Socialist Republic of Viet Nam
Hai Phong Water Supply One Member Co.,Ltd

PREPARATORY SURVEY REPORT
ON
PROJECT FOR IMPROVING
AN DUONG WATER TREATMENT PLANT
IN HAI PHONG CITY
IN SOCIALIST REPUBLIC OF VIET NAM

March 2015

Japan International Cooperation Agency (JICA)

NJS Consultants Co., Ltd.
Water Supply and Sewer Association of Kitakyushu

GE
JR
15-041

PREFACE

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey on project for improving An Duong Water Treatment Plant in Hai Phong City in Socialist Republic of Viet Nam (hereinafter “Viet Nam”) and entrust the preparatory survey on project for improving An Duong Water Treatment Plant in Hai Phong City in Viet Nam.

The Survey Team held a series of discussions with the officials concerned of the Government of Viet Nam, and conducted field investigations. As a result of further studies in Japan, the present report was finalized.

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

Finally, I wish to express my sincere appreciation to the officials concerned of the Government of Viet Nam for their close cooperation extended to the Survey Team.

March, 2015

Takemi FUWA
Director General,
Global Environmental Department
Japan International Cooperation Agency

SUMMARY

1.Outline of Viet Nam

Viet Nam is an extended north and south S-shaped country located on the South China Sea side of the Indochina Peninsula. The country area is 329,241 km^2 (north-south 1,650km, east-west 600km) and 75% of the area is mountainous or highlands. It is bordered by China, Laos and Cambodia, and the vast Annamese Mountains lies between Viet Nam, China and Laos. The plains are limited to the areas near Red River Delta and Mekong Delta.

The Red River Delta includes the Vietnamese capital Ha Noi city, centrally controlled municipality Hai Phong and eight (8) provinces (Bac Ninh, Ha Nam, Hai Duong, Hung Yen, Nam Dinh, Ninh Binh, Thai Binh, Vinh Phuc). Along with the center of politics, the capital Ha Noi, it also keeps the most fertile soil which provides 20% of the rice production.

The climate of Viet Nam differs by the area and altitude, from the northern subtropical regions to the southern tropical monsoon regions. Northern Viet Nam, including the capital Ha Noi city, is in the temperate/mesodermal climate zone, which has four seasons and an average temperature of 24ºC. The high temperature reached 40ºC in July, and drops to the lowest 3-8ºC in January.

The main industries of Viet Nam are agriculture, fishery, forestry, mining and light industry (Source: website of MoFA). According to the National and Regional Policy Bureau (MLIT), the population ratio for each economic sector is; primary industry 48%, secondary industry 21% and tertiary industry 31%. Although currently almost half of the labor population is engaged in the primary industry, the ratio of secondary and tertiary industry is expected to grow in the future due to the industrialization policies of Viet Nam.

2.Background and Outline of the Project

Hai Phong city is located at the mouth of the Red River, in the north-eastern coastal area of the Socialist Republic of Viet Nam (hereinafter “Viet Nam”), approximately 100 km east of the capital Ha Noi city. It is one of the centrally controlled cities which have the same authorities along with Ha Noi city, Ho Chi Minh city, Da Nang city and Can Tho city. The city holds an important position in Viet Nam’s economy, as it is an important seaport for Viet Nam and has developed as an export processing zone. Hai Phong city is the third most populous city in the country after Ha Noi city and Ho Chi Minh city, with a population of 1.93 million (2013, Hai Phong People's Committee).

Hai Phong Water Supply One Member Co., Ltd. (hereinafter “Hai Phong Water”) manages the water supply business of Hai Phong city. The outline of Hai Phong Water is: supply population 1.36 million, connected supply taps 272,890, supply capacity 213,500m^3/day and total supply pipe length 2,300km

(June 2014, Hai Phong Water). The rate of water supply within the service area extends to over 90% and the Non-Revenue Water (hereinafter “NRW”) ratio is under 15% due to the improved leakage countermeasures, and the business management is overall good as shown by the water supply business income run surpluses.

An Duong Water Treatment Plant (hereinafter “WTP”) (designed supply capacity: 100,000m^3/day, supply population: 860,000) is the largest WTP of the seven (7) WTPs in Hai Phong city. However, it has several issues related to the treated water process and O&M, such as the large amount of coagulant and chlorine used to treat the ammonium nitrogen and organic matters contaminating the water source affected by the inflow of household wastewater to the Re river.

To improve those issues, Kitakyushu City Water and Sewer Bureau proposed the JICA grassroots technical cooperation project (local government type) “Improvement Program for Purification Methods against Organic Matters” which was implemented from 2010 to 2013. This project included a test plant of Upward Flow Biological Contract Filtration (hereinafter “U-BCF”).

According to the survey results of the JICA grassroots technical cooperation project (water source quality, water treatment process, treated water quality, etc.), the cause of the high concentration of ammonium nitrogen and organic matters at the Re River, in where the An Duong WTP intake is located, was due to domestic wastewater inflow to the river. Therefore, the advantage of the U-BCF system by Kitakyushu City Water and Sewer Bureau was indicated and a pilot plant experiment was proposed by the project. Water pollution was caused by domestic wastewater due to the poor coverage rate of the WTP in the area and the effect of the U-BCF after running the pilot plant for one year were favorable as follows: The ammonium nitrogen amount was lower than 0.2mg/L throughout the year, the ammonium nitrogen removal rate at 70 – 100%, the dissolved manganese removal rate at 60 – 70%, and the organic matter removal rate at 30 – 40%.

These results confirmed the stable removal of the above mentioned pollutants which generally consume large amounts of chlorine for water treatment. The U-BCF is expected to show high effectiveness for treating raw water for An Duong WTP for the following main points; reduction of chemical cost, reduction of Tri Halo Methane (hereinafter “THM”) and other hazardous by-product substances of chlorine and organic matter reactions, and last but not least, simplification of O&M.

In the 10-year Socio-Economic Development Strategy (2011-2020), Viet Nam aims to improve its infrastructure to develop as an industrially advanced country, and has announced a national policy regarding the urban water business in the Urban Water Business Development Guideline “Orientation on Water Supply Development of Urban areas and Industrial Zones in Viet Nam up to 2020” (1998). The

objectives of this policy include to “secure safe water for all urban areas by the year 2020” and to “reinforce the human resource development system by introduction of advanced technologies and facilities”.
Therefore, the advanced water treatment technology which is to be introduced by this project will play a significant role in measures to manage with the deterioration of Re River water quality which is expected in the future urbanization and this project is consistent with the Vietnamese policies .

Considering these backgrounds, Viet Nam requested a Grant Aid Project of introducing U-BCF to the Government of Japan, the “Preparatory Survey on Project for Improving An Duong Water Treatment Plant in Hai Phong City in Socialist Republic of Viet Nam” (hereinafter “Project”).

This Project contributes to supply safe drinking water by introducing U-BCF and related facilities, to stabilize the operation of An Duong WTP ,and to reduce to chlorine dosing amount.

In addition, this Project follows the Japanese Government Country Assistance Policy for the Socialist Republic of Viet Nam “Response to fragility”, which confirms the necessity and validity of the Project implementation. Since it is also introducing U-BCF, which is a national patent technology owned by Kitakyushu City Water and Sewer Bureau, to solve national development related issues, it represents the accordance with the Japanese government programs of the “Japan Revitalization Strategy” and “Export of Infrastructure Systems Strategy” by which further enhances the significance of the Project as a Grant Aid Project.

3.Outline of the Survey Results and Project Contents

The Government of Japan has decided to implement the “Preparatory Survey on Project for Improving An Duong Water Treatment Plant in Hai Phong City in Socialist Republic of Viet Nam”, and JICA was designated to implement the survey. The Study Team held discussions with the Vietnamese Government and related parties from July to September 2014, prepared a basic design for the Project Area, and held an explanation meeting for the outline design in December 2014.

Regarding the requests from GoV and field survey results, the basic design for this Project was planned following the below points.

① The water quality of the source river is declining for matters such as ammonium nitrogen. Introduction of advances water treatment facilities are required to respond to the deterioration of raw water quality. The treatment method to be adopted shall be determined by judging various factors such as the validity, construction cost and O&M cost. As a result, U-BCF is to be adopted as the advanced treatment method.

② The U-BCF scale shall be determined based on 2 points. 1: The ammonium nitrogen concentration rate at the chemical mixing basin, 2: the O&M easiness when the WTP is expanded to a 200,000m^3/day capacity in the future. Therefore, the U-BCF capacity was determined as

100,000m^3/day.

③ The transmission method to U-BCF shall be decided comparing various factors such as the construction cost, O&M cost and operational issues for 2 plans. 1: Renewal of the existing intake pump, 2: installing a storage pump at the raw water regulation reservoir. As a result, The existing intake pump is to be renewed to directly draw water to U-BCF.

④ The design conditions for the U-BCF, such as the space velocity, linear velocity and filter thickness, has been determined based on the U-BCF test plant experiment conducted at An Duong WTP during August 2011 to August 2012, and also the status of the currently operating U-BCF at the Honjyo WTP, of Kitakyushu City Water and Sewer Bureau.

⑤ The U-BCF is to be the first advanced water treatment facility in Viet Nam. Field tours from other cities with similar water problems are expected; therefore the facility is designed as a showpiece. For example, pressure-resistant glass shall be used for the U-BCF basin so that the inside of the basin is visible from the outside.

⑥ the Kitakyushu City Water and Sewer Bureau's U-BCF design policy and operation results shall be referred for this Project. For example, the design to make manholes in each basin to remove shellfish from the under drain system will be adopted.

⑦ The pipeline length from the pumping station to the WTP is 4km. It shall be mostly covered by the existing pipelines (after confirmation of flow capacity), although several locations may require bypass construction.

⑧ The U-BCF of this Project is to be added to the existing WTP facility. To suppress the O&M cost for the added pumps, water levels are to be basically adjusted to adopt gravity flow methods.

The basic specification of this Project (U-BCF facility scale) regarding the above policies is summarized below. The basic concept of the Project is shown in Table 1.

Target Year：2018(After 1 year for completion of U-BCF facilities)
Proposed water treatment volume of U-BCF：100,000m^3/day
Water Treatment Method : Upward Biological Contact Filtration (U-BCF)
Storage pump station：Replacement of existing pump facilities

Table 1 Basic Concept of the Project

	Request	Outline Design
Raw Water Reservoir Reclamation	—	Undertaking by Japanese Grant Aid Area 3,570m^2
Construction Works	Upward Biological Contact Filtration (U-BCF)100,000m^3/day, Reinforced Concrete construction	Capacity of U-BCF is decided as 100,000m^3/day
		Pipeline in An Duong WTP (Bypass Pipe) 1,000mm×66m (Ductile Iron Pipe)
		Pipeline in An Duong WTP (U-BCF - Mixing Tank) 1,000mm×88m (Steel Pipe)
		Pipeline in An Duong WTP (U-BCF - Drainage Pond) 300 - 350mm×117m (Ductile Iron Pipe)
		Pipeline in An Duong WTP (U-BCF - Branch Pipe for ADB) 1,000mm×69m (Ductile Iron Pipe)
		Blower for cleaning 37kw×2(1)unit
		Electrical Room in Quan Vinh intake pumping station (13.0m×8.0m)
		Electrical Room in An Duong WTP (12.0m×7.5m)
		Power Receiving Facilities Quan Vinh intake pumping station : Steel inside stand-alone type MCCB225AF
		Power Receiving Facilities An Duong WTP : Steel inside stand-alone type ACB1250AF×2
		Control Panel Steel inside stand-alone type MCC, Inverter panel, Inside stand-alone type control panel
		Monitoring Control Panel Liquid crystal display, Data server, Color printer
		Instrumentation Facilities Magnetic flowmeters / Ultrasonic flowmeters, Radio wave type level gage, Head loss level gage
	—	Intake Pump Facilities 160kw×27.0m×23.15m^3/min×4(1)unit Intake pumps are decided to be renewed.
	—	Raw Water Transmission Pipe 1,000mm×216m (Ductile Iron Pipe)
Procurement Works	Control Panel	Included in U-BCF(Monitoring and Control Panel)
	Water Level Gauge	Included in Instrumentation Facilities of U-BCF
	Removal Screen	Included in U-BCF
	Laboratory Equipment of Water Quality Analysis	As a result of the survey, the laboratory equipment for water quality analysis was sufficient, so procurement is not necessary.
Soft Component	1. Technical instruction for operation and maintenance of U-BCF 2. Technical instruction for water quality management	

Source: JICA Study Team (Based on local survey)

4.Schedule and Cost of the Project

The total Project implementation period is 30 months and the breakdown for each stage is; six (6) months for detail design, two (2) months for tender procedure, 17 months for construction and two (2) months for soft component.

Regarding the estimated Project cost, Japanese side cost is closed due to the confidentiality.
Vietnamese side cost is 115 million VND.

- Cost estimation period： September, 2014
- Construction/Procurement Term : Detail design and construction periods are as mentioned in the implementation schedule.

5.Project Evaluation

1.Relevance

An Duong WTP has several issues related to water treatment, caused by the large amounts of flocculent and chlorine required to treat the progressing water pollution by ammonium nitrogen and organic matters due to the inflow of domestic wastewater to the water source, Re River. Currently, the ammonium nitrogen concentration of the raw water is exceeding the Vietnamese standard (0.2mg/L) for raw water for drinking water. In addition, the river water quality, including the ammonium nitrogen concentration, is assumed to worsen in the future due to the development plans along the river basin. Therefore the introduction of an advanced water treatment method is required.

Viet Nam has announced a national policy regarding the urban water business in the Urban Water Business Development Guideline “Orientation on Water Supply Development of Urban Areas and Industrial Zones in Vietnam up to 2020” (1998). This guideline aims to “secure safe water for all urban areas by 2020” and to “reinforce the human resource development system by introduction of modern technologies and facilities”, and the safe water supply realized by the introduction of an advanced water treatment of this Project shall contribute to the achievement of the guideline objectives.

Also, in the Japanese Government Country Assistance Policy for the Socialist Republic of Viet Nam (December 2012) and the JICA Country Analytical Work (March 2014), “Response to fragility” is highlighted. Along the policy, Japan aims to support Viet Nam to address emerging environmental issues (urban environment, natural environment) caused by rapid urbanization and industrialization, and the Project follows this principle.

This objective of this Project is to introduce U-BCF as an advanced water treatment method to treat the raw water polluted by urbanization of Hai Phong city; therefore it is in accordance with the Vietnamese national policies, the Japanese Government Country Assistance Policy and the priority areas (“Response to fragility”) of the JICA Country Analytical Work, so the necessary and validity of the Project

implementation is high. Furthermore, the U-BCF methods, which is the national patent technology owned by Kitakyushu City Water and Sewer Bureau, shall be introduced to solve the issues of Viet Nam. Hence it is in alignment with the Japanese government programs of the “Japan Revitalization Strategy” and “Export of Infrastructure Systems Strategy” by which further enhances the significance of the Project as a grant aid project.

2.Effectiveness

The expected outputs of the Project are the quantitative/qualitative effectiveness described in the followings:

① Quantitative Effectiveness (Reduction of ammonium nitrogen)

In case the ammonium nitrogen concentration of the raw water is high, the WTP treatment requires large amounts of chlorine to treat the ammonium nitrogen. This causes a chemical reaction between chlorine and ammonium nitrogen which generates chloramine (cause of bad odor/taste), and also a reaction of chlorine and organic matters in the raw water generates THM. Therefore, the ammonium nitrogen concentration in raw water is considered as an important value for Japanese water treatment methods, and is expected to be lower than 0.3mg/L. In Viet Nam, the ammonium nitrogen value for standard surface water quality is lower than 0.2mg/L, which indicates that ammonium nitrogen is understood to be a main factor for water treatment problems.

For the above reasons, the quantitative effectiveness of U-BCF shall be measured by the ammonium nitrogen concentration, and the target value is lower than 0.2mg/L in the treated water at the U-BCF exit.

② Qualitative Effectiveness

The qualitative effectiveness is expected by the Project as follows:

- Stability of the operation of An Duong WTP by reducing the ammonium nitrogen concentration of the raw water.
- Supply of safe drinking water (Reduction of THM generation)
- Improvement of knowledge/technical skills of Vietnamese water business parties by adopting advanced water treatment technology.

Preparatory Survey
on Project for Improving An Duong Water Treatment Plant
in Hai Phong City
in Socialist Republic of Viet Nam

Contents

Preface
Summary
Contents
Location Map / Perspective
List of Figures & Tables
Abbreviations

Chapter1 Background of the Project 1-1
1-1 Background and Outline of Grant Aid Request 1-1
1-2 Natural Conditions 1-4
1-3 Environmental Social Consideration 1-22
1-3-1 Environmental Impact Assessment 1-22
1-3-1-1 Outline of Project Components Which Provide Environmental and Social Impacts 1-22
1-3-1-2 Environmental and Social Conditions around the Project Area 1-24
1-3-1-3 Laws and Regulations on Environmental and Social Consideration in Viet Nam 1-32
1-3-1-4 Comparison of Project Alternatives (Including Zero Option) 1-44
1-3-1-5 Scoping 1-49
1-3-1-6 TOR for Environmental and Social Consideration Survey 1-54
1-3-1-7 Survey Results of Environmental and Social Consideration (Including Predicted Results) 1-54
1-3-1-8 Environmental Impact Assessment 1-65
1-3-1-9 Mitigation Measures 1-70
1-3-1-10 Mitigation Measures Cost (Approximate Estimate) 1-73
1-3-1-11 Environmental Monitoring Plan 1-74
1-3-1-12 Monitoring Implementation System 1-77
1-3-2 Stakeholder Meeting 1-80
1-3-3 Land Acquisition and Resettlement 1-82
1-3-4 Others 1-82

Chapter2 Contents of the Project 2-1
2-1 Basic Concept of the Project 2-1
2-1-1 Upper Level Plan and Project Objective 2-1
2-1-2 Basic Concept of the Project 2-1
2-2 Outline Design of the Japanese Assistance 2-3

2-2-1 Design Policy 2-3
2-2-2 Basic Plan (Construction Plan/ Equipment Plan) 2-7
2-2-3 Outline Design Drawing.....2-39
2-2-4 Implementation Plan.....2-66
2-2-4-1 Implementation Policy 2-66
2-2-4-2 Implementation Conditions 2-67
2-2-4-3 Scope of Works 2-73
2-2-4-4 Consultant Supervision 2-74
2-2-4-5 Quality Control Plan 2-76
2-2-4-6 Procurement Plan 2-76
2-2-4-7 Operational Guidance Plan 2-78
2-2-4-8 Soft Component (Technical Assistance) Plan 2-79
2-2-4-9 Implementation Schedule 2-80
2-3 Obligation of Recipient Country.....2-83
2-4 Project Operation Plan.....2-83
2-5 Project Cost Estimation 2-85

Chapter3 Project Evaluation 3-1
3-1 Preconditions 3-1
3-2 Necessary Actions by Recipient Country 3-1
3-3 Important Assumptions.....3-1
3-4 Project Evaluation.....3-2
3-4-1 Relevance 3-2
3-4-2 Effectiveness 3-4

Appendix

Appendix 1. Member List of the Study Team A-1

Appendix 2. Study Schedule A-3

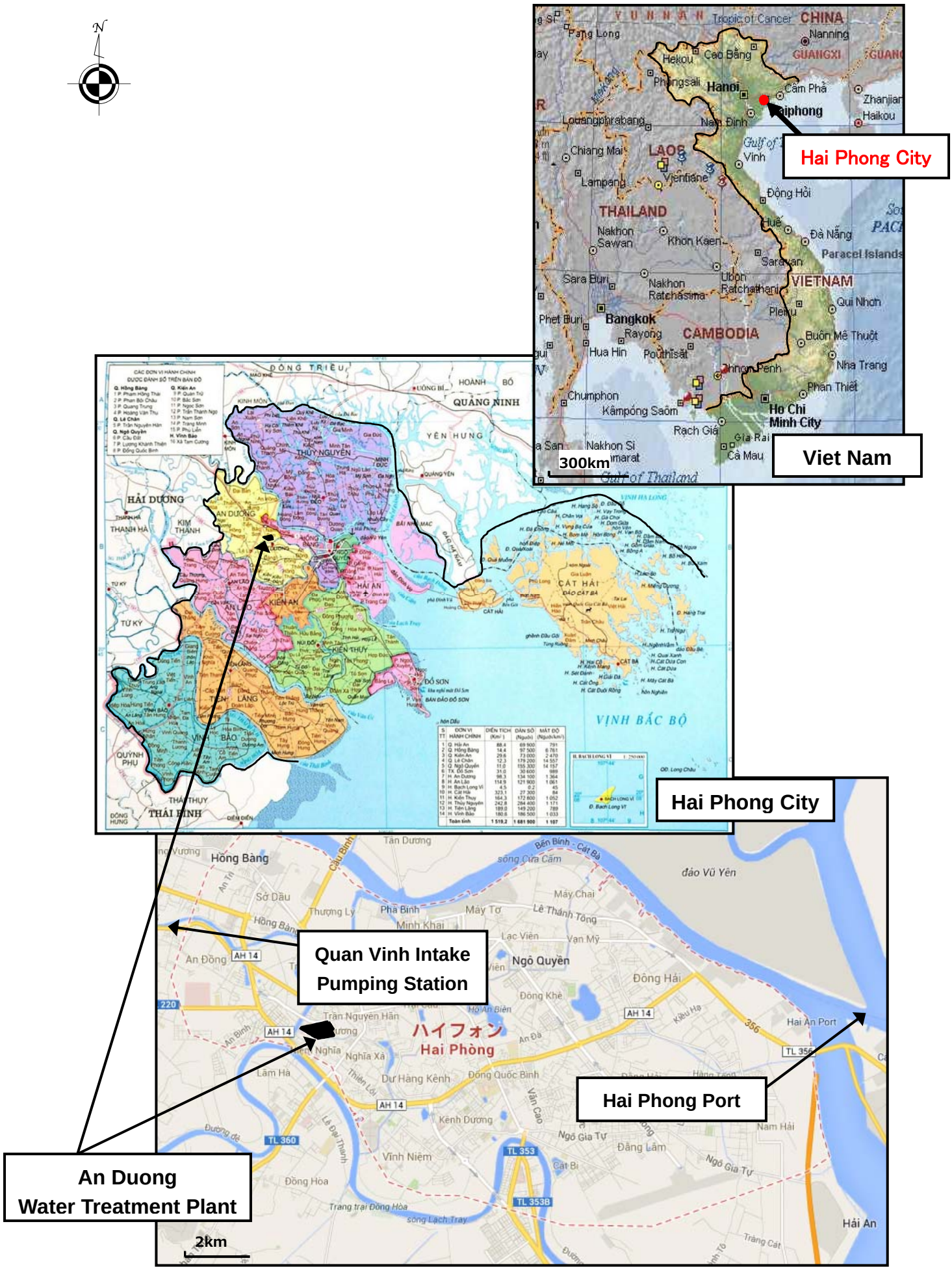
Appendix 3. List of Parties Concerned in the Recipient Country A-5

Appendix 4. Minutes of Discussions
- Appendix 4-1. Minutes of Discussions 1st A-6
- Appendix 4-2. Technical Note A-17
- Appendix 4-3. Minutes of Discussions 2nd A-40

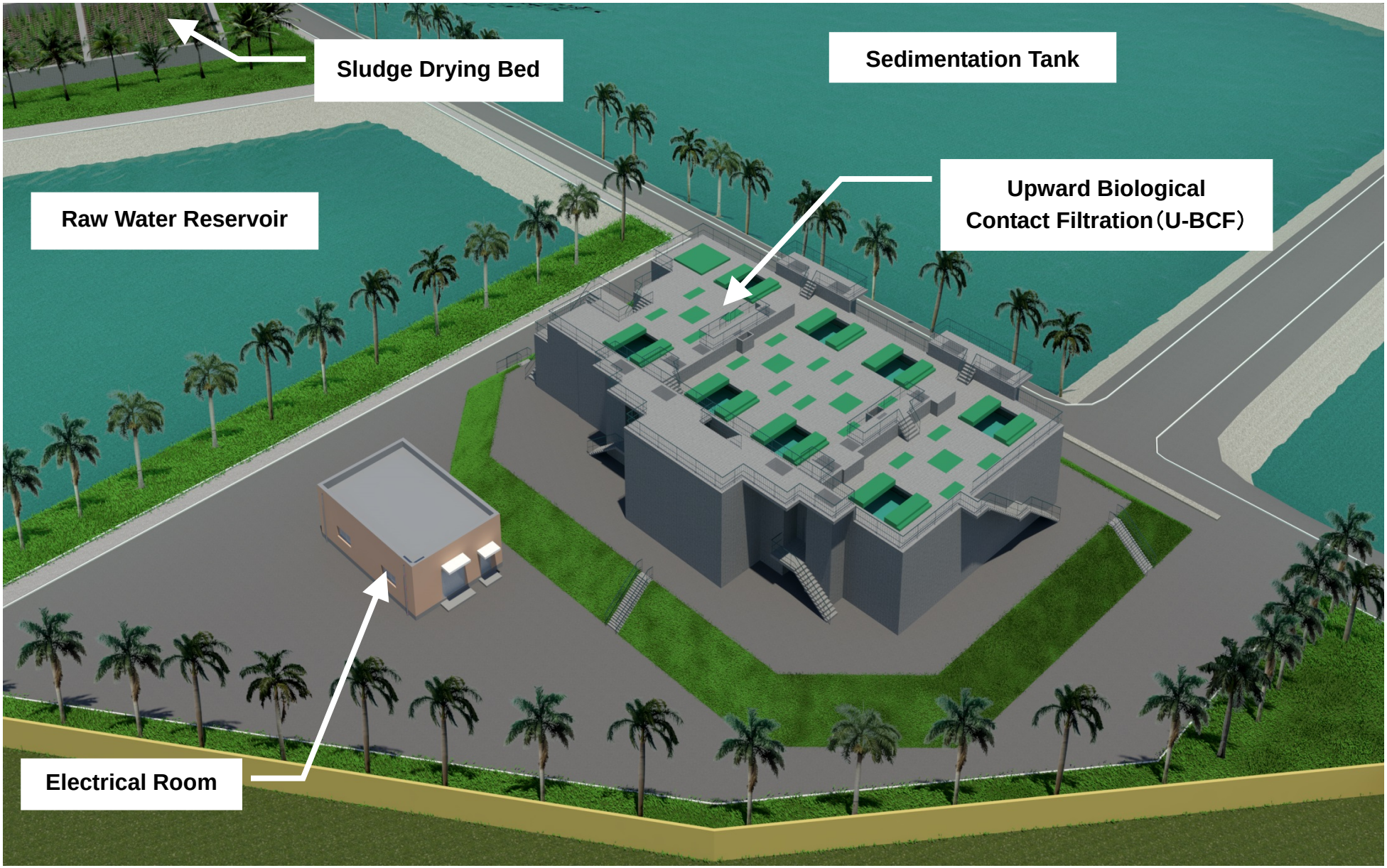
Appendix 5. Soft Component (Technical Assistance) Plan A-69

Appendix 6. Other Relevant Data
- Appendix 6-1. Water Rights of Quan Binh Intake A-76
- Appendix 6-2. Payment certificate for water rights A-82
- Appendix 6-3. Documents of stake holder meeting A-86
- Appendix 6-4. Notification for necessity of EIA A-97
- Appendix 6-5. Memorandum for unnecessary of EIA A-98
- Appendix 6-6. Notification for unnecessary of EIA A-99
- Appendix 6-7. Monitoring Form A-100
- Appendix 6-8. Environment Checklist A-102
- Appendix 6-9. Topographic survey result A-109
- Appendix 6-10. Test pit excavation A-111
- Appendix 6-11. Soil survey A-114
- Appendix 6-12. Water Quality Analysis A-118
- Appendix 6-13. Capacity Calculation and Hydrauric Calculation for U-BCF A-127
- Appendix 6-14. Initial cost of the removal methods for ammonium nitrogen A-137
- Appendix 6-15. Initial cost for the comparison of water transmission method A-138
- Appendix 6-16. Calculation basis of operation and maintenance A-139

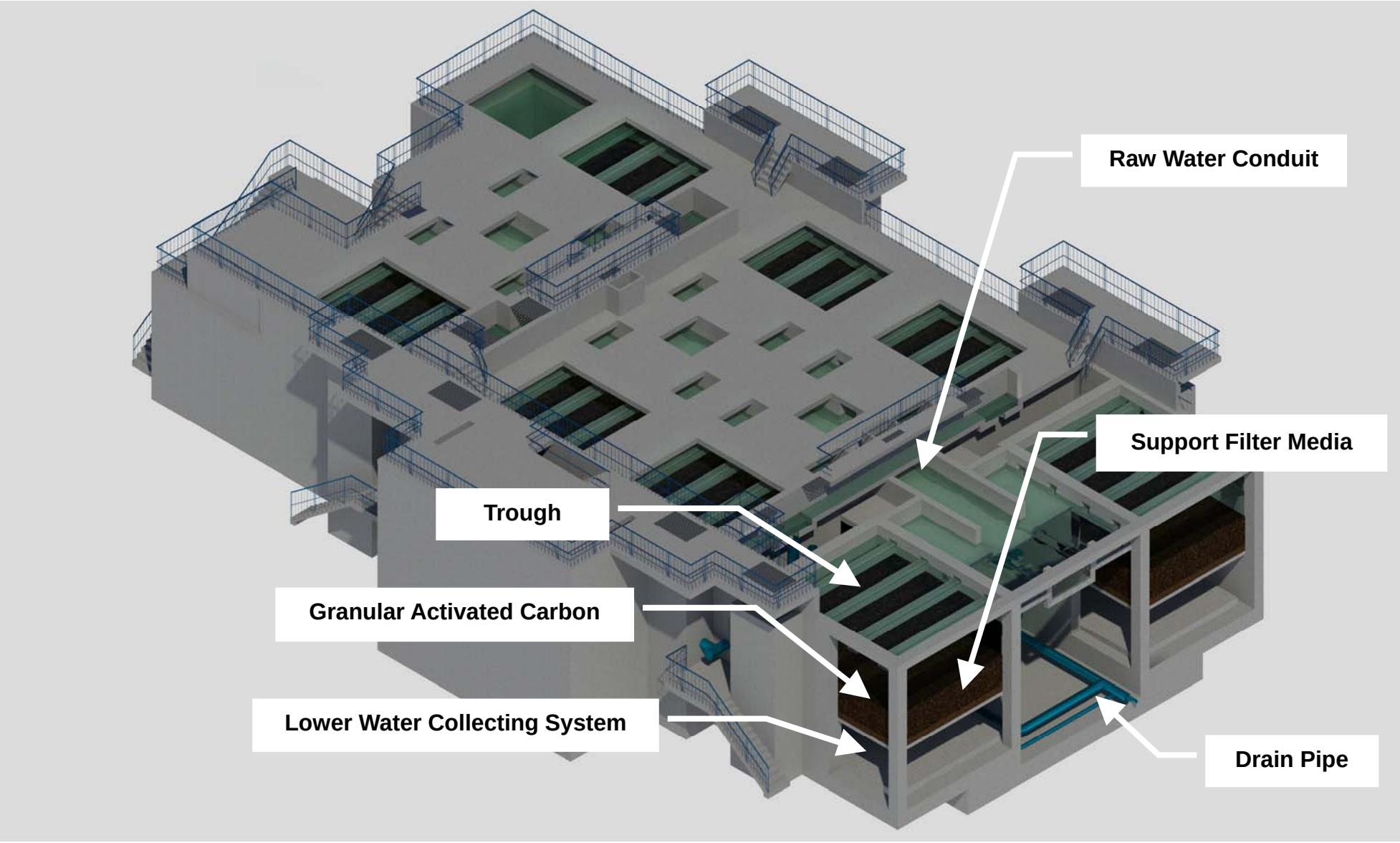
Appendix 7. References A-141
- Appendix 7-1. List of collected Data A-142



Location Map



Perspective（AnDuong WTP　U-BCF Panorama View）



Perspective（AnDuong WTP　U-BCF Detailed View）

【List of Figures & Tables】

Figure 1-2-1 Soil Survey Point Location 1-5
Figure 1-2-2 Boring Columnar Section 1-7
Figure 1-2-3 Monthly Average Precipitation, Humidity and Temperature in Hai Phong City 1-8
Figure 1-2-4 Daily Fluctuation of the Raw Water Turbidity at An Duong WTP 1-15
Figure 1-2-5 Survey Points 1-16
Figure 1-2-6 Explorations Points 1-18
Figure 1-3-1 Locations of Quan Vinh Intake Pumping Station and An Duong WTP, and Situations of Neighboring Areas 1-23
Figure 1-3-2 Locations of the 15 Districts of Hai Phong City 1-25
Figure 1-3-3 Location Map of Main Industrial Parks in Hai Phong City 1-27
Figure 1-3-4 Ratio of Each Industrial Field in GDP for Year 2013 in Hai Phong City 1-28
Figure 1-3-5 Locations of Cultural and Historical Heritages and Monuments Around An Duong WTP 1-30
Figure 1-3-6 Organization Chart of the Ministry of Natural Resources and Environment 1-33
Figure 1-3-7 Organization Chart of People's Committee in Hai Phong City 1-34
Figure 1-3-8 Organization Chart of Department of Natural Resources and Environment, Hai Phong People's Committee 1-35
Figure 1-3-9 EIA Approval Process 1-39
Figure 1-3-10 Organization Chart of Le Chan District 1-42
Figure 1-3-11 Locations of Trang Cat General Waste Landfill and Dinh Vu Construction Debris Landfill Owned by Hai Phong Urban Environment Company 1-56
Figure 1-3-12 Locations of Disposal Sites of Sludge from the Existing An Duong WTP (Including Proposal Sites) 1-58
Figure 1-3-13 Actual Measuring Points of Noise Level 1-76
Figure 1-3-14 Environmental Management System at Construction Site 1-78
Figure 2-2-2 Daily Fluctuation of the Raw Water Temperature at An Duong WTP 2-4
Figure 2-2-3 System Drawing of Intake and U-BCF for Each Plan 2-15
Figure 2-2-4 Calculation Result of Water Hammer 2-20
Figure 2-2-5 Raw Water Transmission Pipeline Route 2-21
Figure 2-2-6 Water Treatment Flow before Completion of the ADB Project 2-23
Figure 2-2-7 Water Treatment Flow after Completion of the ADB Project 2-23
Figure 2-2-8 Layout Plan Before Completion of the ADB Project (After Completion of U-BCF) 2-25
Figure 2-2-9 Layout Plan After Completion of the ADB Project 2-25
Figure 2-2-10 Water Treatment Flow 2-26
Figure 2-2-11 Raw Water Flow 2-27
Figure 2-2-12 Typical drawing of pipe installing 2-32
Figure 2-2-13 Demarcation of the Construction and Cost for EVN Hai Phong Construction Works 2-35
Figure 2-2-14 River Sand Yard Locations for Reclamation 2-68
Figure 2-2-15 Schematic Drawing of Traffic Line and Temporary Stockyard 2-69

Table 1-2-1 Water Quality Analysis 1-10
Table 1-2-2 Water quality survey results of THM（treated water） 1-11
Table 1-2-3 Specification 1-16
Table 1-2-4 Reference Point 1-17
Table 1-2-5 Results of survey 1-17
Table 1-2-6 Specification 1-18
Table 1-2-7 Detail Information and the Condition 1-19
Table 1-2-8 Explorations Result 1-20
Table 1-3-1 Outline of Project Components Which Provide Environmental Social Impacts 1-22
Table 1-3-2 Administrative System of Hai Phong City by District Level 1-24
Table 1-3-3 Outline of Main Industrial Parks in Hai Phong City 1-26
Table 1-3-4 Cultural and Historical Heritage and Monuments around An Duong WTP 1-29
Table 1-3-5 List of Important Fauna and Flora in Hai Phong City 1-31
Table 1-3-6 Main Laws and Regulations Related to Environment and Social Considerations 1-32
Table 1-3-7 Projects Requiring EIA Related to Construction of Water Supply System 1-37
Table 1-3-8 Comparative Table of Alternative Plan (Including Zero Option) 1-46
Table 1-3-9 Scoping List 1-49
Table 1-3-10 TOR for Environmental and Social Consideration Survey 1-54
Table 1-3-11 Proposed Disposal Sites (Including Planned Sites)
as Reclamation Areas of Sludge from Existing An Duong WTP 1-57
Table 1-3-12 Equipment Set up at Intake Pumping Station and U-BCF 1-59
Table 1-3-13 National Noise Standards（QCVN26: 2010/BTNMT） 1-60
Table 1-3-14 Power Consumption of Planned Water Supply Facilities 1-64
Table 1-3-15 Result of Environmental Impact Assessment 1-65
Table 1-3-16 Environmental Management Plan for Construction Stage 1-70
Table 1-3-17 Environmental Management Plan for Operation Stage 1-72
Table 1-3-18 Cost for Implementation of Mitigation Countermeasure 1-73
Table 1-3-19 Monitoring Plan for Environmental Countermeasure at Construction / Operation Stages 1-74
Table 1-3-20 Monitoring Cost (Estimation) at Construction Stage 1-77
Table 1-3-21 Meeting Schedule for Stakeholder 1-80
Table 2-1-1 Basic Concept of the Project 2-2
Table 2-2-1 Comparison of the Removal Methods for Ammonium Nitrogen 2-10
Table 2-2-2 U-BCF Water Transmission Method Comparison Table 2-14
Table 2-2-3 O&M Cost without Project Implementation 2-17
Table 2-2-4 In Case the Project is Implemented (Before ADB-loan facility expansion) 2-18
Table 2-2-5 In Case the Project is Implemented (After ADB-loan facility expansion) 2-19
Table 2-2-6 Factor of Intake Pumps 2-19
Table 2-2-7 Connection of Treated Water and Backwash Drainage Water 2-24

Table 2-2-8 Conditions of the Outline Design 2-31
Table 2-2-9 Power Failure Records for An Duong WTP and Quan Vinh Intake Pumping Station 2-38
Table 2-2-10 List of Outline Design Drawing 2-39
Table 2-2-11 Work Demarcation 2-73
Table 2-2-12 Major Obligations of Each Government 2-74
Table 2-2-13 Tests Related to Quality Control 2-76
Table 2-2-14 Initial Operation Guidance 2-78
Table 2-2-15 Soft Component Target 2-80
Table 2-2-16 Provisional Implementation Schedules of Both Projects 2-81
Table 2-2-17 Implementation Schedule 2-82
Table 2-3-1 Undertaking by GoV and Hai Phong Water 2-83
Table 2-4-1 The Additional Works by the Introduction of U-BCF 2-84
Table 2-5-1 Cost to be Borne by the Vietnamese Side 2-85
Table 2-5-2 O&M Cost after Completion of this Project
(Before ADB-loan Facility Expansion Project) 2-86
Table 2-5-3 O&M Cost after Completion of this Project
(After ADB-loan Facility Expansion Project) 2-87
Table 3-4-1 Quantitative Project Effectiveness 3-4
Table 3-4-2 Monitoring Structure of the Quantitative Project Effectiveness 3-4

【Abbreviations】

ADB	Asian Development Bank	アジア開発銀行
A/P	Authorization to Pay	支払授権書
B/A	Banking Arrangement	銀行取極
DF/R	Draft Final Report	最終報告書案
DONRE	Department of Natural Resources and Environment	自然資源環境局
EIA	Environmental Impact Assessment	環境影響評価
E/N	Exchange of Notes	交換公文
EPC	Environmental Protection Commitment	環境保護責任
F/R	Final Report	最終報告書
EVN	Electricity of Vietnam	ベトナム電力総公社
G/A	Grant Agreement	贈与契約
GoJ	Government of Japan	日本政府
GoV	Government of Viet Nam	ベトナム政府
GRP	Gross Regional Product	域内総生産
GSO	General Statistics Office of Viet Nam	ベトナム統計局
HPPC	Hai Phong City People's Committee	ハイフォン市人民委員会
Hai Phong Water	Hai Phong Water Supply One Member Co., LTD	ハイフォン市水道公社
HPUEC	Hai Phong Urban Environment One Member Co., LTD	ハイフォン都市環境公社
IC/R	Inception Report	インセプションレポート
IPCC	Intergovernmental Panel on Climate Change	気候変動に関する政府間パネル
JICA	Japan International Cooperation Agency	国際協力機構
M/D	Minutes of Discussion	討議議事録
MOFA	Ministry of Foreign Affairs	外務省
MONRE	Ministry of Natural Resources and Environment	自然資源環境省
MPI	Ministry of Planning and Investment	計画投資省
NRW	Non-Revenue Water	漏水
O&M	Operation and Maintenance	運転維持管理
SCADA	Supervisory Control And Data Acquisition	コンピュータによるシステム監視とプロセス制御
THM	Trihalomethane	トリハロメタン
T/N	Technical Note	技術注記
TOC	Total Organic Carbon	全有機炭素
U-BCF	Upward Flow Biological Contact Filtration	上向流式生物接触ろ過
VAT	Value Added Tax	付加価値税
VND	Vietnamese Dong	ベトナムドン
WHO	World Health Organization	世界保健機関
WTP	Water Treatment Plant	浄水場

Chapter 1

Background of the Project

Chapter1 Background of the Project

1-1 Background and Outline of Grant Aid Request

(1) Background and Outline of Grant Aid Request

Hai Phong city is located at the mouth of the Red River, in the north-eastern coastal area of the Socialist Republic of Viet Nam (hereinafter "Viet Nam"), approximately 100 km east of the capital Ha Noi city. It is one of the centrally controlled cities which have the same authorities along with Ha Noi city, Ho Chi Minh city, Da Nang city and Can Tho city. The city holds an important position in Viet Nam's economy, as it is an important seaport for Viet Nam and has developed as an export processing zone. Hai Phong city is the third most populous city in the country after Ha Noi city and Ho Chi Minh city, with a population of 1.93 million (2013, Hai Phong People's Committee).

Hai Phong Water Supply One Member Co., Ltd. (hereinafter "Hai Phong Water") manages the water supply business of Hai Phong city. The outline of Hai Phong Water is: supply population 1.36 million, connected supply taps 272,890, supply capacity 213,500m^3/day and total supply pipe length 2,300km (June 2014, Hai Phong Water). The rate of water supply within the service area covers over 90% and the Non-Revenue Water (hereinafter "NRW") ratio is under 15% due to the improved leakage countermeasures, and the business management is overall good as shown by the water supply business income run surpluses (values from Application Form of Grant Aid).

An Duong Water Treatment Plant (hereinafter "WTP") (designed supply capacity: 100,000m^3/day, supply population: 860,000) is the largest WTP of the seven (7) WTPs in Hai Phong city. However, it has several issues related to the treated water process and O&M., such as the large amount of coagulant and chlorine used to treat the ammonium nitrogen and organic matters contaminating the water source affected by the inflow of household wastewater.

