19	28	41	49	47	2.47
2	49	69	89	106	115	2.35
3	88	113	142	165	184	2.10
4	148	180	213	248	277	1.87
5	488	595	506	571	708	1.45
Phnom Penh						
Quintile group						
1	82	85	126	137	137	1.68
2	177	190	217	229	254	1.44
3	271	290	298	324	363	1.34
4	405	438	415	454	531	1.31
5	1,140	1,135	973	1,017	1,471	1.29
PP/Cmbd						
Quintile group						
1	4.32	3.09	3.07	2.83	2.93	
2	3.61	2.76	2.43	2.17	2.21	
3	3.08	2.57	2.10	1.96	1.97	
4	2.74	2.44	1.94	1.83	1.92	
5	2.34	1.91	1.92	1.78	2.08	

Source: National Institute of Statistics
(http://www.nis.gov.kh/index.php/en/find-statistic/social-statistics/cses/cses-tables.html)

Similar inclination is shown in the NSDP (National Strategic Development Plan 2014-2018), that is, poverty (which is calculated by the cost of purchasing food equivalent to 2,200 kilocalories in the lowest 5th quintiles and the allowance for non-food items) headcount in the whole nation is 17.9% and that in Phnom Penh is 15.3%; namely, poverty is less in Phnom Penh than in the nation. The NSDP aims to lower poverty headcount in 2018 to 12.9% nationwide and 10.3% in Phnom Penh.

(3) Education

Literacy rate in the country has improved during the last decades, as shown in **Table 4.2.5**.

Table 4.2.5 Literacy Rate [Adult Literacy (15+) by Geographical Domain and Sex (%)]

Years	2008			2012		
Domain	Women	Men	Both sexes	Women	Men	Both sexes
Cambodia	67.7	84.6	75.6	73.2	86.9	79.7
Phnom Penh	88.9	96.9	92.6	89.8	98.4	93.8
Other urban	77.6	89.7	83.2	81.3	91.8	86.4
Other rural	63.2	82.2	72.1	69.2	84.2	76.3

Source: Cambodia Socio-Economic Survey (CSES)

(4) Ethnic Group in the Country

People in Cambodia consist of Khmer (90%), Vietnamese (5%), Chinese (1%) and other ethnic groups (4%). Among the other ethnic groups, Cham, Thai, Lao and Khmer Loeu have comparatively high populations (**Table 4.2.6**). Based on the recent sampling of the Cambodia Socio-Economic Survey (CSES), the population of Khmer shares more than 97% (**Table 4.2.7**).

Table 4.2.6 Ethnic Groups in Cambodia (1/2)

	Khmer	Vietnamese	Chinese	Others
Ethnic Groups	90	5	1	4

Source: CIA (2014), The World Fact Book

Table 4.2.7 Ethnic Groups in Cambodia (2/2)

Ethnicity	Geographical Domain (2012)			
	Cambodia	Phnom Penh	Other urban	Other rural
Khmer	97.2	97.6	99.2	96.8
Cham	1.6	1.9	0.2	1.8
Chinese	0.0	0.1	-	0.0
Vietnamese	0.4	0.4	0.4	0.4
Thai	-	-	-	-
Lao	-	-	-	-
Others	0.7	-	0.0	1.0
Not stated	0.1	-	0.1	0.1
Total	100	100	100	100

Source: Cambodia Socio-Economic Survey (CSES)

The indigenous people in Cambodia belong to two distinct linguistic families; the main groups are the Austronesian speaking Jarai and the Mon-Khmer speaking Brao, Kreung, Tampuan, Punong, Stieng, Kui and Poar. Over half of the indigenous population is found in the north-eastern provinces of Ratanakiri and Mondulkiri (NGO Forum on Cambodia, 2006 Indigenous Peoples in Cambodia).

(5) Religion

Buddhism is the state religion as embodied in Article 43 of the Constitution (1993) and more than 96% of the population are Buddhists (**Table 4.2.8**). The Constitution also provides freedom of the belief and among other religions, Muslims and Christians are comparatively more than the others.

Table 4.2.8 Religions in Cambodia

Religions in Cambodia (2008 estimation in %)			
Buddhist	Muslim	Christian	Others
96.9	1.9	0.4	0.8