To improve the those issues, Kitakyushu City Water and Sewer Bureau proposed the JICA grassroots technical cooperation project (local government type) "Improvement Program for Purification Methods against Organic Matters" which was implemented from 2010 to 2013. This project included a test plant of Upward Flow Biological Contract Filtration (hereinafter "U-BCF").

According to the survey results of the JICA grassroots technical cooperation project (water source quality, water treatment process, treated water quality, etc.), the cause of the high concentration of ammonia and organic matters at the Re River, in where the An Duong WTP intake is located, was due to domestic wastewater inflow to the river. Therefore, the advantage of the U-BCF system by Kitakyushu City Water and Sewer Bureau was indicated and a pilot plant experiment was proposed by the project. Water pollution was caused by domestic wastewater due to the poor coverage rate of the WTP in the

area and the effect of the U-BCF after running the pilot plant for one year were favorable as follows: The ammonia nitrogen amount was lower than 0.2mg/L throughout the year, the ammonia nitrogen removal rate at 70 – 100%, the dissolved manganese removal rate at 60 – 70%, and the organic matter removal rate at 30 – 40%.

From the evaluation of these desirable results, the introduction of U-BCF was suggested to be efficient as the system can remove the above mentioned pollutants which consume large amounts of chlorine for water treatment. The implementation results are expected to solve the issues of An Duong WTP by; reducing the chemical cost, reducing the Tri Halo Methane (hereinafter "THM") generation caused by chemical reactions between chlorine and organic matters, simplifying the O&M, etc.

Basic information about the Project:

- Project Title: Preparatory Survey on Project for Improving An Duong Water Treatment Plant in Hai Phong City in Socialist Republic of Viet Nam
- Name of Donor: Japan International Cooperation Agency (JICA).
- Name of Administrative Agency: Hai Phong's People Committee.
- Project Proposing Agency: Hai phong Water Supply One Member Limited Company.
- Project Owner: Hai phong Water Supply One Member Limited Company.
  + Address: No 54, Dinh tien Hoang Street, Hong Bang District, Hai Phong City, Viet Nam.
  + Tel/Fax: 0313.745377.
- Tentative Duration of the Project implementation: 2015-2017.
- Project Location: Hai Phong City.

(2) Outline of Grant Aid Request

The request made to GoJ on May 13, 2013, is as below.

- Facility construction: Constructing a water treatment facility (capacity = 100,000m^3/day) adopting Upward Flow Biological Contact Filtration (hereinafter "U-BCF") inside An Duong WTP

- Equipment procurement: Control panel, screen, water level measuring device, water quality inspection instrument, etc.

1-2 Natural Conditions

(1) Topography

Viet Nam is an extended north and south S-shaped country located on the South China Sea side of the Indochina Peninsula. The country area is 329,241 km^2 (north-south 1,650km, east-west 600km) and 75% of the area is mountainous or highlands (MoFA "Basic Data of Viet Nam", March 2014). It is bordered by China, Laos and Cambodia, and the vast Annamese Mountains lies between Viet Nam, China and Laos. The plains are limited to the areas near Red River Delta and Mekong Delta.

The Red River Delta includes the Vietnamese capital Ha Noi city, centrally controlled municipality Hai Phong and eight (8) provinces (Bac Ninh, Ha Nam, Hai Duong, Hung Yen, Nam Dinh, Ninh Binh, Thai Binh, Vinh Phuc) . Along with the center of politics, the capital Ha Noi, it also keeps the most fertile soil which provides 20% of the rice production. It is also the most populated area of the country with a population of 19,060,000,000 (GSO, 2012). Of the total land area, 58% is agricultural and 8% is forest, and the average height above sea level is only several meters. Belonging to the Red River Delta, Hai Phong is a flat land without a large variation in altitude.

(2) Geology

Hai Phong is rich in natural and mineral resources, due to the geological history and features. For example, Thuy Nguyen County has iron and kaolin mines, Cat Hai County has zinc mines and the soil of Cat Hai and Tien Lang Counties include sedimentary sands and clay.

The Bac Boh Plain in Hai Phong consists of the sediment layered during the Alluvial and Pleistocene epochs. The surrounding hills and mountains were mostly formed in the Mesozoic era, but the foundations of the plains are the sedimentation rocks formed in the Neogene period.

For the U-BCF construction site, a boring test of 3 locations x 15m was originally planned. However, the foundation surface was over 15m deeper than the ground surface; hence a boring test of 1 location x 45m (3 tests worth) was conducted for the geological survey.

The location of the boring test is shown in Figure 1-2-1.

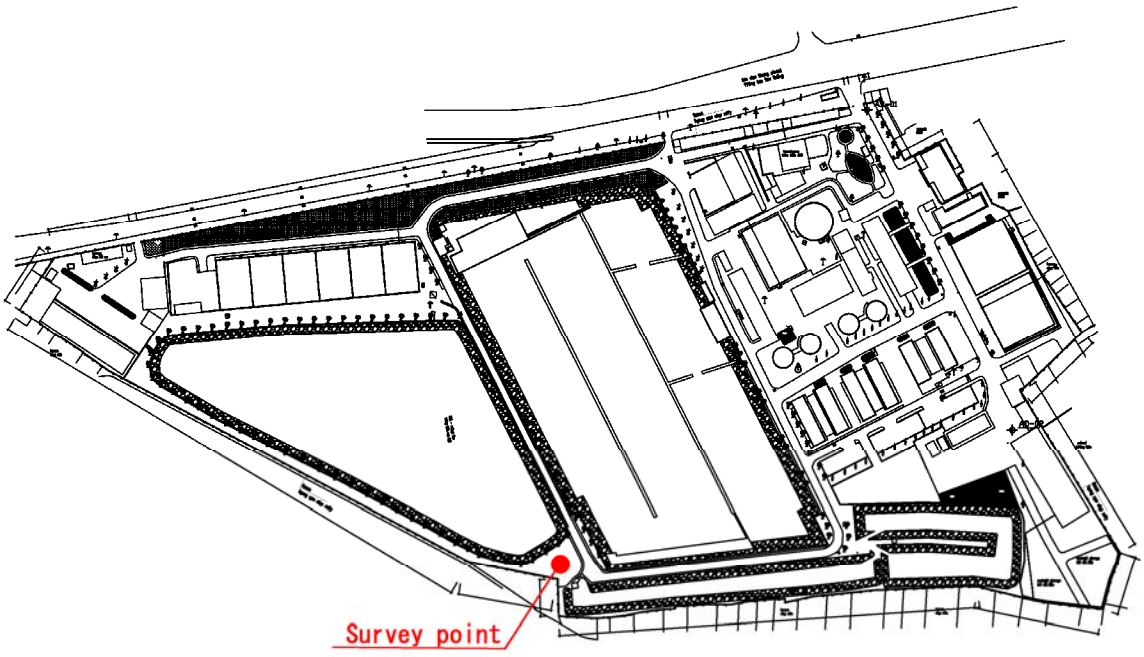


Figure 1-2-1 Soil Survey Point Location

Source: JICA Study Team (Based on local field survey)

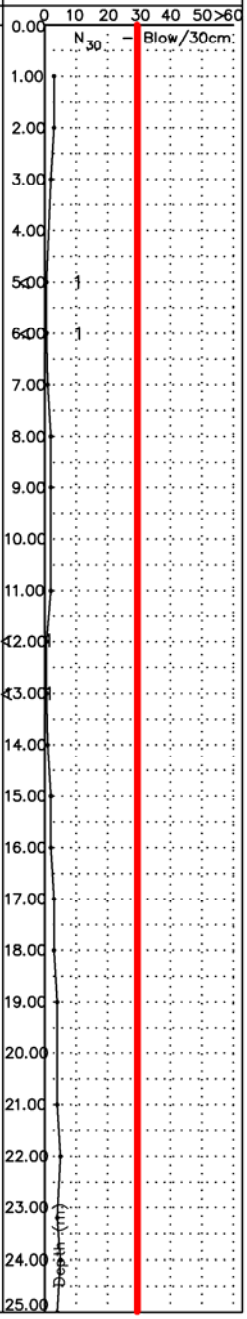
The results of the boring test showed that the Bac Boh Plain, which Hai Phong city is located, consists of the sediment layered during the Alluvial and Pleistocene epochs.

Therefore, the bearing ground is deep and the ground water level is high. A sandy soil layer (N=40) exists 40m below the ground surface, so it is necessary to construct a pile foundation using this layer as the supporting layer.

The boring column diagram is shown in Figure 1-2-2.

Depth (m)	High level (m)	Thick. (m)	Stratum log	Soil, Rock Description	Depth of Undisturbed Sample (m)	SPT Test (N_{30}) Depth (m)	Blow/15cm 15	15	15	N_{30}
0.00	+2.57									
1.00		2.80		Backfill: Consists of clay, sandy–clay; greyish brown; with root, pebble and broken rock.		1.00 – 1.45	1	1	2	3
2.00						2.00 – 2.45	1	1	2	3
3.00	−0.23					3.00 – 3.45	0	1	1	2
4.00										
5.00		6.20		Low plastic clay (CL): Greyish black, liquid condition. With shell and organic decomposition.	4.00 – 5.00	5.00 – 5.45	0	<		N
6.00						6.00 – 6.45	0	<		N
7.00					6.80 –7.00	7.00 – 7.45	0	0	1	1
8.00						8.00 – 8.45	0	1	1	2
9.00	−6.43					9.00 – 9.45	0	1	1	2
10.00										
11.00					10.00–11.00	11.00–11.45	0	1	1	2
12.00				High plastic clay (CH): Grey, greyish brown, light grey; liquid condition. With shell and organic decomposition.		12.00–12.45	0	<		N
13.00		7.80			12.80–13.00	13.00–13.45	0	<		N
14.00						14.00–14.45	0	0	1	1
15.00					14.80–15.00	15.00–15.45	0	1	1	2
16.00						16.00–16.45	0	1	1	2
17.00	−14.23				16.80–17.00	17.00–17.45	1	1	2	3
18.00						18.00–18.45	0	1	2	3
19.00					18.80–19.00	19.00–19.45	1	2	2	4
20.00		8.20		Low plastic clay (CL): Greyish blue, light grey; liquid–plastic condition. With shell and organic decomposition. Liquid condition at some depth.						
21.00					20.00–21.00	21.00–21.45	1	2	2	4
22.00						22.00–22.45	1	2	3	5
23.00					23.00–23.20	23.20–23.65	1	2	2	4
24.00						24.00–24.45	1	2	3	5
25.00	−22.43				24.80–25.00	25.00–25.45	1	2	2	4

SPT Test Diagram



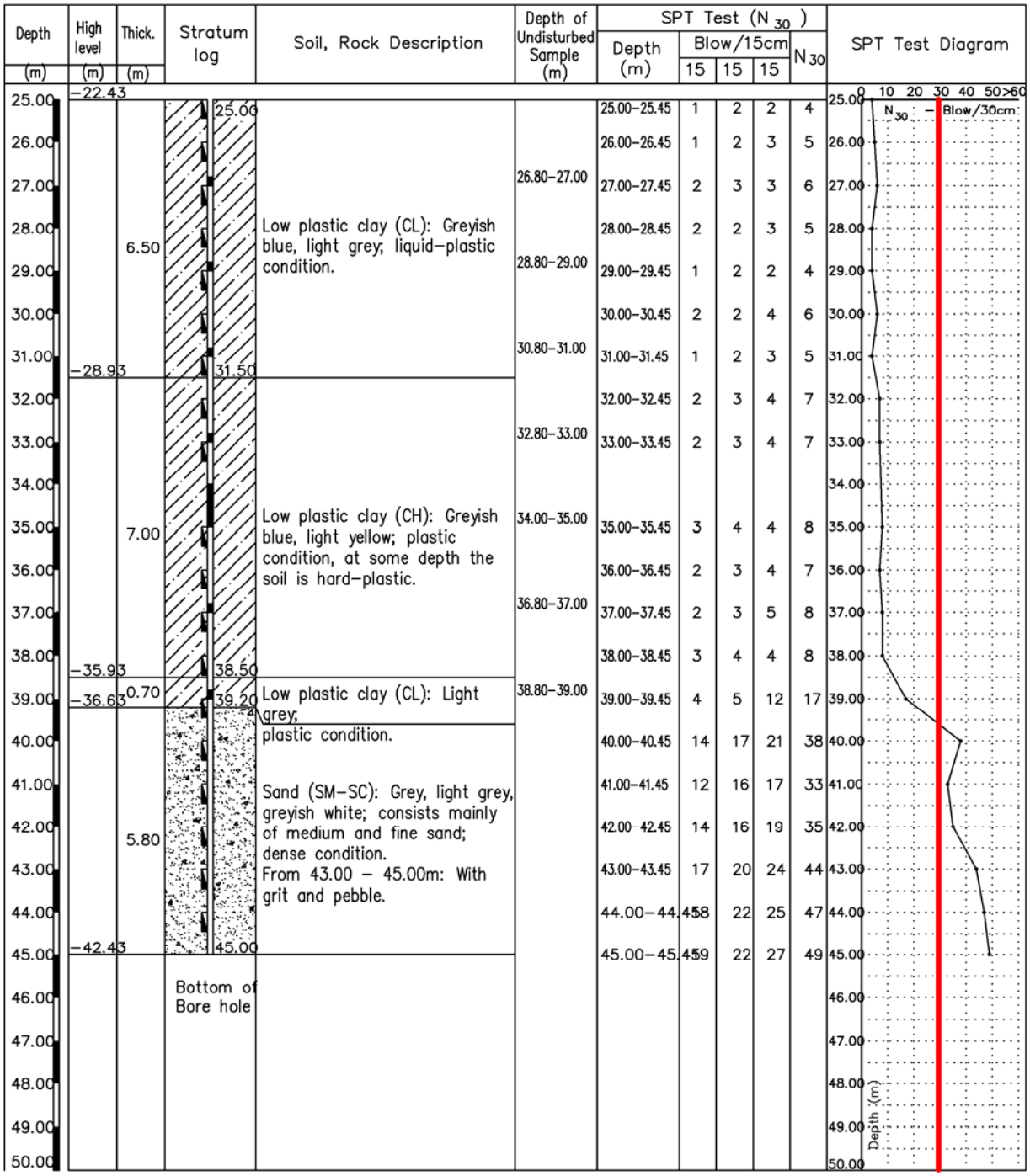


Figure 1-2-2 Boring Columnar Section

Source: JICA Study Team (Based on local geological survey)

(3) Climate

The climate of Viet Nam differs by the area and altitude, from the northern subtropical regions to the southern tropical monsoon regions. Northern Viet Nam, including the capital Ha Noi city, is in the temperate/mesodermal climate zone, which has four seasons and an average temperature of 24ºC. The high temperature reached 40ºC in July, and drops to the lowest 3-8ºC in January.

Figure 1-2-3 shows the records of the monthly precipitation, highest/lowest temperatures and average humidity of Hai Phong City since 1980.

Hai Phong is classified in the subtropical zone, with humid and hot summers and dry winters. Hai Phong city lies at 21º51' north latitude, closer to the mid-latitude. Therefore the temperature difference between summer and winder are greater, the in the hottest period of June – August the temperature reaches 31ºC, and in the winter period of December – February it drops to an average of 14ºC.

For Hai Phong city the rainy season is from May to October, the annual precipitation is 1,720mm and the average humidity is 86%.

Rainfall is expected to have little effect on the Project works, but the project works plans during the rainy season shall require consideration for additional curing works for material/equipment transportation, excavation for civil works, banking works and concrete placing.

Sudden raise of raw water turbidity may occur during the rainy season. In this case special attention for U-BCF operation shall be required, and the countermeasures are planned to be included in the soft component training.

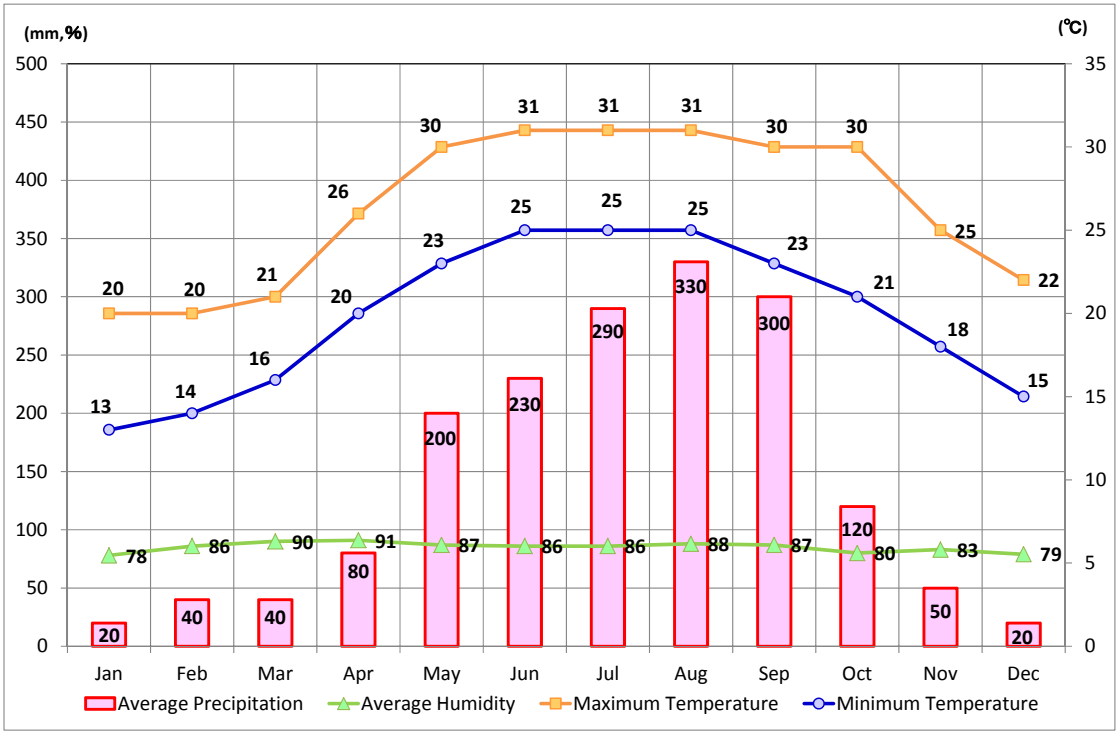


Figure 1-2-3 Monthly Average Precipitation, Humidity and Temperature in Hai Phong City

Source: Weather Database HAIPHONG, VIETNAM 1980-2014

(4) Water Quality

The below water quality analysis were carried out by Vietnamese consultants. The results are shown in Table 1-2-1.

- Sampling point: Existing intake / 2 times
  Sampling day: First; August 3, 2014
  Second; October 2014
  Test items: Agricultural chemicals, chemical substances, heavy metals

- Sampling point: Existing WTP in-process water (raw water reservoir intake/outlet, chemical precipitation basin, filter)
  Sampling day: August 3, 2014
  Test items: THM

- Sampling point: Treated water / 3 times
  Sampling day: First; August 3, 2014
  Second; September 8, 2014
  Third; November 12, 2014
  Test items: Agricultural chemicals, chemical substances, heavy metals, THM

- Sampling point: Water tap / 3 times
  Sampling day: First (15 locations); August 3 and 4, 2014
  Second (11 locations); September 7, 2014
  Third (15 locations); November 12, 2014
  Test items: Agricultural chemicals, chemical substances, heavy metals, THM

Table 1-2-1 Water Quality Analysis

Unit: heavy Metal:mg/L, Pesticides and others:μg/L
単位: 重金属 mg/L, 農薬他:μg/L

Items 項目		Standard Vietnam ベトナム基準	Standard Japan 日本基準	Detection limit 検出限界	Intake 原水	Treated water 浄水	Intake 原水	Treated water 浄水	Remarks 備考
Sampling date 採水日					3rd Aug. 8月3日		7th Sep. 9月7日		
Heavy metals 重金属類	Cd カドミウム	0.003	0.003	0.001	ND	ND	ND	ND	
	Pb 鉛	0.01	0.01	0.001	0.006	0.004	ND	ND	
	As ヒ素	0.01	0.01	0.0001	0.001	ND	ND	ND	
	Cr クロム	0.05	0.05	0.001	ND	ND	ND	ND	
	Al アルミニウム	0.2	0.2	0.001	0.09	0.06	0.018	0.028	
	Fe 鉄	0.3	0.3	0.05	0.34	0.15	ND	ND	
	Mn マンガン	0.3	0.05	0.001	0.18	0.11	ND	ND	
	Sb アンチモン	0.005	0.02	0.001	ND	ND	ND	ND	
	Ni ニッケル	0.02	0.02	0.001	0.002	0.002	ND	ND	
	Mg マグネシウム	-	-	0.001	3.36	3.41	2.58	2.57	2)
	Hg 水銀	0.001	0.0005	0.0005	ND	ND	ND	ND	
Pesticides 農薬類	Aldrin + Dieldrin アルドリン+ディルドリン	0.03	1)	0.01	ND	ND	ND	ND	Insecticide 殺虫剤
	Atrazine アトラジン	2	0.01	0.01	ND	ND	ND	ND	Herbicide 除草剤
	Bentazone ベンタゾン	30	0.2	0.01	ND	ND	ND	ND	Herbicide 除草剤
	Carbofuran カルボフラン	5	0.005	0.01	ND	ND	ND	ND	Herbicide 除草剤
	Chlodane クロルデン	0.2	1)	0.01	ND	ND	ND	ND	Insecticide 殺虫剤
	DDT DDT	2	1)	0.01	ND	ND	ND	ND	Insecticide 殺虫剤
	Hexachlorobenzene ヘキサクロロベンゼン	1	1)	0.01	ND	ND	ND	ND	Fungicide 殺菌剤
	Lindane リンデン	2	1)	0.01	ND	ND	ND	ND	Insecticide 殺虫剤
	Methoxychlor メトキシクロル	20	-	0.01	ND	ND	ND	ND	Insecticide 殺虫剤
	Methachlor メトラクロール	10	-	0.01	ND	ND	ND	ND	Herbicide 除草剤
	Molinate モリネート	6	0.005	0.01	ND	ND	ND	ND	Herbicide 除草剤
	Pentachlorophenol ペンタクロロフェノール	9	-	0.01	ND	ND	ND	ND	Fungicide 殺菌剤
	Propanil プロパニル	20	-	0.01	ND	ND	ND	ND	Herbicide 除草剤
	Simazine シマジン	20	0.003	0.01	ND	ND	ND	ND	Herbicide 除草剤
	Aldoxycarb (deg) アルドキシカルブ	10	-	0.01	ND	ND	ND	ND	Insecticide 殺虫剤
Other Organic Compounds その他有機物	Squalane スクワラン	-	-	0.01	ND	ND	ND	ND	Feedstock Cosmetics 化粧品用剤
	Diethylphthalate フタル酸ジエチル	-	-	0.01	ND	ND	0.06	ND	Plasticizer 可塑剤
	Di-n-butylphthalate フタル酸ジブチル	-	0.2	0.01	ND	ND	ND	ND	Plasticizer 可塑剤
	Bis(2-ethylhexyl)phthalate フタル酸2−エチルヘキシル	8	-	0.01	0.01	0.01	0.01	0.012	Plasticizer 可塑剤
	Methylpalmitate パルミチン酸メチル	-	-	0.01	ND	ND	ND	ND	Anti-inflammatory 消炎剤
	Stearic acid methyl ester ステアリン酸メチル	-	-	0.01	ND	ND	ND	ND	Feedstock Nonionic Surfactant 非イオン界面活性剤
	Octanol オクタノール	-	-	0.01	ND	ND	ND	ND	Feedstock Ester エステル剤
	1-Nonanol 1−ノナノール	-	-	0.01	ND	ND	ND	ND	Feedstock Aroma 芳香剤
	3,5-di-tert-Butyl-4-hydroxybenzaldehyde 3,5-ジ-tert-ブチル-4-ヒドロキシベンズアルデヒド	-	-	0.01	ND	ND	ND	ND	Feedstock 原料油
	Bis(2-ethylhexyl) sebacate セバシン酸ビス(2-エチルヘキシル)	-	-	0.01	ND	ND	ND	ND	Plasticizer 可塑剤
	Dibutylamine ジブチルアミン	-	-	0.01	ND	ND	ND	ND	Corrosion inhibitor 防腐剤
	2,6-Dimethylnaphthalene 2, 6−ジメチルナフタレン	-	-	0.01	ND	ND	ND	ND	Feedstock 原料油
	1,3-Dimethylnaphthalene 1, 3−ジメチルナフタレン	-	-	0.01	ND	ND	ND	ND	Feedstock 原料油
	Acenaphthene アセナフテン	-	-	0.01	ND	ND	ND	ND	Feedstock fluorescence agent 蛍光剤

ND:Detection limit ND: 検出限界 1) 使用禁止 2) Hardness 硬度 基準値:Ca+Mg;300mg/L (Vietnam), 100mg/L (Japan)

Source: JICA Study Team (Based on local water quality survey)

【Water Quality Survey Results】

1. Heavy metals

Surveys for raw water and treated water were carried out in August and September. The first survey for raw water detected Pb, As, Al, Fe, Mn, Sb, Ni and Mg. Within said metals, Pb, Al, Fe, Mn, Ni and Mg were detected in the treated water, but all values were lower than the Vietnamese drinking water standards. In comparison to the Japanese standards, only Mn is higher than the target value.

2. Agricultural chemicals and other organic matters

The survey for agricultural chemicals was carried out based mainly on the items regulated in the Vietnamese drinking water status. This includes substances which have large effects on human bodies and the ecosystem, and many are not used for agricultural means in Japan. The results showed that all substances were lower than the detection limit. For other chemical substances included in daily consumption articles, such as medicine, makeup and/or industrial materials, Bis(2-ethylhexyl)phthalate was detected at a low value.

3. THM

Table 1-2-2 Water quality survey results of THM（treated water）

					第1回目					第2回目		第3回目	
Sample date			Standard		3rd Aug. 8月3日					7th Sep. 9月7日	8th Sep. 9月8日	12nd Nov. 11月12日	12th Nov. 11月12日
Items 項目		Unit 単位	Standard Vietnam ベトナム基準	Standard Japan 日本基準	Raw water reservoir in 原水調整池入口	Raw water reservoir out 原水調整池出口	After Sedimentation 凝集沈澱池後	After Filtration 急速ろ過池後	Treated water 浄水	Raw water 原水調整池	Treated water 浄水	Raw water 原水調整池	Treated water 浄水
THM トリハロメタン	$CHCl_3$ クロロホルム	μg/L	200	60	8.3	9.4	11.8	10.7	27.6		76.4		49.0
	$CHCl_2Br$ ジクロロブロモメタン		60	30	0.5	0.8	1.7	1.2	6.0		20.2		71.1
	$CHClBr_2$ クロロジブロモメタン		100	100	<0.2	0.3	0.5	0.2	2.3		3.5		17.4
	$CHBr_3$ ブロモホルム		100	90	<0.3	<0.3	<0.3	<0.3	<0.3		<0.3		<0.3
	T-THM 総トリハロメタン			100	8.8	10.5	13.9	12.1	35.9		100.1		137.5

Source: JICA Study Team (Based on local water quality survey)

THM is the general term for methane whose hydrogen atom has been replaced by halogen atoms. “Total THM” is the total of water treatment byproduct matters of chloroform, dichlorobromomethane, chlorodibromomethane and bromoform. Within said compounds, chloroform generates the most in supply water and is also known for its carcinogenicity. In Japan, there are regulations for the concentration for each compound and total THM, and in Viet Nam, the concentration for each matter is regulated.

The 1st survey results for service tap THM concentration was chloroform 28μg/L and total THM 36μg/L at the outlet of the WTP. However, these values increased as the service distance increases, and the maximum values were chloroform 52μg/L and total THM 71μg/L.
The results for the 2nd test were worse due to the increase of raw water COD, and were chloroform 70μg/L and total THM over 100μg/L respectively for the treated water. The chloroform values of the treated water for all results were lower than the midpoints of the Vietnamese drinking water standards, but the 2nd test result was higher than the Japanese standards. The results for the service taps were worse; chloroform 138μg/L and total THM 164μg/L at the maximum.

For the chloroform concentration at the WTP exit and in the tap water is 30 – 60% of the Vietnamese drinking water quality standard (200μg/L), however it still exceeds the Japanese standards (60μg/L). There are no regulations for total THM in Viet Nam, but the value is 1.6 times as the Japanese standard (160μg/L).

In the 3rd survey results, according to the local survey team, the water samples were tested several days after obtained due to equipment failures, and therefore it is assumed that the chloroform had volatilized. The results of the 3rd survey showed values of total THM of over 200μg/L for several locations, and the actual values were possibly higher.

In conclusion of the above, although the THM concentration in the tap water is within the Vietnamese

drinking water regulation standards, it is largely surpassing the Japanese standards, The introduction of U-BCF by this Project is expected to enable the supply of safer drinking water by reducing the THM concentration.

Table 1-2-1 Water Quality Survey Results of THM (Tap water)

Sampling date 採水日		1回目 (8/3～8/4)					2回目(9/7)					3回目(11/12)				
Sampling Station		$CHCl_3$ クロロホルム	$CHCl_2Br$ ブロモジクロロメタン	$CHCLBr_2$ ジブロモクロロメタン	$CHBr_3$ ブロモホルム	T-THM 総トリハロメタン	$CHCl_3$ クロロホルム	$CHCl_2Br$ ブロモジクロロメタン	$CHClBr_2$ ジブロモクロロメタン	$CHBr_3$ ブロモホルム	T-THM 総トリハロメタン	$CHCl_3$ クロロホルム	$CHCl_2Br$ ブロモジクロロメタン	$CHClBr_2$ ジブロモクロロメタン	$CHBr_3$ ブロモホルム	T-THM 総トリハロメタン
Treated Water 浄水		27.57	6.0	2.3	<0.3	35.9	76.4	20.2	3.5	<0.3	100.1	49.0	71.1	17.4	<0.3	137.5
Tap water 給水栓	T1	22.80	8.6	2.8	<0.3	34.2	-	-	-	-	-	63.1	55.2	14.1	<0.3	132.4
	T2	35.38	7.8	2.7	<0.3	45.9	99.7	20.3	3.3	<0.3	123.3	60.5	92.6	21.4	<0.3	174.5
	T3	37.44	9.1	3.0	<0.3	49.6	81.3	13.3	2.1	<0.3	96.7	65.4	77.1	10.8	<0.3	153.3
	T4	38.26	9.1	3.1	<0.3	50.4	56.3	11.5	2.2	<0.3	70.0	69.4	102.6	24.8	<0.3	196.8
	T5	26.17	6.7	2.5	<0.3	35.4	64.4	15.1	2.2	<0.3	81.8	65.7	78.4	21.9	<0.3	166.0
	T6	25.88	7.1	2.9	<0.3	35.8	-	-	-	-	-	65.5	118.8	24.1	<0.3	208.4
	T7	29.88	7.9	3.2	<0.3	41.0	73.5	15.8	2.3	<0.3	91.5	73.6	94.6	23.2	<0.3	191.4
	T8	39.01	10.5	3.9	<0.3	53.4	85.7	15.3	2.3	<0.3	103.3	87.2	107.5	36.9	<0.3	231.6
	T9	33.05	12.3	4.8	<0.3	50.2	138.1	23.1	3.0	<0.3	164.2	74.6	91.8	21.1	<0.3	187.5
	T10	52.30	13.6	5.0	<0.3	70.9	126.4	21.4	3.0	<0.3	150.8	84.3	101.7	34.6	<0.3	220.6
	T11	43.86	10.6	3.4	<0.3	57.9	88.0	18.5	2.7	<0.3	109.2	70.1	90.5	20.2	<0.3	180.8
	T12	36.01	14.9	5.9	<0.3	56.8	-	-	-	-	-	59.3	88.8	21.6	<0.3	169.7
	T13	29.92	12.5	5.4	<0.3	47.8	87.1	16.2	2.3	<0.3	105.6	58.2	62.2	11.5	<0.3	131.9
	T14	30.24	10.7	3.8	<0.3	44.7	-	-	-	-	-	63.1	70.9	17.1	<0.3	151.1
	T15	38.64	8.8	3.5	<0.3	50.9	89.7	15.7	2.9	<0.3	108.2	49.0	71.1	17.4	<0.3	137.5
Standard Vietnam ベトナム基準		200	60	100	100		200	60	100	100		200	60	100	100	
Standard Japan 日本基準		60	30	100	90	100	60	30	100	90	100	60	30	100	90	100

Source: JICA Study Team (Based on local water quality survey)

4. Other features

For this Project, several organizations conducted the water quality surveys. Hai Phong Water conducted tests general items such as ammonium nitrogen, COD, etc., and Vietnam Academy of Science and Technology Institute of Environmental Technology (hereinafter "IET") carried out tests for THM, organic substances such as agricultural chemicals and heavy metals. To confirm the accuracy of the surveys, tests were also conducted at Kitakyushu City Water and Sewage Bureau water quality laboratory for available items.

Compared with the results of the Kitakyushu city water quality laboratory surveys, the detection levels of the heavy metals were the same as the results of the IET surveys, although the values differed for several items since the sampling dates were different. Ion other than chloride ion and solid fluorine has not been detected at Hai Phong Water. Chloride ion measured 30-26mg/L (2009 – 2013) for the intake of An Duong WTP and 32-26mg/L for the treated water. That result is the same value as the analysis carried out in this Project, and satisfies the standards. Solid fluorine also measured 146-118mg/L for the intake and 118-106mg/L for the treated water, same value as the Project's analysis and satisfies the standards.

5. Influence factors for U-BCF introduction

According to the local survey results shown in the above 1 and 2, heavy metals, ions, agricultural chemicals and chemical substances which may affect the human body or microorganisms inside U-BCF. No issues have been aroused from surveys commissioned by Hai Phong Water either.

However, turbidity is a water quality factor which has large influence on U-BCF operation. The records of An Duong WTP raw water turbidity from 2008 to 2013 indicates that there were several periods which the maximum turbidity exceeded 50NTU, and the range of fluctuation is 10 – 60NTU.

There are no other factors which may have influence on the U-BCF operation or design according to the Hai Phong Water records.

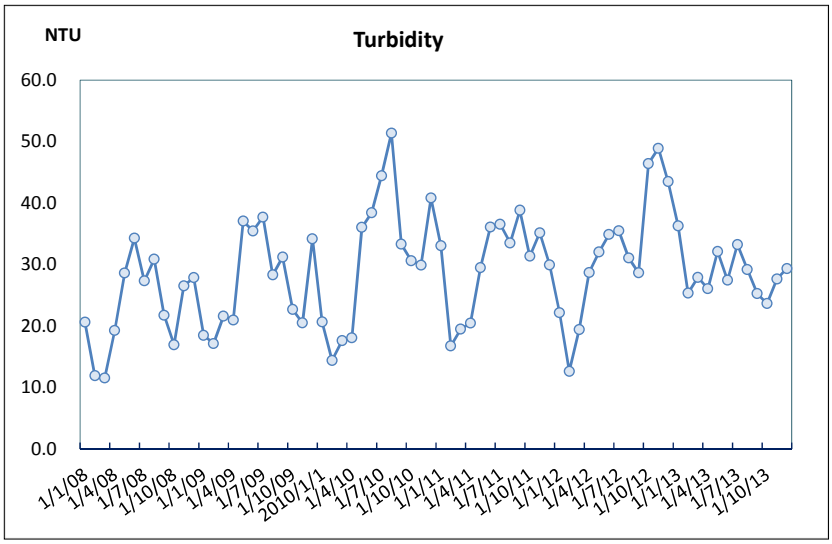


Figure 1-2-4 Daily Fluctuation of the Raw Water Turbidity at An Duong WTP

Source : Hai Phong Water

6. U-BCF Introduction Effects

U-BCF is an effective method to remove ammonium nitrogen. The survey results in the Project's tests at the intake were 0.31mg/L for the 1st survey, 0.31 mg/L for 2nd survey and 0.9 mg/L for 3rd survey, which is only slightly over the Vietnamese surface water standard for water sources, 0.2mg/L. However, the 3rd survey results were a higher 0.9mg/L. The annual ratio of ammonium nitrogen of the water source is gradually increasing, and also the detection of high-concentration spots have increased. For the metal survey results, the value of Manganese is higher than the Japanese management standards. U-BCF can remove substances which require large amounts of chlorine for treatment, such as said substances and other organic matters. Therefore the introduction of the treatment shall not only reduce the amount of chlorine injection, but also maintain the filtration tank clean by reducing the alga growth by always keeping a slight amount of free residual chlorine in the sedimentation and filtration tanks. And as also mentioned in 1-1-1(4), the organic matters included in the raw water of An Duong WTP is expected to increase in the future, but the reduction of THM generation in the treated water and service taps is possible by the chlorine reduction effect and organic matter removal effect of the U-BCF.

(5) Topographic Survey

① Purpose

Topographic Survey was conducted in order to design the parameter of the plant such as floor planning, water level, and height of the structures. The detail of the survey is shown in Table 1-2-3.

Table 1-2-3 Specification

Site	Number	Contents of survey
planned construction site (in An Duong treatment plant)	0.13 ha (1,300m^2)	[plane table survey]：Around Boundary Cross section; every 0.5 meter orthogonal directions Scale; 1/500. [profile and cross survey]：Length and width ;20m×4lines Scale; 1/100
Existing facility in An Duong	32 points	[Leveling]：reference point, main facility（levee crown / bottom slab, overflow weir、and water level）and height of road in plant

Source: JICA Study Team (Based on local entrustment specification documents)

② Survey points

Survey points in An Duong treatment plant are shown in Figure 1-2-5. The levels of 1~32 leveling points in this figure are determined by referring to the reference points AD-01 and AD-02.

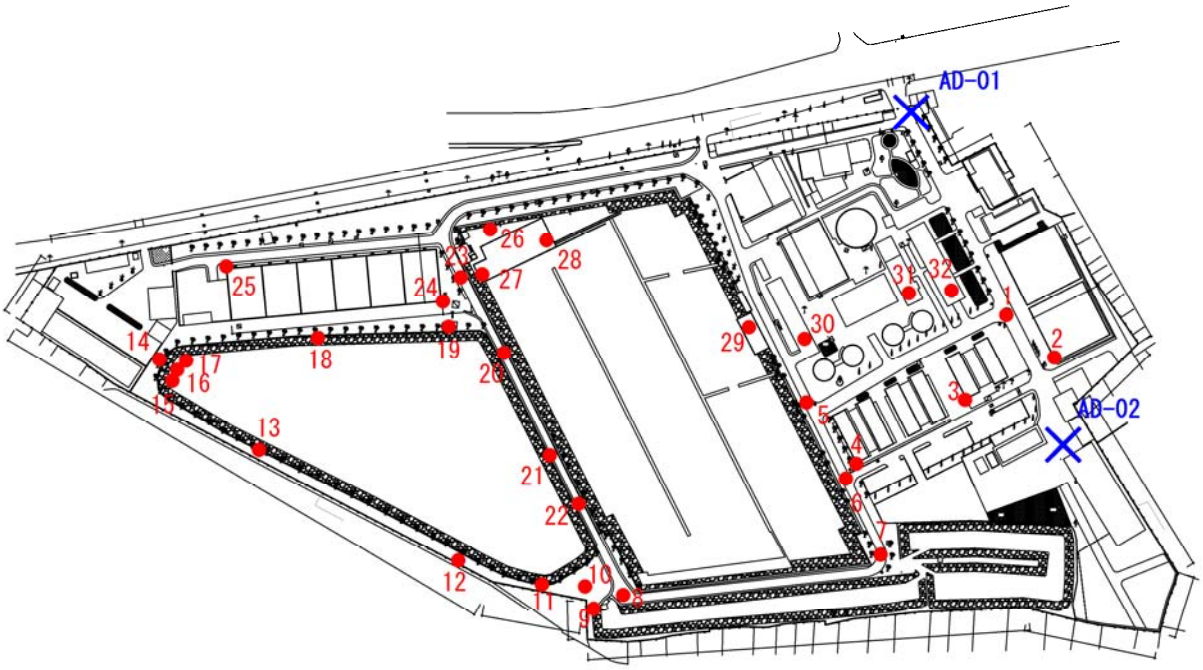


Figure 1-2-5 Survey Points

Source: JICA Study Team (Based on local entrustment specification documents)

③ Condition and detail information

1. Detail information of survey points

- Survey points: 32points
- Plane table survey : Area：1,300m^2
  Scale：1/500、Contour were lined every 0.5m
- Cross survey : Length should be 2,000m x 4 line (there lines were included under water sauce.)
  scale：1/100

2. Reference point

Detail of reference points are shown in Table 1-2-4.

Table 1-2-4 Reference Point

Name	X(m)	Y(m)	Altitude(m)	Elevation(m)
AD-01	2306379.752	594997.807	2.365	4.320
AD-02	2306223.470	595068.848	2.548	4.503

Source: JICA Study Team (Based on local measurement survey)

④ Survey Results

According to the result which is shown in Table 1-2-5, Water level drawing could be drawn up under considered ground levels and difference of elevation, Layout plan drawing of U-BCF can be drawn up, and Preliminary Design can be drawn by the result.

Table 1-2-5 Results of survey

Point No.	altitude (m)	elevation(m)
1	2.362	4.317
2	4.200	6.155
3	5.731	7.686
4	6.791	8.746
5	2.309	4.264
6	2.401	4.356
7	2.727	4.682
8	2.703	4.658
9	2.586	4.541
10	2.672	4.627
11	3.086	5.041
12	2.690	4.645
13	2.975	4.930
14	3.590	5.545
15	2.492	4.447
16	2.436	4.391
17	2.845	4.800
18	2.531	4.486
19	2.651	4.606
20	2.740	4.695
21	2.978	4.933
22	2.821	4.776
23	2.470	4.425
24	3.848	5.803
25	3.840	5.795
26	2.777	4.732
27	1.230	3.185
28	1.045	3.000
29	2.319	4.274
30	2.509	4.464
31	2.638	4.593
32	2.521	4.476

Source: JICA Study Team (Based on local measurement survey)

(6) Trial Exploration

① Explorations purpose

To obtain the reference for plant design and cost estimation, the pit excavation survey on the embedded pipes was implemented in An Duong treatment plant area.

The five points of embedded pipes which should be identified were determined according to the existing references and the hearing survey with employees of Haiphong City Water Service Corporation and then the pit excavation was conducted on these five points. Explorations detail is shown in Table 1-2-6.

Table 1-2-6 Specification

Explorations Point	The number of point	Detail
Along with the route of existing pipe.	5 points	Pit Excavation size 0.5m×3.0m、Depth1～2m

Source: JICA Study Team (Based on local entrustment specification documents)

② Explorations points

The five points which excavation survey were conducted are shown in Figure 1-2-6

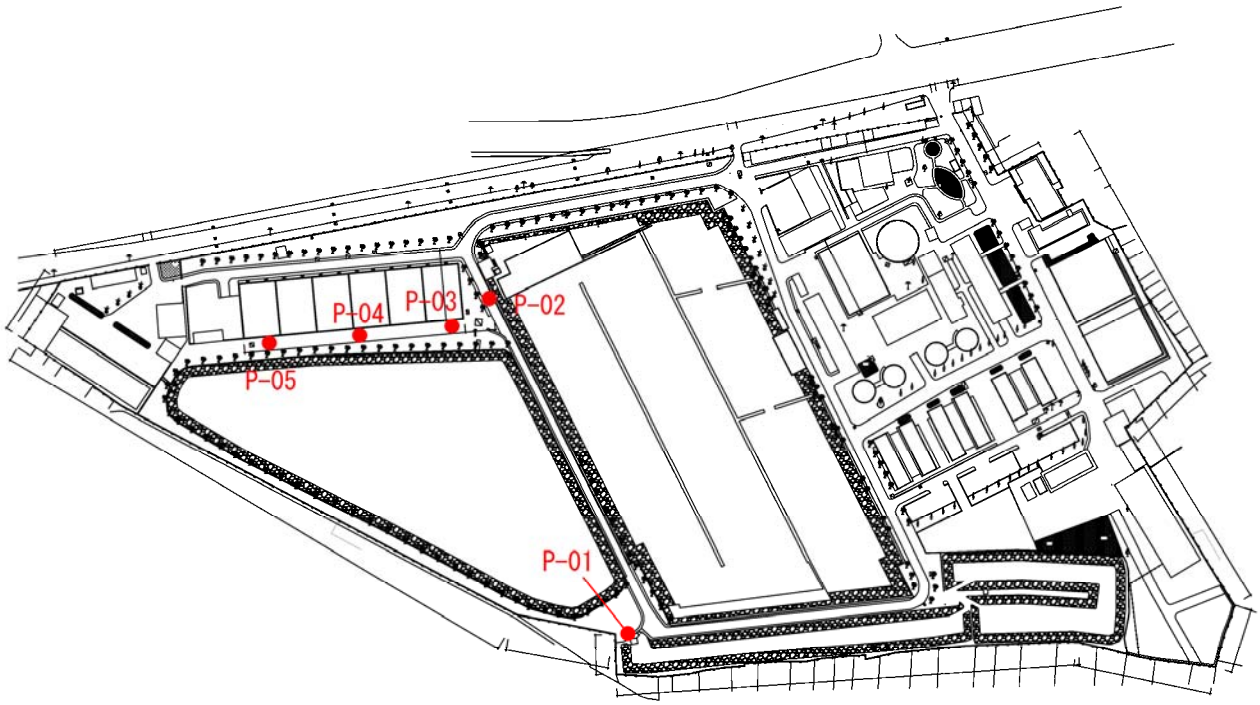


Figure 1-2-6 Explorations Points

Source: JICA Study Team (Based on local entrustment specification documents)

③ Detail information and the condition

The detail information and the condition of each point are shown in Table 1-2-7.

Table 1-2-7 Detail Information and the Condition

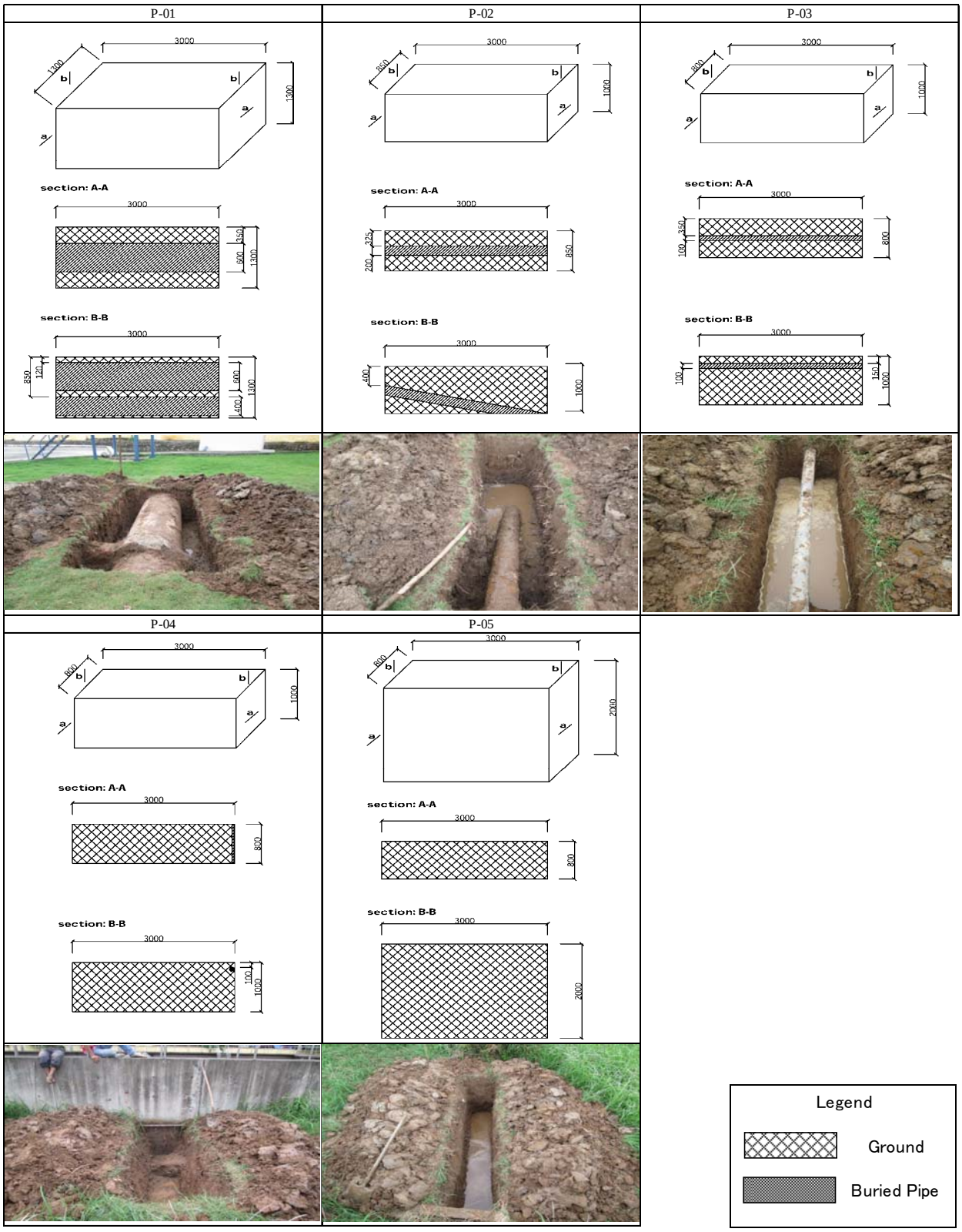
	P-01	P-02	P-03	P-04	P-05
Size(m)	1.30 x 3.00 x 1.30	0.85 x 3.00 x 1.00	0.80 x 3.00 x 1.00	0.80 x 3.00 x 1.00	0.80 x 3.00 x 1.00
High level(m)	2.57	2.57	2.57	2.57	2.57
Horizontal coordinate X (m)	2306157.58	2306294.55	2306287.46	2306284.33	2306281.55
Vertical coordinate Y (m)	594855.81	594781.93	594762.7	594730.71	594697.18
Start day	19/8/2014	19/8/2014	19/8/2014	19/8/2014	19/8/2014
Finish day	19/8/2014	19/8/2014	19/8/2014	19/8/2014	19/8/2014
Procedure	Manual	Manual	Manual	Manual	Manual

Source: JICA Study Team (Based on local entrustment specification documents)

④ Result

The results are shown in Table 1-2-8.

Table 1-2-8 Explorations Result



Source: JICA Study Team (Based on local measurement survey)

The location and depth of the existing pipes were confirmed by the surveys. The piping plans for the

pipes from U-BCF to existing flock basin and from U-BCF to sludge drying bed were decided based on the survey results.

1-3 Environmental Social Consideration

1-3-1 Environmental Impact Assessment

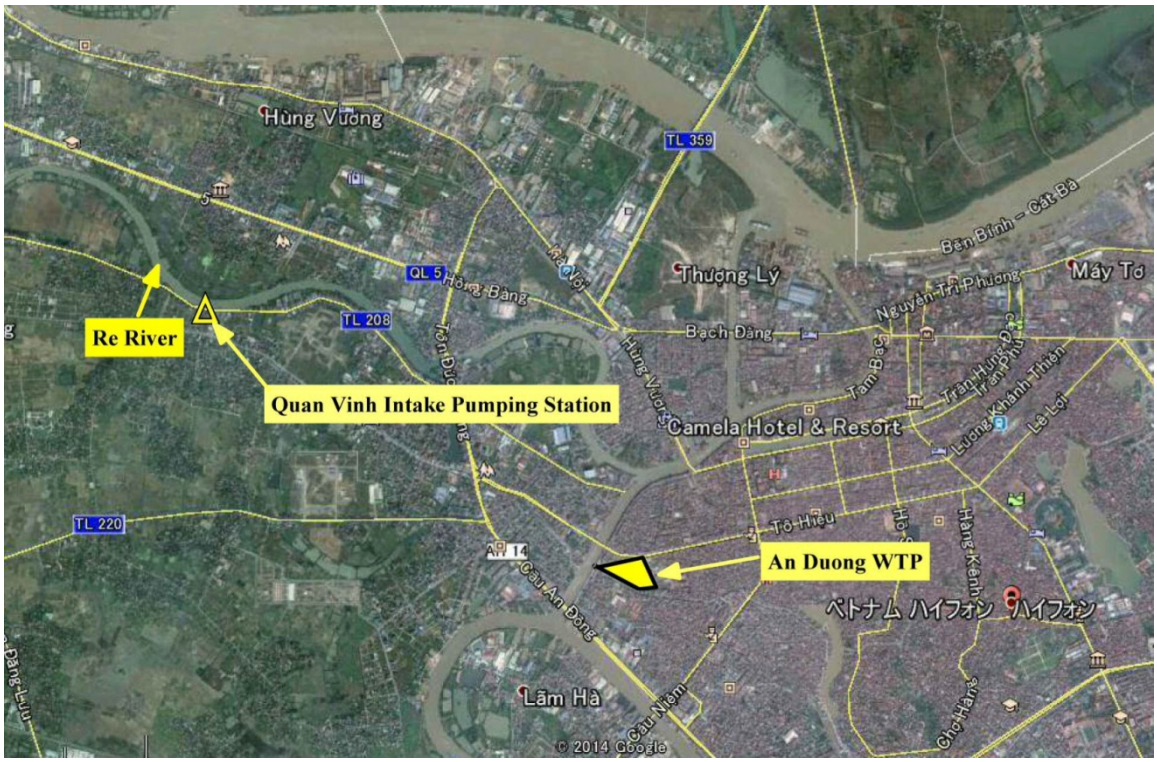
1-3-1-1 Outline of Project Components Which Provide Environmental and Social Impacts

The Project aims to renew old intake pumps at Quan Vinh intake pumping station which was constructed in the 1970s, and to construct an advanced pre-treatment U-BCF in the existing An Duong WTP and set up blowers in related facilities for filter cleaning. The intake pumping station will take raw water from the Re River. Then, the raw water will be transmitted from the intake pumping station to U-BCF at An Duong WTP by using existing raw water transmission pipes (diameter: 1,000 mm, length: 3,700m). The outline of Project components which provide environmental and social impacts is shown in Table 1-3-1. The Project area and its surrounding situations are shown in Figure 1-3-1.

Table 1-3-1 Outline of Project Components Which Provide Environmental Social Impacts

Project Component	Contents	Description	Estimated Environmental Impact
1.Planned intake amount	100,000 m^3/day		The Re River has sufficient water discharge and in the year of 2014, water rights of 120,547 m^3/day are ensured. Thus, the intake volume of 100,000 m^3/day has no problem.
2.Quan Vinh intake pumping station	① Intake Pump (160 kW×4Units)	Intake pumps (3 units duty;1 unit, standby)	① Intake pumping station stands adjacent to a 10m width local asphalt road, and in the morning and evening the traffic slightly increases. ② Along the local road adjacent to the intake pumping station, residential houses are distributed. Thus, noises generated by construction works at construction stage and the operation of intake pumps at operation stage may exceed national noise standards.
3.An Duong WTP U-BCF	① U-BCF ② Blower (37 kW×2units) ③ Raw water transmission pipeline (Dia.1,000 mm × Length 216 m)	Blower (1 unit duty; 1 unit standby) New raw water transmission pipeline is used to convey raw water from the end of the existing pipeline to U-BCF.	① An Duong WTP is surrounded by high density housing areas. Thus, noises generated by the construction and operation of the blower after completion of U-BCF may exceed national noise standards. ② When construction vehicles access to An Duong WTP, traffic accidents may occur.

Source: JICA Study Team (Based on local survey)



Upper middle: photos of neighboring area of intake pumping station

Left: Surrounding area of An Duong WTP

Figure 1-3-1 Locations of Quan Vinh Intake Pumping Station and An Duong WTP, and Situations of Neighboring Areas

Source: JICA Study Team (Based on GoogleMap)

1-3-1-2 Environmental and Social Conditions around the Project Area

(1) Administrative System of Hai Phong City

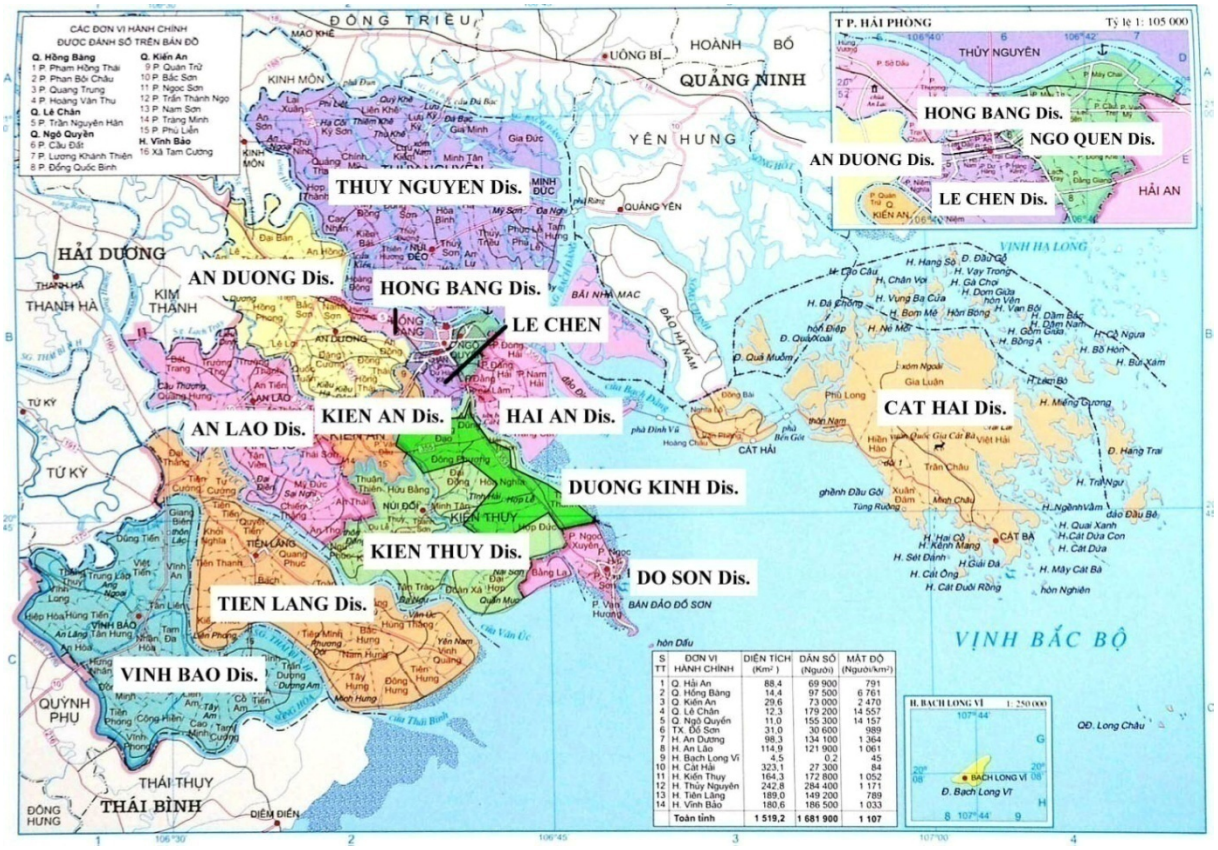
The head of the administrative system in the Socialist Republic of Viet Nam is the Central Government, and the People's Committees of each province/district/ward/commune are organized subordinately. People's Committees of subsidiary organization are also outpost of the national government, and the sections corresponding to each Ministry of the Central Government are established in the People's Committees which functions are an alternative of the Central Government.

Hai Phong city is a local center located at the mouth of Song Coi Delta formed by the Song Coi River, and its population is 1,930,000 (Hai Phong People's Committee, December 2013). The city area is 1,523km^2 and the administrative system is formed by seven (7) districts, six (6) rural districts and two (2) island rural districts. The district names are shown in Table 1-3-2, and the locations are indicated in Figure 1-3-2.

Table 1-3-2 Administrative System of Hai Phong City by District Level

No.	Administrative Unit Name	Centre of District
District		
1.	Duong Kin District	Anh Dung
2.	Do Son District	Do Son
3.	Hai An District	Dang Lam
4.	Kien An District	Kien An
5.	Hong Bang District	Hoang Van Thu
6.	Ngo Quyen District	May To
7.	Le Chan District	Trai Cau
Rural District		
8.	An Duong Rural District	An Duong
9.	An Lao Rural District	An Lao
10.	Kien Thuy Rural District	Nui Deo
11.	Tien Lang Rural District	Tien Lang
12.	Vinh Bao Rural District	Vinh Bao
13.	Thuy Nguyen Rural District	Nui Deo
Island Rural District		
14.	Bach Long Island Rural District	Bach Long Vi
15.	Cat Hai Island Rural District	Cat Ba

Source: Hai Phong Portal Website



S TT	ĐƠN VỊ HÀNH CHÍNH	DIỆN TÍCH (Km²)	DÂN SỐ (Người)	MẬT ĐỘ (Người/km²)
1	Q. Hải An	88,4	69 900	791
2	Q. Hồng Bàng	14,4	97 500	6 761
3	Q. Kiến An	29,6	73 000	2 470
4	Q. Lê Chân	12,3	179 200	14 557
5	Q. Ngô Quyền	11,0	155 300	14 157
6	TX. Đồ Sơn	31,0	30 600	989
7	H. An Dương	98,3	134 100	1 364
8	H. An Lão	114,9	121 900	1 061
9	H. Bạch Long Vĩ	4,5	0,2	45
10	H. Cát Hải	323,1	27 300	84
11	H. Kiến Thụy	164,3	172 800	1 052
12	H. Thủy Nguyên	242,8	284 400	1 171
13	H. Tiên Lãng	189,0	149 200	789
14	H. Vĩnh Bảo	180,6	186 500	1 033
	Toàn tỉnh	1 519,2	1 681 900	1 107

Figure 1-3-2 Locations of the 15 Districts of Hai Phong City

Source: Hai Phong Portal Website

(2) Social and Economic Conditions of the Study Area

Hai Phong city has developed as a port city which faces the Bac Bo Gulf and is a logistic hub for Ha Noi city. However, since industrial parks have recently been established in the city, it has developed as an industrial city, in addition to the past industrial structure formed by agriculture and fishery. Furthermore, the road networks, such as the National Highway No. 5 which runs between Ha Noi city and Hai Phong city, have been arranged and has accelerated the material flow. As indicated in Table 1-3-3, there are seven (7) main industrial parks in the city. Figure 1-3-3 shows the locations of main industrial parks in Hai Phong city.

Table 1-3-3 Outline of Main Industrial Parks in Hai Phong City

1. Nomura Hai Phong Industrial Park	
Investor	Nomura Financial Group
Established year	1994
Location	An Duong District
Land area	153 ha
Characteristics	Foray enterprises are almost occupied by Japanese companies such as machinery manufacturing, precision machineries, auto parts, and electrical manufacturing.
2. Nam Dinh Vu Port・Industrial Park	
Investor	Viet Nam Government
Established year	2007
Location	Hai An District
Land area	900 ha
Characteristics	Compound of port, industrial park, manufacturing factories of petrochemical goods, commercial service, high technology products, and green products.
3. Do Son Industrial Park	
Investor	Do Son Industrial Zone Joint Venture Company
Established year	1997
Location	Do Son District
Land area	150 ha
Characteristics	Machinery parts, auto parts, farm machines, seafood processing machineries and knitted wear manufacturing.
4. Trang Due Industrial Park	
Investor	SHP joint stock company
Established year	2007
Location	An Duong Rural District
Land area	200 ha (Phase 1)
Characteristics	Consumer goods, agriculture products, cattle feed manufacturing, transportation and storage service
5. An Duong Industrial Park	
Investor	Tham Viet united investment Co. Ltd.
Established year	2008
Location	An Duong Rural District
Land area	813 ha
Characteristics	High technology products
6. Nam Cat Kien Industrial Park	
Investor	Shinec shipping joint stock company
Established year	2008
Location	Thuy Nguyen Rural District
Land area	263 ha
Characteristics	High quality paper, steel, furniture, industrial waste recycling, etc.
7. Vinshin Shinec Industrial Park	
Investor	Vinshin investor company
Established year	2006
Location	Thuy Nguyen Rural District
Land area	320 ha
Characteristics	Nylon conduit, shipping blocks, etc.

Source: JETRO Industrial Park Reports of North/Central Viet Nam, 2013

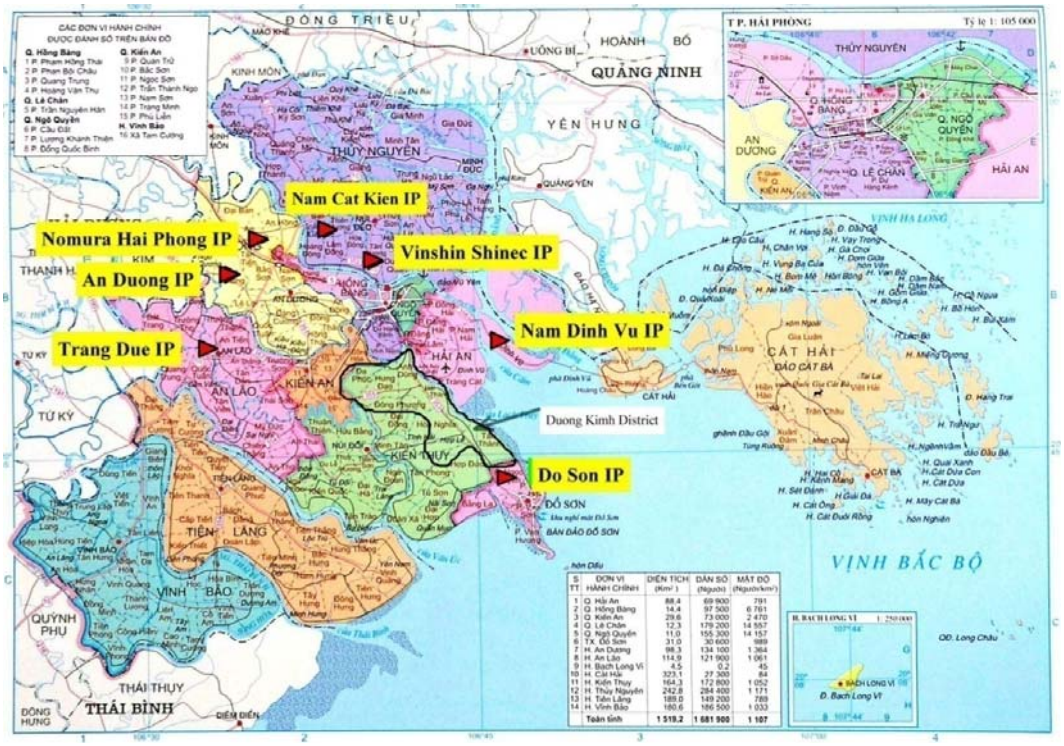


Figure 1-3-3 Location Map of Main Industrial Parks in Hai Phong City

Source: JICA Study Team (Based on JETRO Industrial Park Reports of North/Central Viet Nam, 2013)

Based on the statistic data of the year 2013, the ratio of each industrial field occupied in GDP in the year of 2013 in Hai Phong City was surveyed. The result is shown in Figure 1-3-4. As a result, mining and manufacturing products occupies 33% and it is the largest portion. The products are mostly produced by manufacturing business. There are numerous factories in Hai Phong City due to the establishment of many industrial parks. Foreign investments for that purpose are still implemented and it occupies 13% of GDP. In the same line, large-scale grocery supermarkets are established and it stirs active commercial activities which occupy 18% of GDP. On the other hand, the ratio occupied by agriculture, forestry and fishery which were main industries in the past, has decreased to a small 9% of the total GDP. Currently, it is understood that Hai Phong City has completely changed to a new image as an industrial city from the past image as an agricultural and fishery city.

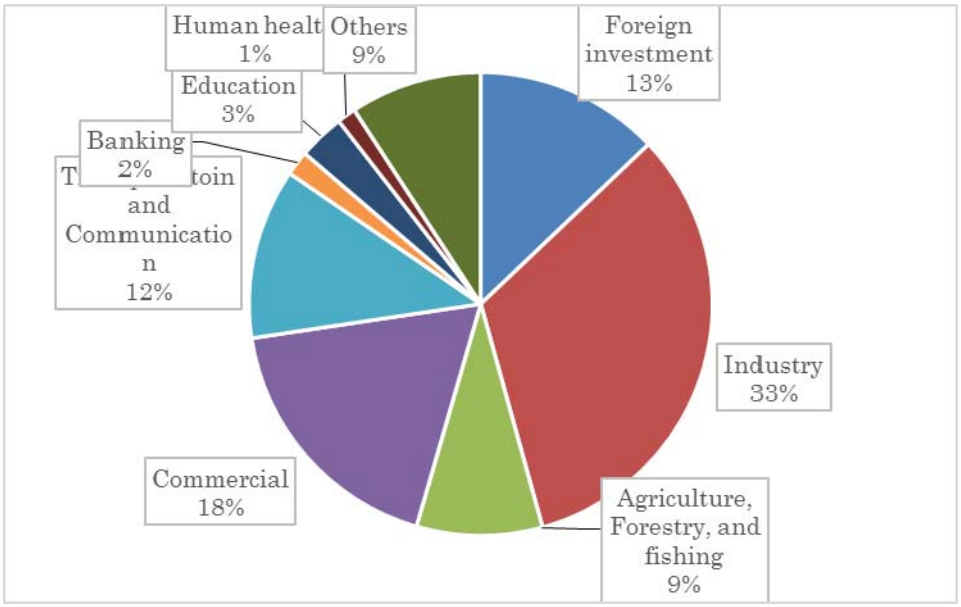


Figure 1-3-4 Ratio of Each Industrial Field in GDP for Year 2013 in Hai Phong City

Source：Hai Phong City statistic books, 2013

(3) Ethnic Minorities and Indigenous People

In Hai Phong City, the ethnic minority Hoa live together with the majority tribe Kinh. According to the Department of Labour, Invalid, and Social Affairs of Hai Phong City People's Committee, the Hoa tribe belongs to the Chinese. Although many people lived along the international border between Viet Nam and China in the past, most Hoa people had shifted into Chinese territory after the war between Viet Nam and China in 1979. The current population is only 1,000. Hoa people are living as Chinese workers mixed with the Kinh tribe, and have no special residential areas. Hence, water supply is equally serviced to all citizens.

(4) Cultural and Historical Heritages and Monuments

As the Project aims to renew intake pumps of the existing intake pumping station and to set up pre-treatment U-BCF in An Duong WTP, there are no laying works of distribution pipelines as common water supply improvement plans. Thus, the Project does not relate to cultural and historical heritages and monuments. For reference, the list of cultural and historical heritages and monuments of Le Chan, Hong Bang, An Duong, Ngo Quyen, Kien An, and Hai An districts is shown in Table 1-3-4, and the locations are indicated in Figure 1-3-5.

Table 1-3-4 Cultural and Historical Heritage and Monuments around An Duong WTP

No.	Name of cultural and historical heritage and monument	Location	Established year	Reason
1	Hang Kenh temple	Vinh Niem Precinct, Le Chan Dis, Hai Phong	1719	Historic structure
2	Nghe temple	An Bien Precinct, Le Chan Dis, Hai Phong	1919	Worship to female Minister Le Chan
3	Nghe mausoleum	121 Du Hang Street, Le Chan Dis, Hai Phong	1672	Religious beliefs
4	Du Hang mausoleum	Chua Hang Street, Le Chan Dis, Hai Phong	1899	Historic structure
5	Niem Nghia temple	Vinh Niem Precinct, Le Chan Dis, Hai Phong	1851	Worship to Minister Pham Tu Ngi
6	An Bien temple	170 Hai Ba Trung Street, Le Chan Dis, Hai Phong	1919	Historic structure
7	Pho Chieu temple	Du Hang Kenh Precinct, Le Chan Dis, Hai Phong	1953	Religious beliefs
8	Phạm Tu Nghi mausoleum	Vinh Niem Precinct, Le Chan Dis, Hai Phong	19th century	Historic structure
9	Hai Ninh temple	Vinh Niem Precinct, Le Chan Dis, Hai Phong	1930	Religious beliefs
10	Nam Hai temple	An Bien Precinct, Le Chan Dis, Hai Phong	—	Religious beliefs
11	An Duong Doai temple	An Dong, An Duong Dis, Hai Phong	—	Religious beliefs
12	An Da temple	An Da Street, Ngo Quyen Dis, Hai Phong	1974	Religious beliefs
13	Dong Khe temple	Dong Khe Precinct, Ngo Quyen Dis, Hai Phong	1836	Historic structure
14	Gia Vien temple	Dong Khe Precinct, Ngo Quyen Dis, Hai Phong	—	Historic structure
15	Pho Minh temple	Le Loi Street, Ngo Quyen Dis, Hai Phong	—	Religious beliefs
16	Hai Phong opera house	Hoang Van Thu Street, Hong Bang Dis, Hai Phong	1904	Public cultural center
17	Ha temple	Thuong Ly Precinct, Hong Bang Dis, Hai Phong	1921	Historic structure
18	Vinh Phuc temple	Quan Tru Precinct, Kien An Dis, Hai Phong	18th century	Religious beliefs
19	Vinh Phuc temple	Hung Vuong Precinct, Hong Bang Dis, Hai Phong	19th century	Historic structure
20	Lac Vien temple	Lac Vien Precinct, Ngo Quyen Dis, Hai Phong	—	Historic structure
21	Do temple	Le Lai Street, Ngo Quyen Dis, Hai Phong	1717	Historic structure
22	Phuong Luu temple	Dong Hai Precinct, Hai An Dis, Hai Phong	1880	Worship to King Ngo Quyen

Source: The Department of Cultural and Sports and Tourism of Hai Phong City People's Committee

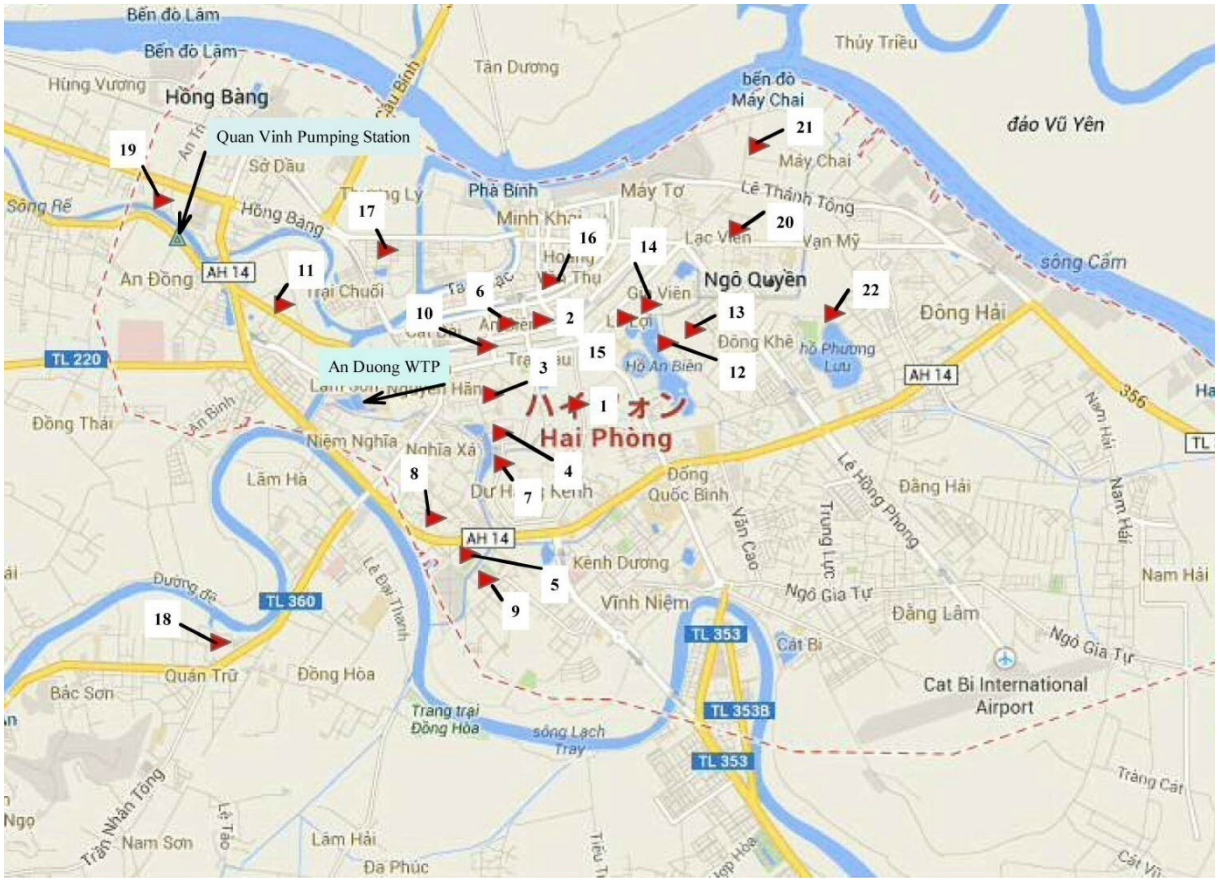


Figure 1-3-5 Locations of Cultural and Historical Heritages and Monuments Around An Duong WTP

Source: JICA Study Team (Based on information by The Department of Cultural and Sports and Tourism of Hai Phong City People's Committee)

(5) Natural Protection Area

According to the Department of Natural Resources and Environment of Hai Phong City People's Committee, the only natural protection area in Hai Phong City is Cat Ba national park which is located in Cat Hai island rural district. Cat Ba national park, located in the southwest direction of Ha Long Bay, consists of 366 islands and Cat Ba island is the largest with an area of 100 km^2. Cat Ba national park has been established as national park in 1986, and when including marine ecological environment the total area adds onto 16,240 ha. In addition, Cat Ba islands were registered as the World Biosphere Reserve Area by UNESCO in 2005. The area has diversity such as mangrove trees, limestone mountains, forests, and coral reefs. Cat Ba national park has a diversified fauna and flora system, which consists of 2,330 species, including 282 forestry animal species, 538 seabed animal species, 196 sea fish species, 771 terrestrial floral species, 23 mangrove species, 75 sea grass species, and 177 coral species.

Since the Project area is located in An Duong and Le Chan Districts, Cat Ba national park is approximately 40 km off the Project area, and not directly related to the Project. It was mentioned due to the important information regarding Hai Phong city.

(6) Ecological System

Conservation of the ecological system is controlled by the Department of Agriculture and Rural Affair of Hai Phong City People's Committee. Fauna and flora which are rated as endemic, rare, and endangered species are protected by "Penal Code, 1999" and its modified regulation, and "Biodiversity Act, 2009." However, said important fauna and flora have not been completely protected and their numbers have actually reduced. Table 1-3-5 shows a list of the important fauna and flora in Hai Phong city.

The Project aims to renew intake pumps in intake pumping station and to set up the pre-treatment U-BCF in the existing An Duong WTP. Although there are no green areas in the urbanized sites of the intake pumping station and the WTP, and the important fauna and flora are not directly affected by the Project, they are shown in the following for the importance of the information.

Table 1-3-5 List of Important Fauna and Flora in Hai Phong City

No	Scientific Name	Local name (General name)
Important Fauna		
1	Trachypithecus poliocephalus	Voọc đầutrắng (white-headed langur)
2	Eretmochelysimbricata	Đồimồi
3	Crettacaretta	Rùaquảnđồng
4	Dermochelyscoriacea	Rùa da
5	Pica pica	Chimáclà
6	ManisPentadactyla	Têtêvàng
7	Callosciurusprevostii	SócBụngđỏ (Asian tri-colored squirrel)
8	Capricormissumatraensis	Sơn Dương
9	Photololigo chinensis	Mực Thước
10	Trochusniloticus	Ốcđụncái (Tectus niloticus)
11	Rhincodontypus	Cánhámvoi
12	Pernaviridis	Vẹmvỏxanh (Asian green mussel)
13	Lutrariarhynchaena	Tuhài
Important Flora		
1	Nageiafleuryi	Kim giao (Decussocarpus fleuryi)
2	Chukrasiavelutina	Láthoa (Chukrasia tabularis)
3	Madhucapasquieri	Sếnmật (Sapotaceae)
4	Sargassum tenerrimum	Rongmơmềm (Sargassaceae)
5	Junceollagemmacea	San hôrừngcànhdẹp
6	Acroporaaspera	San hôlỗđinhxùxì
7	Acroporacerealis	San hôlỗđinhhạt
8	Acroporaformosu	San hôlỗđinhđài loan
9	Acroporanobilis	San hôlỗđinhnô – bi
10	Poriteslobatadana	San hôkhốiđầuthùy (Poritidae)

Source: The Department of Agriculture and Rural Affairs of Hai Phong City People's Committee

1-3-1-3 Laws and Regulations on Environmental and Social Consideration in Viet Nam

(1) Laws and Regulations on Environmental and Social Considerations

1) Laws and regulations on environmental and social consideration

Table 1-3-6 shows the laws and regulations related to environmental and social considerations.

Table 1-3-6 Main Laws and Regulations Related to Environment and Social Considerations

Environmental Laws	Contents
Law on Environmental Protection (No.52/2005/QH11) (2005)	Describes policy, procedure and resources, regulates organizations, households, individual rights/obligations and activities for environmental protection and provides legal frameworks. Especially, it regulates the outlines of necessary projects, report contents, evaluation, and responsibility authorities for EIA.
Circular No.26/2011/TT-BTNMT, (July 18, 2011)	Concretely describes the procedures and report contents for SEA, EIA, and Environmental Protection Commitment.
Decree, (regulates SEA/EIA and Environmental Protection Commitment) (No:29/2011/ND-CP) (August 18, 2011)	Modifies past Decrees/Circulars and it includes regulations newly enacted for SEA/EIA. It regulates the contents of EIA report, evaluation procedures, period, and necessary projects of EIA.
National Technical Regulation on Surface Water, the Decision of MONRE, No.16/2008/QD-BTNMT, (December 31, 2008)	Categorizes surface water into 4 categories; A1, A2, B1, and B2 by the purposes for water use.
National Technical Regulation on Underground Water、2009/NTNMT (QCVN09)	Regulates permissible limits for water quality.
National Technical Regulation on the Effluent of Aquatic Products Processing Industry (No.16/2008QD-BTNMT) (December 31, 2008)	Regulates the effluent standards for aquatic products processing industry.
National Technical Regulations on Noise and Vibration (QCVN26: 2010/BTNMT), Circular No.39/2010/TT-BTNMT of MONRE regarding national technical regulation on noise and vibration (December 16, 2010)	Divides regulated areas into particular area (medical and health care center, library, kindergarten, school, and pagoda, etc.) and common area (apartment block, guest house, hotel, office, etc.) and regulates maximum allowable limit for noise and vibration level during daytime (6:00 a.m.-9:00p.m.) and nighttime (9:00 p.m.-6:00 a.m.).
National Technical Regulation on Ambient Air（QCVN 05-2009）	Regulates ambient air standards of 7 items; $PM_{10}/NO_2/SO_2/O_3$/CO/TSP/Pb.
National Technical Regulation on Hazardous Substances in Ambient Air (QCVN 06/-2009/BTNMT）	Regulates the standards for 19 hazardous substances in ambient air.
Drinking Water Standards （QCVN01/2009/BIT）	Regulates quality standards for drinking water.
Laws on Social Consideration	Contents
Labour Code, 2012 (No.10/2012/QH13) (May 1, 2013）	Regulates wide range fields including contract of employment, occupational safety and health, payment for overtime work, rest period, rights and obligations of employers, labour dispatch, establishment and management of trade union, etc.

Source: JICA Study Team (Based on local study)

2) Related Agencies and Organizations on Environmental and Social Consideration

The central agency of environmental management is the Ministry of Natural Resources and Environment (hereinafter “MONRE”). In the administrative system of Viet Nam, People's Committees of provinces, districts, wards, and communes form the outpost agencies of the national government and acts as the functions of central agencies. Hai Phong city is under direct control by the central government, along with Ha Noi city, Ho Chi Minh city, Da Nang city, and Can Tho city. The city has the

administrative function of same level as Hai Duong Province. In its people's committee, all local offices of central agencies are concentrated and a local agency relative to environmental management is the Department of Natural Resources and Environment (hereinafter "DONRE"). In addition, a local agency relating to labour safety to be a part of social consideration is the Department of Labour, Invalid, and Social Affair.