Source: CIA (2014), The World Fact Book

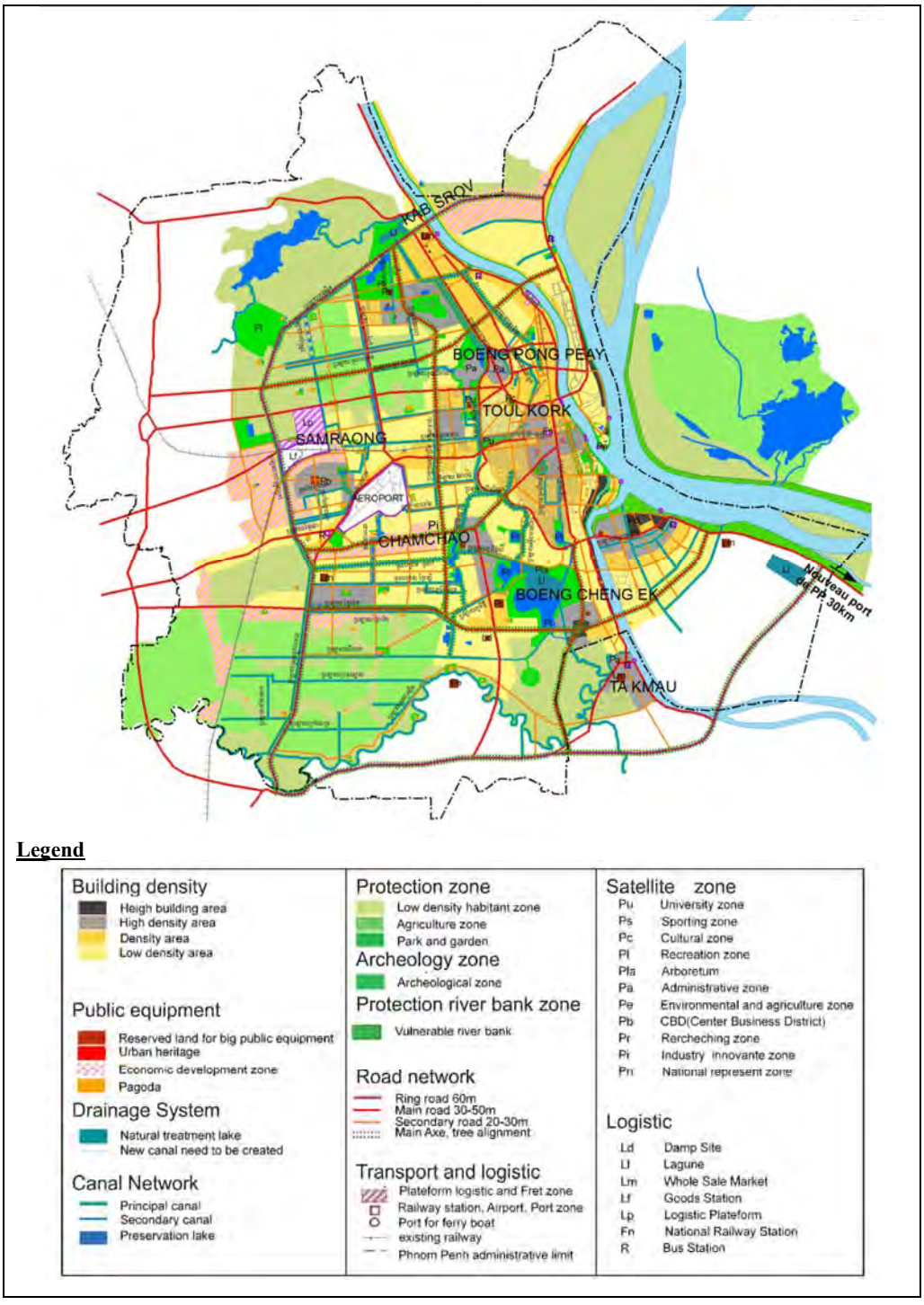
(6) Land Use

Administration area of PPCC was changed in 2008 and the area was expanded from approximately 377 km^2 to approximately 678.5 km^2. Land use in the previous capital (Old Phnom Penh Capital area of about 377 km^2) is shown in **Table 4.2.9** and Land use plan for year 2035 is shown in **Fig. 4.2.2**.

Table 4.2.9 Land Use Pattern in Phnom Penh

Land use	Percentage (%)
Greens and forest	0.15
Lake, swamp, farmland	81.93
Urban area	16.53
Road	1.33
Water way	0.045
Total	100

Source: Korean Industry & Technology Institute (2011), Feasibility Study of Sewerage Treatment Plant in Phnom Penh, Kingdom of Cambodia based on Current Socio-Economy and Environment Status in the Kingdom of Cambodia (2009.10, MOE)



Source: White Book on Development and Planning of Phnom Penh, PPCC

Fig. 4.2.2 Land Use for the Year 2035

(7) Energy Use

Electrical power in Cambodia is supplied by EDC (Government Enterprise, Electricite du Cambodia), IPP (Independent Power Producer) or imported from Thailand and Vietnam. Sixty percent of total power is imported. Therefore, in Cambodia, the operation of large-sized hydroelectric power plants and thermal power plants has started, to increase the domestic power generation capacity.

Electricity charges in PPCC is more expensive than those of neighbouring countries (0.15-0.20 USD/kWh for domestic and 0.18-0.22 USD/kWh for commerce, industry and government institutions), because the main power source at present is small-sized diesel power generators or imported.

(8) Traffic Volume

In parallel with the economic development, traffic flow has become heavy in PPCC. The traffic volume in PPCC is 60 to 90 thousand vehicles/day. Seventy-five percent of the traffic consist of motorcycles (Project for Comprehensive Urban Transport Plan in Phnom Penh Capital City, 2014). In the installation of drainage and sewer pipes, traffic flow in the city area may be affected.

(9) Waste Management

There are three waste management companies in PPCC; namely, 1) CINTRI: collection and transport of domestic waste; 2) Carom: collection and dispose of industrial waste; and 3) Red Cross Phnom Penh: burning of hazardous waste (waste from hospitals). PPCC is managing the landfill site in Dangkor District. Capacity of the site is approximately 31.4 ha. The landfill site of industrial waste is managed by the Carom in Po Senchey District in an area of approximately 5 ha.

4.3 Environmental Situation related to the Sewerage Priority Project

The priority project covers "Preparatory Project" consisting of STP construction with the capacity of 5,000 m^3/day in Angkit Dangkor in Khan Dangkor. The treatment method of the STP is Conventional Activated Sludge Process (CASP). Since environmental situations in PPCC are already described in the preceding sections of this chapter, only brief explanations on Khan Dangkor and the Cheung Aek Lake are given below.

Khan Dangkor is located at the south edge (outside of outer dike) of the capital bordering Kandal Province and it includes the western part of the Cheung Aek Lake. The Khan is divided into 13 Sangkats having the population of 73,287 with the density of 6.2 persons/ha.

On the other hand, Cheung Aek Lake originally has approximately 2,600 ha and is located in the south-eastern edge of PPCC partly belonging to Kandal Province. The area has been recently declared as a state public land in Sub-Decree, 2008 No. 124 ANKr. BK, " Identification of area of Cheung Aek Lake and canal in Mean Chey and Dangkor Khan in Phnom Penh and Takmao District in Kandal Province as State Public Land" with the area of 520 ha. The area is well known as one of the killing fields, mass grave yards where peoples were collectively killed and buried at the regime of Khmer Rouge.

The Lake is used for flood control and natural wastewater treatment lagoon of Phnom Penh before flowing into Bassac River. Swamp area, seasonal land area and permanent water body in the lake have been used by the people for cultivation of aquatic plants and animal husbandry and fisheries.

The Lake area has been widely used by farmers even in permanent water surface. Seasonal wetland can be utilized for the cultivation of water spinach, water mimosa and rice. Water surface can be utilized for aquaculture using floating raft. According to a study conducted by the Royal University of Agriculture in 2009 (PHEARITH TEANG & PUY LIM, 2010, International Journal of Environmental and Rural Development), majority of the area was used for water spinach cultivation (43% of the area), as shown in **Table 4.3.1**.

Table 4.3.1 Area occupied by Human Activities at Cheung Aek Lake in the Dry Season

Human Activities	Total area (ha)	Percentage (%)
Water spinach area	429	43.2
Water mimosa area	32	3.2
Dry season rice field	13.5	1.5
Fishing activity	15	1.5
Duck raising	10	1
Other aquatic plant and water surface	492.5	49.6
Total lake surface	992	100

Source: (PHEARITH TEANG2009, Spatial Analysis of Human Activities Performed in Cheung Ek Inundated Lake, Cambodia, International Journal of Environmental and Rural Development (2010))

According to the study (PHEARITH TEANG 2009), commercial fishery in the Cheung Aek Lake is not common and it is limited to domestic consumption. A wide range of fish species is found in the Lake, including common carp *(Cyprinus carpio*), silver carp *(Hypophthalmichthys molitrix)*, tilapia *(Orechromis niloticus)*, snakehead fish *(Channa striata*) and walking catfish *(Clarias batrachus*).

4.4 Environmental Situation related to the Priority Project in Drainage Management

The sub-catchment area for the priority project includes 4 sangkats in 3 khans in PPCC; namely, Chaom Chau Sangkat and Kakab Sangkat in Khan Po Senchey, Tuek Thla Sangkat in Khan Sensok and Stueng Mean Chey Sangkat in Khan Meanchey. Since the environmental situations in PPCC are already described in the preceding sections of this chapter, only brief explanations of the site are given below.

(1) Khan Po Senchey

The khan is located at the western edge of the capital, bounded by Kandal Province. An outer ring dike passes at the middle of the khan at the north-south direction and National Highway No. 4 passes at the east-west direction, connecting the capital and Sihanoukville. The international airport is also located in this khan. The khan is divided into 10 sangkats having the population of 159,455 with density of 10.6 persons/ha.

(2) Khan Sen Sok

The khan is located in the area between the outer and inner ring dikes. In the area, Hanoi Road passes in the north-south direction as the main road. The khan is divided into 4 sangkats having the population of 137,772 with density of 26.5 persons/ha.

(3) Khan Meanchey

The khan is located at the middle southern edge of the capital, bounded by Kandal Province. An outer ring dike passes at the north of the khan and it includes a part of Cheung Aek Lake and Bassac River bank. The khan is divided to 4 sangkats having the population of 194,636 with density of 77.9 persons/ha. Tumpun Lake functioning as one of wastewater treatment lagoon, is located in the area.

(a) Road Condition where Drainage Facilities are proposed

Drainage facilities are proposed under the existing roads of Veng Sreng Blvd., Trung Morn Street, St. Duong Neap II and Street 2004.

(i) Trung Morn Street (North Bridge Street)

The street is connected to the Hanoi Road at the north and Veng Sreng Blvd. at the south, longitudinally crossing the Phnom Penh's western sub-urban area. Currently expansion works are ongoing (as of November 2015). The works will be financed by China in 2016 and it will be completed in 2017.

(ii) Veng Sreng Blvd. (Chm Chhoa Street)

Road improvement works such as expansion and concrete paving have been ongoing since 2014. The work has been delayed due to resettlement works (conflict on compensation, the Cambodian Daily, May 14, 2014, Veng Sreng Street Upgrade Behind Schedule). Completion of the construction work is scheduled in 2016. According to the Cambodian law, ROW of the public road was declared as public state land. In case the of provincial road, the ROW is 20 meters from the center according to the 1999 MEF Prakas No. 6 "Measures to Crack Down on Anarchic Land Grabbing and Encroachments". The ROW of the road is 30 m (22 m of the road and 4 m×2 walkway at opposite sides according to DPWT/PPCC)

(iii) St. Duong Neap II

The road is newly paved with concrete. The ROW is 20 m (12 m of main road and 4 m×2 walkway at both sides). The road improvement work has not yet been completed.

(iv) Street 2004

Road improvement construction work is still ongoing and is probably completed in 2016. Twin pipelines of 1,500 mm are installed in opposite sides of the road at present.

CHAPTER 5 PUBLIC PARTICIPATION

5.1 Public Consultation

The study results have been disseminated through a series of seminars/workshops to the major stakeholders in the government. The seminars/workshops were held three times to promote capacity development and understanding of the study results of the Master Plan and Pre-Feasibility Study, targeting personnel from relevant authorities, other donors, NGOs, etc.

5.2 Results of Public Consultation

(1) Result of Public Consultation, First Workshop

With 81 participants, the first workshop was chaired by the Governor at the Phnom Penh Capital City Hall on 17 March 2015. The major comments from the participants are as summarised in **Table 5.2.1**.

Table 5.2.1 Comments from Stakeholders in the First Workshop

Comments from participants of the first workshop (17 March 2015)
Participants of the First Workshop were fully aware of the water environment condition in the capital. The major comments are as follows: • Reinforcement and strict implementation of relevant legislation, such as: - Construction permit (Anukret 86 ANK/BK/December 19, 1997) for septic tank installation - Lack of sewage management law • Institutional capacity development - DOE on pollution monitoring - Agencies concerned in sewage management in the national and provincial level - Land management office and departments concerned in land-use control

Source: JICA Study Team

(2) Result of Public Consultation, Second Workshop

With 61 participants, the second workshop was chaired by the Deputy Governor at the Phnom Penh Capital City Hall on 19 November 2015. The contents of the Master Plan for sewage and drainage management were presented and the priority projects proposed in the Master Plan were explained. As a case study the successful achievement of sewage and drainage management in Kitakyushu City, Japan, was also presented. Representatives from the concerned ministries, local governments, universities, government-owned companies and private companies joined the workshop. Comments were made on the projects/plan proposed by the JICA study team. The main comments are as summarised in **Table 5.2.2**.

Table 5.2.2 Comments from Stakeholders in the Second Workshop

Comments from participants of the second workshop (19 November 2015)
The major comments are as follows: • The condition of Kitakyushu City 50 years ago is similar to the current condition of Phnom Penh. We can learn many things from the experiences of Kitakyushu City. PPCC has to pay more attention to the establishment of an environmental-friendly living condition. • Treatment method should be selected in consideration of technical and economic views. • It is necessary to confirm the landowner of the proposed sites of treatment plant, pumping station and other facilities. • To set-up the new institution, PPCC need to collaborate with MOE. MOE has already established a new division for wastewater management, especially, for regulating water quality (MOE is ready to work with the Study Team and PPCC). • We should learn from the experiences on sewerage management in Kitakyushu City. Flood damage in Phnom Penh became smaller than that of 10 years before, because some drainage improvement projects have been implemented.

Comments from participants of the second workshop (19 November 2015)
However, environmental pollution has become serious, especially in Tamok Lake basin. • We find improvement of flooding. However, we still have inundation in the rainy season. We request JICA to provide more projects in all areas. • Capacity development for the staff is very important. • Wastewater management is very important, • We need to place priority on improving living condition of the people.

Source: JICA Study Team

(3) Results of Public Consultation in the Third Workshop

The third workshop chaired by the City Vice Governor was successfully held with 58 participants at the Phnom Penh City Hall. In the workshop, the study team presented overall result of M/P and Pre-F/S. The participants commented about the projects/plan. The main comments from the participants are as shown in **Table 5.2.3**.

Table 5.2.3 Comments from Stakeholders in the Third Workshop

Comments from participants of the third Workshop (15 September 2016)
The major comments are as follows. • I would like to know about the methodology of selection of construction site of Cheung Aek STP. • Reclamation of lakes/swamps due to rapid urbanization accelerates inundation in PPCC. • Decrease in impervious surface accelerates inundation in PPCC. • To secure disposal site for sludge from STP is essential. • To provide incentive for people is essential in the on-site treatment area in which Johkasou is installed. • Detailed location of proposed drainage channel should be presented in the M/P. • Decentralised system is a good option the new development area. • I would like to know about cost and lifetime of Johkasou

Source: JICA Study Team

CHAPTER 6 ENVIRONMENTAL IMPACT AND MITIGATION MEASURES

6.1 Impact Assessment for Priority Projects in Sewage Management

Impact assessment for priority projects in sewage management is shown in **Table 6.1.1**.