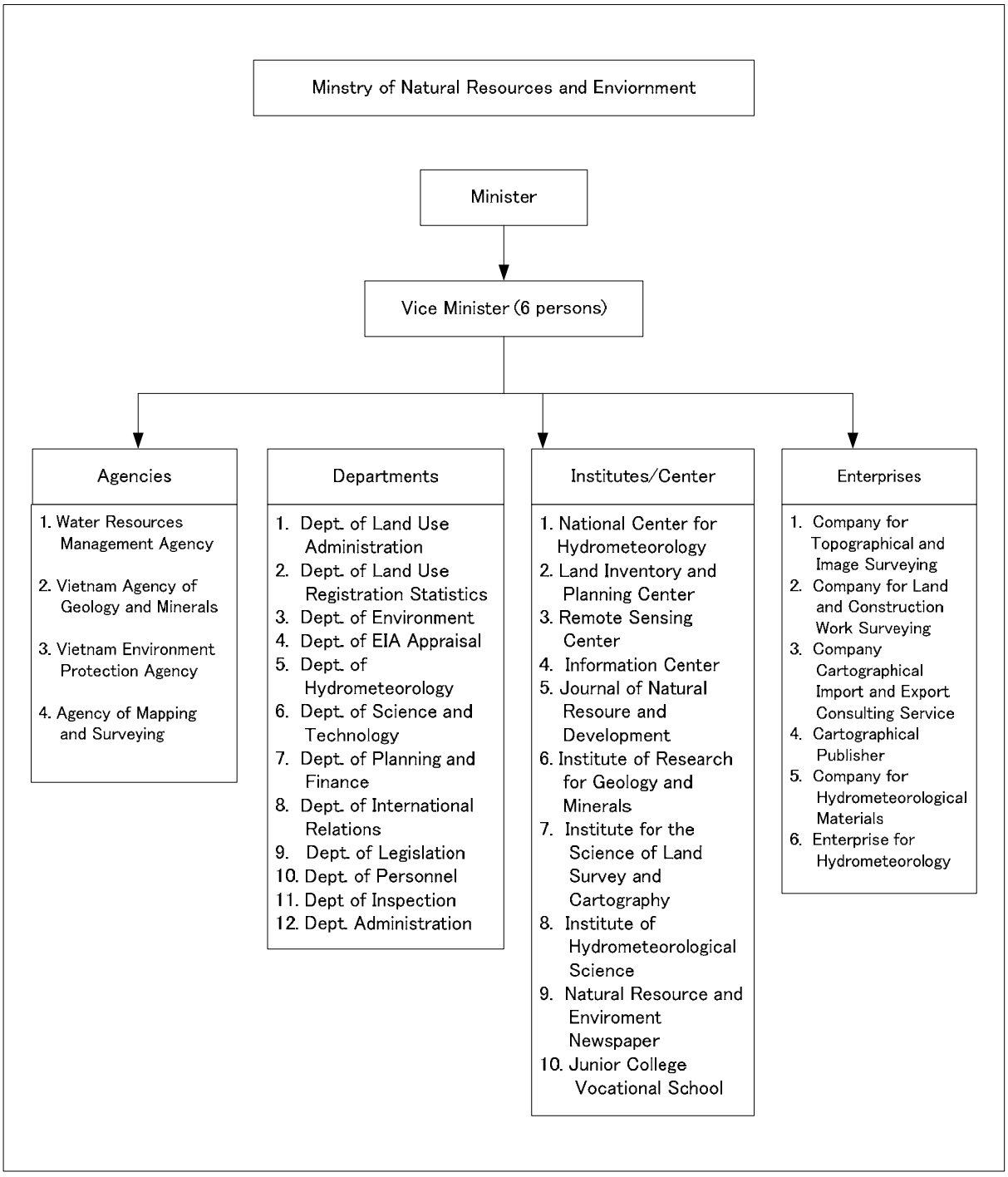


Figure 1-3-6 Organization Chart of the Ministry of Natural Resources and Environment

Source: MONRE Website

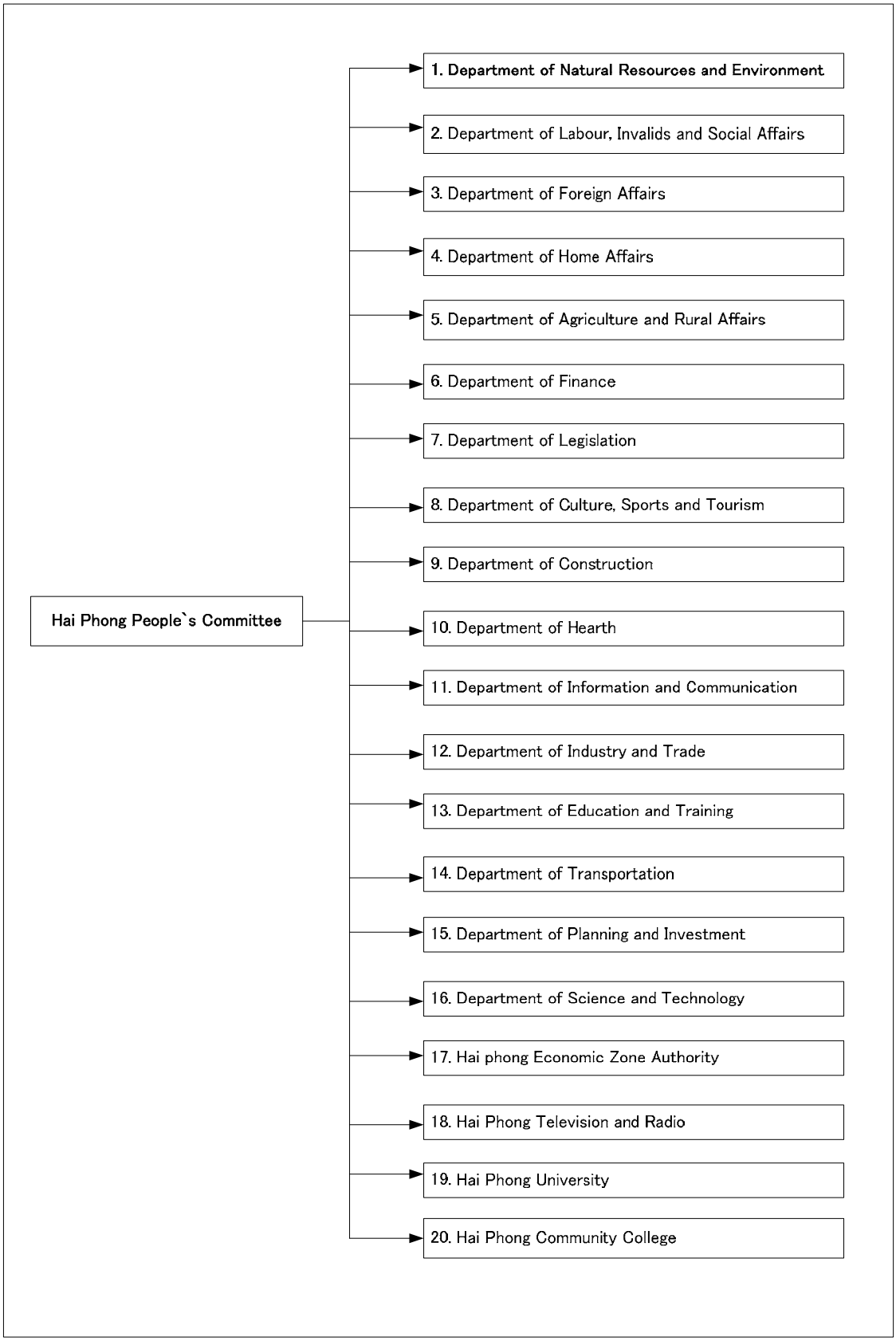


Figure 1-3-7 Organization Chart of People's Committee in Hai Phong City

Source: People's Committee in Hai Phong City Website

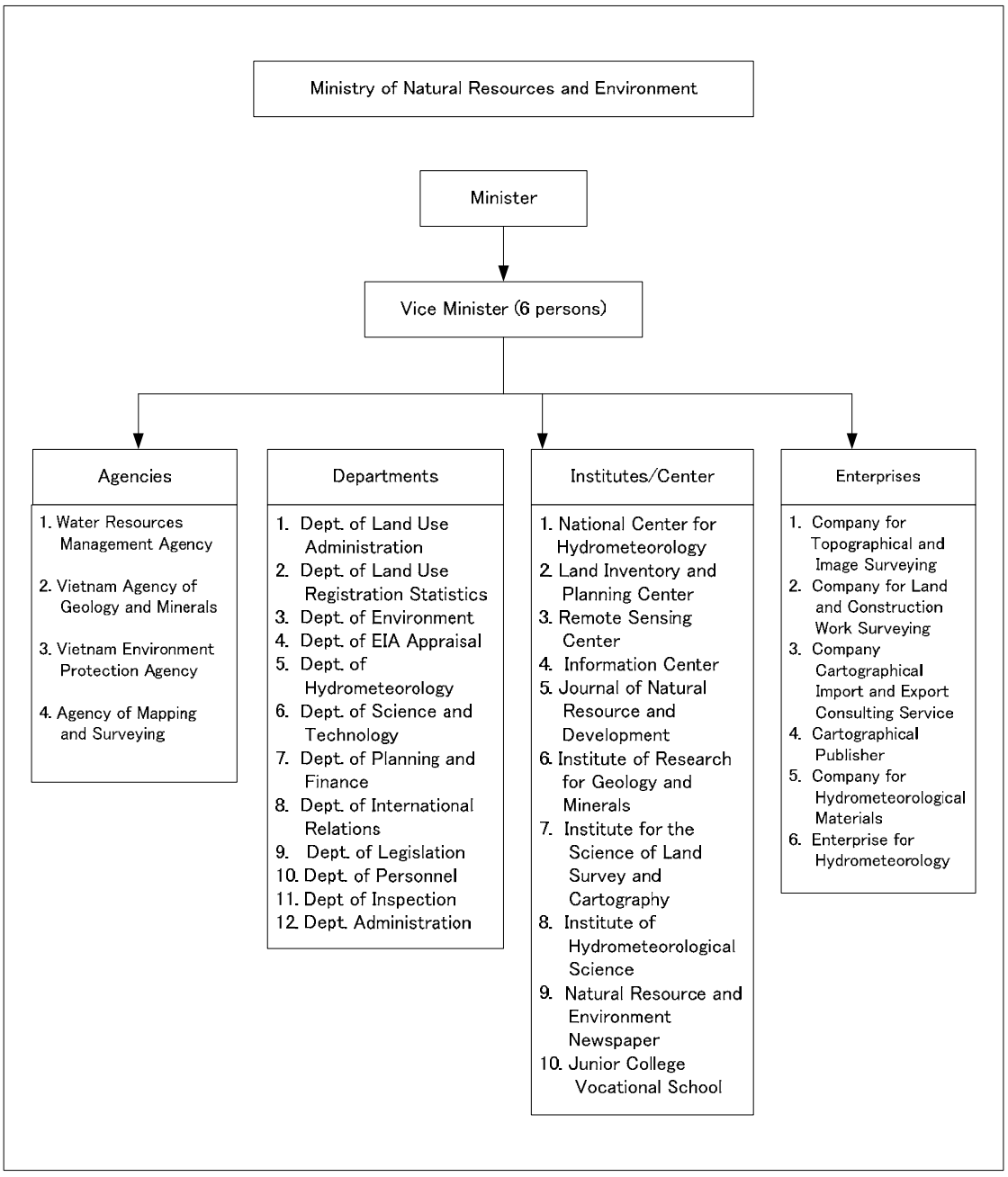


Figure 1-3-8 Organization Chart of Department of Natural Resources and Environment, Hai Phong People's Committee

Source: MONRE Website

3) Necessity of EIA and Its Procedures

a) EIA procedures to be conducted by central government

Many decrees and circulars have been regulated, renewed and modified since the Law of Environment Protection was enacted in 2005. The Decree (No.29/2011/ND-CP) providing strategic environment assessment (hereinafter "SEA"), environment impact assessment (hereinafter "EIA") and environmental protection commitment (hereinafter "EPC") and The Circular No.26/2011/TT-BTNMT were enacted which were modified from the past regulations and furthermore regulated detail contents.

The procedures for EIA approval are divided into 2 categories: 1) projects conducted by the MONRE of the central government and 2) projects done by the DONRE of Hai Phong people's committee. The projects conducted by MONRE of the central government are as follows:

Projects Necessary of EIA Approval Conducted by Ministry of Natural Resources and Environment of Central Government

① Projects in which the investment is decided by the National Assembly or the Prime Minister.
② Projects using land of national parks, nature reserves, world heritages, historical and cultural relics, ranked national landscapes and area of biosphere reserve.
③ Projects to build atomic power plants, thermonuclear plants, nuclear reactors; thermos power plants with a capacity of 300 MW or more and located less than 2 km off an urban center or concentrated residential area; other thermos power plants with a capacity of 600 MW or more; hydro-power plants and irrigation works with a reservoir capacity of 100 million m^3 or more.
④ Projects encroaching the sea on 20 ha or larger; projects requesting change of use purposes of watershed protection forests, wave-, wind- and sand-sheltering protection forests, special use forest of 20 ha or larger or other natural forests of 100 ha or larger; projects using 20 ha of land under two rice crops per year or larger.
⑤ Projects to build oil refineries and petro-chemistry plants; projects to build plants of basic chemicals, plant protection drugs, detergents, additives and chemical fertilizer with an annual capacity of 10,000t of products or more; projects to build battery plants with an annual capacity of 300,000 KWh or 600 t of products or more; cement plant projects with an annual capacity of 1.2 million t or more; plants storing radioactive substances or with radioactive waste; projects to build pulp mills with an annual capacity 25,000 t of products or more; projects to build alcohol or spirit breweries with an annual capacity of 500,000 L of products or more; projects to build beer or beverage plant with an annual capacity of 2 million L of products or more; projects to build aquatic products processing plants with an annual capacity of 5,000 t of products or more.
⑥ Oil exploitation projects; solid mineral exploitation projects with an annual capacity of 500,000 m^3 of primary materials (including tailings and minerals) or more; projects to exploit rare earth and radioactive minerals; projects to sort and enrich rare earth and radioactive minerals with an annual capacity of 50,000 t of products or more, and other large-scales development projects.

In the other large scales of projects which need EIA approval, the DONRE of provinces and chartered cities conducts the evaluation and approval for EIA.

b) EIA procedures to be conducted by DONRE of Hai Phong City

Appraisal procedures for EIA approval are carried out by DONRE of Hai Phong City's People's Committee. After DONRE reports the appraisal results to the People's Committee, the People's Committee calls the Board for Evaluation which is consisted of the relating agencies and the chief of DONRE, and said Board makes the decision on the approval or refusal of EIA. The period for the procedures of EIA approval is 45 working days (about 2 months). The report on public consultation is requested to be submitted with EIA report at the time of EIA appraisal and project proponent requests to conduct public consultation to the local government at the ward area where project site is located. The appraisal of EIA related to the construction of water supply system is conducted by DONRE under control of the People's Committee belonging to provinces and chartered cities. Projects which require EIA related to construction of water supply system are regulated by Attachment II, "the list of projects subject to EIA reporting" of the Decree (No29/2011/ND-CP) as shown below.

Table 1-3-7 Projects Requiring EIA Related to Construction of Water Supply System

No	Project	Scale
53	Projects to exploit water for supply for production, business, service and daily-life activities	Exploit of groundwater of 5,000 m^3/day or more, and surface water of 50,000 m^3/day or more

Source: Decree (No.29/2011/ND-CP) providing SEA, EIA, and EPC, Attachment (April 18, 2011)

The Project dos not have a large scale which MONRE requires EIA procedures. Since the Project objective is the improvement of an existing WTP and its scale is in accordance as to be done by DONRE, the judgement for the necessity of EIA procedures and its decision are conducted by DONRE.
The approval process of EIA is shown below, and Figure 1-3-9 indicates its process.

① Elaboration of project report and submission of its report to DONRE

- If DONRE judges that the Project does not cause critical environmental impacts and/or its mitigation measures are appropriate to bring under control, DONRE issues EIA license together with imposed conditions.
- If DONRE judges that the Project causes critical environmental impacts and/or the project report does not propose effectual mitigation measures, DONRE requests to implement the EIA survey to project proponent.

② The case that EIA survey is needed.

- Implementation of scoping survey

  Scoping survey: process to confirm critical issues relative to proposed Project.
- Elaboration of TOR for EIA survey (the same time as scoping process)
- Submission of scoping report (including TOR) to DONRE

③ EIA survey

- EIA survey examines all issues included in TOR of which the proponent will work out in compliance to counsels from DONRE and relating agencies.
- EIA survey is conducted by EIA experts registered by DONRE.
- EIA survey report is submitted to DONRE.
- Public consultation is implemented during project planning, and a certification (explanation letters) on the implementation of public consultation is attached to EIA survey report.

④ Decision of approval with/without imposed conditions or its deny of EIA survey report by DONRE.

⑤ In case of EIA approval, EIA license is issued by DONRE.

c) Environmental audit

Environmental audit is implemented after DONRE issues EIA licenses and the construction for the project starts, or after U-BCF system operates. Environmental audit is conducted and evaluated based on baseline information that is accessed during EIA process.

Based on the results of environmental audit, DONRE evaluate the extent and strength of environmental impacts that the project influences to environment and appraise the appropriateness of mitigation measures. DONRE makes recommendations to project proponent if mitigation measures during the project implementation are not appropriate or ample. If the project proponent does not comply with DONRE's orders, DONRE shall cancel EIA licenses.

① Contents of environmental audit

- Check effectiveness of EIA report
- Verification of implementation conditions of audit of organization relating to the project management
- Check environmental impacts that are caused by the implementation of the project
- Check the accuracy of prediction by comparison between the prediction of environmental impacts and actual conditions

② Function of DONRE on environmental audit

- To decide the time and necessity of environmental audit
- To definite the objectives of environmental audit
- To approve the criteria for environmental audit
- To approve environmental audit plans and their scopes
- To receive and review environmental audit reports
- To guarantee follow-up against the recommendations by environmental audit report

d) Environmental auditor

There are two types of environmental audits consisting of the public audit implemented by DONRE and the private audit conducted by project proponent. In case of the private audit, environmental audit is conducted by auditors who are registered by DONRE and are requested by project proponent.

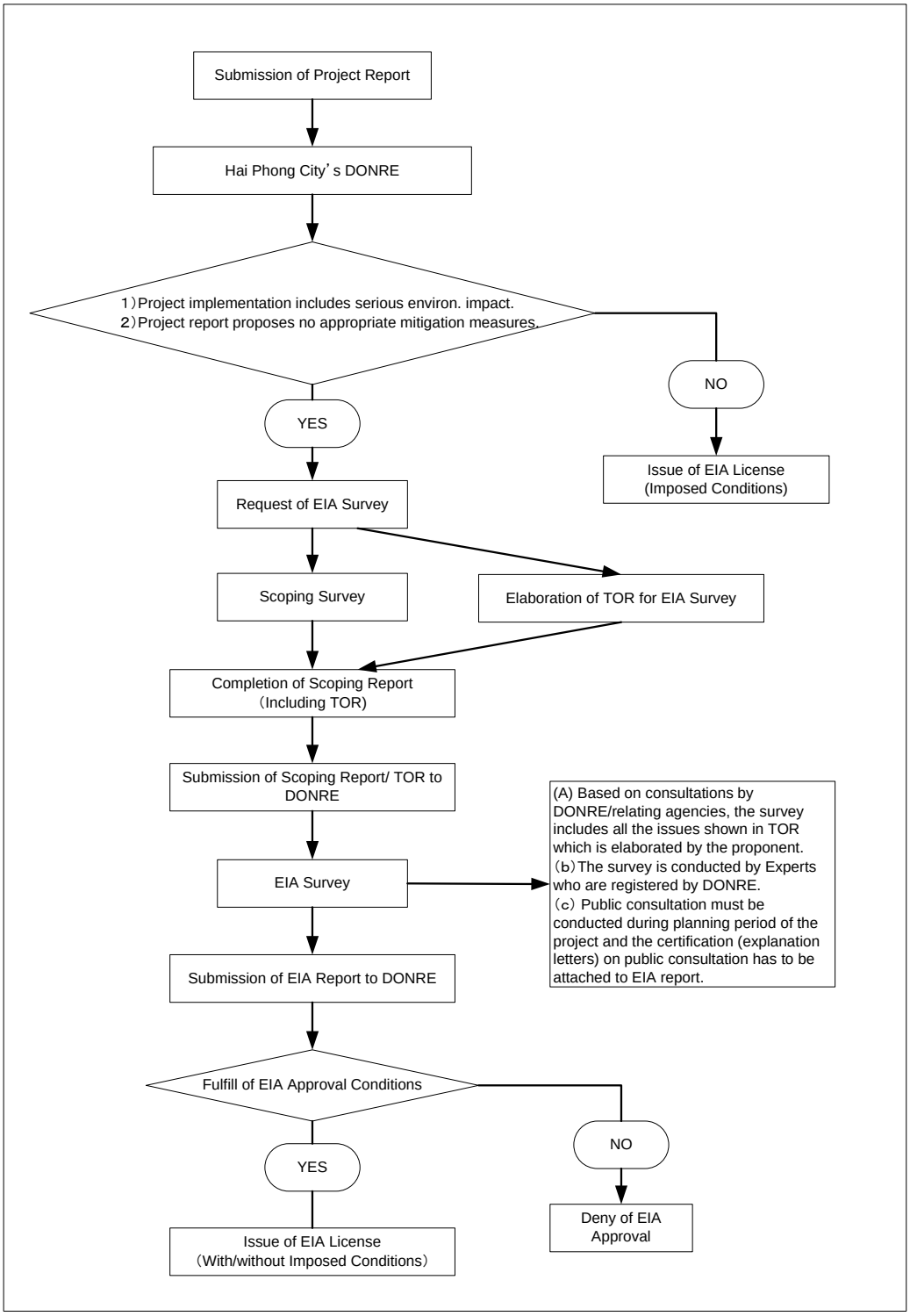


Figure 1-3-9 EIA Approval Process

Contents of EIA Report

The contents of EIA report are as follows:

Preface

Purpose of project implementation, legal and technical basis of EIA, methodology of EIA and implementation

Chapter 1. Brief Introduction of the Project

Project name, investor, location, and main contents of the project

Chapter 2. Natural Environment and Socio-Economic Conditions

Geographical, geological, meteorological, and hydrological conditions, and current status of biological resources, socio-economic conditions, etc.

Chapter 3. Environmental Impact Assessment

The preparation phase/the construction phase/the operation phase

Chapter 4. Mitigation Measures and Environmental Incident Prevention

Chapter 5. Environment Monitoring and Supervision Program

Environment monitoring program, environment supervision program

Chapter 6. Public Consultation

Public Consultation, Conclusion/Petition/Commitment

Source: Attachment of Decree (No.26/2011/TT-BTN)

e) Necessity of EIA for the project

As mentioned in the previous section, projects which require EIA procedures related to the construction of water supply system are the projects with development of surface water over 50,000 m^3/day. However, this Project plans only to set a pre-treatment facility (U-BCF) for the improvement of supplying water quality at the existing WTP and does not plan to develop new water sources.

Initially, DONRE to be a responsibility agency of EIA procedures issued a decision letter of which EIA procedures for the implementation of the project were needed. However, after that, Hai Phong people's committee to be the supervising organization of DONRE decided that the addition of U-BCF at An Duong WTP will not change the size, capacity, without increasing the level of adverse impact on the environment and waste, the project has no obligation of EIA. As Hai Phong people's committee was the supervising organization of DONRE, Department of Planning and Investment, and Department of Construction etc., and had equivalent jurisdiction to province level, the decision by Hai Phong people's committee became final.

Concretely, regarding the necessity of EIA procedures, the following communications among DONRE, Hai Phong People's Committee, and Hai Phong Water were made and it was decided that EIA procedures shall not be an obligation for this Project.

At the end of August 2014, Hai Phong Water asked the necessity of EIA to DONRE of Hai Phong

People's Committee for the Project. As a result, DONRE confirmed the necessity of EIA to Hai Phong Water by the official letter dated on September 9, 2014.

After the above, the JICA Study Team submitted an outline survey report on environmental and social consideration and drawings to Hai Phong Water in order to request application for EIA procedures and the finalization of necessity documents for its procedures. At this stage, Hai Phong Water again negotiated the necessity of EIA procedures with Hai Phong People's Committee by indicating that the Project had a limited adverse impact.

As a result, the Department of Planning and Investment (hereinafter “DPI”) notified Hai Phong People's Committee of the following comment: “As the addition of U-BCF at An Duong WTP will not change the size, capacity, without increasing the level of adverse impact on the environment and waste, the DPI agrees to implement the Project without the obligation of EIA.”

Hai Phong People's Committee had held conferences with DONRE, DPI, Department of Construction, Department of Science and Technology, and Hai Phong Water. As a result, it had been agreed upon that EIA was unnecessary, has been reported by DPI as a representative, and has been approved as the final decision.

To summarize the above results, although DONRE first issued an official letter stating the necessity of EIA procedures for the Project, EIA procedures were finally determined to not be obligated by the decision of Hai Phong People's Committee.

These following notice letters are shown in the followings:
Appendix 06-04, Notice letter on the necessity of EIA procedures by DONRE; Appendix 06-05, Comment letter on the non-obligation of EIA procedures by the DPI; Appendix 06-06, Final decision letter on the non-obligation of EIA procedures to DONRE, the Department of Construction, the Department of Science and Technology, DPI, and Hai Phong Water by Hai Phong People's Committee.

4) Necessity of Submission of Environmental Protection Commitment

According to the Decree (No29/2011/ND-CP), for small-scale projects not mentioned in Attachment II, the list of projects subject to EIA reporting, EPC must be finalized, submitted and registered.

Hai Phong People's Committee decided that the Project is not obligated to EIA procedures by the notice dated in October 30, 2014. In this case, EPC needs to be submitted to implement the Project. Submission agency of the EPC is DONRE of Le Chan district in where the An Duong WTP Project site is located. Figure 1-3-10 shows the organization chart of Le Chan district.

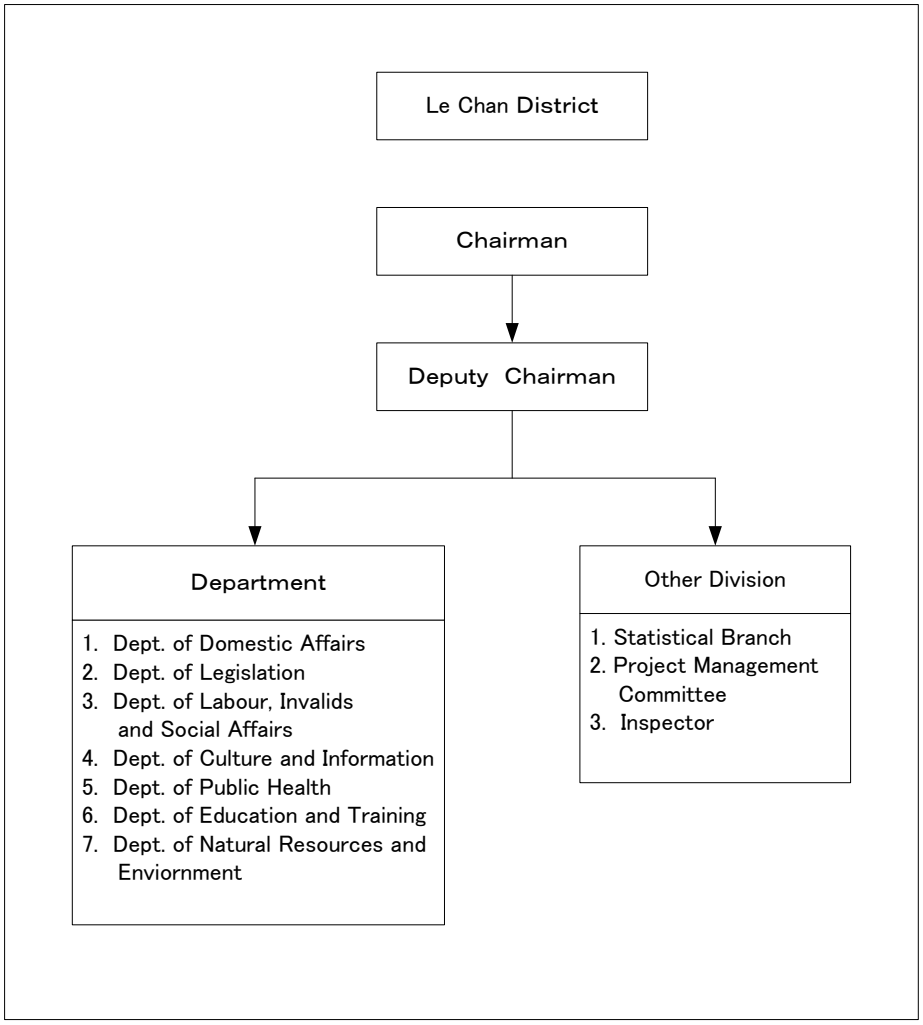


Figure 1-3-10 Organization Chart of Le Chan District

Source: Le Chan District Website

In addition, the Decree (No29/2011/ND-CP) regulates the descriptions of the EPC dossier, registration, and the responsibility of project owner as shown below:

a) Contents of EPC dossier and registration, and the responsibility of project owner after registration

EPC dossier includes the followings:

- Brief explanations of the Project: Name and address of project implementer, project name and location, project scale and technical contents, demand of raw material and fuel, etc.
- Types of wastes generated, total volume of wastes and their concentrations
- Commit conduction of waste treatment, solutions to mitigate negative impacts which are mentioned; commit that the polluted parameters of the wastes after treating can meet all current environmental standards; commit conduction of environmental protection measures based on the Law of Environmental Protection.

b) Registration dossier of EPC consists of the followings:

① EPC dossier

② F/S reports of investment projects, or plans for production and business

c) Registration time of EPC dossier

① Project owner must register prior to commencement of investment, production, and business activities.

d) Registration procedures of EPC dossier

① Project owner submits registration dossier of EPC to the People's Committee of Le Chan district in where the Project site is located.

② The People's Committee of Le Chan district notifies the project owner of acceptance or refusal of the registration dossier within five (5) working days. In case of refusal, it shall clearly state the reason.

e) Sending of registered written EPC

The People's Committee of Le Chan district sends one copy of written EPC to the People's Committee of commune-levels in which the project is carried out, within two (2) working days.

f) Responsibilities of the project owner after written EPC registration

① To take measures to mitigate adverse environmental impacts stated in the registered written EPC.

② To stop operations and promptly report to the commune-level People's Committee and district-level People's Committee of the locality in which the project is implemented in case an incident which exerts adverse impacts on the environment quality and community health during project implementation occurs.

③ To cooperate, create favorable conditions and share relevant necessary information with the environmental protection management agency to conduct supervision, examination, and inspection during the investment project implementation.

(Remarks)

a) Actual submission time of EPC dossier and procedure period of EPC approval

According to Decree (No29/2011/ND-CP), the submission of EPC dossier has to be submitted prior to commencement of facility construction and the decision of acceptance or refusal of registration dossier is conducted within five (5) working days. In case of refusal, it shall clearly state the reason. However, according to Hai Phong Water's official in charge of the environment fields, under actual conditions, the procedures for registration dossier generally take one to two months after the submission of EPC dossier to district, although the period depends on the person in charge of the registration of the district. Furthermore, in case a modified request of the dossier is notified instead of a registration notice, the project owner may gain approval within a few days if the project owner swiftly and directly contacts the

person in charge for registration and the EPC dossier can be registered within a few weeks.
Thus, it shall be recommended to take into consideration about three months for the procedure period until the EPC dossier is registered. Based on the above reasons, it is considered that in an early stage prior to facility construction, namely, at the time of detailed design, the EPC dossier shall be submitted.

b) Inspection fee of the EPC dossier

Since the inspection fee for the EPC dossier is allocated by the budget of District People's Committee, the project owner is not required to bear the fee.

c) Permits Relating to Environmental and Social Consideration Necessary for Project Implementation

An Duong WTP draws raw water from Quan Vinh intake pumping station, which is located at the Re River 3.5 km in the northwest of the WTP. Re River is a large river with width of approximately 60 m. At the survey in August 2014, the river beds were not observed and the river was full with surface water.

The water right of An Duong WTP is secured by the contract on intake amount between Hai Phong Water and An Hai Water Conservancy Works Exploiting Ltd. Co., which is the river water management company of Le Chan District, commissioned by Hai Phong City People's Committee and by paying the intake fees. This contract is generally called “Economic Contract”, which allows to draw raw water for water treatment production. It is also known as “water permission”. In each district of Hai Phong city, there are river water management companies which are entrusted to river water management. The City People's Committee decides the water use volume of each company and each river water management company issues the water permission.

In An Duong WTP, in the year from January 1, 2014 to December 31, 2014, the permitted water intake volume was 44,000,000 m^3 (120,548 m^3/day), and if an increase of the intake amount is required, it shall be approved by paying additional intake fees. The intake fee in the past was 750 VND/m^3, although it was raised to 900 VND/m^3 from July 1, 2014. As a reference, the Economic Contract on intake of raw water is shown in Appendix 06-02.

1-3-1-4 Comparison of Project Alternatives (Including Zero Option)

Three alternative plans (including zero option) have been considered as follows:

A plan: Zero option, which does not conduct the Project.

B plan: Construction of pre-treatment U-BCF with 4 booster pumps (3 units duty; 1 unit standby) which convey the raw water from pre-treatment basin to U-BCF, and 2 blowers (1 unit duty; 1 unit standby) in An Duong WTP

C plan: Raw water is directly conveyed to U-BCF by 4 renewed intake pumps (3 units duty; 1 unit standby) at the intake pumping station and 2 blowers (1 unit duty; 1 unit standby) are set up to clean the filters of U-BCF.

In these cases, the natural and social conditions of the Project sites are nearly the same. The difference between the three plans are in the points whether the coagulant and chlorine treat organic matters such as NH_4 and NO_3 or U-BCF treats them, and in the point of water quality/safety concerning the generation of THM. Merits and demerits on the evaluation items such as water quality/safety and O&M are examined, and the pros and cons of the alternative plans are comparatively examined.

A Plan: Zero option, which does not conduct the Project.
The Re River, the water source of An Duong WTP, is polluted with NH_4, NO_3 and Mn by the inflow of domestic wastewater. The WTP consumes large amounts of PAC coagulant and chlorine to remove the ammonium nitrogen and organic matters by oxidation, which is causing water treatment issues. In case the Project is not implemented, the source water quality will be decline in the future, and the WTP is anticipated to increase the consumption of PAC and chlorine. Also due to the remaining issues regarding the safety of treated water, zero option is not recommended.

B Plan: Installation of U-BCF with Booster Pumps (3 Units Duty; 1 Unit Standby) and Blower (1 Unit Duty; 1 Unit Standby) at An Duong WTP (Note: raw water for supply is drawn to the existing pre-sedimentation tank of the WTP by using the existing booster pumps set in the intake pumping station. In B plan, new booster pumps are set up at U-BCF in An Duong WTP to transmit raw water from the sedimentation pond to U-BCF.)
Due to the installation of U-BCF, ammonium nitrogen and organic matters within the raw water are removed by natural purification power of microorganism and the injection amount of PAC and chlorine shall decrease. In addition, in case of a large fluctuation of the quality of water source, the water treatment process for said substances, such as coagulation and filtration, shall remain stable since the treatment methods after U-BCF treatment are uniform.

C Plan: Direct Transmission of Raw Water up to U-BCF by 4 Renewed Intake Pumps (3 Units Duty; 1 Unit Standby) in Intake Pumping Station and Setting 2 Blowers (1 Unit Duty; 1 Unit Standby) for Washing Filters of U-BCF at An Duong WTP.
Due to the installation of U-BCF, ammonium nitrogen and organic matters within the raw water are removed and the injection amount of PAC and chlorine shall decrease. In addition, as the water quality after U-BCF treatment is uniform for said substances, the process of water treatment shall become stable. These points are the same as the B Plan. However, C plan sets a one-step pumping up to directly convey raw water to U-BCF, it has advantage in the viewpoint of O&M cost compared with B Plan. Thus, the implementation of C plan is mostly recommended.
The above three plans are summarized in the Table 1-3-8 Comparative Table of Alternative Plan (Including Zero Option).

Table 1-3-8 Comparative Table of Alternative Plan (Including Zero Option)

Comparative Category	A Plan: Zero option which does not conduct the Project.	Evaluation	B Plan: Installation of U-BCF with 4 pumps and 1 blower	Evaluation	C Plan: Raw water is directly conveyed to U-BCF by 4 renewed intake pumps at the intake pumping station and 2 blowers are set up to clean up the filters of U-BCF.	Evaluation
a) Topography	The existing WTP and intake pumping station are located at flat lands.	○	The proposed construction site is located at flat land.	○	Same as the left.	○
b) Vegetation & ecological system	The existing WTP and intake pumping station has no places with important vegetation and ecological system..	○	The proposed construction site has no places with important vegetation and ecological system.	○	Same as the left.	○
c) Urbanization	The existing WTP and intake pumping station are located in the urbanized area.	△	The proposed construction site is located in the urbanized area.	△	Same as the left.	△
d) Cultural and historical heritage & monument	The existing WTP, intake pumping station and surrounding areas have no important cultural and historical heritages and monuments.	○	The proposed construction site has no important cultural and historical heritages and monuments..	○	Same as the left.	○
e) Impact to Hydrological Conditions	The existing WTP and intake pumping station are located near the rivers but there is no influence by intake of river water.	○	The proposed construction site is located near the rivers but there is no influence to hydrological conditions by intake of river water.	○	Same as the left.	○
f) Resettlement	As the existing facilities are owned by Hai Phong Water, resettlement is not necessary.	○	As the proposed construction sites are located in An Duong WTP, resettlement is not necessary.	○	As the proposed construction sites are located in Quan Vinh intake pumping station and An Duong WTP, resettlement is not necessary.	○
g) Conflict of Interest in the Project area	As constant water treatment of moderate quality is conducted by the existing WTP and the supply condition is good, conflict of interest in the Project area will not occur.	○	Supply water quality shall improve by construction of the planned U-BCF. However, as constant water treatment of moderate quality is conducted by the existing WTP and the supply condition is good, conflict of interest in the Project area will not occur.	○	Same as the left.	○

Comparative Category	A Plan: Zero option which does not conduct the Project.	Evalua-tion	B Plan: Installation of U-BCF with 4 pumps and 1 blower	Evalua-tion	C Plan: Raw water is directly conveyed to U-BCF by 4 renewed intake pumps at the intake pumping station and 2 blowers are set up to clean up the filters of U-BCF.	Evalua-tion
h) Landscape	Although the existing facilities have the height of a 2-3 stories building, the surrounding houses have the same height or more, the existing facilities shall not cause a problem.	○	The U-BCF has the height of a two stories building. However, the surrounding houses have the same height or more, so the facility's construction does not shall not cause a problem.	○	Same as the left.	○
i) Local Economy of Employment & Livelihood	The existing facilities require only O&M. Thus, impact against the local economy such as employment and livelihood of the inhabitants does not generate.	○	Implementation of the Project may provide positive impacts by hiring construction workers and consuming construction materials.	○	Same as the left.	○
j) Water Use	For the THM generation due to treatment chemicals, the treated water has health concerns.	×	U-BCF ensures safe water quality and even if the quality of raw water fluctuates, stable quality of treated water is secured.	◎	Same as the left	◎
k) Gender	House connection by the existing facilities is conducted. Thus, water fetching works do not affect genders.	○	As proposed facility is constructed to improve supply water quality and house connection is already conducted by the existing facilities, water fetching works do not affect genders	○	Same as the left	○
l) Nearby to ordinary road	As the existing facility is located near ordinary roads, there are risks of traffic accidents.	○	As the proposed construction sites are located near ordinary roads, there are risks of traffic accidents.	○	Same as the left.	○
m) Chemical amount to be used for water treatment process	Consumption of PAC and chlorine is large and is estimated to increase in the future.	×	Chemical cost is decreased 30% by installation of U-BCF.	◎	Same as the left	◎
n) O&M Cost (Cost of Chemical + Electricity + Activated carbon)	23,629,000,000 VND (¥114,598,000)	◎	26,876,000,000 VND (¥130,348,000)	△	25,052,000,000 VND (¥121,503,000)	○

Comparative Category	A Plan: Zero option which does not conduct the Project.	Evalua-tion	B Plan: Installation of U-BCF with 4 pumps and 1 blower	Evalua-tion	C Plan: Raw water is directly conveyed to U-BCF by 4 renewed intake pumps at the intake pumping station and 2 blowers are set up to clean up the filters of U-BCF.	Evalua-tion
Comprehensive Evaluation	Both the uncertainty on the safety of treated water, and the future consumption of chemicals will increase. Thus, this plan is not recommended.	×	By installation of U-BCF, safety/quality of supply water is ensured and even if the raw water quality fluctuates, stable water quality is secured. The O&M cost is higher than C Plan.	○	By installation of U-BCF, safety/quality of supply water is ensured and even if the raw water quality fluctuates, stable water quality is secured. The O&M cost is the lowest.	◎

(Legend) Sign of evaluation categories means: ◎good, ○ fair, △intermediate level between ordinary and bad, × bad.

Source: JICA Study Team (Based on local survey)

According to the results above, natural and social conditions are almost the same in every plan. Thus, comprehensive evaluation is carried out for the 3 components of treated water quality, consumption of chemicals, and O&M cost in cases of installation and no installation of U-BCF. As a result, it is judged that implementation priority is higher in the order of C Plan, B Plan, A Plan.

Based on this result, C Plan, “Direct transmission of raw water up to U-BCF by renewal of 4 intake pumps (3 units duty; 1 unit standby) in intake pumping station and setting of 2 blowers (1 unit duty; 1 unit standby) for cleaning filters at U-BCF at An Duong WTP” is judged to have the highest implementation priority.

1-3-1-5 Scoping

The result of scoping is shown in Table 1-3-9 Scoping List.

Table 1-3-9 Scoping List

Category	No.	Impact Items	Evaluation		Evaluation Reasons
			P-Const* U-Const*	Operating*	
Pollution Countermeasure	1	Air Pollution	B-	D	U-Const: Degradation of air quality and generation of fog and dust are possible at the temporary bases by operation of construction machines and vehicles. Operating: Degradation of air quality will not be caused because the pumps and blower are mainly operated by commercialized electric power.
	2	Water Pollution	B-	D	U-Const: Water pollution may be caused by drainage water from construction sites, construction machineries and vehicles. For the discharge to side ditches at the WTP, it will be necessary to pay attention for the clogging of the ditches by soil and wastes discharge. In addition, for the construction of U-BCF in itself, pre-mixed concrete is generally used at the sites, and water for curing concrete structures is stored by slightly higher mounts surrounding the ceiling of the building or is sprayed on bundles of straw and cloth wraps covering the concrete structure, and is lost only by evaporation. As the concrete surface rapidly consolidates, turbid water does not generate. U-BCF system is constructed by earth filling of a part of pre-sedimentation pond. if the earth filling of pre-sedimentation pond is conducted by using ordinary soil, turbid water is directly discharged to the pond. As its raw water is treated, supplying water does not have any issues in water quality and turbid water by construction is not to be drained to the outsides of the WTP. For the intake pumping station, the situation is the same as the WTP. the setting of motors and pumps are the main works, and turbid water is not drained to the outsides of the intake pumping station. Operating: Although backwashing water to clean the filter of U-BCF is discharged, the discharged water is drained to the sun drying bed, and after evaporation, residual liquid from the sun drying bed returns to pre-sedimentation pond for raw water again. Thus, as the discharged water circulars in the WTP and not drained to the outside of the WTP, adverse impact is not expected.