Table 6.1.1 Preliminary Scoping for Priority Projects in Sewage Management (December 2015)

Classification	No.	Items	Reason and Description	Rating
Social Environment	1	Involuntary resettlement	**Planning Phase, Construction Phase:** Some residents are living close to the discharge point of the existing Tumpun Pumping Station where sewage interception facilities and sewer to STP are proposed. There is dense population around the existing road No. 371 (Outer ring road). At the improvement of the existing channels, impact to the residents should be avoided and/or minimized based on adequate survey at the planning phase. **Planning Phase, Construction Phase:** There are some raised floor structures in the Cheung Aek Lake where people may be living permanently or temporarily. At the planning phase, impact to the people including resettlement and land acquisition, should be avoided and/or minimized. Cheung Aek Lake for the STP site has been used for agriculture and domestic fishery. Some residents may lose partly or fully their income source. Although the land of the Cheung Aek is declared as public state land, adequate socio-economic survey may be required for establishing compensation/rehabilitation schemes in accordance with the JICA environmental and social consideration guideline (2010).	C-
	2	Local economy such as employment and livelihood, etc.	**Planning Phase, Construction Phase:** Some of the residents who live in Cheung Aek Lake may be poor. They may lose a part of their income source of farm land. In such cases, supporting programs such as resettlement plan and rehabilitation plan will be required. **Construction Phase:** The project is expected to increase working opportunity for construction.	C-
	3	Land use and utilization of local resources	**Planning Phase, Construction Phase:** In STP construction, water bodies/wetland which local people are using for agriculture and fishery will be reclaimed. Although the STP area is not large (3.5 ha), the impact should be avoided and/or minimized at the planning phase. If not fully avoidable, adequate compensation should be made based on socio-economic survey in the area.	B-
	4	Social institutions	**Planning Phase, Construction Phase:** There are many land development projects in which wetland is converted to other land use such as residential area and industrial area. Associated with those developments, there may be some problems in flood and land use. Adequate information disclosure by implementation agency to Project-Affected People (PAP) may be required at the planning phase.	B-
	5	Existing social infrastructures and services	**Construction Phase:** In the priority project, sewer is to be installed under the access road which connects Road No. 371 and the proposed STP. Associated with the construction work of access road, disturbance to the road traffic movement in Road No. 371 may occur.	B-
	6	The poor, indigenous and ethnic people	**Planning Phase, Construction Phase:** Special consideration should be taken for poor households in the wetland for the selection of STP site. There are some raised floor structures in the Cheung Aek Lake where people may be living permanently or temporarily. Some residents are living close to existing channels. At the planning phase, impact to those residents including resettlement and land	B-

Classification	No.	Items	Reason and Description	Rating
			acquisition should be avoided and/or minimized.	
	7	Misdistribution of benefit and damage	**Planning Phase:** Although the project aims to contribute environmental improvement in the capital, residents may be living around the STP site and along the existing channels. Impact to the residents should be avoided and/or minimized considering the current situation based on adequate survey at the planning stage.	B-
	8	Historical and cultural heritage	No particular impact is identified at the moment.	D
	9	Local conflict of interests	**Planning Phase:** There are many land development projects in which wetland is converted to other land uses such as residential area and industrial area. Associated with those developments, there may be some problems in flood and land use. PPCC is currently implementing identification of land rights. Some conflict on land rights may occur if private land is involved in the project area.	B-
	10	Water usage or water rights and rights of common	No particular impact is identified at the moment.	D
	11	Sanitation	**Operation Phase:** The project expects to improve current water environment situation in capital.	A+
	12	Hazardous (risk) infectious diseases such as HIV/AIDS	**Operation Phase:** After commission, risk of water-related disease is expected to be reduced.	A+
Natural Environment	13	Topography and geographic features	**Construction Phase:** Some topographical modification associated with land filling may occur in the Cheung Aek Lake.	B-
	14	Groundwater	**Operation Phase:** Water quality of groundwater is expected to be improved with the operation of STP.	A+
	15	Soil erosion	**Construction Phase:** For the construction of the STP, land reclamation for access road and STP in the Cheung Aek Lake is planned. Countermeasures to protect ground surface should be considered.	B-
	16	Hydrological situation	**Planning Phase, Construction Phase:** The project will be planned based on the current water flow, and thus no large hydrological change is anticipated. No particular impact is identified at the moment. Land reclamation in the Cheung Aek Lake may affect current water flow in the area depending on the site selection. Appropriate hydrological study may be needed to avoid flood damage.	B-
	17	Coastal zone	There is no coastal zone in the project area.	D
	18	Fauna and flora and biodiversity	**Planning Phase, Construction Phase:** There is no legally protected area such as national park, wildlife preserve, protected scenic view area and multi-purpose area in the project area. Habitats for common fish species in the Cheung Aek Lake may be affected. Cheung Aek Lake is functioning as natural wastewater treatment lagoons for the capital and water quality is severely deteriorated. Due to the decline of water quality, biodiversity becomes poor. **Operation Phase:** Through the water quality improvement by the project, biological value of the lake may increase.	B-/B+
	19	Meteorology	No particular impact is identified at the moment.	D
	20	Landscape	No particular impact is identified at the moment.	D
	21	Global	With the construction and operation of sewage facilities, excessive global	D

Classification	No.	Items	Reason and Description	Rating
		warming	warming gas emission is not expected.	
Pollution	22	Air pollution	**Construction Phase:** Suspended dust and gas emission from the construction machinery is expected in a limited area.	B-
	23	Water contamination	**Construction Phase:** Associated with earthwork, the turbidity of water may increase.	B-
	24	Soil contamination	**Construction Phase:** Accidental spillage of toxic chemicals such as fuel, lubricants, and solvents may cause soil contamination.	B-
	25	Waste	**Construction Phase, Operation Phase:** Project owner should properly handle waste (including sludge).	B-
	26	Noise and vibration	**Construction Phase:** Noise pollution will be generated with the use of vehicles, stone crushing, generators, etc.	B-
	27	Ground subsidence	Ground modification and groundwater exploitation is not planned and no impact is anticipated.	D
	28	Offensive odor	**Construction Phase:** Associated with the disturbance of river bottom sediment in bed excavation and foundation works, offensive odour may be generated. **Operation Phase:** Associated with the operation of STP, offensive odour at surrounding area may increase. On the other hand, odour at the surrounding area of existing channels and lagoon may by improved by the operation of STP.	B-/B+
	29	Bottom sediment	No particular impact is identified at the moment.	A+
	30	Accidents	**Construction Phase:** Operation of heavy vehicles and machinery may cause traffic accidents to residents and labourers in and around the project sites.	B-

Rating
A-: Serious impact is expected if no measure is implemented against the impact.
B-: Some impacts are expected if no measure is implemented against the impact.
C-: Extent of impact is unknown (Examination is needed. Impact may become clear as study progresses.)
D: No impact is expected.
A+: Remarkable effect is expected due to project implementation itself and environmental improvement caused by the project.
B+: Some effect is expected due to project implementation itself and environmental improvement caused by the project.
Source: JICA Study Team

6.2 Impact Assessment for Priority Projects in Drainage Management

Impact assessment for priority projects in drainage management is shown in **Table 6.2.1**.