Category	No.	Impact Items	Evaluation		Evaluation Reasons
			P-Const* U-Const*	Operating*	
Pollution Countermeasure	3	Waste	B-	B-	U-Const: Construction wastes, scrap wood and general wastes are expected to generate at construction site. Operating: General wastes will be caused by workers. However, they will be disposed with solid wastes at the existing WTP, adverse impact is not expected. Sludge will also be generated by U-BCF operation.
	4	Soil Contamination	B-	D	U-Const: Soil contamination caused by oil spills from construction machines is possible. Roads may be dirtied by tires of construction vehicles with adherent soils, and soils that fall from vehicles transporting equipment, materials and surplus soils. Operating: Adverse impact is not expected.
	5	Noise and vibration	B-	B-	U-Const: Noise and vibration caused by construction works, operation of construction heavy machines and vehicles are expected. Operating: Noise by operation of intake pumps and blower are expected.
	6	Land subsidence	D	D	Construction works which cause land subsidence are not planned.
	7	Bad odor	D	D	Operating: Facilities which cause bad odor are not planned.
	8	Bottom sediment	D	D	U-Const: Since the Project purpose is to renew intake pumps in the existing intake pumping station and to construct a small scale U-BCF at existing An Duong WTP, adverse impact to bottom sediment is not expected.
Natural Environment	9	Protection area	D	D	The Project sites are located in the existing Quan Vinh intake pumping station and An Duong WTP. Since there is no protection area around the Project area, construction works will have no influence.
	10	Ecosystem	D	D	The Project sites are located at the existing intake pumping station and the WTP. As they have no vacant area consisting of trees, adverse impact to ecosystem is not expected.
	11	Hydrology	D	D	Since the Project purpose is to renew intake pumps in the existing intake pumping station and to construct a U-BCF in the existing WTP, it does not develop new water sources and does not expand the WTP. Thus, the Project does not cause adverse impact to hydrology.
	12	Topography /geology	D	D	As the Project purpose is to renew intake pumps in the existing intake pumping station and to construct a small scale U-BCF in existing An Duong WTP located in flat topography, it has no adverse impact to topography and geology.

Category	No.	Impact Items	Evaluation		Evaluation Reasons
			P-Const* U-Const*	Operating*	
Social Environment	13	Resettlement	D	D	As the Project sites are located in the existing intake pumping station and the existing An Duong WTP, resettlement is not caused.
	14	Poverty group	D	D	The Project aims to set up U-BCF pre-treatment facility to remove NH_4, etc. and to improve quality of supplying water. In the surrounding area of proposed construction sites, conventional houses and commercial stores are distributed and there are no poverty areas such as slums. Since the improvement of supply water quality targets the whole supply area, it will provide positive impact to all people living in the area.
	15	Ethnic minorities and indigenous people	D	D	In Hai Phong City area, the majority Kinh tribe and the minority Hoa tribe (population: 1,000) whom belong to the Chinese are living. The Hoa tribe is living as workers mainly employed by Chinese enterprises and are not living in special limited areas but in mixing conditions. Thus, this improvement Project for supply water quality provides equal benefit to the minority tribe.
	16	Local economy consisting of employment & livelihood, etc.	B+	B－	U-Const: The employment of construction workers and consumption of construction materials may have positive impact on local employment condition and local economy. Operating: The operation of intake pumps and U-BCF will increase the numbers of Hai Phong Water staff.
	17	Land use and utilization of local resources	B+	B+	U-Const: There are many concrete manufacturing factories producing construction materials in the local area. Thus, it is expected that the procurement of the construction materials may have positive impact on utilization of local resources. Operating: The granular active carbon used for UBCF filter is produced in the local area.
	18	Water use	D	B+	U-Const: The project does not conduct new water source development of the river but only sets up pre-treatment facility to the existing and operating WTP. Thus, it does not influence existing water use of the river. In addition, as U-BCF system is connected to the existing and operating WTP after completion of U-BCF, water supply conditions of the existing WTP are not intermitted. Operating: For the existing WTP, NH4 and organic matter concentration of the intake river water is high and hazardous THM substance by disinfection with chlorine is expected to generate in large volumes. Due to the U-BCF installed by the Project, the NH4 concentration shall decrease. It is expected to have positive impacts on the living conditions of the residents. In addition, the operation of U-BCF system has not new water source development (new water use) so as to influence the existing water use of the river to be source for water supply.

Category	No.	Impact Items	Evaluation		Evaluation Reasons
			P-Const* U-Const*	Operating*	
Social Environment	19	Existing social infra and social service	B-	D	U-Const: Roads may be dirtied by tires of the construction vehicles with soils, and soils that fall from transporting equipment, materials and surplus soils. Operating: After completion of U-BCF, as the roads is covered by concrete or asphalt, they will not be dirtied by vehicle tires.
	20	Social organization such as social capitals and local authority	D	D	Water supply system forms a part of social infrastructures. U-BCF for pre-treatment is operated and managed by Hai Phong Water.
	21	Bias distribution of damage and benefit	D	D	Construction sites for the Project are the existing intake pumping station and a part of the existing An Duong WTP. Residential houses surrounding the existing facilities may be adversely impacted by noise, etc. during short periods for construction works. However after the completion of the facility, it does not cause adverse impacts because the facility does not release bad odor. On the other hand, improvement of supply water quality will widely provide benefits to the residents. Thus, issues on bias distribution of damage and benefit will not be caused.
	22	Conflict of interests in the project area	D	D	In present conditions, conflicts of interests in the Project area not caused because water is appropriately supplied by a traditional treatment system and by operation of the existing WTP. The water supply condition in Hai Phong City is comparatively good. In the future, water users in other areas may request for similar advanced treatment facilities as the Project for other WTPs.
	23	Cultural heritage	D	D	At the Project sites and its periphery areas, there are no cultural heritages.
	24	Landscape	D	D	The new intake pumps are set in the existing intake pumping station and U-BCF is also constructed in the existing WTP. Other facilities with equal height of U-BCF are already constructed at the WTP. Thus, the implementation of the Project does not cause adverse impact to the landscape.
	25	Gender	D	D	The implementation of the Project does not have any impacts to the labor of domestic water drawing by women and children.
	26	Children's right	D	D	The Project aim is to improve the quality of supplying water and it is not related to children's rights.
	27	Infectious diseases of HIV/AIDS etc.	B-	D	U-Const: Inflow of laborers from outside of Hai Phong City may cause occasions to be exposed to infectious diseases such as HIV/AIDS. Operating: As officials who are in good health conditions shall conduct operation, the possibility of exposure to infectious diseases such as HIV/AIDS is expected to be low.
	28	Work environment (Including safety control)	B-	B-	U-Const: It is necessary to arrange work environment (including safety control) for construction workers. Operating: It will be necessary to pay attention for handling of pumps and blower.

Category	No.	Impact Items	Evaluation		Evaluation Reasons
			P-Const* U-Const*	Operating*	
Others	29	Accidents	B-	B-	U-Const: During the construction works are conducted at the existing intake pumping station and the existing WTP, traffic accidents by vehicles passing the in-plant roads and access gates of the WTP to ordinary roads may occur. In addition, as ADB-financed augmentation works are expected to be carried out in the same period, traffic and construction work accidents may occur. Operating: It is necessary arrange measures for handling equipment accidents. In addition, traffic accidents by passing ordinary roads and in-plant roads of transportation vehicles of activate carbon may occur.
	30	Trans-boundary impact and climate change	D	D	Adverse impact by implementation of the project is not expected.

(Note) P-Const*: Pre-construction stage, U-Const*: Under construction stage, Operating*: Operating stage.
A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progress.)
D: No impact is expected.

Source: JICA Study Team (Based on local survey)

1-3-1-6 TOR for Environmental and Social Consideration Survey

Based on the scoping results of environmental and social consideration survey, the TOR for environmental and social consideration survey was finalized as shown in Table 1-3-10.

Table 1-3-10 TOR for Environmental and Social Consideration Survey

Environmental Item	Survey Item	Survey method
Air Pollution	① Confirmation of environmental standards	① Collection and review of existing information
Water Pollution	① Confirmation of environmental standards	① Collection and review of existing information
Waste	① Disposal manners of construction waste	① Interviews to relating authorities ② Information collection on disposal criteria, location of disposal site, disposal site owner, land area, disposal fee, permission for disposal, etc.
Soil Contamination	① Protection manners of oil spills during construction stage	① Reviewing of protection method
Noise and Vibration	① Confirmation of environmental standards ② Construction method	① Collection and review of existing information ② Confirmation of application or not of piling method
Existing Social Infrastructure and Social Service	① Confirmation of current status of existing social infrastructures and social services at surrounding construction sites	① Confirmation by site inspection and aerial photos
Infectious diseases of HIV/AIDS etc.	① Protection countermeasures of infectious diseases as HIV/AIDS etc. caused by the inflow of construction workers	① Reviewing of protection method
Labour Environment (Including work safety)	① Survey on work safety laws and regulations	① Control agencies regarding work safety, and regulations, etc.
Accidents	① Survey on accident countermeasures for construction and operation stages	① Survey on work safety laws and regulations
Impacts to Trans-boundary and Climate Change	① Survey on releasing amount of CO_2 gas to the atmosphere	① Investigation of emission amount of CO_2 gas to the atmosphere by consumption of commercial electricity by operation of intake pumps and blower

Source: JICA Study Team (Based on local survey)

1-3-1-7 Survey Results of Environmental and Social Consideration (Including Predicted Results)

(1) Environmental Pollution Control

1) Pollution of Ambient Air

The 4 new intake pumps for the intake pumping station and 2 blowers for the U-BCF of An Duong WTP which are to be installed are to be operated by commercial electricity, which has small possibilities of electric power failure. Hence the pollution of ambient air will not be an issue.

Air pollution by the emission gas from pilling machines, bulldozers and transportation vehicles for construction materials may be caused. The contractor shall keep the air pollution at a minimum level by maintaining machines in good conditions and by using quality fuels and new machines as much as possible.

In addition, generation of grit and dust is expected when construction machines are operated at the construction site. The contractor shall spray water to prevent the grit and dust.

2) Treatment of Discharged Water

For the operation of the pre-treatment U-BCF system which is set in An Duong WTP, microscopic organism propagates in the filters of activated carbon, the supporting layers of sand and gravel, and bottom elements. As head loss rises by water flow, constant backwashing is required. Backwashing is done by using air and water, therefore discharged water shall generate. The discharged water is drained to the existing sun drying beds to evaporate, and the residual water in the beds is returned to pre-sedimentation basin. Since this is a closed system which circulates in the WTP, it shall not cause environmental pollution problems by discharged water.

However at the construction stage, small amounts of drainage water from construction sites may leak outside of the WTP. As the drainage water is discharged through side ditches inside of the WTP, it will need to keep the drainage water clear of wastes so as not to clog the side ditches by construction debris, soil, and wastes. In addition, in case the drain water includes siltation, it will be necessary for the drainage water to be settled for a certain amount of time in a small pond.

3) Disposal of Construction Debris and Wastes

Waste collection and disposal in Hai Phong city are carried out exclusively by Hai Phong Urban Environment Company (HPUECo). This company was established in 1976, employs 1,300 workers and its supervising agency is the Department of Construction.

HPUECo owns 39 refuse trucks and collects general wastes in the 4 districts of Hong Bang, Ngo Quyen, Le Chan, Hai An, and the waste is disposed to the company-owned Trang Cat general waste landfill along the Lach Tray River in Hai An District. Waste segregation for degradable and non-degradable is not applied for waste collection. Construction debris is disposed at Dinh Vu landfill, which is also owned by the company.

During the construction period of the Project, construction debris is generated by removal of concrete such as the pre-sedimentation pond, and installation of the access gate for transportation vehicles which shall require removal of concrete walls on the premise of the WTP. General wastes during construction will also occur. Said construction debris and general waste of the construction stage of the Project shall be disposed at Dinh Vu landfill and Trang Cat general waste landfill by entrusting to HPUECo. In

addition, the company can dispose waste oil and grease up to 2 tons/day. Details of Trang Cat general waste landfill and Dinh Vu landfill are shown below, and locations are shown in Figure 1-3-11.

Trang Cat General Waste Disposal Landfill

Management entity：Hai Phong Urban Environmental Company
Location：Hai An District
Land area：40 ha（29ha closed. At present,11 ha operating）
Commencement year of operation：1998
Current service waste amount：400 tons/day

Dinh Vu Construction Debris Disposal Landfill

Management entity：Hai Phong Urban Environmental Company
Location：Hai An District
Land area：19.6 ha (14.5 ha closed. At present, 5.1 ha operating)
Commencement year of operation：2007
Current service waste amount：depending and differing by demands, periods and cases

However, HPUECo has no specific plans for the operation periods of landfills. Therefore when the landfill becomes full, the company will close it and construct new landfill.

Figure 1-3-11 Locations of Trang Cat General Waste Landfill and Dinh Vu Construction Debris Landfill Owned by Hai Phong Urban Environment Company

Source: JICA Study Team (Based on local survey)

4) Disposal of Sludge from the Existing An Duong WTP

Amount of sludge generated in the backwashing process of U-BCF: ADB loan project estimates the generated sludge amount to be about 5,900 kg/day from ordinary WTP which does not include U-BCF (Treated capacity 200,000 m^3/day). On the other hand, the Project estimates the sludge generation to be about 3.1 kg/day. This backwashing sludge shall be disposed with sludge generated from the existing WTP in compliance with the regulations of Viet Nam country.

The sludge from the existing An Duong WTP is presently planned to be disposed at the landfills owned by HPUECo, or the reclaimed areas of WTPs to be under construction and/or to be planned. Table 1-3-11 shows the disposal sites (including planned sites) of sludge from the existing An Duong WTP and Figure 1-3-12 indicates the locations of the construction sites of planned WTPs as reclaimed areas.

Table 1-3-11 Proposed Disposal Sites (Including Planned Sites) as Reclamation Areas of Sludge from Existing An Duong WTP

No.	WTP	Construction Year (Planned)	Construction Fund	Treatment Volume	Current Status of Sludge Disposal
1.	Vat Cach WTP	2012 - 2014	Hai Phong Water	20,000 m^3/day	Currently disposed in site under construction.
2.	Hung Dao WTP	2015 - 2017	ADB, Planned	25,000 m^3/day	Future plan
3.	Ngu Lao WTP	2018 - ?	ADB, Planned	25,000 m^3/day	Future plan
4.	Kim Son WTP	2018 - ?	ADB, Planned	25,000 m^3/day	Future plan

(Note) According to Hai Phong Water, sludge is disposed to landfills which owns by HPUECo. and/or reclaimed sites of WTPs which are under construction and are planned in the future.

Source: Hai Phong Water

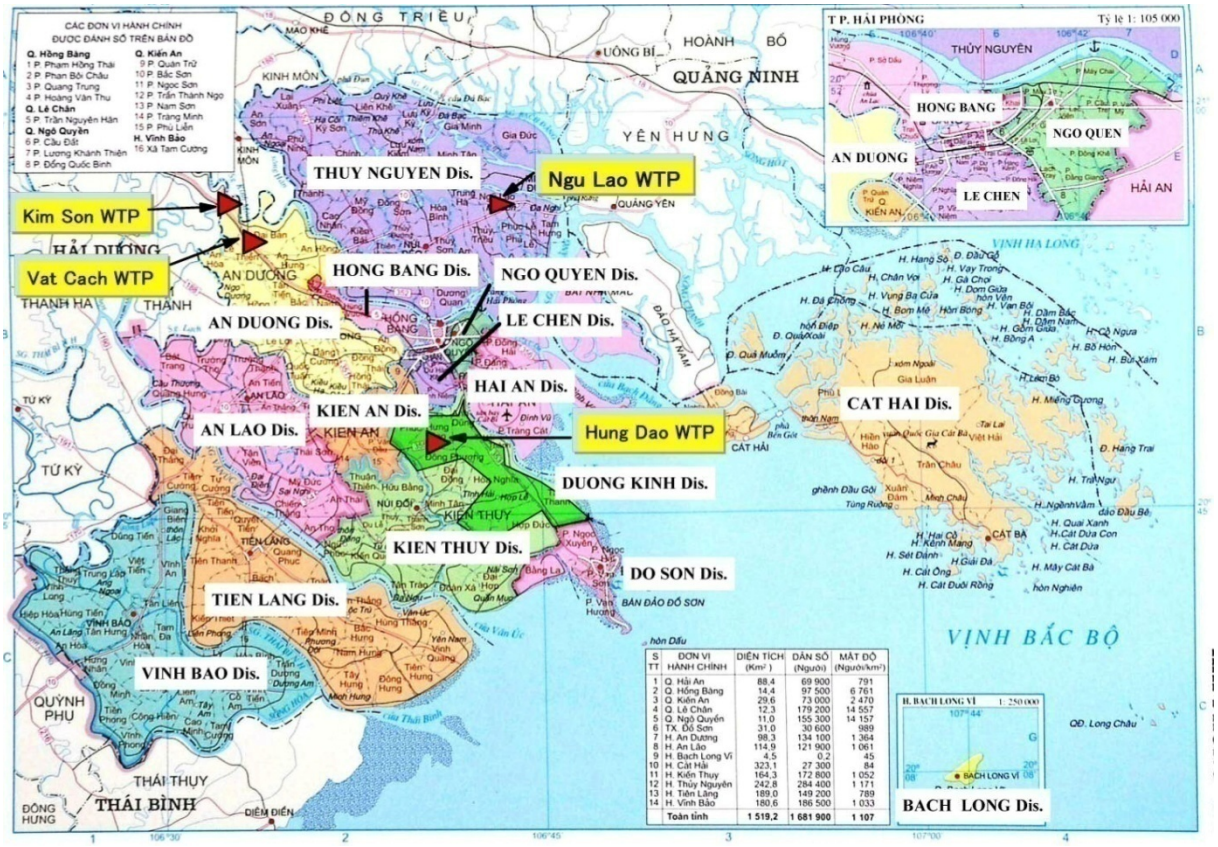


Figure 1-3-12 Locations of Disposal Sites of Sludge from the Existing An Duong WTP (Including Proposal Sites)

(Proposal sites for disposal are reclaimed by Vat Cach, Hung Dao, Ngu Lao, Kim Son WTPs.)

Source: Hai Phong Water

5) Soil Contamination

The pre-treatment U-BCF is to be constructed near the pre-sedimentation pond of the existing WTP where the raw water flows into, and installation works for new booster pumps are conducted in the existing intake pumping station. Therefore, fuel and oil leakage accidents caused by construction machines and vehicles may have large impacts on the treated water, along with soil contamination at construction sites. The contractor must pay attention not to cause leakage accidents at the construction sites. Stock yards for construction machines shall be made and the parking places are to be apart from the construction sites, and the contractor shall clean the surroundings so not as to cause pollution. If soil contamination is caused, the contractor must remove all the contaminated soil and dispose it in safe disposal sites.

In addition, when transportation vehicles with tires dirtied by soils of construction sites run on the general roads, the roads may become dirty by the tires and the soil that falls from the vehicles. The contractor must wash tires to not pollute general roads and also, shall always clean the roads.

For the operation stage, the bases inside the WTP, garages and mechanical rooms are to be covered by concrete pavement; hence soil contamination by fuel and oil shall not occur.

6) Noise and Vibration

The U-BCF is to be constructed at the reclaiming corner of the pre-sedimentation basin located in the southwest side of An Duong WTP. In the line of construction of U-BCF, 3 intake pumps and a standby pump in Quan Vinh intake pumping station, and 1 blower and a standby blower to clean the U-BCF filter are planned to be installed. For the U-BCF, equipment which generates noise is only the intake pumps and blower as shown below.

Table 1-3-12 Equipment Set up at Intake Pumping Station and U-BCF

No.	Equipment	Unit	kW	Noise Level at Noise Source	Setting Purpose
1	Intake pumps	3units: duty 1unit: standby	160 kW/unit	80 dB	To directly transmit raw water to U-BCF.
2.	Blower	1 unit: duty 1 unit: standby	37 kW/unit	90 dB	To clean the filter of U-BCF.

Source: JICA Study Team (Based on local survey)

At the surrounding areas of An Duong WTP and Quan Vinh intake pumping station, residential houses are densely distributed. Since high noise levels may become a large social problem, noise levels are planned to be decreased by setting the intake pumps and the blower in an inside room, vibration protection mounts at the bases of pumps and motors, and especially in the existing room for intake pumps, putting acoustic boards on walls and ceilings, and closing the windows by acoustic boards. Furthermore, the blower which shall especially generate large noise is designed to attach a silencer in order to reduce the noise level. By these countermeasures, at outside locations close to the noise sources,

the noise level of intake pumps and the blower is expected to become 60 dB.

Table 1-3-13 National Noise Standards（QCVN26: 2010/BTNMT）

No.	Area	Maximum allowable limit for noise level (dB)	
		From 6 a.m. to 9 p.m.	From 9p.m. to 6 a.m.
1.	Particular area (medical/health care center, library, kindergarten, school, pagoda, and other restricted areas）	55 dB	45 dB
2.	Common area (apartment block, guesthouse, hotel , office, separated and adjacent houses)	70 dB	55 dB

Source: National Noise Standards, QCVN26: 2010/BTNMT, (February 15, 2011)

An Duong temple and schools are specified as special limited areas in National Noise Standards in the surrounding area of An Duong WTP. Noise regulation for these particular areas is especially strict with 45 dB in the night time. After completion of U-BCF, noise level generated by the operation of the equipment will not cause noise problems against said temple and schools due to the attenuation of sound level by the distance from noise source.

The straight distance from the blower installed at U-BCF to; An Duong temple is 280 m, the school is 500 m, and the nearest houses located in the south west direction of U-BCF is 60 m. If the noise level at the houses is within the range of National Noise Standards, the noise level at An Duong temple and the school is estimated to be lower than that of the houses by attenuation of distance of sound level and therefore noise problems shall not emerge. The noise level of the houses located south west of U-BCF was estimated by noise equipment and calculation. The estimated noise levels considering the attenuation by the distance from noise source are shown below.

Noise Calculation Equation

- Noise calculation equation: $L2 = L1 - 20 \log_{10} (d2/d1)$, L2: Noise level in prediction distance (dB), L1: Noise level in standard distance (dB), d2: Prediction distance, d1: Standard distance near a point sound level
- Combined sound levels in case of overlapping sounds: $L\ (dB) = 10 \log_{10} (10^{L1/10} + 10^{L2/10} +$ ----------), L(dB): Combined noise level, Li (dB): Noise level by each sound source

Calculated noise level of the nearest residential houses from U-BCF

Distance of blower to the nearest residential houses: approximately 60 m

As measures to decrease the noise level, a blower is set in the inside the room, along with the attachment of a silencer. The noise level is expected to be 60 dB at the noise source.

In this case, the noise level attenuated by the distance from the blower to the nearest residential house is

calculated. By noise calculation equation, the noise level of the blower at the nearest residential house is 24 dB, which is below the regulated 55 dB during the night time at residential area, based on National Noise Standards (QCVN26: 2010/BTNMT） and thus, noise issues shall not occur. Since the nearest houses to blower is located in the south west corner of the WTP, the noise level at An Duong temple and schools which are located in further places compared with the houses is estimated to be very low. Noise issues of said places shall not occur.

However, noise levels at the nearest residential houses in case the doors and windows are open during operating of equipment is 54 dB according to the calculation, and as this is close to the maximum limit of 55 dB regulated for the night time, it is recommended that the blower is operated with the doors and windows closed, and with the attachment of a silencer.

Calculated noise level at the nearest residential house from intake pumping station
Distance from intake pumping station to the nearest residential houses: approximately 10 m

The noise level attenuated by distance from the intake pumps to the nearest residential house is calculated in this situation.

To decrease the noise level, the existing rooms of intake pumping station is renovated to reduce noise caused by vibration, by setting a vibration protection mount in bases of pumps and motors and by closing up acoustic boards on walls, ceilings and windows. As a noise reduction countermeasure, it is necessary to set ventilating apparatus in the river side. By this, the original noise level of 90 dB caused by an intake pump is expected to be maintained at 60 dB.

By substituting the noise level of 60 dB in case of noise reduction countermeasure and the distance of 10 m from intake pumping station to the nearest residential house into the noise calculation equation, the anticipated noise level is calculated. The calculated result shows that the noise level caused by one intake pump is L = 40 dB. Furthermore, for simultaneously operating 3 intake pumps, the combined noise level is calculated to be L (dB) = 44.8 dB. Thus, the calculated noise level is within 55 dB of Noise Standards and noise problems are not expected.

However, this is the case that the windows and doors of the intake pumping station are closed. If not closed, the noise level of one intake pump is 60 dB and the combined noise level reaches L (dB) = 64.7 dB. As this noise level exceeds the regulated 55 dB for the night time, intake pumps shall be required to be operated with the windows and doors of intake pumping station closed in the night time.

Noise problems during the construction stage shall especially require careful attention for high density areas of residential houses at the surrounding area of intake pumping station and the installation location of U-BCF in An Duong WTP. Possible noise sources are; pilling machines to construct the support base

of U-BCF, concrete pumping vehicles, cement mixer trucks, transportation vehicles of construction materials, bulldozers and compactors etc. for the construction works. Of these machines, the pilling machines are expected to especially cause noise problems. Therefore, it shall be recommended to use low-vibration and noise-reduction type pilling machines. In residential areas, as noise regulation in the night time is a very strict 55 dB, construction works shall be also recommended not to conduct in the night time and to end the works by 9 p.m. In addition, for the daytime works, as the maximum allowable noise limit value is 70 dB, small types of construction machines with lower noise levels are planned to be used.

Regarding the vibration of intake pumps and blower in the operation stage after completion of the facilities, no problems shall be caused for the machines itself are designed so as to prevent vibrations.

(2) Social Consideration Conditions

1) Impact to Existing Social Infrastructure and Social Service

The surrounding areas of An Duong WTP are condensed zones of residential houses and commercial stores. The U-BCF is to be constructed not along a main road of the north side of the WTP, but in the reclamation land which is a part of the pre-sedimentation pond. Access roads to the construction site is planned to be connected to a tributary road by constructing an access gate along the surrounding walls in the south west of the WTP. As this tributary road is not the main road, traffic is light. However, as residential houses at the side of the tributary road are located in the concentrated zones, the contractor must pay sufficient attention to the access of construction vehicles. During the construction time, plural security guards shall be allocated.

As Quan Vinh intake pumping station directly faces a local road with width of 10 m, traffic amount in the morning and the evening tends to increase. In the similar style to An Duong WTP, plural security guards at the access gate of the pumping station shall be allocated to control the traffic.

2) Infectious Diseases (HIV/AIDS etc.)

During the construction, general workers of the sub-contractors will enter the area from outside cities. Therefore, the possibility of exposure to infectious diseases such as HIV and AIDS etc. may increase. Construction supervisors of the contractors are required to enhance the awareness of workers to prevent infection of said diseases by providing notice on sanitary conditions at morning assemblies and meetings.

3) Labour Safety

It is to be made compulsory for all workers to wear safety shoes and helmets, and to set “authorized person only” signboards at dangerous places to maintain the safety of construction workers during both the construction and operation stages of the Project. In regulations, “Labour Code 2012” was enacted and further regulations to protect the safety of labourers were arranged. The new Labour Code

(No.10/2012/QH13) was adopted by the National Assembly in June 18, 2012 and took effective in May 1, 2014. According to the Labour Code, the conditions of employment and labour regulations are the same level as advanced countries. Especially during the construction stage, the contractor must respect the code.

① Obligation of periodical health check-ups at least once every 6 months for the employees who undertake works in heavy and harmful conditions, including young workers (under 18 years old) and elderly employees (over 60 years old for males and 55 years old for females)
② Female employees are entitled to 6 months of prenatal and postnatal leave.
③ Dismissal shall be applied in the following circumstances: an employee commits an act of theft, embezzlement, gambling, intentionally causing injury, using illicit drugs at the workplace, disclosing technological or business secrets or infringing the intellectual property rights of the employer, or commits acts which are seriously detrimental or posing seriously detrimental threats to the assets or interests of the employer.
④ Labour dispatch enterprise recruits are permitted in 17 job categories. Within the job categories, there are workers of operation, maintenance and repair of construction machines, security guards, and drivers etc.
⑤ Dialogue at the workplace is carried out periodically once every 3 months or at the request of employees and/or employer. Employer must hold an employee conference at least once 12 months and has the obligation to report the records to the People's committee every year. In case of a violation of this law, a fine of 20,000,000 to 30,000,000 VND may be levied.
⑥ Part-time workers also may forms labour unions. The trade union official shall be entitled to use his or her working hours to undertake trade union activities and is to be remunerated by the employer.

Furthermore, the Ministry of Labour, Invalid, and Social Affair of the Central Government, Division Labour Safety distributes a book titled "Safety Management System." This book concretely explains the safety management system with drawings which the contractor is recommended to refer.

The agency which controls labour safety is the Department of Labour, Invalid, and Social Affair of Hai Phong City People's Committee. The department monitors whether labour safety regulations are respected or not. Thus, the project owner shall submit a project report 6 months prior to the commencement of the Project. The department has 10 inspectors to regularly visit construction sites or conduct inspections at least once a year. Furthermore, the Project owner must submit reports on the compliance of labour laws twice a year.

(3) Others

1) Generation of Traffic Congestion by Construction Works

Since the gateway from construction site of An Duong WTP to ordinary roads is not connected to a main road but to a tributary road along the walls located south west of the WTP, heavy traffic congestion shall

not be caused by construction works. In addition, the Quan Vinh intake pumping station directly faces an ordinary road. Therefore, plural security guards with safety indications at both sites are allocated in order to control the traffic.

2) Impact to Environmental Issues in Global Scale

The Project purpose is to renew intake pumps of the existing Quan Vinh intake pumping station and to construct a pre-treatment U-BCF at the existing An Duong WTP. The additional electricity consumption for Project implementation is expected as 120.8KWh, and the indirect release bicarbonate gas corresponding to the electric charge is expected. However, implementation of the Project shall not have direct influence on Climate Change.

The electricity consumption as a result of this Project is expected to be 120.8KWh. The released bicarbonate gas is estimated as 46.6 CO_2 ton/month, approximately 559.4 CO_2 ton/year.
(Note: Released bicarbonate gas amount is estimated by referring to "appendix table CO_2 emission coefficient of grid electric power of each country (Viet Nam 0.536 t CO_2 e/MWh) of IPCC Guidelines for National Greenhouse Gas Inventories in 2006.")

Table 1-3-14 Power Consumption of Planned Water Supply Facilities

No	Equipment	Motor (KW)	Quantity	Total KW	Operating hour/day	KW/day	KWh
Setting equipment for pre-treatment U-BCF							
1	Intake pump	40 KW/unit	3 (operating)	120	24 hrs/day	2,880 KW	120 KWh
2	Blower	37 KW/unit	1 (operating)	37	0.5 hrs/day	18.5 KW	0.8 KWh
Total						2,898.5 KW	120.8 KWh

(Notice) As a blower is intermittently operating, daily power consumption was calculated by daily based average one converted from weekly based operating hours.

Source: JICA Study Team (Based on local survey)

1-3-1-8 Environmental Impact Assessment

The result of environmental impact assessment is shown in Table 1-3-15.

Table 1-3-15 Result of Environmental Impact Assessment

Category	No	Impact Items	Impact Assessment at Scoping time		Impact Assessment Based on Survey Results		Reasons
			Before Const. During Const.	Operating	Before Const. During Const.	Operating	
Pollution Countermeasure	1	Air pollution	B-	D	B-	D	U-Const: Air pollution by incomplete combustion of fuel of construction machines is anticipated to generate. In addition, fog and dust by operation of construction machines generate. Operating: Degradation of air quality will not be caused because pumps and blower are generally operated by commercialized electric power.
	2	Water pollution	B-	D	B-	D	U-Const: Although large amounts of turbidity water will not generate, water leaks through side ditches may occur. However, water pollution may be caused by drainage water from construction sites, construction machineries and vehicles. For the discharge to side ditches at the WTP, it will be necessary to be careful to not clog the side ditches by soil and waste discharge. But as there is no land creation, there is no large scale of soil discharge. In addition, the amount of drain water which may have adverse impacts to the downstream of the drained river is small therefore it shall not cause water pollution. Operating: Although backwashing water used to clean the U-BCF filter is discharged, the discharged water is drained to sun drying bed and after evaporation, residual liquid from the sun drying bed returns to the pre-sedimentation pond as raw water again. Thus, as the discharged water circulars and is not drained to the outside of the WTP, adverse impact is not expected.
	3	Waste	B-	B-	B-	B-	U-Const: Construction debris is generated by removing portions of the concrete dike of the pre-sedimentation pond and concrete walls to make the access gate for vehicles. In addition, general wastes will be caused by workers at construction sites. Operating: Sludge is generated by operation of U-BCF.
	4	Soil contamination	B-	D	B-	D	U-Const: Soil contamination by oil spill from construction machines may occur. Roads may also be dirtied by tires of construction vehicles with adherent soils, and the soils that fall from vehicles transporting equipment, materials and surplus soils. Operating: As in-plant roads and the bases of parking area and machinery rooms are covered by concrete and asphalt, soil contamination by leakage of fuel and oil shall not occur.

Category	No	Impact Items	Impact Assessment at Scoping time		Impact Assessment Based on Survey Results		Reasons
			Before Const. During Const.	Operating	Before Const. During Const.	Operating	
Pollution Countermeasure	5	Noise・vibration	B-	B-	B-	D	U-Const: As residential houses are located near the construction sites, noise and vibration due to construction works, operation of construction heavy machines and vehicles are expected. Operating: As noise insulation measures at the pump room of the intake pumping station and blower room of the WTP are conducted and silencer is set to the blower, noise issues should not occur if windows and doors at operation time are closed, according to the estimation by noise calculation equation.
	6	Land subsidence	D	D	D	D	Construction works which cause land subsidence is not planned.
	7	Bad odor	D	D	D	D	Operating: Facilities which cause bad odor are not expected.
	8	Bottom sediment	D	D	D	D	U-Const: Since the Project has a purpose to renew intake pumps in the existing intake pumping station and to construct a small scale U-BCF at existing An Duong WTP, adverse impact to bottom sediment is not expected.
Natural Environment	9	Protection area	D	D	D	D	The Project sites are located in the existing Quan Vinh intake pumping station and An Duong WTP. Since there are no protection areas around the Project area, construction works has no influence the protection area.
	10	Ecosystem	D	D	D	D	The Project sites are located at the existing intake pumping station and the WTP. As they have no vacant area consisting of trees, adverse impact to ecosystem is not expected.
	11	Hydrology	D	D	D	D	Since the Project purpose is to renew intake pumps in the existing intake pumping station and to construct U-BCF in the existing WTP, the Project does not develop new water sources and does not expand the WTP. Therefore, no adverse impact to hydrology shall be caused.
	12	Topography /geology	D	D	D	D	As the Project purpose is only to renew intake pumps in the existing intake pumping station and to construct a small scale U-BCF in the existing An Duong WTP located in flat topography, it has no adverse impact to topography and geology.
Social Environment	13	Resettlement	D	D	D	D	As the Project sites are located in the existing intake pumping station and the existing An Duong WTP, resettlement is not caused.

Category	No	Impact Items	Impact Assessment at Scoping time		Impact Assessment Based on Survey Results		Reasons
			Before Const. During Const.	Operating	Before Const. During Const.	Operating	
Social Environment	14	Poverty group	D	D	D	D	The Project aims to set up a pre-treatment U-BCF facility to remove NH_4, etc. and to improve the quality of supply water. In the surrounding areas of proposed construction sites, residential houses and commercial stores are distributed and there are no poverty areas such as slums. Since the improvement of supply water quality targets all the people in the area, it will have a positive impact to the people living in the supplying zone.
	15	Ethnic minorities and indigenous people	D	D	D	D	In Hai Phong City area, the majority Kinh tribe and the minority Hoa tribe (population: 1,000) whom belong to Chinese party are living. The Hoa are living as workers employed by Chinese and they are not living in special limited areas, but in mixed with the Kinh. Therefore, the improvement of supply water quality of the Project benefits equally to the minority tribe.
	16	Local economy of employment and livelihood	B+	B+	B+	B＋	U-Const: the employment of construction workers and consumption of construction materials may have a positive impact to local employment conditions and local economy. Operating: the operation of intake pumps and U-BCF will increase the numbers of Hai Phong Water's staff.
	17	Land use and utilization of local resources	B+	B+	B+	B+	U-Const: There are many concrete manufacturing factories providing construction material in the local area. It is expected that the procurement of the construction materials will have positive impacts on utilization of local resources. Operating: The granular active carbon used as U-BCF filter is procured in the local area.
	18	Water use	D	B+	D	B+	U-Const: Not a large amount of turbid water is expected to leak or to be drained outside of the WTP and therefore shall not influence water use in the Project area. Operating: In the existing WTP, NH_4 concentration of intake river water is high and hazardous THM substance caused by chlorine disinfection is expected to generate in large volumes. Due to U-BCF implementation of the Project, the NH_4 concentration in the treated water shall decrease. Hence, positive impact to living conditions of residents is expected.
	19	Existing social infrastructure and social service	B-	D	B-	D	U-Const: Roads may be dirtied by tires of construction vehicles with adherent soils, and the soils that fall from vehicles transporting equipment, materials and surplus soils. Operating: After completion of U-BCF, as the inside roads are covered by concrete or asphalt, they shall not be dirtied by soiled vehicle tires.

Category	No	Impact Items	Impact Assessment at Scoping time		Impact Assessment Based on Survey Results		Reasons
			Before Const. During Const.	Operating	Before Const. During Const.	Operating	
Social Environment	20	Social organization such as social capital and local authority	D	D	D	D	Water supply system forms a part of the social infrastructure. U-BCF for pre-treatment is operated and managed by Hai Phong Water.
	21	Bias distribution of damage and benefit	D	D	D	D	Project construction sites are located in the existing intake pumping station and a part of the existing An Duong WTP, and residential houses surrounding the existing facilities may be adversely impacted by noise, etc. during short periods for construction works. However, after completion of the facility, it does not cause adverse impacts because the facility does not release bad odor. On the other hand, improvement of supply water quality will widely provide benefits to the citizens. Thus, issues on bias distribution of damage and benefit will not be caused.
	22	Conflict of interest in the Project area	D	D	D	D	In present conditions, the conflict of interests in Project area do not occur because water is appropriately supplied by the traditional treatment system and operation of the existing WTP, and water supply conditions in Hai Phong City is comparatively good. However in the future, water users may request for advanced treatment facility as the Project facility at other WTP supplying zones.
	23	Cultural heritage	D	D	D	D	In the Project sites and its periphery area exist no cultural heritages.
	24	Landscape	D	D	D	D	The new intake pumps are set in the existing intake pumping station and the U-BCF is constructed in the existing WTP. Other facilities with an equal height of U-BCF are built in the existing WTP. Hence, the implementation of the Project does not cause adverse impact to landscape.
	25	Gender	D	D	D	D	The implementation of the Project does not have any impacts to the labor of domestic water drawing by women and children.
	26	Children's right	D	D	D	D	The Project purpose is to improve supply water quality and is not related to children's rights.
	27	Infectious diseases of HIV/AIDS etc.	B-	D	B-	D	U-Const: Inflow of laborers from outside of Hai Phong City may cause occasions to be exposed to infectious diseases such as HIV/AIDS. Operating: As officials who are in good health conditions shall conduct operation, the possibility of exposure to infectious diseases such as HIV/AIDS is expected to be low.
	28	Work environment (Including safety control)	B-	B-	B-	B-	U-Const: It is necessary to arrange work environment (including safety control) for construction workers. Operating: It will be necessary to pay attention for handling of pumps and blower.

Category	No	Impact Items	Impact Assessment at Scoping time		Impact Assessment Based on Survey Results		Reasons
			Before Const. During Const.	Operating	Before Const. During Const.	Operating	
Others	29	Accidents	B-	B-	B-	B-	U-Const: During the construction works are conducted at the existing intake pumping station and the existing WTP, traffic accidents by vehicles passing the in-plant roads and access gates of the WTP to ordinary roads may occur. In addition, as ADB-financed augmentation works are expected to be carried out in the same period, traffic and construction work accidents may occur. Operating: It is necessary arrange measures for handling equipment accidents. In addition, traffic accidents by passing ordinary roads and in-plant roads of transportation vehicles of activate carbon may occur.
	30	Trans-boundary impact and climate change	D	D	D	D	There is no adverse trans-boundary impact. Climate change: Although the operation of U-BCF consumes commercial electric power which signifies that the bicarbonate generated to the environment by the electric company will increase according to electrical charge, there is no direct impact to climate change by the implementation of the Project.

(Note) P-Const*: Pre-construction stage, U-Const*: Under construction stage, Operating*: Operating stage.
A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-:Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progress.)
D: No impact is expected.

Source: JICA Study Team (Based on local survey)

1-3-1-9 Mitigation Measures

(1) Environmental Management Plan for Construction and Operation Stages

1) Environmental Management Plan for construction stage

Adverse impact and mitigation measures against environment during the construction stage are shown in Table 1-3-16.