Table 6.2.1 Preliminary Scoping for Priority Projects in Drainage Management (December 2015)

Classification	No.	Items	Reason and Description	Rating
Social Environment	1	Involuntary resettlement	**Planning Phase, Construction Phase:** Some residents are living close to the existing channels such as Phum Mor Canal at the downstream. At the improvement of water flow/drainage, impact to the residents in downstream should be avoided and/or minimized based on adequate survey in the downstream. The project may require resettlement of the residents who live near the existing channels. **Planning Phase, Construction Phase:** Construction of box culvert, new pumping station, and new regulation pond may require additional land acquisition and resettlement. Expansion of the existing pumping station may affect the residents nearby.	C-

Classification	No.	Items	Reason and Description	Rating
	2	Local economy such as employment and livelihood, etc.	**Planning Phase, Construction Phase:** Some poor households living in the marginal area such as wetland and drainage channel may lose a part of their income source or to be resettled/loss the land. In such cases, supporting programs such as resettlement plan and rehabilitation plan will be required. At the construction phase, the project increases working opportunity. **Operation Phase:** By operating the drainage system, flood damage will be reduced and local economy will be improved.	C-/B+
	3	Land use and utilization of local resources	**Operation Phase:** With the operation of drainage system, flood damage will be reduced and local economy will be improved.	B+
	4	Social institutions	**Planning Phase, Construction Phase:** There are many land development projects in which wetland is converted to other land uses such as residential area and industrial area. Associated with those developments, there may be some problems in flood and land use. Adequate information disclosure by implementation agency to Project-Affected People (PAP) may be required at the planning phase.	B-
	5	Existing social infrastructures and services	**Construction Phase:** The drainage facilities will be basically installed under existing roads. Associated with the installation work, disturbance to road traffic movement may occur. **Planning Phase:** The proposed site of the box culvert includes roads being improved or to be improved such as Veng Sreng Blvd., Northbridge Street, St. Doung Neap II and St. 2004. Adequate coordination with the road construction plan may be required. **Operation Phase:** With the operation of drainage system, traffic movement in the rainy season may be improved.	B-/ B+
	6	The poor, indigenous and ethnic people	**Planning Phase, Construction Phase:** Some residents are living close to existing channels. At the planning phase, impact to those residents including resettlement and land acquisition, should be avoided and/or minimized.	C-
	7	Misdistribution of benefit and damage	No particular impact is identified at the moment.	D
	8	Historical and cultural heritage	No particular impact is identified at the moment.	D
	9	Local conflicts of interest	**Planning Phase:** In capital, there are many land development projects in which wetland is converted to other land uses such as residential and industrial use. Associated with those developments, there are some problems in flood and land use. The city government is currently proceeding with the identification of land rights. Associated with the above land acquisition and resettlement (if involved), some conflicts on land rights may occur in the process of resolution.	B-
	10	Water usage or water-rights and common rights	**Planning Phase:** No particular impact is identified at the moment. Some canals in Phnom Penh Capital are managed by the water resource department for irrigation purposes. For the water flow improvement, adequate coordination with the irrigation is required.	B-
	11	Sanitation	**Operation Phase:** The project is expected to improve the current water environment in the capital.	A+
	12	Hazardous (risk) infectious diseases such	**Operation Phase:** After operation, the risk of water-related diseases is expected to be reduced through the sewerage and drainage projects.	A+

Classification	No.	Items	Reason and Description	Rating
		as HIV/AIDS		
Natural Environment	13	Topography and geographic features	**Construction phase:** Some topographical modification of waterway is expected.	B-
	14	Groundwater	No particular impact is identified at the moment.	D
	15	Soil erosion	No large soil erosion is anticipated because the area is generally flat. Water way modification may be expected.	D
	16	Hydrological situation	The project will be planned based on the current water flow and no large hydrological change is associated. No particular impact is identified at the moment. With new pumping station and regulation ponds, modification of the water flow may be expected.	B-
	17	Coastal zone	There is no coastal zone.	-
	18	Fauna and flora and biodiversity	**Planning Phase:** There is no legally protected area such as national park, wildlife preserve, protected scenic view area and multipurpose area in the project area. Most existing ditches and regulation ponds in the capital are highly polluted for wildlife. At the planning phase, the situation may be confirmed in the survey.	D/B+
	19	Meteorology	No particular impact is identified at the moment.	-
	20	Landscape	No particular impact is identified at the moment.	D
	21	Global warming	No particular impact is identified at the moment.	D
Pollution	22	Air pollution	**Construction Phase:** Suspended dust and gas emission from construction machinery is expected in a limited area.	B-
	23	Water contamination	**Construction Phase:** Associated with earthworks, turbidity of water may increase.	B-
	24	Soil contamination	**Construction Phase:** Accidental spillage of toxic chemicals such as fuel, lubricants, and solvents may cause soil contamination.	B-
	25	Waste	**Construction Phase:** Project owner should properly handle waste (including sludge).	B-
	26	Noise and vibration	**Construction Phase:** Noise pollution will be generated with the use of vehicles, stone crushing, generators, etc.	B-
	27	Ground subsidence	Ground modification and groundwater exploitation is not planned and no impact is anticipated.	-
	28	Offensive odor	**Construction Phase:** Associated with the disturbance of river bottom sediment in bed excavation and foundation works, offensive odour may be generated.	B-
	29	Bottom sediment	**Operation Phase:** With the improvement of existing channels, improved water flow may reduce sedimentation.	B+
	30	Accidents	**Construction Phase:** Operation of heavy vehicles and machinery may cause traffic accidents to residents and labourers in and around the project sites.	B-

Rating
A-: Serious impact is expected if no measure is implemented against the impact.
B-: Some impact is expected if no measure is implemented against the impact.
C-: Extent of impact is unknown (Examination is needed. Impact may become clear as study progresses.)
D: No impact is expected.
A+: Remarkable effect is expected due to project implementation itself and environmental improvement caused by the project.
B+: Some effect is expected due to project implementation itself and environmental improvement caused by the project.
Source: JICA Study Team

CHAPTER 7 ENVIRONMENTAL MANAGEMENT PLAN (TENTATIVE)

7.1 Mitigation Measures for Priority Projects in Sewage Management

The Environmental Management Plan (EMP) should be finalized in time for the EIA processing in accordance with the further detail study. The EMP at the IEE stage is as tentatively presented in **Table 7.1.1**.