Table 1-3-16 Environmental Management Plan for Construction Stage

No	Impact Items	Adverse Impact	Mitigation Measures	Responsible and Supervising Organizations on implementation of mitigation measures	Cost defrayer and Implementation cost
1.	Air pollution	Temporary air pollution by operating construction machines	The contractor shall use new construction machines instead of secondhand ones as much as possible and arranges engines and emission system in good conditions and keeps emission gas in clean condition.	Responsible organization: Contractor, Supervising organization: Consultant, Hai Phong Water, Le Chan district	Cost defrayer: contractor, Implementation cost is included in construction cost.
		Fog and dust during construction works	To prevent fog and dust caused by construction works, water shall be sprayed before or/and during works.	Ditto	Ditto
2.	Water pollution	Clogging of the WTP side ditches due to soil and wastes, including discharged water from construction works	Carefully observe the drainages and remove soil and wastes. If the discharged siltation amount is large, discharge water should be stored in a sedimentation pond for a certain period and afterwards, the supernatant water is to be drained.	Ditto	Ditto
3.	Waste	Dumping of construction debris and waste treatment of general wastes at construction sites	Surroundings of the construction areas must always be kept clean. Construction debris is disposed to designated landfills owned by HPUECo. General wastes are disposed in disposal bins to be segregated as oil, general wastes, and hazardous wastes.	Ditto	Ditto
4.	Soil contamination	Soil Contamination and pollution of discharged water by oil and grease and fuel	Avoid placing construction machines near flowing and drainage channels. Safe disposal and storage of grease etc. Keep storage sites of clear of construction machines, and to avoid environmental pollution by spill of fuel and oil.	Ditto	Ditto
		Roads dirtied by tires with wet soils, and fallen objects from vehicles used for transportation of equipment and materials and surplus excavation soils	The contractor must create a system to collect objects dropped by transportation vehicles for construction, and also inspect the roads at least twice per day for any hazardous materials which may disturb traffic. Furthermore, the contractor should clean the tires of transportation vehicles so as not to soil roads by dirty tires with wetted soils and conduct the cleaning of the dirty parts of roads.	Ditto	Ditto

No	Impact Items	Adverse Impact	Mitigation Measures	Responsible and Supervising Organizations on implementation of mitigation measures	Cost defrayer and Implementation cost
5.	Noise / vibration	Noise and vibration at construction period	The planned construction sites are in the existing intake pumping station and An Duong WTP, which are surrounded by residential houses. Thus, special attention shall be required for noise generation Noise levels are regulated in National Technical Standards. Especially, the maximum limit value for residential areas in the night time is lower than 55 dB and in particular areas such as schools and temples is 45 dB. Hence, the construction works shall be conducted in the daytime. In addition, it is very important to prevent the generation of high noise levels and vibrations by using the small or medium type excavating machines and equipment with silencers. In the Project, pilling machines to construct support basis for U-BCF are planned to be used. Noise protection type machines should be used.	Ditto	Ditto
6.	Infectious diseases such as HIV/AIDS etc.	Infectious diseases such as HIV/AIDS	As inflowing of construction workers may increase the emergency risks of infectious diseases of HIV/AIDS etc, contractor's construction site supervisor shall promote awareness through morning meetings.	Ditto	Ditto
7.	Work environment (Including safety control)	Safety control of construction workers	The contractor must record working hours, conduct medical checkups for employees and submit the compliance report of labour code as regulated in “Labour Code, 2012” to the Department of Labour, Invalid, and Social Affairs of Hai Phong City People’s Committee. In addition, any worker / personnel to enter the construction sites must wear safety shoes and helmets. The contractor’s site manager must conduct morning assembly every day by gathering all laborers and provide instructions on construction site safety control, and thoroughly conduct safety management of the sites. In the construction sites where heavy machines for construction are operated, entrance except concerned parties should be banned.	Responsible organization: Contractor, Supervising organization: Consultant, Hai Phong Water, Department of Labour, Invalid, and Social Affair under Hai Phong People's Committee	Ditto
8.	Accidents	Generation risk of traffic accidents at the entrance and exit gate and in-plant area of the existing An Duong WTP	As the construction works are conducted in an area of the existing WTP, fences and sign boards should be set up as to prevent entrance except construction workers. In the access gate for ordinary roads and passing roads of construction vehicles, more than one security guard shall be deployed to guide construction vehicles safely. The contractor shall enhance awareness of the construction machine and vehicle drivers for traffic safety. According to construction schedule of ADB project, the Project may conduct the construction works simultaneously at An Duong WTP. In that case, the contractor's supervisor shall sufficiently communicate with ADB contractor's supervisor and take countermeasures to prevent accidents.	Responsible organization: Contractor, Supervising organization: Consultant, Hai Phong Water, Le Chan district	Ditto

Source: JICA Study Team (Based on local survey)

2) Environmental Management Plan for Operation Stage

Environmental management plans for the operation stage are shown in Table 1-3-17.

Table 1-3-17 Environmental Management Plan for Operation Stage

No.	Impact Items	Adverse Impact	Mitigation Measures (Environment Management Plan)	Responsible and Supervising Organizations on implementation of mitigation measures	Cost defrayer and Implementation cost
1.	Noise/vibration	After completion of pre-treatment U-BCF facility, operation of intake pumps and a blower may cause noise problems.	Intake pumps and blower are set in the facility rooms. The blower particularly causes high noise levels, hence it is planned to attach a silencer for noise reduction. However, it is necessary to close doors and windows for prevention of noise leakage during operation. No vibration problems are expected due to vibration protection apparatus attached to the equipment itself.	Responsible organization: Contractor, Supervising organization: Consultant, Hai Phong Water, Le Chan district	Cost defrayer: Hai Phong Water, Implementation cost is included in O & M cost.
2.	Accidents	Labour accidents by handling of operation equipment may happen.	Installation of machines and equipment and trial operation should be conducted under experienced supervisors. If necessary, safety fences shall be installed. On the operation methods, operation manuals shall be prepared and machines are to be operated based on said manuals.	Ditto	Ditto
		Traffic accidents by passing of ordinary and in-plant roads for transportation of activated carbon may happen.	To enhance awareness of drivers to drive transportation vehicles carefully at the access gate to ordinary and in-plant roads. In addition, security guards to control traffic are employed.	Ditto	Ditto

Source: JICA Study Team (Based on local survey)

1-3-1-10 Mitigation Measures Cost (Approximate Estimate)

As shown in "1-3-1-9 Mitigation Measures", the cost for implementation of mitigation countermeasure is limited to the renewal of the intake pump room, the construction of blower room and the attachment of silencer. The total cost is JPY 41,308,000 as shown in Table 1-3-18.

Table 1-3-18 Cost for Implementation of Mitigation Countermeasure

No	Mitigation Countermeasure	Contents	Implementation Cost
1	Renovation cost of intake pump room	Intake pumps are set inside the room, and acoustic boards are put on walls, ceilings and windows.	JPY 21,000,000.-
2	Construction cost of blower room	Blowers are set inside the room.	JPY 20,208,000.-
3	Attachment of silencer to blowers	Silencers are attached to blowers.	JPY 100,000.-
Total			JPY 41,308,000.-

Source: JICA Study Team (Based on local survey)

1-3-1-11 Environmental Monitoring Plan

(1) Monitoring Plan

Adverse impacts and mitigation measures at construction and operation stages, and monitoring plans for environmental protection are shown in Table 1-3-19. Monitoring results should be recorded and saved by formatted documents.

Table 1-3-19 Monitoring Plan for Environmental Countermeasure at Construction / Operation Stages

No	Adverse Impact and Countermeasure	Monitoring Parameters	Monitoring Locations	Monitoring Methods	Frequency	Responsibility of Monitoring	Cost defrayer and Monitoring cost
Construction Stage							
1.	Temporal pollution of ambient air by operation of construction machines	Color and odor of emission gas from construction machines	All construction sites	Physical observation	During construction 1 time /day	Environmental management supervisor, Consultant, Hai Phong Water	Defrayer: Contractor, Monitoring cost is included in construction cost.
2.	Clogging of side ditches located in the intake pumping station and the WTP caused by soil and wastes including discharge water from construction sites	Clogging of side ditches located in the intake pumping station and the WTP	All construction sites	Physical observation	During construction 1 time /day	Ditto	Ditto
3.	Disposal of construction debris and general waste at construction sites	Safety and sanitary of dumping sites	Landfills of soil and general wastes	Physical observation	During construction 1 time /week	Ditto	Ditto
4.	Contamination of ground surface and discharged water by oil, grease, and fuel	Contamination of ground surface and discharged water by oil, grease, and fuel	All construction sites	Physical observation	During construction 1 time /week	Ditto	Ditto
5.	Noise and vibration*	Noise and vibration	All construction sites	Complaint by residents & actual measurement of noise level*	During construction 3 times/day	Ditto	Ditto
6.	Safety control of construction workers	Safety management rules and obligation of safety shoes and helmets	All construction sites	Physical observation	During construction 1 time/week	Ditto	Ditto
7.	Risk of accidents at access gate of construction vehicles at the in-plant area of An Duong WTP and intake pumping station.	Number of traffic accidents	Access gate to ordinary road, in-plant area of An Duong WTP and intake pumping station.	Reviewing accident reports and interviews on causes of accidents	During construction 2 times/week	Ditto	Ditto

No	Adverse Impact and Countermeasure	Monitoring Parameters	Monitoring Locations	Monitoring Methods	Frequency	Responsibility of Monitoring	Cost defrayer and Monitoring cost
8.	Fog and dust during construction works	Fog and dust	All construction sites	Physical observation	During construction 2 times / week	Ditto	Ditto
9.	Increase of risk of infection diseases of HIV/AIDS	Sanitary conditions including after toilet and before meals, washing hands with soap and dish cleaning	All construction sites	Physical observation	During construction	Ditto	Ditto
10.	Fallen objects and dirtied roads	Objects that fall to roads and dirtied roads by soiled tires of construction vehicles	All construction sites	Physical observation	During construction 2 times / week	Ditto	Ditto
Operating Stage after Completion of U-BCF							
1.	Risk of accidents by handling of operation equipment	Causes of accidents and generation number of accidents	Intake pumps and U-BCF	Reviewing accident reports and interviews on causes of accidents	During trial run	Ditto	Defrayer: Hai Phong Water. Monitoring cost is included in O & M cost.
2.	Risk of traffic accidents during traveling general roads and in-plant roads for vehicles of activated carbon.	Generation number of traffic accidents	Access gate to ordinary roads from An Duong WTP and its in-plant area.	Reviewing accident reports and interviews on causes of accidents	Operation stage	Hai Phong Water	Ditto
3.	Noise issues during operation time of equipment*	Ambient noise level and equivalent sound level during operation of equipment	Surrounding houses of An Duong WTP and Quan Vinh intake pumping station	Actual measurement of noise level*	3 times a day/every 3 months	Ditto	Ditto

Source: JICA Study Team (Based on local survey)

(Note) For the monitoring method of "5. Noise and vibration*," the actual measurement of noise level* is conducted by the following method:
The contractor shall measure equivalent sound level by using normal sound level meters at fixed time every three time a day at the nearest residential house' locations from the intake pumping station and the WTP. Site manager or his agent shall conduct actual measurement of noise level and he shall record the data to recording sheets and shall use measuring method which is designated in National Noise Standards (QCVN26/2010/BTNMT). In addition, before the commencement of construction works, the contractor shall measure background data as baseline ones during one day (24 hours), every two hour. The measuring points are shown below,

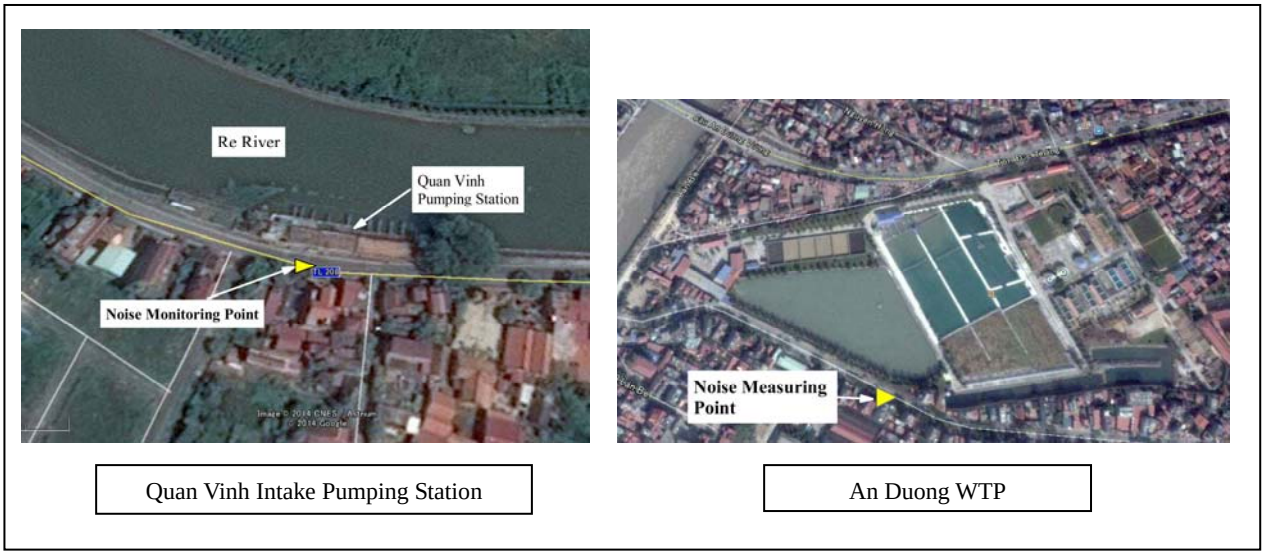


Figure 1-3-13 Actual Measuring Points of Noise Level

Source: JICA Study Team (Based on local survey)

(2) Monitoring Cost

The contractor shall employ one person as an environmental and safety management supervisor for environmental and safety control at construction sites of the planned water supply system. In the operating stage after completion of the planned facilities, there shall be hardly any environmental impacts and the Hai Phong Water staffs are to conduct monitoring works as routine works for environmental control including environmental audit.

At An Duong WTP, a total 3 security guards are planned to be always employed: two for the access gate to ordinary road from construction site and one for safety control of traffic and construction works. For the intake pumping station, as the station directly faces a local road and the area of the intake pumping station is very small, two security guards for renewal of intake pumps are allocated. The construction period of U-BCF is estimated as 16 months. On the other hand, the estimated construction period for installation of new intake pumps is 6 months. Table 1-3-20 shows the monitoring cost (estimation), which is estimated as JPY 2,615,000 for the construction stage.

Table 1-3-20 Monitoring Cost (Estimation) at Construction Stage

No.	Cost Item	Contents	Cost
1	Employment of environmental management supervisor	Contractor's employment cost for one environmental management supervisor to control environment for construction period. Construction period: 16 months	13,800,000 VND/month×16 months ＝220,800,000 VND
2	Security guard for control of traffic and safety management	Employment cost for two security guards to control traffic at access gate to ordinary road from An Duong WTP, and of one security guard for safety management supervising at in-plant and construction site. Construction period: 16 months Employment cost of two security guards to control traffic at access gate at intake pumping station. Construction period: 6 months	5,400,000 VND/month×16 months/person＝259,200,000 VND 5,400,000 VND×6 months ×2 persons = 64,800,000 VND
Total			544,800,000 VND
			JPY 2,615,040≒JPY 2,615,000

(Note) Above cost indicates net monitoring except VAT .

(Exchange rate) VND = JPY 0.00485 (JICA exchange rate: average rate of May - July 2014)

Source: JICA Study Team (Based on local survey)

1-3-1-12 Monitoring Implementation System

(1) Monitoring System at Construction Stage

The Project aims to renew intake pumps at the existing intake pumping station and to construct pre-treatment facility in the WTP; therefore there are no forest lands where important fauna and flora inhabit. Thus, the environmental management plan is made only for the fields of the safety of in-plant traffic of the WTP site during construction, the access gate for construction vehicles to ordinary roads from in-plant area, and inspection of discharge water from construction sites and waste disposal etc.

However, for the safety of in-plant traffic and the access of construction vehicles, an adequate supervising system is required to prevent traffic and construction accidents because the Project sites are surrounded by residential areas with high population density and comparatively heavy-traffic roads. Also, the construction works for the Project are to be carried out at the operating WTP and the construction works for the ADB Project are anticipated to be conducted at the same time in the same yard. At the construction sites, guard fences, signboards for "authorized personnel only" and night illumination lamps shall be set up. In addition, construction workers must wear safety shoes and helmets.

During the construction works, the contractor and consultant shall discuss safety management by holding safety countermeasure meetings at least once a week or on a required basis. Regarding the conduction of the ADB project construction works, the Project supervisor shall discuss safety management by holding regular meetings with the operational manager or the safety manager of the ADB project.

For complaint management regarding noise and other problems, the contractor and consultant shall notify the residential people of contact information such as Project name, construction schedule, the

person in charge of construction works, and the telephone number of the complaint control person by preparing a signboard at the access gate to ordinary road from the WTP during construction works. If complaints from residential people occur, the operational manager will directly contact said resident by telephone or other manners, and the solution of the problems shall be conducted by meetings with the contractor's Project operational manager and/or supervisor at construction site and the consultant.

To pursue the environmental management plan, the contractor shall designate an engineer as an environmental management supervisor to be in charge of environmental management for all sites. Also for An Duong WTP, two security guards will always be allocated at the access gate to ordinary roads for safety management. In addition, another security guard shall be always arranged for safety management of traffic and construction works at the in-plant area and the construction site. For Quan Vinh intake pumping station, although the intake pumping station faces an ordinary road and its traffic is not heavy, two security guards shall be allocated to prevent traffic accidents and to control traffic on the ordinary road.

Figure 1-3-14 shows the environmental management system at construction sites.

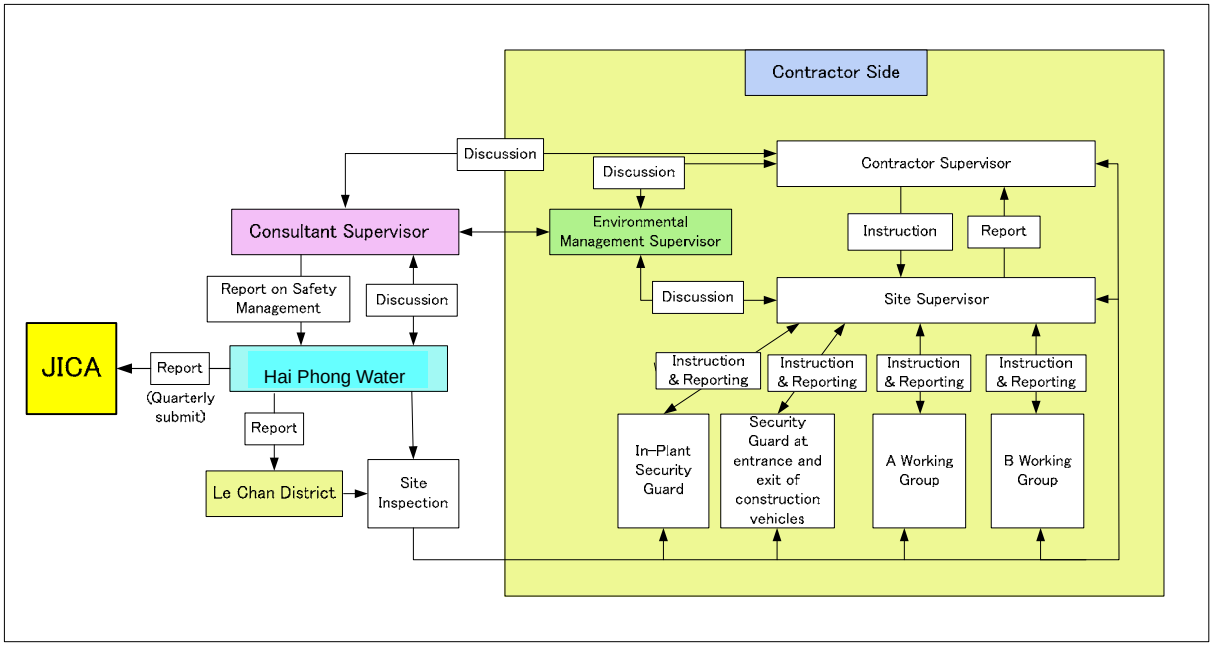


Figure 1-3-14 Environmental Management System at Construction Site

Source: JICA Study Team (Based on local survey)

(2) Monitoring System at Operation Stage

Monitoring works at operation stage after completion of U-BCF are conducted by officials of Hai Phong Water. In the existing An Duong WTP, 104 officials are organized by two deputy directors, 4 O&M teams, 1 intake team, 1 maintenance team, and 1 data collection team under a director, to conduct routine O&M works of the WTP. After completion of U-BCF, it is operated and maintained as a part of

the existing facilities and its monitoring works are carried out by data collection team consisting of 12 officials.

(3) Finalization of Environmental Management Report and Submission

1) Finalization of Environmental Management Report and Submission at Construction Stage

The contractor makes an environmental management report including environmental management system, safety management system and inspection items once a week, to organize and submit to the consultant. After approval, the consultant adds opinion attachments and submits monthly to Hai Phong Water. Hai Phong Water shall submit the monitoring results to JICA every three (3) months. In addition, Hai Phong Water reports the results to DONRE of People's Committee of Le Chan district, and if necessary Hai Phong Water reports the results on basis of safety management report to submit when the inspectors visit the site.

2) Finalization of Environmental Management Report and Submission at Operation Stage

The Hai Phong Water monitoring reports, which the data collection team of the WTP finalizes, after reviewing by the Director of An Duong WTP and the Company-General Director, are to be submitted to JICA every six (6) months for one year.

1-3-2 Stakeholder Meeting

The stakeholder meeting was held at the conference room of Hai Phong Water from 8:30 to 11:00 on August 25, 2014, with a total attendance of 32 persons from the Department of Finance, the Department of Natural Resources and Environment, the Department of Foreign Affairs, the Department of Construction, the Department of Culture, Sports, and Tourism, Hai Phong City Urban Environment Company, Hai Phong City Transportation Mechanic-Electricity Company, water users from three supply zones of An Duong WTP, the Chairman of Hai Phong Water and representatives of relative departments. Furthermore, mass media, Hai Phong TV and radio and Hai Phong newspaper attended. The meeting progressed as the following schedule:

Photo 1-3-1 Stakeholder Meeting at the third floor of Hai Phong Water on August 25, 2014

Table 1-3-21 Meeting Schedule for Stakeholder

Time Schedule	Contents	Presenter
8:30 - 9:00	Registration	Hai Phong Water Company Chairman
9:00 – 9:10	Introduction of attendants	Mr. Nguyen Van Duc, Deputy Director of PMU
9:10 – 9:30	Hai Phong City's water supply conditions (Current status and issues)	Mr. Tran Van Duong, Deputy General Director
9:30 – 10:00	Outline of JICA Project	Mr. Akira Hasebe, JICA study team
10:00 – 10:30	Environmental impact and mitigation measures	Mr. Kenji Takayanagi, JICA study team
10:30 – 11:00	Open Discussion	Attendants
11:00 – 11:05	Closing speech	Hai Phong Water Chairman

Source: JICA Study Team (Based on local survey)

In open discussion secession, the following opinions were presented:

① Representative of Department of Natural Resources and Environment

- The DONRE fully supports the Project.
- It is vital for Hai Phong city to reduce the pollution of raw water and the DONRE plans to control the pollution of the rivers as sources for water supply.
- It was mentioned that there were not many environmental impacts on the Project.
- He asked why the Project does not expand the capacity to 200,000 m^3/day to meet the increasing water demand of Hai Phong city.

② Customer of Hong Bang District

- He sincerely thanked the Japanese Government and JICA for their great support for Hai Phong people.
- They are very pleased that Hai Phong people can receive clean water from 2017.
- He is hoping that the Project would ensure supplying water with good quality as presented.

③ Customer of Hai An District

- At the construction stage of the Project, especially in case it is coincidentally overlapped with ADB Project, is it possible to supply water to the residents without interruption?
- Is it possible for the Hai Phong people to receive cheaper water with this grant aid Project by JICA?

④ Answer by chairman of Hai Phong Water, Mr. Vu Hong Duong

- On the question of expansion to 200,000 m^3/day, the current budget of Hai Phong Water cannot afford to expand the supply volume from 100,000 m^3/day to 200,000 m^3/day.
- On the question of the interruption of supply during the implementation of the Project, Hai Phong Water will ensure to supply a sufficient water volume for Hai Phong people.
- On the question of water charge, although the water charge of Hai Phong City is somewhat higher than the national average, it is still acceptable. In the future, Hai Phong Water will borrow loan from international organizations to expand supply volume of 100,000 m^3/day and more. In that time, the water charge may become slightly higher than the current. It is expected to not be a major problem for residents due to the economic growth in Hai Phong City in the future.

The meeting schedule, attendant list and meeting minutes are shown in Appendix 6-03.

1-3-3 Land Acquisition and Resettlement

The Project aims to construct a pre-treatment U-BCF at An Duong WTP and to renew existing intake pumps which are managed and owned by Hai Phong Water. Thus, land acquisition is not necessary and resettlement shall not be required.

1-3-4 Others

1-3-4-1 Monitoring Form (Draft)

The monitoring form is shown in Appendix 6-07.

1-3-4-2 Environment Checklist

The environment checklist is shown in Appendix 6-08.

Chapter 2

Contents of the Project

Chapter2 Contents of the Project

2-1 Basic Concept of the Project

2-1-1 Upper Level Plan and Project Objective

Viet Nam has announced a notional policy regarding the urban water business in the Urban Water Business Development Guideline "Orientation on Water Supply Development of Urban areas and Industrial Zones in Viet Nam up to 2020" (1998). The objectives of this policy include to "secure safe water for all urban areas by the year 2020" and to "reinforce the human resource development system by introduction of modern technologies and facilities".

The Prime Minister of Viet Nam approved the "Adjustment Master Plan Orientation for Viet Nam's Urban System Development to 2025 with a Vision to 2050" on April 7, 2009. Based on this, Hai Phong city announced the development plan "Approving Adjustment of Construction General Planning of Hai Phong City by 2025 and with a Vision 2050, September 16, 2009, No. 1448/QD-TTg", in which an objective for the water supply ratio in the urban areas reach 100% is included, and expansion plans for An Duong WTP.

Regarding the upper level plan mentioned in the above, the objective of this Project is to improve the water treatment efficiency of An Duong WTP of Hai Phong city, and to enable the supply of safe drinking water from An Duong WTP. Specifically, the Project shall construct U-BCF at the WTP to reduce the ammonium nitrogen concentration in the raw water, which will ensure stable operation of the WTP and reduce the amount of chlorine consumption.

2-1-2 Basic Concept of the Project

To achieve the objectives, this Project plans to introduce U-BCF and to implement soft component for reinforcement of the Project. Reduction of ammonium nitrogen in the raw water will be substantiated. The grant aid cooperation project target is the construction of U-BCF (capacity: 100,000m^3/day) and related facilities (renewal of pumping station facilities, extension of distribution pipes, in-site pipeline, electric facilities), and the renewal of the intake facility (renewal of intake pumps, additional transmission pipes) for energy saving.

The basic concept of the Project is shown in Table 2-1-1.

Table 2-1-1 Basic Concept of the Project

	Request	Outline Design
Raw Water Reservoir Reclamation	—	Undertaking by Japanese Grant Aid Area 3,570m^2
Construction Works	Upward Biological Contact Filtration (U-BCF)100,000m^3/day, Reinforced Concrete construction	Capacity of U-BCF is decided as 100,000m^3/day
		Pipeline in An Duong WTP (Bypass Pipe) 1,000mm×66m (Ductile Iron Pipe)
		Pipeline in An Duong WTP (U-BCF - Mixing Tank) 1,000mm×88m (Steel Pipe)
		Pipeline in An Duong WTP (U-BCF - Drainage Pond) 300 - 350mm×117m (Ductile Iron Pipe)
		Pipeline in An Duong WTP (U-BCF - Branch Pipe for ADB) 1,000mm×69m (Ductile Iron Pipe)
		Blower for cleaning 37kw×2(1)unit
		Electrical Room in Quan Vinh intake pumping station (13.0m×8.0m)
		Electrical Room in An Duong WTP (12.0m×7.5m)
		Power Receiving Facilities Quan Vinh intake pumping station : Steel inside stand-alone type MCCB225AF
		Power Receiving Facilities An Duong WTP : Steel inside stand-alone type ACB1250AF×2
		Control Panel Steel inside stand-alone type MCC, Inverter panel, Inside stand-alone type control panel
		Monitoring Control Panel Liquid crystal display, Data server, Color printer
		Instrumentation Facilities Magnetic flowmeters / Ultrasonic flowmeters, Radio wave type level gage, Head loss level gage
	—	Intake Pump Facilities 160kw×27.0m×23.15m^3/min×4(1)unit Intake pumps are decided to be renewed.
	—	Raw Water Transmission Pipe 1,000mm×216m (Ductile Iron Pipe)
Procurement Works	Control Panel	Included in U-BCF(Monitoring and Control Panel)
	Water Level Gauge	Included in Instrumentation Facilities of U-BCF
	Removal Screen	Included in U-BCF
	Laboratory Equipment of Water Quality Analysis	As a result of the survey, the laboratory equipment for water quality analysis was sufficient, so procurement is not necessary.
Soft Component	1. Technical instruction for operation and maintenance of U-BCF 2. Technical instruction for water quality management	

Source: JICA Study Team (Based on local survey)

2-2 Outline Design of the Japanese Assistance

2-2-1 Design Policy

(1) Basic Policy

① As mentioned in "1-1 Background and Outline of Grant Aid Request", the water quality of the source river is declining for matters such as ammonium nitrogen. Introduction of advances water treatment facilities are required to respond to the deterioration of raw water quality. The treatment method to be adopted shall be determined by judging various factors such as the validity, construction cost and O&M cost. As described in the latter "2-2-2(2)", U-BCF is to be adopted as the advanced treatment method.

② The U-BCF scale shall be determined based on 2 points. 1: The ammonium nitrogen concentration rate at the chemical mixing basin, 2: the O&M easiness when the WTP is expanded to a 200,000m^3/day capacity in the future. As described in the latter "2-2-2(3)", the U-BCF capacity was determined as 100,000m^3/day.

③ The transmission method to U-BCF shall be decided comparing various factors such as the construction cost, O&M cost and operational issues for 2 plans. 1: Renewal of the existing intake pump, 2: installing a storage pump at the raw water regulation reservoir. As described in the latter "2-2-2(3)", the existing intake pump is to be renewed to directly draw water to U-BCF.

④ The design conditions for the U-BCF, such as the space velocity, linear velocity and filter thickness, has been determined based on the U-BCF test plant experiment conducted at An Duong WTP during August 2011 to August 2012, and also the status of the currently operating U-BCF at the Honjyo WTP, of Kitakyushu City Water and Sewer Bureau.

⑤ The U-BCF is to be the first advanced water treatment facility in Viet Nam. Inspection tours from other cities with similar water problems are expected; therefore the facility is designed as a showpiece. For example, pressure-resistant glass shall be used for the U-BCF basin so that the inside of the basin is visible from the outside.

⑥ Kitakyushu City Water and Sewer Bureau's U-BCF design policy and operation results shall be referred for this Project. For example, the design to make manholes in each basin to remove shellfish from the under drain system will be adopted.

⑦ The pipeline length from the pumping station to the WTP is 4km. It shall be mostly covered by the existing pipelines (after confirmation of flow capacity), although several locations may require bypass construction.

⑧ The U-BCF of this Project is to be added to the existing WTP facility. To suppress the O&M cost for the added pumps, water levels are to be basically adjusted to adopt gravity flow methods.

(2) Natural Environment Condition Policy

Hai Phong is classified in the subtropical zone, with humid and hot summers and dry winters. Hai Phong city lies at 21º51' north latitude, closer to the mid-latitude. Therefore the temperature difference between summer and winder are greater, the in the hottest period of June – August the temperature reaches 31ºC, and in the winter period of December – February it drops to an average of 14ºC.

For Hai Phong city the rainy season is from May to October, the annual precipitation is 1,720mm and the average humidity is 86%.

Rainfall is expected to have little effect on the Project works, but the project works plans during the rainy season shall require consideration for additional curing works for material/equipment transportation, excavation for civil works, banking works and concrete placing.

According to the U-BCF plant experiment conducted by Kitakyushu City Water and Sewer Bureau during September 1998 – September 1999, when the water temperature was over 10ºC there were no issues regarding to THM precursor removal and the ammonium nitrogen removal ratio was maintained over 80% throughout the whole period. The raw water temperature for An Duong WTP during the period of 2011 to 2013, which is shown in Figure 2-2-1, has not dropped below 10ºC hence there should be no problems. It is necessary to keep in consideration that biological activity diminishes and therefore the ammonium nitrogen removal ratio declines when the water temperature is under 10ºC.

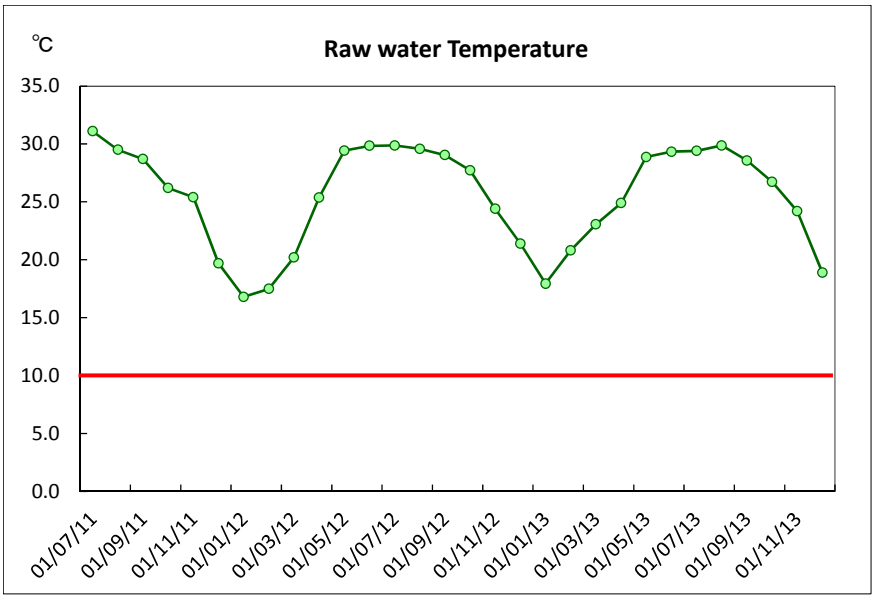


Figure 2-2-2 Daily Fluctuation of the Raw Water Temperature at An Duong WTP

Source : Hai Phong Water

As mentioned in “1-2 Natural Conditions”, the results of the boring test showed that the Bac Boh Plain, which Hai Phong city is located, consists of the sediment layered during the Alluvial and Pleistocene epochs.

Therefore, the bearing ground is deep and the ground water level is high. A sandy soil layer (N=40) exists 40m below the ground surface, so it is necessary to construct a pile foundation using this layer as

the supporting layer.

The geotechnical test showed that the groundwater level was 1.0m from the ground surface. In the excavation tests however, groundwater did not appear immediately when the excavation depth exceeded 1.0m. From these results, it has been concluded that the groundwater amount is large, and it may be necessary to drain the excavation locations by sumping in case the water should affect the works.

(3) Construction/Procurement Condition Policy

The Vietnamese Government has been working on a strategy to accelerate national industrialization and modernization by the year 2020. Examples of infrastructure arrangements are; the construction of Noi Bai International Airport, North-South Express Railway and North-South Expressway in the transportation field, construction of the port/container terminal near Hai Phong in the harbor field and water supply/wastewater works improvement at the major cities such as Ha Noi and Ho Chi Minh in the water field.

Therefore, material for civil/construction works will be easy to procure in Viet Nam. The U-BCF of this Project is based on mechanical and electrical equipment, and the core facility components which require a certain quality to maintain the performance as a water treatment system, as well as products which are difficult to procure in Viet Nam, are to be from Japan or another country.

Ductile iron pipes used widely in Viet Nam are to be adopted for this Project. The diameter is large and can be used as the facility main, and also it has already been used by other Japanese Grant Aid Projects.

(4) Local Contractor (Constructor, Consultant) Policy

Using local contractors is possible in Viet Nam, due to the fact that many projects including infrastructure improvement projects have been implemented. Construction machinery, such as backhoes and cranes, are also available and construction works by local operators are practicable.

There are multiple construction companies in Hai Phong city, and for simple works the labour cost is low and the supply is sufficient. This Project will actively utilize local constructors under supervision of Japanese companies, which shall also provide a raise to the Vietnamese construction techniques.

When Hai Phong Water plans the construction of another U-BCF in the future, the improvement of local constructor’s skills will be beneficial for the Project sustainability.

(5) Operation and Management Policy

The O&M cost is expected to increase following the introduction of U-BCF by this Project, due to the increase of items for daily periodical inspection and O&M. In the case of Honjyo WTP in Kitakyushu City Water and Sewer Bureau and Vinh Bao WTP in Hai Phong City (U-BCF in operation) for example,

periodical inspection for equipment, replenishing of granular activated carbon and cleaning of the lower water collecting device had been added.

The works of U-BCF reservoir basin operation and cleaning has also been added as operational items in this case.

Although instrumentation for the chemical feeding, pump operation and filter basin cleaning are added to the O&M items, introduction of U-BCF will equalize the raw water quality and the water treatment will contribute to reduce the load of water treatment. Therefore, the introduction of U-BCF will not increase works which will require new organizations, as the additional works will not change the total work load and can be included in the current operation system. The training/guidance for operation/management items for introduction of U-BCF shall be included in the soft component plans, as mentioned in the followings.

(6) Construction/Procurement Methods, Construction Period Policy

The structure for this Project will be ordinary RC structures; therefore the construction works will be carried out by Vietnamese constructors. Since the water basin structure requires a certain level of quality for the reinforced concrete, Japanese engineers shall be allocated for the quality management. The period of construction shall be determined considering the abovementioned natural/socio-economic conditions as well as the quality/safety management.

- Construction plan/design requires approval from Department of Construction of Hai Phong city (hereinafter "DOC"); therefore it is necessary to appropriately schedule anticipating the days necessary for inspection and approval.
- Since the construction is to be carried out at the existing WTP/pumping station with a capacity of 100,000m^3/day which are the main water supply facilities for Hai Phong city, it will be necessary to establish construction plans to not interrupt the existing facility operation.
- Viet Nam's public holidays are Saturday afternoons and Sundays, and the Labour Law regulates the working hours as a maximum eight (8) hours per day and 48 hours per week. Few days are declared as national holidays. Tet (New Year) holidays are the most important, which usually are for about 10 days in the ends of January to beginnings of February. Since domestic economic activities are suspended during this period, the Project management should conform these holidays to secure one-month vacation for the holiday.

(7) U-BCF Policy

The patent of the U-BCF which is to be introduced in this Project (Patent Name: Public water facility, Patent No.: 3831055) is owned by Kitakyushu City Water and Sewer Bureau. A Patent License Agreement has been concluded between Kitakyushu City Water and Sewer Bureau and JICA, therefore there shall be no issues to disclose information required for U-BCF planning and/or designing. In addition, Kitakyushu City Water and Sewer Bureau and NJS Consultants have also made a written

agreement regarding the maintaining of patent-related confidential items for the Project.

Hence, issues related to patent shall not arise for the U-BCF planning, designing and construction this Project, and neither shall other factors which may affect the procurement competition.

2-2-2 Basic Plan (Construction Plan/ Equipment Plan)

2-2-2-1 Basic Configuration

(1) Fundamentals

The fundamentals required for planning of water treatment facility is already presented by the Vietnamese authorities for this Project in September 2014, the conditions are as follows:

Service Area:	1,042 ha
Service Population :	855,000
Projected Water Consumption:	
Summer season	=140,000 m^3/day
Winter season	=115,000 m^3/day
Daily Average Flowrate (2013 average):	
	125,000 m^3/day
Unit Rate	:143 L/population/day

The unit rate for water supply is reportedly based on domestic water consumption (excluding commercial/industrial use water). However, according to the projected flowrate of water supply based on the population and unit rate, it reaches 122,300m^3/day which is close to the abovementioned daily average flowrate and there is no margin for enterprise use. Based on this result, further studies for water consumption are necessary regarding the future water use.

855,000 population×143 L /population/day÷1000=122,300 m^3/day

Other fundamentals of this Project for capacity of U-BCF are summarized as shown below:

Target Year：2018 (1 year after completion of U-BCF facilities)
Proposed water treatment volume of U-BCF：100,000m^3/day
Water Treatment Method : Upward Biological Contact Filtration (U-BCF)
Storage pump station：Replacement of existing pump facilities

(2) Water Treatment Method

As mentioned in “1-1 Background and Outline of Grant Aid Request”, the introduction of advanced water treatment facility is necessary to deal with the river water quality deterioration. According to the “Guidelines for Introduction of Advanced Water Treatment Facility” (Japan Water Works Association, 1988), an advanced water treatment facility is defined as “a facility which adopts or combines activate

carbon treatment, ozone treatment or biological treatment".

Within the advanced treatment methods, biological treatment and biological activated carbon treatment have advantage of removing ammonium nitrogen which is the main issue at An Duong WTP.

Therefore, the methods of biological treatment and biological activated carbon treatment have been selected as advanced water treatment methods. Results of the study are shown in Table 2-2-1.

It shows the comparison table showing results of ammonium nitrogen removal by advanced water treatment method of Biological Activated Carbon Filtration, Honeycomb-type Contact Aeration and Rotating Disk Biological Contactor, as well as the currently adopted Chlorine Treatment.

Although all methods show positive results for ammonium nitrogen removal, disinfection by-product may be generated by chlorine treatment. The order of small area required for facility installation is chlorine treatment, biological activated carbon filtration and biological treatment, for the emission of odor. Since the area required for biological treatment is 1,500m^2 – 3,000m^2, which is 5 – 10 times bigger than required for biological activated carbon filtration, it is not physically possible to construct inside the existing An Duong WTP site.

The CAPEX (Capital Expenditure) comparison was made based on the condition upon biological activated carbon filtration rated as 100. Honeycomb-type method is 140 in the same condition, and rotating disk method is 120. Hence the biological activated carbon filtration method has the advantage by the CAPEX.

For OPEX (Operation Expenditure) comparison, upon biological activated carbon filtration 8the method with the lowest O&M cost) rated as 100, rotating disk method is 2.7 folds and honeycomb-type method is 27 folds.

As a reference, regarding the organic matters which the concentration is increasing in the raw water of An Duong WTP, biological activated carbon filtration shows the most positive results. The removal rate for biological treatment is 10%, and although chlorine treatment also shows good results, THM may generate depending on the concentration of organic matters in the raw water.

From the above points, biological activated carbon filtration (U-BCF) provides the best results regarding both the construction and O&M cost, and ammonium nitrogen/organic matter removal.

Biological activated carbon filtration can adopt both upward and downward flow methods. In the downward method, suspended substances are caught between the filter materials when the water flow increases, which shall require frequent cleaning and also cause discharge of activated carbon. For the

upward method, the head loss is small, does not require frequent cleaning and the filtration time is short since it uses finer activated carbon.

Therefore, U-BCF introduction is appropriate.

It has also been shown in the results of an one-year test plant operation at An Duong WTP during a JICA grassroots technical cooperation Project conducted by Kitakyushu City Water and Sewer Bureau that, U-BCF can provide sufficient water treatment such as sustaining the annual ammonium nitrogen concentration below 0.2mg/L.

Table 2-2-1 Comparison of the Removal Methods for Ammonium Nitrogen

Item	Biological activated carbon treatment (Biological activated carbon contact filtration)	Biological Treatment (Honeycomb type contact aeration)	Biological Treatment (Rotating disk biological contactor)	Chlorine treatment
Treatment process	Fill the treatment basin with granular filtration material and crate an upward flow of raw water through it for purification by biological membrane of the filter.	Install a honeycomb filter with biological membrane inside the treatment basin for purification by rotating the raw water.	Install 40% of a row of circular disks inside the treatment basin and slowly rotate it for purification by biological membrane of the disks.	Use the oxidation power of chlorine to remove the ammonium nitrogen by feeding chlorine to the raw water.
Raw water turbidity	Below 300 degrees	Below 100 degrees	Below 300 degrees	－
relative merits	◎	△	◎	－
Removal ratio of ammonium nitrogen	Above 80%	Above 80%	Above 80%	Above 80%
relative merits	◎	◎	◎	×(Due to form the disinfection by-product)
Removal ratio of organic matter	30%	10%	10%	－
relative merits	◎	△	△	×(Due to form the disinfection by-product)
Required area	0.005-0.006m^2/(m^3・day)	0.015-0.020 m^2/(m^3・day)	0.020-0.030 m^2/(m^3・day)	0.001 m^2/(m^3・day)
Necessary area (treatment amount)	500-600m^2 (100,000m^3/day)	1,500-2,000 m^2 same as on the left	2,000-3,000 m^2 same as on the left	Approximately 100 m^2 same as on the left
relative merits	○	△	×	◎
Aeration facility	Not required	Need for the circulation of water	Not required	Not required
relative merits	◎	△	◎	◎
Washing facility	Air and water	Necessary	Not required	Not required
relative merits	○	○	◎	◎
Desludging facility	Not required due to wash per unit per three or four days	Necessary (Sludge collected at the understructure of honeycomb)	Necessary (Sludge collected at the water tank)	Not required
relative merits	○	△	△	◎
Ratio of initial cost	Biological contact filtration basin etc 100	Biological contact filter etc 140	Biological contact filter etc 120	Chemical injection pump etc 3
relative merits	◎	×	○	◎

Item	Biological activated carbon treatment (Biological activated carbon contact filtration)	Biological Treatment (Honeycomb type contact aeration)	Biological Treatment (Rotating disk biological contactor)	Chlorine treatment
Ratio of O&M cost	Electrical cost for the washing blower etc 100	Electrical cost for the washing blower etc 2700	Driving power cost etc 270	Electrical cost for the chemical injection pump etc 11
relative merits	◎	×	○	◎
Evaluation	First ◎ …… 6 ○ …… 3 △ …… 0 × …… 0	Third ◎ …… 1 ○ …… 1 △ …… 5 × …… 2	Second ◎ …… 4 ○ …… 2 △ …… 2 × …… 1	Not covered by the evaluation ◎ …… － ○ …… － △ …… － × …… －

Source： 「Water treatment technical guideline 2010、JAPAN WATER RESEARCH CENTRE、P.115～120」
「Water engineering Gihodo Shuppan、P.280～331」
「Design criteria for waterworks facilities 2012、JAPAN WATER WORKS ASSOCIATION、P.289～324」

(3) U-BCF Scale and Location Consideration

1) U-BCF Scale

The facility capacity of An Duong WTP is currently 100,000m^3/day, but is treating over the facility limits at peak times (as up to 140,000m^3/day). The facility capacity is planned to be upgraded to 200,000m^3/day by a ADB-loan project.

The U-BCF scale for this Project is to be determined regarding the An Duong WTP capacity, water supply circumstances and future expansion plans. Considering the below two points, the U-BCF capacity has been decided as 100,000m^3/day.

- Considering said plans to expand the capacity to200,000m^3/day, it is recommended to construct 2 systems of 100,000m^3/day capacity hence the maintenance works, such as sedimentation basin cleaning, is easier.

- The main objective for U-BCF introduction by this Project is to reduce the ammonium nitrogen concentration of the raw water to under 0.2mg/L (the Vietnamese drinking water quality standard). This objective is expected to be achieved even if the U-BCF treated water and untreated water is mixed (as explained later) therefore, the U-BCF treatment capacity is to be 100,000m^3/day.

  - ✓ The average ammonium nitrogen concentration at Quan Vinh intake pumping station (January 2013 – July 2014) was 0.33mg/L, with exceptions during the rainy season when the raw water ammonium nitrogen concentration suddenly rises. The results of the U-BCF test plant carried out by Kitakyushu City Water and Sewer Bureau showed that the removal ratio of ammonium nitrogen after U-BCF treatment was 81.4%, from which the concentration can be calculated as 0.06mg/L. Therefore, if the water treated by this Project's U-BCF (100,000m^3/day) and the untreated water (40,000m^3/day) is mixed, the ammonium nitrogen concentration average is expected to be 0.13mg/L, which shall satisfy the Vietnamese drinking water quality standard.

Calculation formula

: (0.33mg/L×(100%-81.4%)×100,000 m^3/day+0.33mg/L×40,000 m^3/day)÷140,000m^3/day=0.13 mg/L

  - ✓ Additionally, the facility expansion project planned by ADB loan (to expand the WTP capacity from 100,000m^3/day to 200,000m^3/day) does not include U-BCF at the moment. In this case, when the water treated by this Project's U-BCF (100,000m^3/day) and the untreated water (100,000m^3/day) is be mixed, the ammonium nitrogen concentration average is expected to be 0.19mg/L, which shall satisfy the Vietnamese drinking water quality standard.

Calculation formula

: (0.33mg/L×(100%-81.4%)×100,000 m^3/day+0.33mg/l×100,000 m^3/day)÷200,000m^3/day=0.19 mg/L

As mentioned above, U-BCF construction is not included in the ADB-loan expansion Project (total capacity = 200,000m^3/day) at the moment. Considering the financial status of Hai Phong Water (refer to "2-3 Obligation of Recipient Country"), the construction of a U-BCF for the additional 100,000m^3/day shall be affordable for Hai Phong Water.

During the period between the operations of the U-BCF of this Project starts until the U-BCF of the ADB Project is completed, both U-BCF treated and untreated water shall be mixed for the WTP. The WTP outlet water is currently meeting the water quality standards (although residual chlorine is not detected at several end-point water taps). However, the inflow of U-BCF treated water is expected to improve the quality of the mixed water to enable the raw water which shall satisfy the Vietnamese drinking water standards (Ammonium nitrogen: 0.2mg/L).

2) Transmission Methods to U-BCF

The ADB-loan facility expansion plan is to increase the facility capacity of An Duong WTP from 100,000m^3/day to 200,000m^3/day. A treatment facility with the capacity of 100,000m^3/day is to be added, but also the treatment process is to be revised to meet the facility expansion.

Currently, An Duong WTP draws raw water by using an intermediate pump between the sedimentation tank and rapid sand filter. The new treatment process will adopt gravity flow method from the receiving tank to the distribution pump, and the intermediate pump is planned to be cancelled.

Regarding the above future plans, it will be necessary to set the HWL higher than the current water treatment process.

Therefore, transmission method of this Project is to renew the intake pumps and draw the raw water directly to U-BCF, for the following 3 reasons.

- To draw water from the raw water regulating reservoir, it will be necessary to create a 2-step pumping operation (intake pump and lifting pump) and this shall raise the maintenance cost.
- When the raw water is drawn directly to the U-BCF without using the regulating reservoir, there are possibilities which the raw water quality (mainly turbidity) will affect the U-BCF operation. However, this method can be accepted considering the raw water turbidity and U-BCF operation results of Kitakyushu City Water and Sewer Bureau.
- Currently, there is no standby generator in the An Duong WTP and Quan Vinh intake pumping station.
  In addition, based on actual performance of Honjyo WTP at Kitakyushu City Water and Sewer Bureau, a U-BCF which is continuously out of service for about 3 days because of regular inspection and maintenance can be also recovered to the normal performance level within 1 or 2 days although the required time for the recovery depends on parameters of water quality.

However, if another U-BCF is constructed by landfilling more sections of the raw water regulation reservoir in the future after the ADB project expanding the capacity up to 200,000m^3/day, the water supply service may have trouble regarding its stability due to the reduction of total water storage of the WTP which is available for emergency.

Therefore, it is recommended to take countermeasures in the future such as installing a standby generator especially when the additional U-BCF is installed.

Regarding the operation and maintenance cost, Table 2-2-2 compares the 2 methods mentioned above. Figure 2-2-3shows the system drawings. The construction cost is based on the Honjyo WTP (Kitakyushu City Water and Sewer Bureau) results and the estimation on being introduced in Hai Phong city.

Table 2-2-2 U-BCF Water Transmission Method Comparison Table

Plan	Plan 1	Plan 2
Design filtration flow	100,000m^3/day	
Pump station	Installation beside U-BCF	Replacement of the existing pump in the intake pumping station
Application of raw water reservoir	Yes	No
Merit	Available to absorb the water quality fluctuation in the raw water reservoir	・Only one intake pump / one step for lift up ・Advantage in the initial cost and O&M cost
Demerit	・Intake and storage pump required to be two steps for lift up. ・Raise in initial cost and O&M cost	Operation is difficult in case of water quality fluctuation
Supplementary Facilities	①Storage up pump 90kw×3unit ②Pipeline from U-BCF to the mixing tank ③Pipeline from U-BCF to the sludge drying bed ④Pipeline from U-BCF to the future receiving tank	①Intake pump 160kw×3unit ②Raw water transmission pipe φ1000mm×200m ③Pipeline from U-BCF to the mixing tank ④Pipeline from U-BCF to the drying bed ⑤Pipeline from U-BCF to the future receiving tank
Initial Cost	100	103
O&M Cost	100	70

※The initial cost calculation supposed that U-BCF is constructed in Hai Phong city based on the actual cost of Honjyo WTP of Kitakyushu City Water and Sewer Bureau (The construction material cost refers to unit price in Viet Nam).

Source: JICA Study Team (Based on local survey)

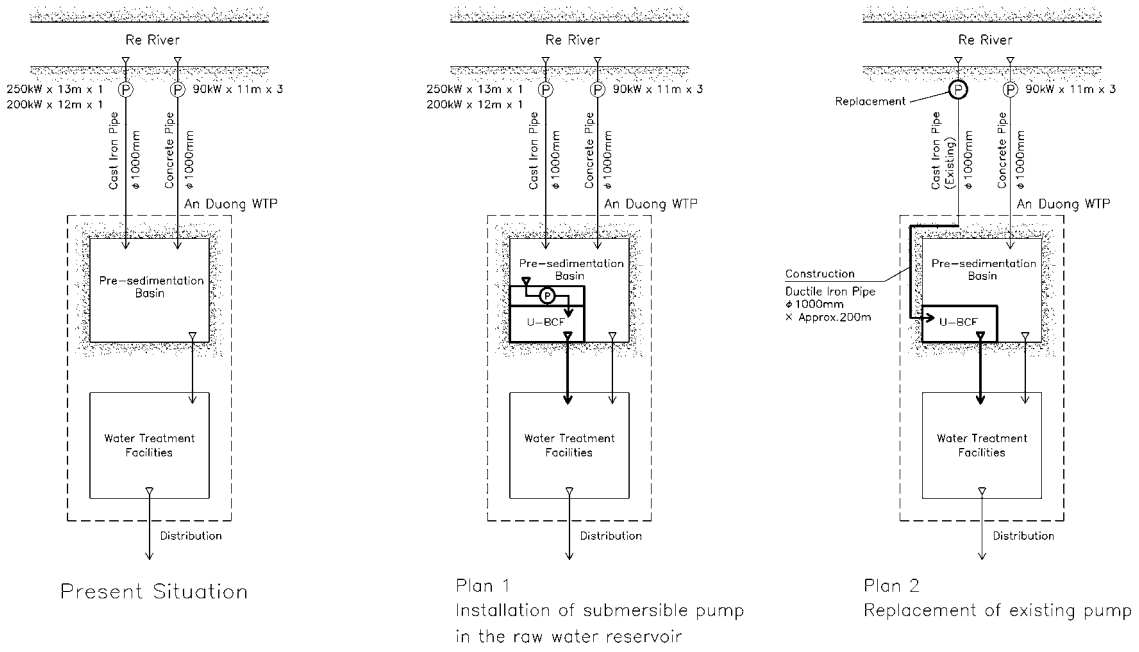


Figure 2-2-3 System Drawing of Intake and U-BCF for Each Plan

Source: JICA Study Team (Based on local survey)

Regarding the clogging, for Plan 2, it is necessary to verify the effects of raw water quality change has on U-BCF operation, since the water is to be pumped directly from the intake pumping station to the upper water levels of the U-BCF, without using the existing raw water regulation reservoir. Clogging caused by suspended substance or sand may occur. The raw water turbidity in An Duong WTP is shown in Figure 1-2-4, and the daily variation of the raw water, through the raw water reservoir, surpasses 50NTU at the maximum point.

In cases which the raw water reservoir water level falls and the bottom mud is stirred by water flow, the turbidity at the adjustment basin raw water outlet reaches nearly 50NTU when compared with the Re River raw water. According to the Kitakyushu City Water and Sewer Bureau U-BCF operation records, it is possible to treat 100NTU if the operation is controlled carefully, so there shall be no particular issues concerning the turbidity fluctuations.

Turbidity may be a major issue for U-BCF operation. For example, if the turbidity causes clogging in the activated carbon layer, the raw water cannot have sufficient contact with the activated carbon and as a result, the treatment efficiency shall drop.

Therefore it will be necessary to carefully control the operation by monitoring the intake river water quality after rapid quality changes, such as first flush caused by rainfall. Measures such as adjusting the intake amount, or increasing the cleaning frequency of the activated carbon layer shall be required.

For this reason, emergency response training to correspond to first flush is to be included in soft

component. The O&M works are the same methods for everyday operation, and it is possible be carried out by the O&M staff and water quality inspection staff at An Duong WTP.

Water source quality is currently measured five times per week at An Duong WTP. U-BCF O&M management using the gathered data is planned in the soft component.

For Plan 1, the capacity and ability of the raw water regulation basin for water quality fluctuation is as mentioned in below.

- Capacity of regulation basin left after the completion of ADB Project
  = 4,800m^2×4.0m=19,200m^3
- Retention time at the adjustment basin against total water amount
  ＝19,200 m^3÷200,000 m^3/day×24 hours=2.3 hours

If a heavy rainfall occurs while the daily wastewater draining is continuing at the source river, the river water fluctuation cannot be settled within 2.3 hours in all cases. Therefore, it cannot be expected for the raw water reservoir to absorb all fluctuation accurately.
From the above points, Plan 2 is recommended considering the O&M cost.

(4) Evaluation of O&M cost for Project Implementation

1) Calculation of O&M cost

As previously mentioned, the source of An Duong WTP, Re River, is showing deterioration of water quality due to the inflow of domestic wastewater. The progress of pollution caused by ammonium nitrogen and organic matters is the main issue, which is increasing the amount of chlorine and coagulant (poly aluminum chloride: PAC) used as antioxidant. This increase leads to the generation of carcinogenic THM in the treated water and other health problems. An Duong WTP has this problem as well as other issues regarding the treated water quality and O&M.

If this Project is not implemented, it is predicted that the raw water quality shall deteriorate further, and the consumption of PAC and chlorine as well as the chemical cost shall increase.

On the other hand, U-BCF introduction by this Project shall remove ammonium nitrogen and organic matters in the raw water by the self-purification of microorganisms, which will reduce the necessary chlorine and PAC amount. In addition, the quality of the water treated by U-BCF is consistent even in cases of heavy fluctuation of the source water quality. This shall benefit to the stable treatments of the after U-BCF sedimentation and filtration processes.

The WTP O&M cost comparison for with/without implementation of the Project is described in the followings. It is to be taken into notice that, this comparison is of the overall estimation cost for the main components of the introduction of the U-BCF and not the total WTP cost.
(The daily treatment amount average is assumed as 125,000m^3/day, based on the 2013 records. The daily

average for U-BCF treatment is assumed as 100,000m^3/day)

① In case the Project is not implemented

If the Project is not implemented, electricity cost for pump operation, the chlorine and PAC cost shall increase annually. Based on the existing pump electricity costs and the chemical injection records of the past ten years, the O&M cost is estimated to reach JPY 115million/year. (1VND=0.00485JPY)

Table 2-2-3 O&M Cost without Project Implementation

Items		unit	Quantity	Unit Cost	Cost	
				VND	million VND	JPY
Intake Pump		kwh/year	3,416,400	1,388	4,742	22,998,522
Chemical Injection	PAC	kg/year	526,513	9,150	4,818	23,365,308
	Chlorine	kwh/year	91,250	11,200	1,022	4,956,700
Raw Water Pump		kwh/year	2,858,504	1,388	3,968	19,242,878
Distribution Pump		kwh/year	6,541,320	1,388	9,079	44,034,858
Water Treatment Cost in An Duong WTP					23,629	114,598,266

Source: JICA Study Team (Based on local survey)

② In case the Project is implemented (Before ADB-loan facility expansion)

The water treatment process is to be reviewed after the implementation of this Project, as a part of the ADB-loan facility expansion project, and the intermediate pumps are to be removed to reduce the O&M cost. Therefore it shall be necessary to reinforce the capacity of the intake pumps.

In case the Project is implemented, the annual O&M cost is estimated as JPY 121 million/year, which includes the electricity cost calculated from the existing pump and the new installed pump (before ADB-loan facility expansion), the U-BCF operation electricity, replenishing of activated carbon, equipment maintenance, the reduction rate of the chemical at Vinh Bao WTP and chemical cost estimated from the past 10 year injection average at An Duong WTP. This O&M cost is JPY 7 million/year higher than the case which the Project is not implemented.

The breakdown is as follows; JPY 7 million/year increase for the renewal of intake pumps, JPY 6 million/year for U-BCF O&M and a reduction of JPY 6 million/year for the chemical cost.

The estimation details for each item are described in “2-5-2 Operation and Maintenance Cost”.
The calculation details for each item are described in “Appendix 6-14”.

Currently the ADB-loan project construction is scheduled to be completed in June 2018, however, if the expansion construction is delayed, said cost shall continue to incur.

Table 2-2-4 In Case the Project is Implemented (Before ADB-loan facility expansion)

Items		unit	Quantity	Unit Cost	Cost	
				VND	million VND	JPY
Intake Pump		kwh/year	4,467,600	1,388	6,201	30,074,990
U-BCF	Electrical	kwh/year	23,579	1,388	33	158,729
	Acivated Carbon Supplementation	m^3/year	29.4	17,750,150	522	2,530,994
	Mechanical Maintenance	m^3	36,500,000	20	730	3,540,500
Chemical Injection	PAC	kg/year	406,468	9,150	3,719	18,038,018
	Chlorine	kg/year	71,467	11,200	800	3,882,087
Raw Water Pump		kwh/year	2,858,504	1,388	3,968	19,242,878
Distribution Pump		kwh/year	6,541,320	1,388	9,079	44,034,858
Water Treatment Cost in An Duong WTP					25,052	121,503,054

Source: JICA Study Team (Based on local survey)

③ In case the Project is implemented (After ADB-loan facility expansion)

After the implementation of both this Project and the ABD-loan facility expansion project, the annual O&M cost is estimated as JPY 102 million/year, which includes the electricity cost calculated from the existing pump and the new installed pump (After ADB-loan facility expansion), the U-BCF operation electricity, replenishing of activated carbon, equipment maintenance, the reduction rate of the chemical at Vinh Bao WTP and chemical cost estimated from the past 10 year injection average at An Duong WTP. This O&M cost is JPY 12 million/year lower than the case which the Project is not implemented.

The breakdown is as follows; JPY 7 million/year increase for the renewal of intake pumps, JPY 12 million/year for U-BCF O&M, a reduction of JPY 6 million/year for the chemical cost and a reduction of JPY 19 million/year by abolishing the intermediate pumps.

The estimation details for each item are described in “2-5-2 Operation and Maintenance Cost”.
The calculation details for each item are described in “Appendix 6-14”.

Table 2-2-5 In Case the Project is Implemented (After ADB-loan facility expansion)

Items		unit	Quantity	Unit Cost	Cost	
				VND	million VND	JPY
Intake Pump		kwh/year	4,467,600	1,388	6,201	30,074,990
U-BCF	Electrical	kwh/year	23,579	1,388	33	158,729
	Acivated Carbon Supplementation	m^3/year	29.4	17,750,150	522	2,530,994
	Mechanical Maintenance	m^3	36,500,000	20	730	3,540,500
Chemical Injection	PAC	kg/year	406,468	9,150	3,719	18,038,018
	Chlorine	kg/year	71,467	11,200	800	3,882,087
Distribution Pump		kwh/year	6,541,320	1,388	9,079	44,034,858
Water Treatment Cost in An Duong WTP					21,085	102,260,176

Source: JICA Study Team (Based on local survey)

2) Evaluation of O&M cost

- As described in the above, the annual O&M cost is estimated to increase by JPY 7 million/year by the implementation of this Project before the ADB-loan facility expansion project completion. After the ADB expansion project is completed, however, the annual O&M cost is expected to decrease by JPY 12 million/year, therefore the benefit of implementing this Project is high.
- The benefit and cost of U-BCF does not differ between before and after the Project implementation, because the increase in cost for electricity, replenishment of activated carbon and equipment maintenance is counterbalanced by the reduce in chemical cost.

2-2-2-2 Facility Plan

(1) Intake Pumping Station

The raw water drawn by the existing intake pump flows through transmission pipes to the raw water reservoir of An Duong WTP (GL +3.5m). Upon installation of U-BCF, it is necessary to draw the water to the maximum water level of the U-BCF receiving tank (HWL, GL+14.8m). Therefore the intake pump lifting requires ability to draw water through the transmission pipe (1,000mm, length 4km) and up to the maximum water level of the U-BCF receiving tank (HWL, GL+14.8m).

The factors for the five existing intake pumps are shown in the below table. The current operation uses 2 to 3 pumps to transmit 100,000m^3 - 140,000m^3/day.

Table 2-2-6 Factor of Intake Pumps

Factor	Capacity	Installation period
250kw×13m 1unit	3,800m^3/h/unit＝63.33m^3/min	2001
200kw×13m 1unit	3,851m^3/h/unit＝64.18m^3/min	2001
90kw×13.5m 3units	1,710m^3/h/unit＝28.50m^3/min	2010

The intake pumps for this Project are planned according to the following calculations.

- Transmission volume: 100,000m^3/day = 4,167m^3/hr = 69.44m^3/min
- Transmission pipe: existing DCIP ϕ 1000 (laid in 2010)

Pipe length (L) = 3,672m (from Quan Vinh intake station to An Duong WTP raw water reservoir)
Pipe length for hydraulic calculation (L) = 3,880m {=3,672m + 208m (in-site piping)

- Intake water level: Re River LWL + 2.5m
- Transmission destination water level: An Duong WTP U-BCF receiving well HWL + 14.8m
- Hydraulic calculation: Formula - Hazen–Williams equation

  Velocity coefficient: C = 100

  Actual hydraulic head: H = 14.8m – 2.5m = 12.3m

The new intake pump factors according to the economical hydraulic calculation based on the above conditions is:

*160kw x 23.15 m^3/min (36,187 m^3/day) x 29m x 4 units (1 unit standby)

As shown in Figure 2-2-4, the water hammer for the new pumps will be under negative pressure of -14.2m at the transmission pipe located 3000m from Quan Vinh intake pumping station. Hence for this Project, a ϕ 800 back pressure pipe and back pressure valve shall be installed in the same method as the existing pumps, and a fly wheel is also to be attached to the new pumps.

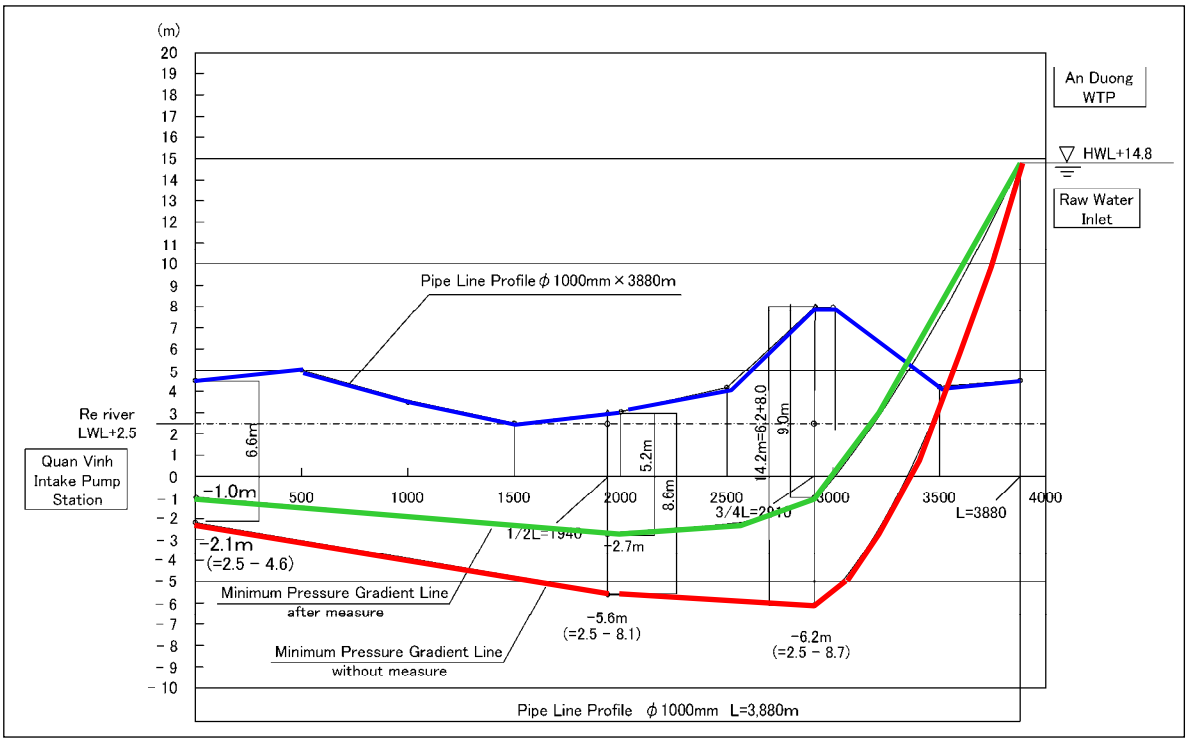


Figure 2-2-4 Calculation Result of Water Hammer

Source: JICA Study Team (Based on local survey)

(2) Transmission Pipe

Currently two (2) transmission pipes are connecting the intake pumping station and An Duong WTP raw water regulation reservoir, and the specifications are as below (refer to also Figure 2-2-5).

No.1: 1,000mm, concrete pipe ; 4,057m
No.2: 1,000mm, ductile iron pipe ; 3,672m

As mentioned in the before chapters, the total lifting for the intake pipes witch are to be renewed is 26.4m. By adding the calculated water hammer pressure 14.6m, the pressure inside the transmission pipe is 41.0m (0.42MPa).

Taking this into consideration, the existing DCI transmission pipes have been laid in 2010 and the pressure resistance notion PM10 (maximum pressure 1.0MPa) has been confirmed by local surveys, for which they have been judged to have sufficient pressure resistance capacity. Therefore, said DCI transmission pipes shall be used to directly draw water to U-BCF.

Temporary bypass construction is required at the outlet side of the pumping station, and inside An Duong WTP site to connect with U-BCF. This construction shall use the two pipes alternately to avoid water supply interruption.

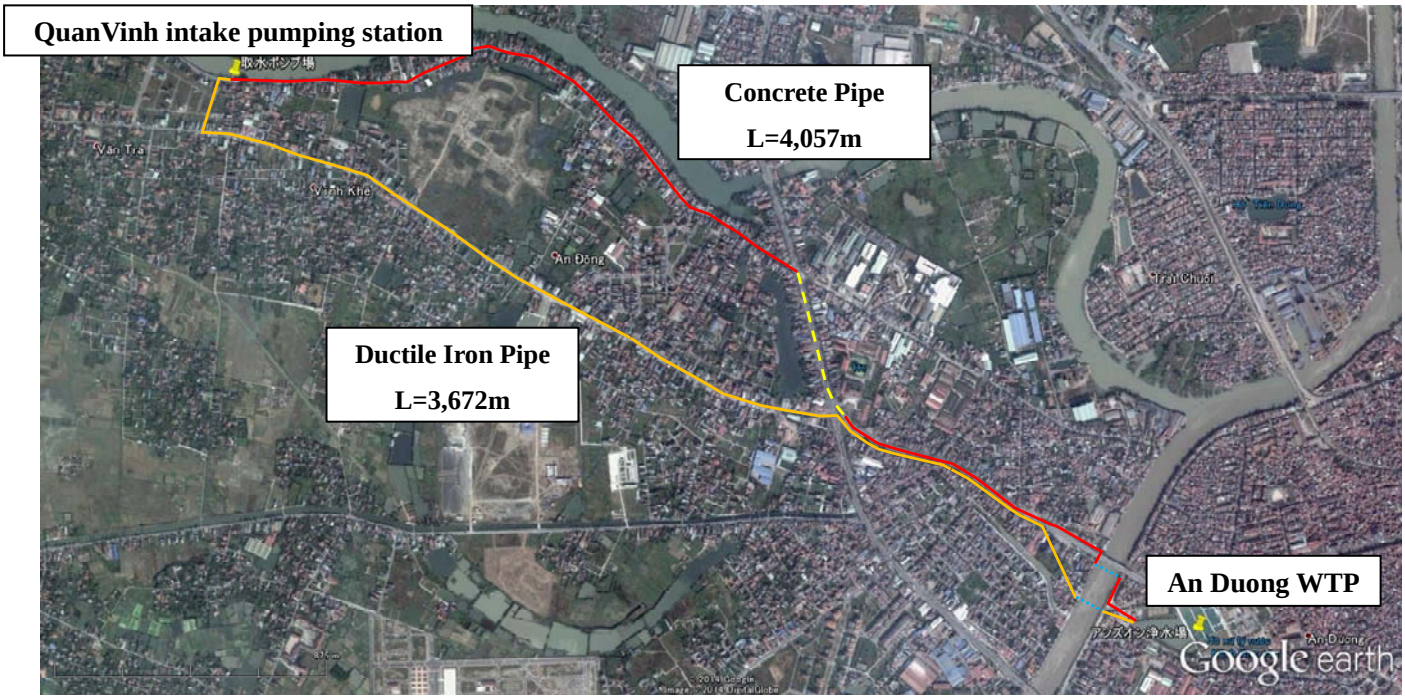


Figure 2-2-5 Raw Water Transmission Pipeline Route

*Steel pipes used for several locations in the broken line

Source: JICA Study Team (Based on interviews with Hai Phong Water)

Currently, An Duong WTP is over operating at a treatment amount of 125,000m^3/day, while the designed facility capacity is 100,000m^3/day. Therefore after the U-BCF completion, 100,000m^3/day is to be transmitted directly to U-BCF by the newly installed pumps, and the surplus amount will be pumped to the raw water regulating reservoir using the existing intake pumps and concrete pipes for treatment.

As mentioned in the before chapters, no supply water quality issues are expected if the U-BCF treated and untreated water are mixed.

(3) U-BCF

1) Treatment Flowchart

The establishment of U-BCF and related facilities are the main target of this Project, and as shown in Figure 2-2-6, said facilities are to be installed before of the flush mixing tank. After the future ADB supported facility expansion Project, the treatment flow is expected to be as Figure 2-2-7.

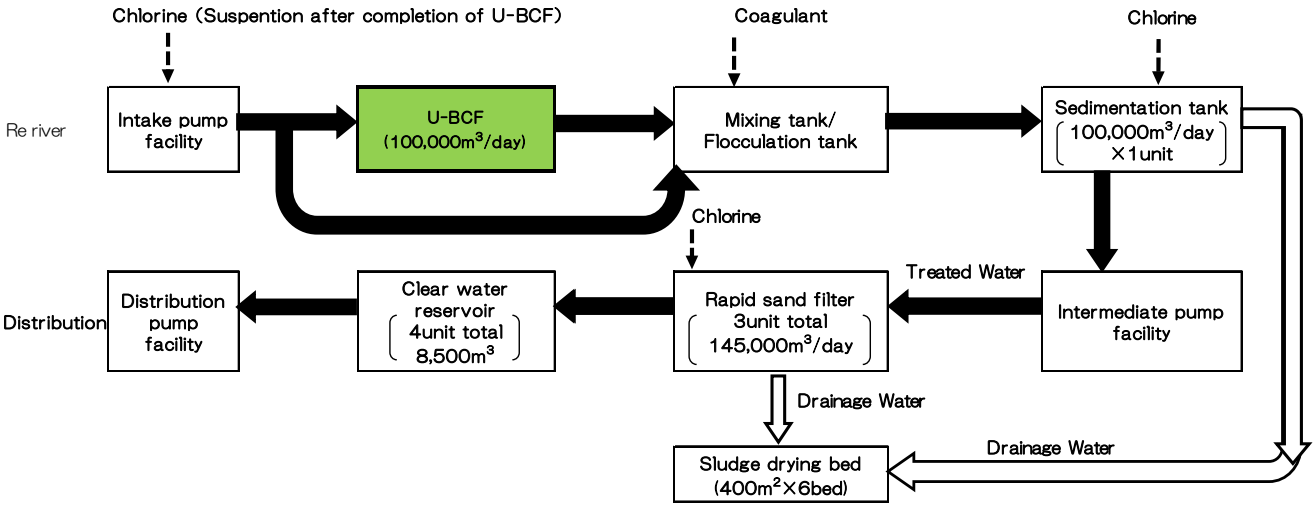


Figure 2-2-6 Water Treatment Flow before Completion of the ADB Project

Source: JICA Study Team (Based on interviews with Hai Phong Water)

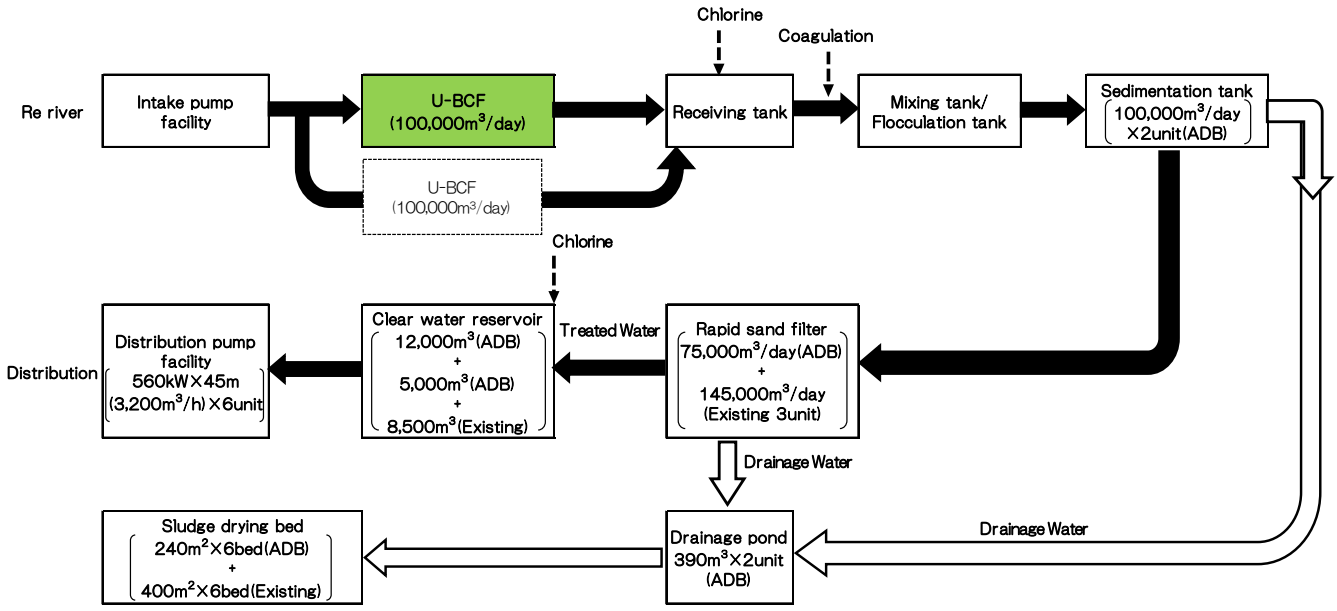


Figure 2-2-7 Water Treatment Flow after Completion of the ADB Project

Source: JICA Study Team (Based on interviews with Hai Phong Water)

After the completion of U-BCF of this Project until the completion of the ADB Project, valve chambers and valves shall be installed along the pipeline by this Project to prepare for future expansion constructions. The connection of treated water and backwash drainage is shown in Figure 2-2-7.

The water level of U-BCF shall be set to enable gravity flow to the receiving basin which is to be constructed by the ADB Project.

Currently, chlorine injection can be made at three points; intake, after sedimentation, and after sand filtration. In the past, injection was made at the intake and after sand filtration, but THM generation reduction was expected and choline injection was changed to after coagulant treatment of organic matters (precursor of THM). Therefore since November 2013, chlorine injection has been cancelled at the intake and is done after sedimentation and sand filtration. The water treatment of U-BCF uses self- purification of microorganisms, hence to prevent the wipe out of necessary organisms, it is proposed to Hai Phong Water to suspend chlorine feeding at the intake after completion of U-BCF.

However, "Golden Mussel (*Limnoperna fortunei*)" has occurred at Vinh Bao WTP's U-BCF pipes and flowmeters, and is causing flow problems in the water column. Small amounts of chlorine are added in the transmission pipes as a countermeasure.

Based on the "Guideline for Golden Mussel (*Limnoperna fortunei*) Damage Countermeasure (Ministry of Agriculture, Forestry and Fisheries, March 2013)", the below methods may be adopted for An Duong WTP.

- Apply epoxy resin lining to the insides of the pipes
- Install fine screens
- Remove by human or machine power
- Chemical treatment, such as chlorine

For this Project, measures to apply epoxy resin lining to the insides of the new pipes and to install fine screens (which shall not block the water flow) are to be adopted to prevent golden mussel interference.

The golden mussels stuck to the facilities are to be physically removed by human or machine power, and also the measurement to inject small amounts of chlorine into the transmission pipes which will not affect the U-BCF operation shall be considered.

Table 2-2-7 Connection of Treated Water and Backwash Drainage Water

Phase	Treated water	Backwash Drainage water	Remarks
Before completion of the ADB Project	Connect to the existing mixing tank	Drain to the existing sludge drying bed	Construction works of Grant Aid (refer to Figure 2-2-8) ① Pipeline to the mixing tank ② Pipeline to the sludge drying bed ③ Branch pipes and valves for the future
After completion of the ADB Project	Connect to the new receiving tank	Drain to the new sludge drying bed through the new drainage pond	Construction works of Recipient (refer to Figure 2-2-9) ① Pipeline from the branch valve to the new receiving tank ② Pipeline from the branch valve to the new drainage pond

Source: JICA Study Team (Based on local survey)

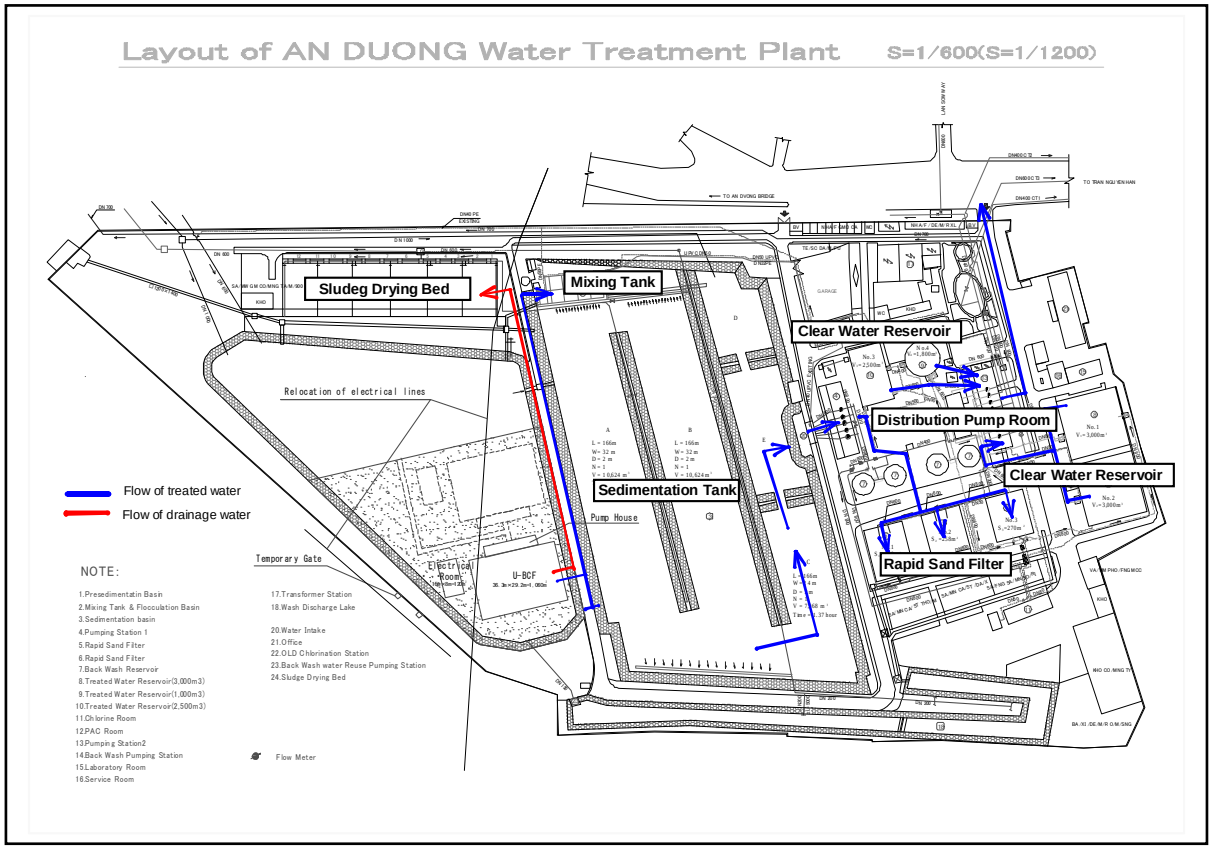


Figure 2-2-8 Layout Plan Before Completion of the ADB Project (After Completion of U-BCF)

Source: JICA Study Team (Based on local survey)

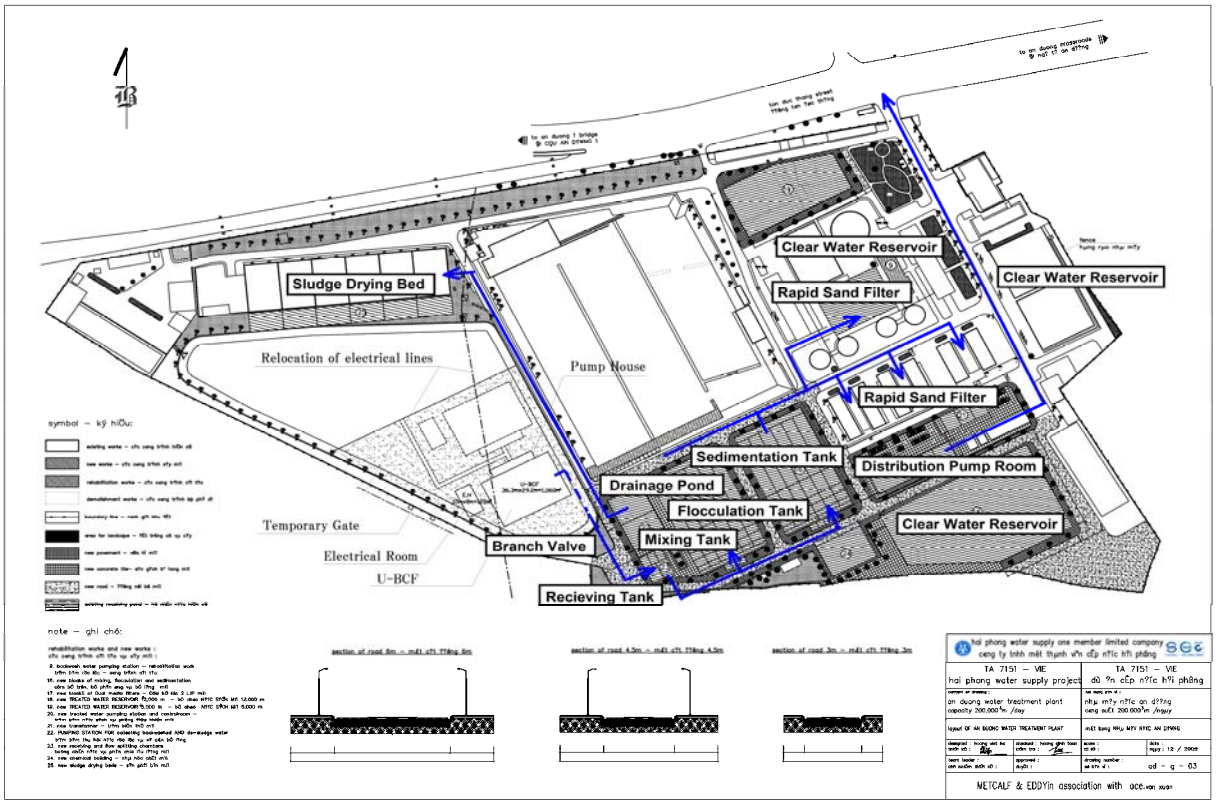


Figure 2-2-9 Layout Plan After Completion of the ADB Project

Source: JICA Study Team (Based on local survey)

2) Basic Design Policy

- The height of the U-BCF receiving tank (HWL) is to be set at a level which enables gravity flow to the pH regulating receiving reservoir (HWL + 11.1m), which is to be constructed in the future.