Table 7.1.1 Impact and Possible Mitigation Measures for Priority Projects in Sewage Management (Tentative, December 2015)

Classification	No.	Items	Rating	Reason and Description	Possible Measure
Social Environment	1	Involuntary resettlement	C-	**Planning Phase, Construction Phase:** Some residents are living close to the discharge point of the existing Tumpun Pumping Station where sewage interception facilities and sewer to STP are proposed. There is dense population at the area of the existing road of No. 371 (Outer ring road). At the improvement of the existing channels, impact to the residents should be avoided and/or minimized based on the adequate survey at planning phase. **Planning Phase, Construction Phase:** There are some raised floor structures in the Cheung Aek Lake where people may be living permanently or temporarily. At the planning phase, impact to the people including resettlement and land acquisition should be avoided and/or minimized. Cheung Aek Lake for the STP site has been used for agriculture and domestic fishery. Some residents may lose partly or fully their income source. Although the land of the Cheung Aek is declared as public state land, adequate socio-economic survey may be required for establishing compensation/rehabilitation schemes in accordance with the JICA environmental and social consideration guideline (2010).	Socio-economic survey at the project site should be conducted to avoid or minimize resettlement and land acquisition.
	2	Local economy such as employment and livelihood, etc.	C-	**Planning Phase, Construction Phase:** Residents who live in Cheung Aek Lake may include some poor households and they may lose a part of their income source of farm land. In such cases, supporting programs such as resettlement plan and rehabilitation plan will be required.	Consideration will be required to minimize area for acquisition.
	3	Land use and utilization of local resources	B-	**Planning Phase, Construction Phase:** In STP construction, water bodies/wetland which local people are using for agriculture and fishery will be reclaimed. Although the STP area is not large (3.5 ha), the impact should be avoided and/or minimized at the planning phase. If not fully avoidable, adequate compensation should be made based on the socio-economic survey in the area.	Adequate compensation to the people who use the lake for fisheries/agriculture will be required.
	4	Social	B-	**Planning Phase, Construction Phase:**	Information disclosure by

Classification	No.	Items	Rating	Reason and Description	Possible Measure
		institutions		There are many land development projects in which wetland is converted to the other land uses such as residential area and industrial area. Associated with those development, there may be some problems in flood and land use. Adequate information disclosure by implementation agency to Project-Affected People (PAP) may be required at the planning phase.	implementation agency at the planning phase.
	5	Existing social infrastructures and services	B-	**Construction Phase:** In the priority project, sewer is installed under the access road which connects Road No. 371 and the proposed STP. Associated with the construction work of access road, disturbance to the road traffic movement in Road No. 371 may occur.	Adequate traffic guide should be provided to reduce accidents at the site in the construction phase.
	6	The poor, indigenous and ethnic people	B-	**Planning Phase, Construction Phase:** Special consideration should be taken for poor households in the wetland in the selection of STP site. There are some raised floor structures in the Cheung Aek Lake where people may be living permanently or temporarily. Some residents are living close to existing channels. At the planning phase, impact to those residents including resettlement and land acquisition should be avoided and/or minimized.	Resettlement and land acquisition should be avoided and/or minimized at planning phase. If not avoidable, adequate compensation based on proper study should be provided.
	7	Misdistribution of benefit and damage	B-	**Planning Phase:** Although the project aims to contribute environmental improvement in the capital, residents may live around the STP site and along the existing channels. The impact to residents should be avoided and/or minimized considering current situation based on adequate survey at the planning phase.	Resettlement and land acquisition should be avoided and/or minimized at the planning phase. If not avoidable, adequate compensation based on proper study should be provided.
	8	Local conflict of interests	B-	**Planning Phase:** There are many land development projects in which wetland is converted to other land uses such as residential area and industrial area. Associated with those developments, there may be some problems in flood and land use. PPCC is currently proceeding with the identification of land rights. Some conflicts on the land right may occur if private land is involved in the project area.	Resettlement and land acquisition should be avoided and/or minimized at planning phase. If not avoidable, adequate compensation based on proper study should be provided.
Natural Environment	9	Topography and geographic features	B-	**Construction Phase:** Some topographical modification may occur associated with land filling in the Cheung Aek Lake.	Project scheme is under consideration. Adequate survey should be conducted, if necessary.
	10	Soil erosion	B-	**Construction Phase:** For the construction of the STP, land reclamation for access road and STP in the Cheung Aek Lake is planned. Countermeasure to protect ground surface should be considered.	Project scheme is under consideration. Adequate survey should be conducted, if necessary.
	11	Hydrological situation	B-	**Planning Phase, Construction Phase:** The project will be planned based on the current water flow, and thus no large hydrological change is anticipated. No particular impact is identified at the moment. Land reclamation in the Cheung Aek Lake may affect current water flow in the area depending on the site selection. Appropriate hydrological study may be needed to avoid flood	Project scheme is under consideration. Adequate survey should be conducted, if necessary.

Classification	No.	Items	Rating	Reason and Description	Possible Measure
				damage.	
	12	Fauna and flora and biodiversity	B-	**Planning Phase, Construction Phase:** There is no legally protected area such as national park, wildlife preserve, protected scenic view area and multipurpose area in the project area. Habitats for the common fish species in the Cheung Aek Lake may be affected. Cheung Aek Lake is functioning as natural wastewater treatment lagoon for the capital and water quality is severely deteriorated. Due to decline of the water quality, biodiversity becomes poor.	Project scheme is under consideration. Adequate survey should be conducted, if necessary.
Pollution	13	Air pollution	B-	**Construction Phase:** Suspended dust and gas emission from the construction machinery is expected in a limited area.	To minimize pollution, construction related emissions should be regulated; e.g., maintaining machinery and avoiding unnecessary idling. Regular water spray on dry surface to reduce dust generation must be practiced.
	14	Water contamination	B-	**Construction Phase:** Associated with earthworks, the turbidity of water may increase.	Handling, storage and spillage of the potential contaminants has to be strictly controlled to avoid water pollution.
	15	Soil contamination	B-	**Construction Phase:** Accidental spillage of toxic chemicals such as fuel, lubricants, and solvents may cause soil contamination.	Handling, storage and spillage of the potential contaminants has to be strictly controlled to avoid water pollution.
	16	Waste	B-	**Construction Phase:** Project owner should properly handle waste (including sludge).	Workers should be instructed not to dump waste at surrounding areas. Adequate dumping site should be planned.
	17	Noise and vibration	B-	**Construction Phase:** Noise pollution will be generated with the use of vehicles, stone crushing, generators, etc.	Adequate maintenance of machinery will be required. Construction works should be done in accordance with the standards.
	18	Offensive odor	B-	**Construction Phase:** Associated with the disturbance of river bottom sediment in bed excavation and foundation works, offensive odour may be generated. **Operation Phase:** Associated with the operation of STP, offensive odour at surrounding area may increase.	Prevention measure should be considered at the designing such as applying deodorization equipment for the STP.
	19	Accidents	B-	**Construction Phase:** **O**peration of heavy vehicles and machinery may cause traffic accidents to residents and labourers in and around the project sites.	Adequate traffic guide should be provided to reduce accidents at the site.

Source: JICA Study Team

7.2 Mitigation Measures for Priority Projects in Drainage Management

The Environmental Management Plan (EMP) should be finalized in time for the EIA processing in accordance with the further detail study. The EMP at the IEE stage is as tentatively presented in **Table 7.2.1**.

Table 7.2.1 Impact and Possible Mitigation Measures for Priority Projects in Drainage Management (Tentative, December 2015)

Classification	No.	Items	Rating	Reason and Description	Possible Measure
Social Environment	1	Involuntary resettlement	C-	**Planning Phase, Construction Phase:** Some residents are living close to existing channels such as Phum Mor Canal at the downstream. At the improvement of water flow/drainage, impact to the residents in downstream should be avoided and/or minimized based on the adequate survey in downstream. The project may require resettlement of the residents who live near the existing channels. **Planning Phase, Construction Phase:** Construction of box culvert, new pumping station, and new regulation pond may require additional land acquisition and resettlement. Expansion of the existing pumping station may affect the residents nearby.	Further study should be conducted to verify the situation at the EIA study.
	2	Local economy such as employment and livelihood, etc.	C-	**Planning Phase, Construction Phase:** Some poor households living in marginal areas such as wetland and drainage channel may lose a part of their income source or to be resettled/loss the land. In such cases, supporting programs such as resettlement plan and rehabilitation plan will be required. At the construction phase, the project increases working opportunity. **Operation Phase:** With the operation of drainage system, flood damage will be reduced and local economy will be improved.	Adequate compensation scheme should be applied in case of resettlement. Livelihood rehabilitation plan should be prepared, if the project affects poor people.
	3	Social institutions	B-	**Planning Phase, Construction Phase:** There are many land development projects in which wetland is converted to other land uses such as residential area and industrial area. Associated with those developments, there may be some problems in flood and land use. Adequate information disclosure by the implementation agency to Project-Affected People (PAPs) may be required at the planning phase.	Adequate information disclosure such as public consultation meeting by implementation agency should be considered at actual planning stage in case resettlement/land acquisition is required.
	4	Existing social infrastructures and services	B-	**Construction Phase:** The drainage facilities will basically be installed under existing roads. Associated with the installation works, disturbance to road traffic movement may occur. **Planning Phase:** The proposed site for the box culvert includes being improved or to be improved roads such as Veng Sreng Blvd., Northbridge Street, St. Doung Neap II and St. 2004. Adequate	Adequate traffic control with adequate notice such as signboard, signs and diversion road should be provided to reduce traffic jams. Adequate coordination with the road construction plan may be needed.

Classification	No.	Items	Rating	Reason and Description	Possible Measure
				coordination with the road construction plan may be required.	
	5	The poor, indigenous and ethnic people	C-	**Planning Phase, Construction Phase:** Some residents are living close to existing channels. At the planning phase, impact to those residents including resettlement and land acquisition should be avoided and/or minimized.	Detail survey should be conducted in the EIA study.
	6	Local conflict of interests	C-	**Planning Phase:** In the capital, there are many land development projects in which wetland is converted to other land uses such as residential area and industrial area. Associated to those developments, there are some problems in flood and land use. Capital government is currently proceeding with the identification of land rights. Associated with the above-mentioned land acquisition and resettlement (if involved), some conflict on the land right may occur in the process of resolution.	Detail survey should be conducted at the EIA study. With the socio-economic survey, the situation may be clarified.
	7	Water usage or water rights and rights of common	B-	**Planning Phase:** For water flow improvement, adequate coordination with the irrigation sector is required.	Adequate coordination with the irrigation sector should be required.
Natural Environment	8	Topography and geographic features	B-	**Construction Phase:** Some topographical modification of waterway is expected.	Hydrological study should be conducted to prevent unexpected flooding caused by phased development.
	9	Hydrological situation	B-	**Construction Phase:** With new pumping station and regulation ponds, modification of the water flow may be expected.	Hydrological study in downstream should be conducted at planning stage.
	10	Fauna and flora and biodiversity	B-	**Planning Phase:** There is no legally protected area such as national park, wildlife preserve, protected scenic view area and multipurpose area in the project area. Most existing ditches and regulation ponds in the capital are highly polluted for wildlife. At the planning phase, the situation may be confirmed in the survey.	Site confirmation prior to the project may be required at the planning stage.
Pollution	11	Air pollution	B-	**Construction Phase:** Suspended dust and gas emission from the construction machinery is expected in a limited area.	To minimize pollution, construction related emissions should be regulated; e.g., maintaining machinery and avoiding unnecessary idling. Regular water spray on dry surface to reduce dust generation must be practiced.
	12	Water contamination	B-	**Construction Phase:** Associated with earthworks, the turbidity of water may increase.	Handling, storage and spillage of potential contaminants has to be strictly controlled to avoid water pollution.
	13	Soil contamination	B-	**Construction Phase:** Accidental spillage of toxic chemicals such as fuel, lubricants, and solvents may cause soil contamination.	Handling, storage and spillage of potential contaminants has to be strictly controlled to avoid water pollution.

Classification	No.	Items	Rating	Reason and Description	Possible Measure
	14	Waste	B-	**Construction Phase:** Project owner should implement adequate handling of waste (including sludge).	Workers should be instructed not to dump waste at surrounding areas. Adequate dumping site should be planned.
	15	Noise and vibration	B-	**Construction Phase:** Noise pollution will be generated with the use of vehicles, stone crushing, generators, etc.	Adequate maintenance of machinery will be required. Construction works should be done in accordance with the standards.
	16	Offensive odor	B-	**Construction Phase:** Associated with the disturbance of river bottom sediment such as bed excavation and foundation works, offensive odour may be generated.	Prevention measures shall be considered at the designing such as applying deodorization equipment.
	17	Accidents	B-	**Construction Phase:** **O**peration of heavy vehicles and machinery may cause traffic accidents to residents and labourers in and around the project sites.	Adequate traffic guide should be provided to reduce accidents at the site.

Source: JICA Study Team

CHAPTER 8 CONCLUSION AND RECOMMENDATION

This IEE study was conducted as a preliminary environmental assessment for the Pre-Feasibility Study on the IEE level based on the available secondary information. Further studies are recommended in the subsequent project stages. In **Tables 8.1.1** and **8.1.2**, drafts of the Terms of Reference (TOR) for conducting studies on the Full Environmental Impact Assessment (FEIA) and the Land Acquisition and Resettlement Action Plan (LARAP) are shown as references. The environmental study should be conducted by a company registered with the Ministry of Environment (MOE). On the other hand, the study on the Initial Resettlement Action Plan should be conducted by a company registered with the Ministry of Economy and Finance (MEF).

8.1 Draft TOR for FEIA

The Draft TOR for FEIA is summarised in **Table 8.1.1**.

Table 8.1.1 Draft Terms of Reference (TOR) for FEIA

	Items	Contents	Resources and Methodology
1	Introduction	• Project Overview: Brief project background, reasons for the formative project and general situation of the project site. • Objectives of preparing the EIA report. • Methodologies and Scope of Study: Information on the project, data needed, methodology of data collection, and data analysis. In the case of FEIA report, the project owner shall study methodologies in detail and develop separable chapters.	Compiled from the Result of Technical Review at the Feasibility Study.
2	Legal Framework	Description of laws, sub-decrees and various policies related to the project.	
3	Project Description	Description of project details such as background, owners' experience, project site, project type/scope and time of project activities, action plan of work and program of activities of the project: 1) Sources and quantity of raw materials to be used; 2) machinery requirement; 3) local and foreign work force requirement; 4) quantity of final products; 5) income and expenditure; 6) production-chain of the project; 7) general waste management plan, etc.	
4	Description of Environmental Resources	Description of natural environmental and socio-economic resources (primary and secondary data) in and around the project location including: • Natural Environmental Resources <u>Physical Resources</u> ・ Soils: geology, soil formation/topology, soil types, soil erosion and sedimentation (also earthquake and geology) ・ Weather: temperature, rainfall, air speed and regime, air pressure, air direction and humidity ・ Air quality (air quality analysis in the project location), noise and vibration (noise and vibration measures in the project location) ・ Hydrology: quality and quantity of surface and underground water (including analysis of quality of surface and underground water), water current and flow <u>Biological Resources</u> ・ Forest: forest land area, forest species and forest classification ・ Fauna species, rare species, endangered species and migration ・ Habitats ・ Biodiversity and ecology system ・ Wetland system (attached relevant maps) <u>Socio-economic Resources</u> ・ Demography and settlement ・ Economic status (employment and income)	

	Items	Contents	Resources and Methodology
		・ Land use ・ Water use ・ Energy use ・ Infrastructure system ・ Education ・ Public health ・ Cultural heritage, historical buildings, ancient temples, pagodas, customs/traditions, ethnic minority or indigenous people ・ Tourism area	
5	Public Participation	Report on the Public Consultation - Introduction - Conduct of public consultation ・ Dissemination for authorities and local communities about development projects ・ Comments from relevant ministries, institutions, departments and local authorities ・ Comments from relevant non-government organizations (NGOs) ・ Local people consultation - Conclusion on the results of public consultation	This will be prepared as a report on the Stakeholders' meeting.
6	Environmental Impacts and Mitigation Measures	Description of both positive and negative environmental and socio-economic resource impacts arising from the projects' activities: impacts during the project pre-operation (project design and construction), operation and mitigation measures, etc. - Describe the negative environmental and socio-economic resource impact during project pre-operation (project design and construction), operation - Summarize the above points on the scope of negative environmental impact mitigation measures in table form as stated in Annex 2. - Cumulative impacts - Describe the positive environmental and socio-economic resource impacts.	
7	Environmental Management Plan	Description of the draft Environmental Management Plan containing the Implementation Agency's measures against the impacts, establishment of a fund and an office with qualified technical staff, appropriate equipment, methodologies and well-prepared schedule for monitoring environmental quality in close collaboration with relevant institutions in order to mitigate negative socio-economic and environmental resource impacts to the minimum level. The EMP shall include: - Summary of main negative environmental impacts and mitigation measures - Training to be provided - Monitoring schedule during construction, operation and closure phases that the project owner shall take, including the following: ・ Control institutions for the project monitoring ・ Parameter to be controlled ・ Methodology of control ・ Environmental norms or guidelines to be taken in the implementation ・ Schedule and cycle to be controlled ・ Assess output of self-monitoring ・ Prepare quarterly report to be submitted to MOE and relevant ministries/institutions.	
8	Economic Analysis and Environmental Value	Description of benefits of the projects in comparison with the scope and value of environmental damage arising from the project activities.	
9	Conclusion and Recommendations	Conclusion of environmental impact assessment study indicating the minimization of impacts to physical, biological and socio-economic resources.	

Source: JICA Study Team, based on the Declaration on General Guideline for Conducting Initial and Full Environmental Impact Assessment Reports (MOE, 2009, N. 376 BRK.BST)

8.2 Draft TOR for LARAP

The Draft TOR for LARAP is summarised in **Table 8.2.2**.

Table 8.2.1 Draft TOR for LARAP

Items	Contents	Remarks
1. Introduction	- Description of the project - Resettlement action plan for the drainage improvement - Definitions	
2. Description of Impacts and Socio-economic Characteristics	- Project area - Census and baseline survey - Social and economic characteristics of the PAPs - Impact of the project - Relocation requirement	Population census for all PAPs Socio-economic survey covering at least 20% of PAPs.
3. Eligibility and Legal Framework	- Description of the cut-off date - Eligibility - Legal and illegal Project-Affected Persons (PAPs) - Relevant Acts and Bylaws	
4. Compensation Policy and Entitlements	- Objectives of resettlement policy - Principles of resettlement policy - Detailed compensation, resettlement and rehabilitation entitlements - Subsistence allowance	
5. Public Participation	- Objectives of public information and consultation - Public information dissemination - Public participation - Public participation and consultation in resettlement - Public participation in project monitoring and ex-post evaluation - Grievance redress process	Public Consultation to PAPs(at least 2 different times)
6. Organizational Set up	- Institution for resettlement - External monitoring - Resettlement and rehabilitation capacity in PIU	
7. Resettlement Costs and Budget	- Procedures for flow of Funds - Implementation, administration and contingency costs - Unit price for cost estimation	
8. Implementation Schedule	- Pre-implementation activities - Resettlement implementation activities	
9. Monitoring and Evaluation	- Internal monitoring - External monitoring - Post implementation evaluation study - Monitoring and evaluation reports	

Source: JICA Study Team, based on JICA's Environmental and Social Consideration Guidelines (2010), MEF, Cambodia (2012), Basic Resettlement Procedure, MPWT, JICA (2014), Preparatory Survey for National Road No. 5 Improvement Project / Middle Section: - from Thlea Ma'am to Battambang - from Sri Sophorn to Poipet.

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- JICA (2013), Profile on Environmental and Social Considerations in Cambodia
- KEITI, GS E&C, Sunjin Engineering & Architecture (2011), Feasibility Study of Sewage Treatment Plant in Phnom Penh, Kingdom of Cambodia
- Ministry of Land, Infrastructure, Transport and Tourism of Japan (MLIT) (2012), Study on Water Environment Improvement in Phnom Penh, Kingdom of Cambodia