- The raw water inflow method is to be divided into 2 systems, considering the possibility of a long-period operation suspension for daily cleaning, repair, parts replacement and accidents. The inflow is to be divided at the channel from the inflow well, to flow through the raw water intake pipe at the bottom of the channel to the cleaning shafts of each U-BCF, to the raw water culvert.

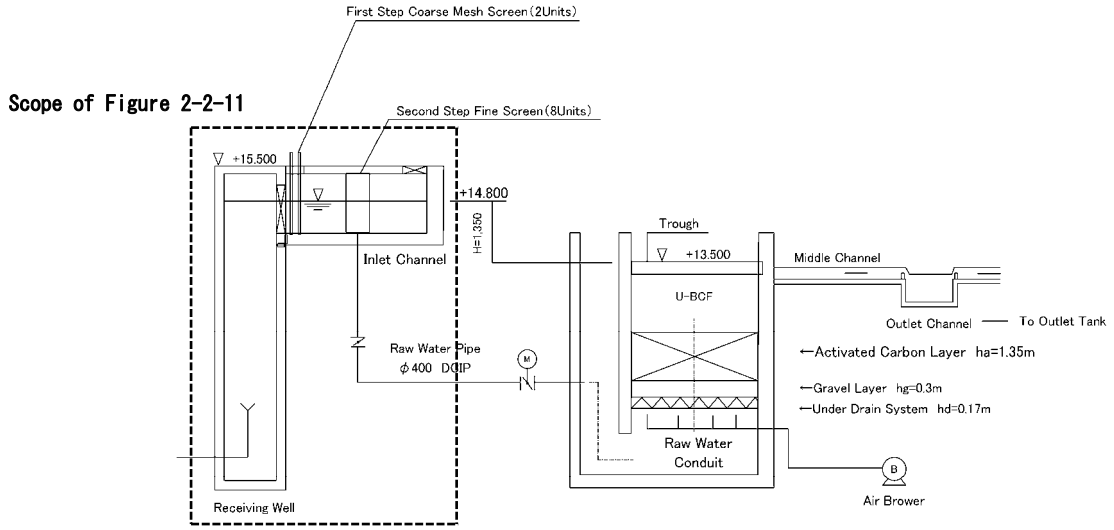


Figure 2-2-10 Water Treatment Flow

Source: JICA Study Team (Based on local survey)

- U-BCF adopts upward flow method; hence it is necessary to prevent clogging at the lower underdrain system. For this design, a two-step dust filter is to be established before the raw water inlet culvert. The first step is installed at the outlet of the U-BCF receiving tank (2 outlets), and the second is to be installed at the raw water intake (8 intakes) at the raw water inflow channel.

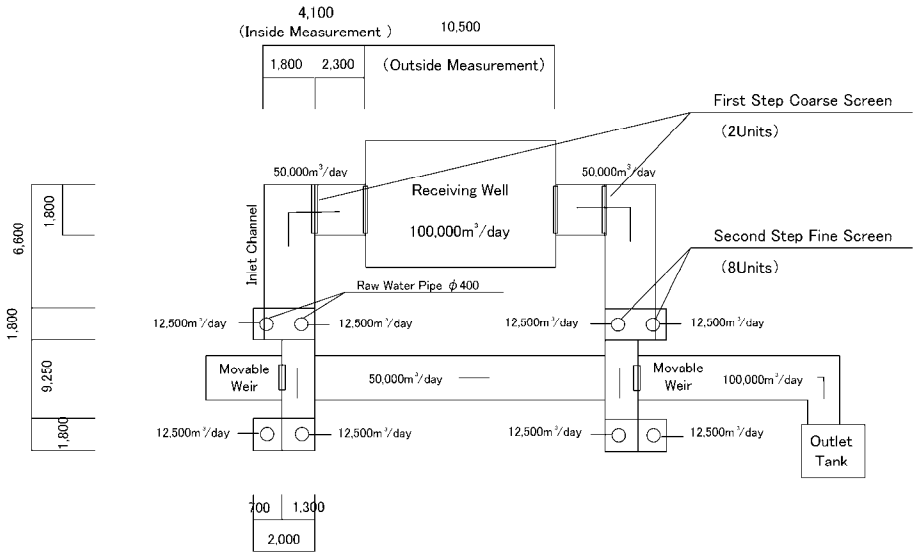


Figure 2-2-11 Raw Water Flow

Source: JICA Study Team (Based on local survey)

- Design Planning of U-BCF

Water quality improvement results by biological treatment depend largely on both the raw water quality and environmental conditions such as the water temperature.

Design factors for An Duong WTP's U-BCF are set based on the results of the U-BCF test plant experiment conducted from August 2011 to August 2012.

The below factors have been studied from the An Duong WTP raw water data.

1) Water temperature

The optimum temperature for microorganisms related to aerobic treatment is 20 – 30ºC, and the biological activity drops as the temperature drops, hence the water treatment efficiency will decrease. Especially, the activity of nitrobacteria shows a significant fall below 5ºC.

- The factor affected by water temperature related to hydraulic accounting is the dead loss of the activated carbon layer (1.35m).
- The water density drops when the water temperature rises, hence the water loss increases.
- The safety regarding water height level of the WTP shall be considered in the design.
- Raw water temperature 33ºC is to be used for the calculations

2) Dissolved oxygen (DO)

A blower is to be installed in the raw water inflow well (receiving well) for dust clearing and oxygen supplying, and aeration treatment by the diffusing pipe.

3) Turbidity

In case the frequency of U-BCF clogging due to high turbidity rises, either the cleaning interval period is to be shortened or the water shall be transmitted to the sedimentation tank via a by-pass pipe without passing the U-BCF. A by-pass pipe of ϕ 1000mm shall be installed for this measure.

4) Flow debris / organisms

The following issues are occurring at Vinh Bao WTP.

- ✓ Golden mussels of various sizes are growing in the transmission pipes.
- ✓ Golden mussels are attaching to the flow meters and other equipment in the raw water inflow pipes and are causing water transmission problems.

For prevention measures of these issues, the epoxy resin lining pipes are to be installed for the raw water pipe and two-step stainless steel screens are to be installed in the inflow canals of this Project.

3) Basic Design Components

① Raw water culvert

The raw water trough is set at the bottom of the U-BCF, at a height which enables the cleaning of the underdrain system. It shall be tilted toward the drainage pit to improve the raw water drainage inside the culvert. In the drainage pit, a drainage pipe for backwashing in the biological contact filtration basin and a chemical drainage pipe for draining after chemical cleansing will be installed.

② Underdrain system

The system is to be made by porous plate-type stainless steel, with dispersion stability for water and air, easy to clean and pollution/clogging-free. It is also required to be capable of adapting to head loss, and able for a person to clean from below the equipment.

③ U-BCF treated water catchment

The water treated by U-BCF is to be collected in a stainless steel full-width trough (U type) installed at the upper part of the facility.

④ Manhole for the cleaning worker at the raw water culvert

Two (2) manholes are to be made for each U-BCF to allow the cleaning worker's entrance to the raw water culvert at the bottom of the facility. One manhole made for the worker by concrete, located at the top of the shaft outside the basin and uses a ladder down to the raw water culvert. The other is a φ800mm hole at the basin wall leading from the pipe chamber, which is to be used as for the manhole piping into the raw water culvert.

⑤ Cleaning method

Periodical cleaning; 2 times/week. Cleaning method; 2-step method by air cleaning and air & water cleaning. An electrical meter shall be installed to change the steps.

Stainless steel pipe of 200A for the U-BCF pipe chamber air cleaning, and 150A for the receiving well dust removal are to be used.

In addition, to confirm the expansion rate of the activated carbon (the surface level of the filter), a monitoring window is to be constructed for each basin to decide the cleaning activities and timing.

⑥ Drainage pipe for cleaning

Three types of drainage pipes shall be installed, which will be drain to the drainage pit in the raw water trough.

- U-BCF drainage pipe: Drainage pipe to lower the water level by 50 – 60 cm from the trough as preparation for air cleaning by stopping the filtration.
- U-BCF drain pipe: Pipe to drain the wastewater at the filter layer after air cleaning.
- U-BCF cleansing drainage pipe: Pipe to drain wastewater after the air & water cleansing.

⑦Drainage side of the drain wastewater

U-BCF treatment facilities are to be cleaned once in two days, and the wastewater after cleaning is to be drained to the sludge drying bed. The WTP currently has six (6) 400m^2 beds, and an additional six (6) 240m^2 beds are planned by the ADB Project. The total area is to be 3,840m^2.

The solid waste included in the wastewater from U-BCF is calculated by the following values. Raw water turbidity (60NTU), wastewater amount (13.54m^3/facility), and the waste amount per basin/one wash is 60NTU (specific gravity of wastewater turbidity)×1.3g/m^3×13.54m^3 / 1000 = 1.06kg. Total eight (8) basins are cleaned once in two days; therefore 1.06kg×8/2 = 4.24kg/day of waste are to be deposited to the sludge drying bed.

The ADB Project calculates the solid sludge from the treatment facilities (not including U-BCF) as 5,891.6kg/day, and the maximum sludge load at the drying bed is designed to be 80kg/m^2. The solid waste total from both U-BCF and the WTP facilities including the ADB Project is to be 5,895.8kg/day, the sludge load is to be 73.68kg/m^2, which is lower than the limit and hence it is possible for the sludge drying bed to receive the wastewater from U-BCF.

⑧ Outflow channel

The treated water from the trough flows through the outflow channels to the WTP receiving basin.

⑨ Outflow basin

The outflow basin is to hold the U-BCF treated water until it is sent to the sedimentation basin. The minimum retention time is 1.5minutes. One outflow pipe and one drainage pipe for washing of the outflow basin are required.

⑩ Test starting operation adjustments for biological treatment

The biological membrane forming period was first confirmed by the experimental plant of the grass roots project at An Duong WTP results showed that, when the plant operation began on June 23, 2011, the removal of organic matters and dissolved manganese was confirmed in one month, and the removal of ammonium nitrogen was confirmed one and a half month later. From these results, the biological membrane forming period is expected to be 1.5 – 2 months.

It shall be necessary to undergo test operation with the biological membrane formed and the water treatment performance at the full level for facility handover. Extension of the construction period shall raise the cost; therefore it is recommended to make the biological filter at an early stage of the construction to install and activate the carbon.

4) Basic Design Conditions

As mentioned in (3) 1) to (3) 3) , the design conditions for An Duong WTP U-BCF, based on the experiment plant run by Honjyo WTP U-BCF of Kitakyushu City Water and Sewer Bureau, are listed in Table 2-2-8 for consideration.

Table 2-2-8 Conditions of the Outline Design

Item	Contents			
1.Design Filtration Flow	Q＝100,000m^3/day			
2.Design Water Level	Re river Water level	Intake pump Hydraulic water level	Biological contact filtration Recieving tank water level	Receiving well constructed for expanding facilities by ADB loan
	WL＋3.0m	WL＋25.0m	HWL＋14.8m	HWL＋11.1m
	Hydraulic calcurations should be satisfied between Re river water level, intake pump water level, receiving tank water level and pH regulating reservoir water level.			
3.Biological Contact Filtration Filter Conditions of the outline design	① Space Velocity : SV＝ 10 1/h＝0.167 1/min ② Contact Time : 1/SV＝6 min ③ Linear Velocity : LV＝SV×H＝10×1.35＝13.5m/h＝324m/day ④ Filter Layer Depth : H＝1.35m ⑤ Treated Water Amount : Q＝100,000m^3／day ⑥ Filtartion Bed Area : A＝Q/LV＝100,000÷324m/day＝309m^2 ⑦ Number of Chamber : n＝8 chamber(no setting up a stand by) ⑧ Treatment water amount per 1 chamber：q＝12,500m^3／day ⑨ Filtartion Bed Area per 1 chamber：A´＝309m^2÷8basin＝38.6m^2/ chamber ⑩ Packing Filtration Media(Granular Activated Caron)Volume： No④, ⑥1.35m×309m^2＝417m^2≒420m^3 ⑪ Stracture : Reinforced Concrete construction			
4.Biological Contact Filtration Detail Conditions	① Method of raw water transmission from the receiving tank to each filter Open channel and pipe line (DIP) ② Underdrain system ・ Porous plate-type made by stainless steel ・ Stracuture should be easy to access to clean the under drain system ・ Installation of air pipe and pressure pipe ・ Making a free surface ③ Gravel layer ・Thickness of the filter：300mm Particle size φ2-4mm Thickness75mm Particle size φ4-7mm 〃 Particle size φ7-12mm 〃 Particle size φ12-20mm 〃 ④ Ganural Activated Carbon layer Effective Size ：0.5mm Uniformity Coefficient ：1.4 Specific Gravity ：2.0 ⑤ Trough ・Material ：Stainless steel ・Position ：Calculation by hydrologic accounting ・Length ： 〃 ⑥ The Overflow water of the receiving tank should be tansmitted to the outlet tank. ⑦ Dust removal facilities : two-stage mesh screen of coarse and fine screen ⑧ Backwashing drainage water(Q＝12.5m^3/min×15min＝187.5m^3≒188m^3) ⟶to the drying bed ⑨ Biological contact filtration Proposed ground level ・present ground level GL＋4.5m ・proposed ground level GL＋7.2m and GL＋4.5m ・slope gradient 1:1.2			

Item	Contents
5.Location of construction	Biological contact filtration should be constructed after a part of the south area of the raw water reservoir is reclaimed.
6.Ground	The founation ground (N=47,49) is located at -44m to -45.0m from the present ground (GL+4.5m). The ground between consists of clay and sand, and the N value of the clay is 1-8 degrees.
7.Foundation	The depth from the foundation of structure to the foundation ground is expected as approximately 45m, so the foundation type should be the pile foundation.

Source: JICA Study Team (Based on local survey)

(4) In-site piping

The ϕ 1000mm pipe running from the U-BCF to the chemical mixing tank is to be removed after the ADB-loan expansion project completion. Hence steel pipes which require low material and construction cost will be used for the temporary piping of this Project.

Water inflow into an excavation

Water inflow into an excavation is expressed by the following formula in case water is pumped only at the bottom of the excavation.

$Q\ (m^3/h) = 4\ k\ r0\ H0$

k : coefficient of permeability (m/h)

r0 : equivalent radius of the excavation (m)

H0 : gap between the static groundwater level and the bottom of excavation (m)

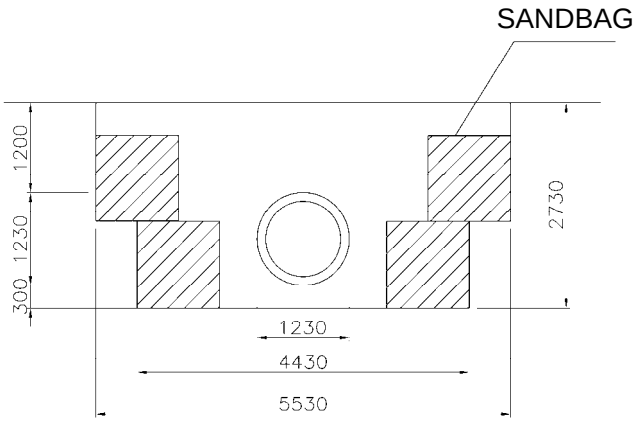


Figure 2-2-12 Typical drawing of pipe installing

Source: JICA Study Team (Based on local survey)

The maximum length of an excavation is set at 20 m in the construction plan of piping work. Therefore, if the width of an excavation is 2.0 m, the maximum of total length of an earth retaining structure for an excavation is 20×2 + 2.0×2 = 44 m. The equivalent radius of this excavation is

$2\pi r0 = 44$
$r0 = 7.0$ m.

The following coefficient of permeability was obtained in the laboratory test of geotechnical survey performed in August 2014. This coefficient is employed for the calculation.
k = 4.62×10-7 cm/s (= 1.66×10-5 m/h)

The groundwater level was found to exist at around the depth of 1.0 m from the ground through the geotechnical survey. In this regard, however, interviews to Hai Phong Water and the geotechnical survey company revealed that the groundwater level is likely to lower in December to April, which are the months piping work is planned to be carried out, by approximately 50 – 70 cm from August as December to April is the dry season. Thus, the depth of the static groundwater level is assumed to be 1.5 m. Since the depth of the excavation for 1000 mm dia. pipe is 2.8 m, H0 = 2.8 - 1.5 = 1.3m.

Therefore the water inflow into this excavation is calculated as follows:
$Q = 4\times1.66\times10\text{-}5\times7.0\times1.3 = 6.04\times10\text{-}4\ m^3/h = 1.45\times10\text{-}2\ m^3/d$.

(5) Electrical Room
The electrical room is to be built directly founded above the reinforced fill geotextile.

Geotextile for reinforcement of the fill is designed in accordance with “Manual for design and construction of reinforced soil using geotextile” (Public Works Research Center of Japan).

Bearing capacity per unit area of the reinforced soil using geotextile is expressed by the following formula:
$qd = \alpha \cdot C \cdot Nc + 2T \cdot \sin\theta / B + T \cdot Nq/r + \gamma \cdot Df \cdot Nq$,
where α is the shape coefficient, C is the cohesion of the ground, Nc and Nq are the bearing capacity factors, T is the tensile strength of geotextile, B is the loading breadth of machine used to lay and compact fill material, r is the radius of the approximate circle for deformation of the ground while laying and compacting, θ is the angle the deformed ground makes with the horizon, γ is the unit weight of the ground, and Df is the sinking depth of the ground.

The N-value of the soil near the pond bottom is assumed to be unity, and the following values are employed:
$C = 6.25\ kN/m^2$
Nc = 5.4
Nq = 1.1

The first term of the right side shows the bearing capacity of the ground that is attributable to only

cohesion. The weight of 4m-thick soil should be added to this term because the pond bottom has beard the weight. The unit weight of soil is assumed to be 18 kN/m^3.

r, θ, and Df are obtained by the following equations. H is the thickness of the first soil layer after compaction that is directly laid on the geotextile. H = 0.3 m is substituted.

r = 0.125・C + 1.909 = 2.69 m
θ = -2.954・C + 36.220 = 17.75°
Df = (-0.054・C＋0.77)H = 0.12 m

A geotextile whose tensile strength is about 150 kN/m is employed in the construction plan and the cost estimation of this project. Thus T = 150 kN/m is substituted in the formula.

Therefore, the bearing capacity of the reinforced soil is
qd = 2/3×6.25×5.4 + 18×4 + 2×150×0.304/3.6 + 150×1.1/2.69 + 18×0.12×1.1
= 183.5 kN/m^2

1.3 is employed as the safety factor for the weight per unit area of fill and Electrical Room (4731 kN / 125.13m^2 = 37.8kN/m^2).
Therefore, the weight multiplied by the safety factor is
N = (18×4.0+37.8)×1.3 = 142.74 kN/m^2 < qd.
The reinforced soil can support Electrical Room.

(6) Electrical Facilities

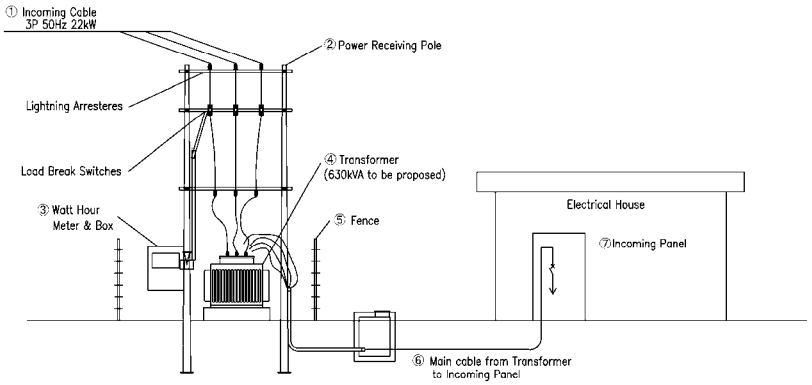
1) Power receiving/distributing facility

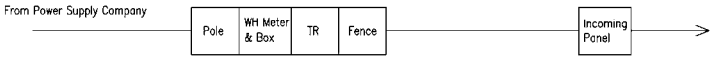
An electrical room is to be constructed next to the U-BCF at An Duong WTP, and power receiving and distributing panels for the U-BCF is to be installed inside the electrical room. The receiving capacity shall cover the necessary power to operate the U-BCF; therefore a 100kVA transformer is to be newly installed near the electrical room. The configuration of the panels is; incoming panel, low voltage feeder panel, motor control center, air blower for washing inverter panel, PLC panel and UPS panel.

As for Quan Vinh intake pumping station, an electrical room is also planned to be constructed to install power receiving and distributing panels for the station. These panels shall be able to cover the operation of the whole pumping station, including the intake pumps installed by this Project (160kW x 4 units) and the existing pumps (90kW x 3 units). The capacity of the existing transformer (750kVA) is not sufficient, hence it is planned to be replaced by a 1000kVA transformer. The configuration of the panels is; motor control center, intake pump inverter panel, PLC panel and UPS panel.

The construction fee for installation of the new transformers to the electricity company shall be

burdened by Hai Phong Water, and the demarcation of the construction/costs is shown in Figure 2-2-13.





		①	②	③	④	⑤	⑥	⑦
Cost	Grant Aid Project						○	○
	Hai Phong Water	○	○	○	○	○		
	EVN Hai Phong							
Equipment supply	Grant Aid Project						○	○
	Hai Phong Water							
	EVN Hai Phong	○	○	○	○	○		
Construction	Grant Aid Project						○	○
	Hai Phong Water							
	EVN Hai Phong	○	○	○	○	○		
Maintenance	Grant Aid Project							
	Hai Phong Water						○	○
	EVN Hai Phong	○	○	○	○	○		

EVN Hai Phong : Electrical of Viet Nam in Hai Phong

Figure 2-2-13 Demarcation of the Construction and Cost for EVN Hai Phong Construction Works

Source: JICA Study Team (Based on local survey)

2) Instrumentation equipment

To measure the values required for appropriate U-BCF operation at An Duong WTP, the following equipment is to be installed.

- U-BCF receiving tank water level meter: 1 unit
- Blower airflow meter: 1 unit
- U-BCF basin inflow meter: 1 unit per each U-BCF basin (total 8 units)
- Differential pressure meter: 1 unit per each U-BCF basin (total 8 units)

As for Quan Vinh intake pumping station, an intake flow meter and a river level meter shall be installed at the station.

3) Monitoring and control system

SCADA (Supervisory Control And Data Acquisition) system is to be installed as a U-BCF monitoring and control system at An Duong WTP. An operator's room shall be made in the electrical room for stationed operators, and equipment for the SCADA system shall be installed in this room. It will enable

the operators not only to monitor the values of the instrumentation, operating status for motor loads and failure signals but also to change parameters of U-BCF washing procedure by computer. In addition, it shall also be designed to monitor the measurement values and operating status of Quan Vinh intake pumping station.

Apart from the SCADA system installed for the U-BCF by the Project, An Duong WTP originally has an existing central monitoring system to monitor the entire WTP facility in the existing central monitoring room. Even though it was discussed whether to revamp the existing monitoring system in the Project, it has been concluded that the Project would not include the revamp of the existing monitoring system in the scope of work according to the following reasons:

① Operators are to be stationed for 24 hours at the operator's room in the electrical building constructed by the Project this time.

② A facility expansion project by ADB is planned in the near future, and the existing system flowchart is expected to be changed greatly following the construction. Considering this situation, even if the existing monitoring system is renewed by this Project, it shall require another significant renewal soon in the ADB project, which is not acceptable as a result of a grant aid project.

③ The existing central monitoring system was originally installed in An Duong WTP as a part of comprehensive monitoring system of Hai Phong Water head office. That is to say the same monitoring system was also installed in Hai Phong Water head office and other facilities in Hai Phong City at the same time with a private internet network so that Hai Phong Water could monitor and gather all the real-time information of the facilities at the head office. If the Project revamped the existing monitoring system in An Duong WTP, it would be inevitable to affect operation of the other facilities outside An Duong WTP which are linked through the private internet network. Therefore, regarding both the economical and operational points of views, multiple constructions for the system within a short span is not recommended.

From the above situations, reflecting U-BCF facility into the existing central monitoring system is an issue to be proposed to the ADB project.

4) Consideration of installing a standby generator

Currently, there is no standby generator in the An Duong WTP and Quan Vinh intake pumping station.

In case of power failure at the An Duong WTP, the entire water treatment process of the WTP would stop working. However, there is still no need to install a generator there because the WTP has higher priority to secure the power supply from the electrical company and actually power failure has not happened many in the WTP. On the other hand, in case of power failure at the Quan Vinh intake

pumping station, it would be possible to continue operation of the WTP by means of utilizing raw water stored in raw water regulation reservoir even though water transmission from the pumping station to both U-BCF and the raw water regulation reservoir would be stopped.

In addition, based on actual performance of Honjyo WTP at Kitakyushu City Water and Sewer Bureau, an U-BCF does not have any problems to be resumed its operation after standby condition for more than a half day. It means the U-BCF in the An Duong WTP would also be able to operate without problems even after water transmission to the U-BCF continuously stops for some time due to the power failure in the Quan Vinh intake pumping station. Furthermore, a U-BCF which is continuously out of service for about 3 days because of regular inspection and maintenance can be also recovered to the normal performance level within 1 or 2 days although the required time for the recovery depends on parameters of water quality.

For these reasons, it is concluded that the Project will not include the installation of a standby generator.

However, if another U-BCF with the capacity of 100,000 m3/day is constructed by landfilling more sections of the raw water regulation reservoir in the future after the ADB project expanding the capacity up to 200,000m3/day, the water supply service may have trouble regarding its stability due to the reduction of total water storage of the WTP which is available for emergency. Therefore, considering the current condition with frequent power failures at Quan Vinh intake pumping station (refer toTable 2-2-9), it is recommended to take countermeasures in the future such as installing a standby generator especially when the additional U-BCF is installed.

Table 2-2-9 Power Failure Records for An Duong WTP and Quan Vinh Intake Pumping Station

The number of incidents of a power failure		An Duong WTP		Quan Vinh Intake Pump Station	
		Times	Minutes	Times	Minutes
2012	Jan	2	18	9	759
	Feb	1	90	2	180
	Apr	0	0	2	39
	Aug	2	75	1	210
	Sep	1	9	0	0
	Oct	3	30	2	729
	Nov	1	6	2	165
	Dec	1	9	3	219
2012 Total		11	237	21	2,301
2013	Jan	0	0	3	168
	Feb	1	54	0	0
	Mar	0	0	2	54
	Apr	0	0	1	36
	May	2	24	5	381
	Jun	0	0	2	39
	Jul	0	0	2	126
	Aug	0	0	6	909
	Sep	0	0	1	6
	Oct	0	0	2	48
	Nov	1	180	2	525
	Dec	0	0	4	528
2013 Total		4	258	30	2,820
2014	Feb	0	0	1	150
	Mar	3	60	4	204

Source: Hai Phong Water

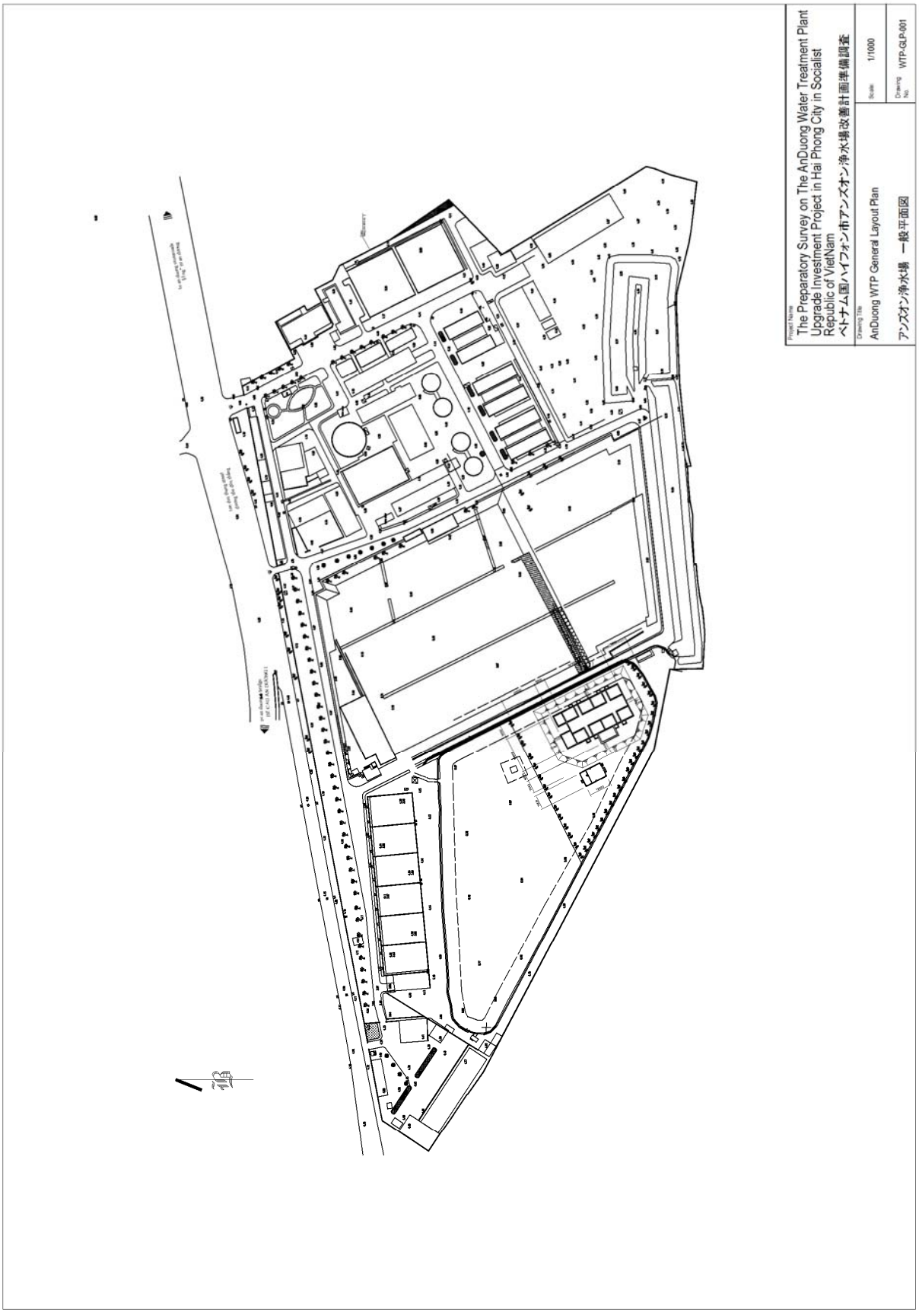
2-2-3 Outline Design Drawing

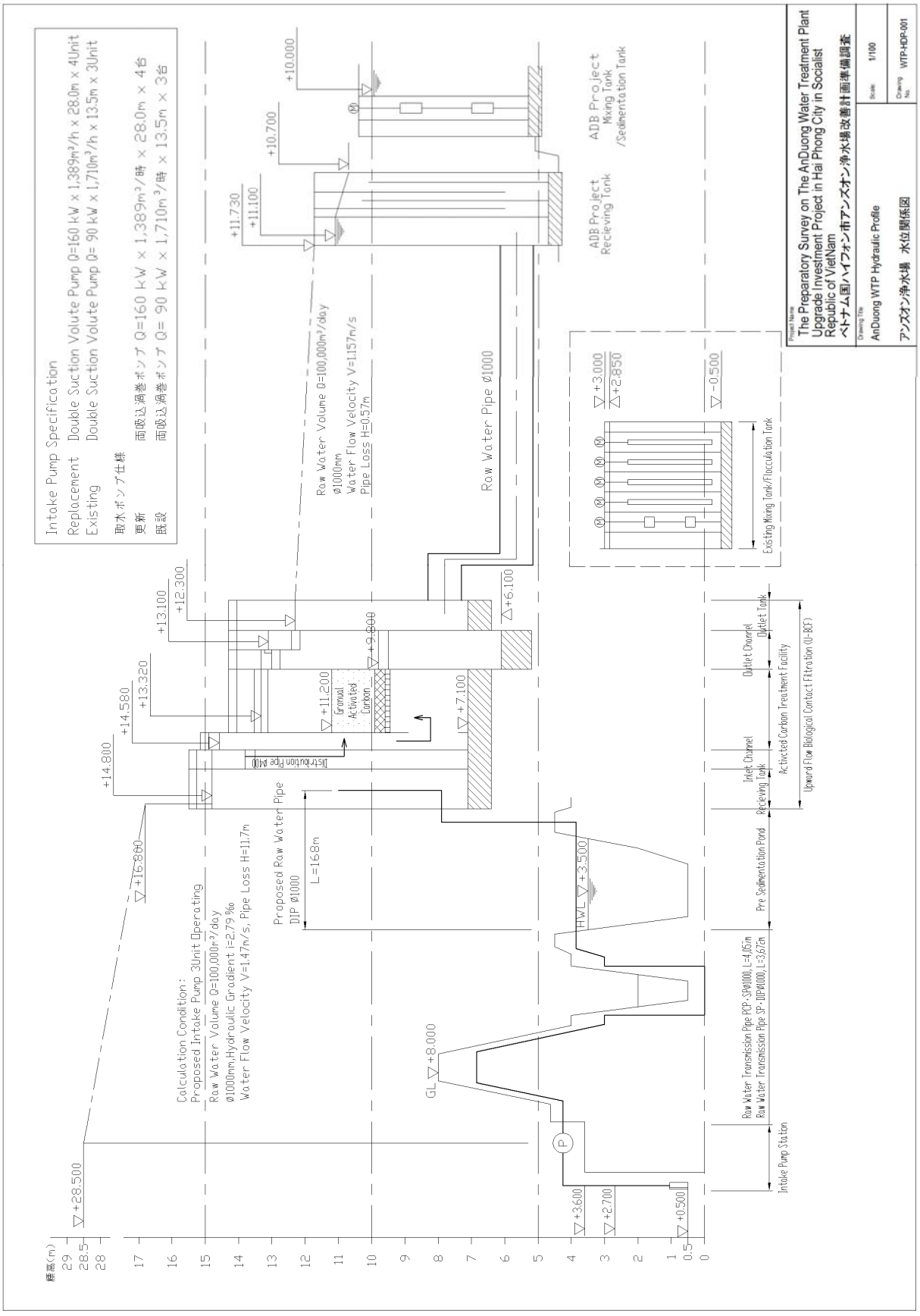
The list of Outline Design Drawing for this project is as show in Table 2-2-10.

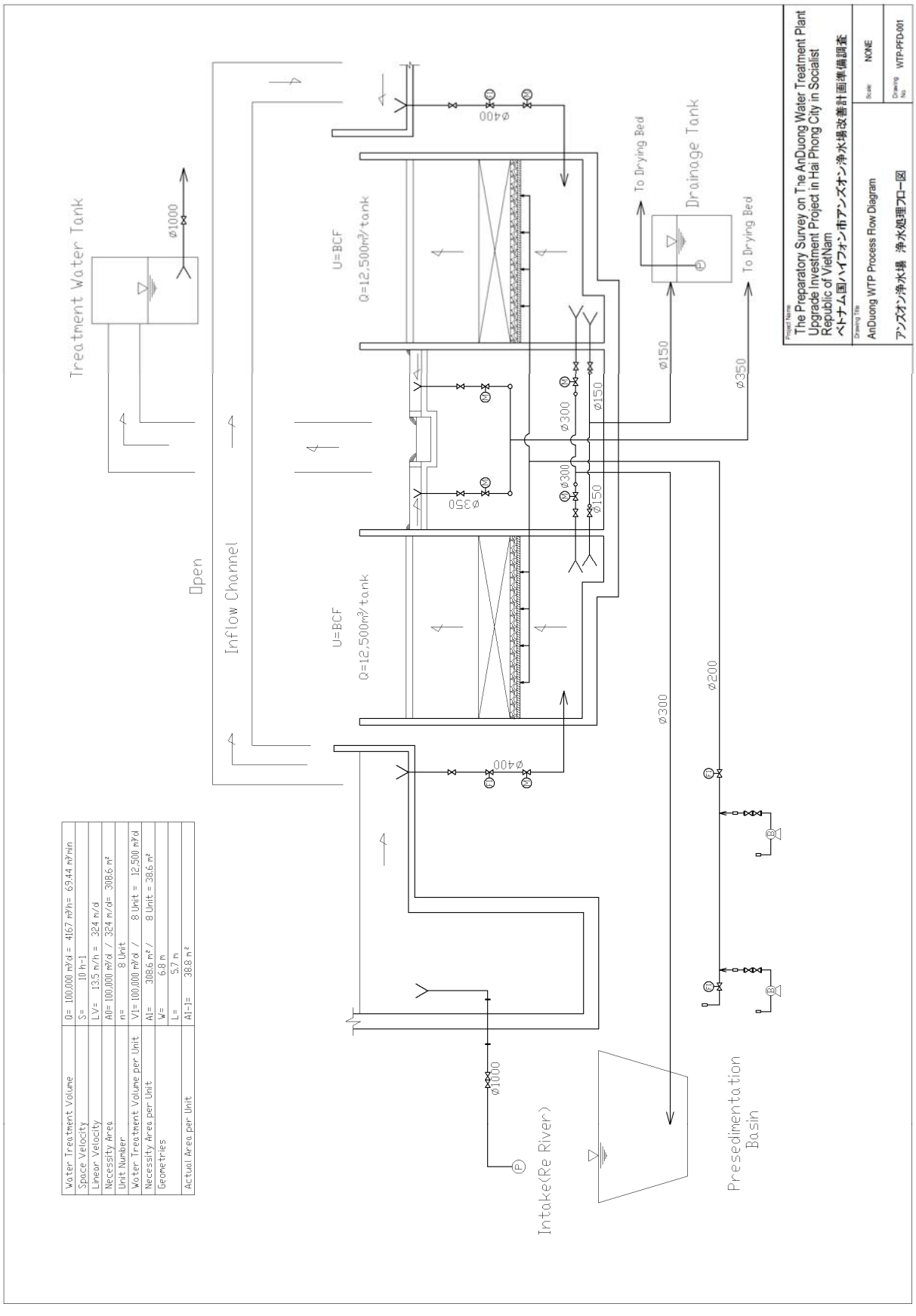
Table 2-2-10 List of Outline Design Drawing

Registration No.	Drawing No.	Drawing Title	Scale
001	WTP-GLP-001	An Duong WTP General Layout Plan	1/1000
002	WTP-HDP-001	An Duong WTP Hydraulic Profile	1/100
003	WTP-PFD-001	An Duong WTP Process Flow Diagram	NONE
004	WTP-MFD-001	An Duong WTP Mechanical Flow Diagram	NONE
005	WTP-RGP-001	An Duong WTP Reclamation General Layout Plan	NONE
006	WTP-RCS-001	An Duong WTP Reclamation Cross Section	NONE
007	WTP-PLP-001	U-BCF Second Floor Plan	1/200
008	WTP-TFP-001	U-BCF Top Floor Plan	1/200
009	WTP-SFP-001	U-BCF Second Floor Plan	1/200
010	WTP-FFP-001	U-BCF First Floor Plan	1/200
011	WTP-CRS-001	U-BCF Cross Section(1)	1/200
012	WTP-CRS-002	U-BCF Cross Section(2)	1/200
013	WTP-CRS-003	U-BCF Cross Section(3)	1/200
014	WTP-CRS-004	U-BCF Cross Section(4)	1/200
015	WTP-GLP-001	An Duong WTP Pipeline General Layout Plan	1/1000
016	WTP-DLP-001	An Duong WTP Pipeline Detail Layout Plan(1)	1/250
017	WTP-DLP-002	An Duong WTP Pipeline Detail Layout Plan(2)	1/250
018	WTP-DLP-003	An Duong WTP Pipeline Detail Layout Plan(3)	1/250
019	WTP-DLP-004	An Duong WTP Pipeline Detail Layout Plan(4)	1/250
020	WTP-ELR-001	U-BCF Electrical Room Plan and Section	1/200
021	WTP-IFD-001	An Duong WTP Instrumentation Flow Diagram	1/200
022	WTP-SLD-001	An Duong WTP Single Line Diagram(1)	NONE
023	WTP-SLD-002	An Duong WTP Single Line Diagram(2)	NONE
024	WIF-GLP-001	Quan Vinh Water Intake Facility General Layout Plan	1/200
025	WIF-SLD-001	Quan Vinh Water Intake Facility Single Line Diagram	NONE
026	WTF-ELR-001	Quan Vinh Water Intake Facility Electrical Room Plan	1/200

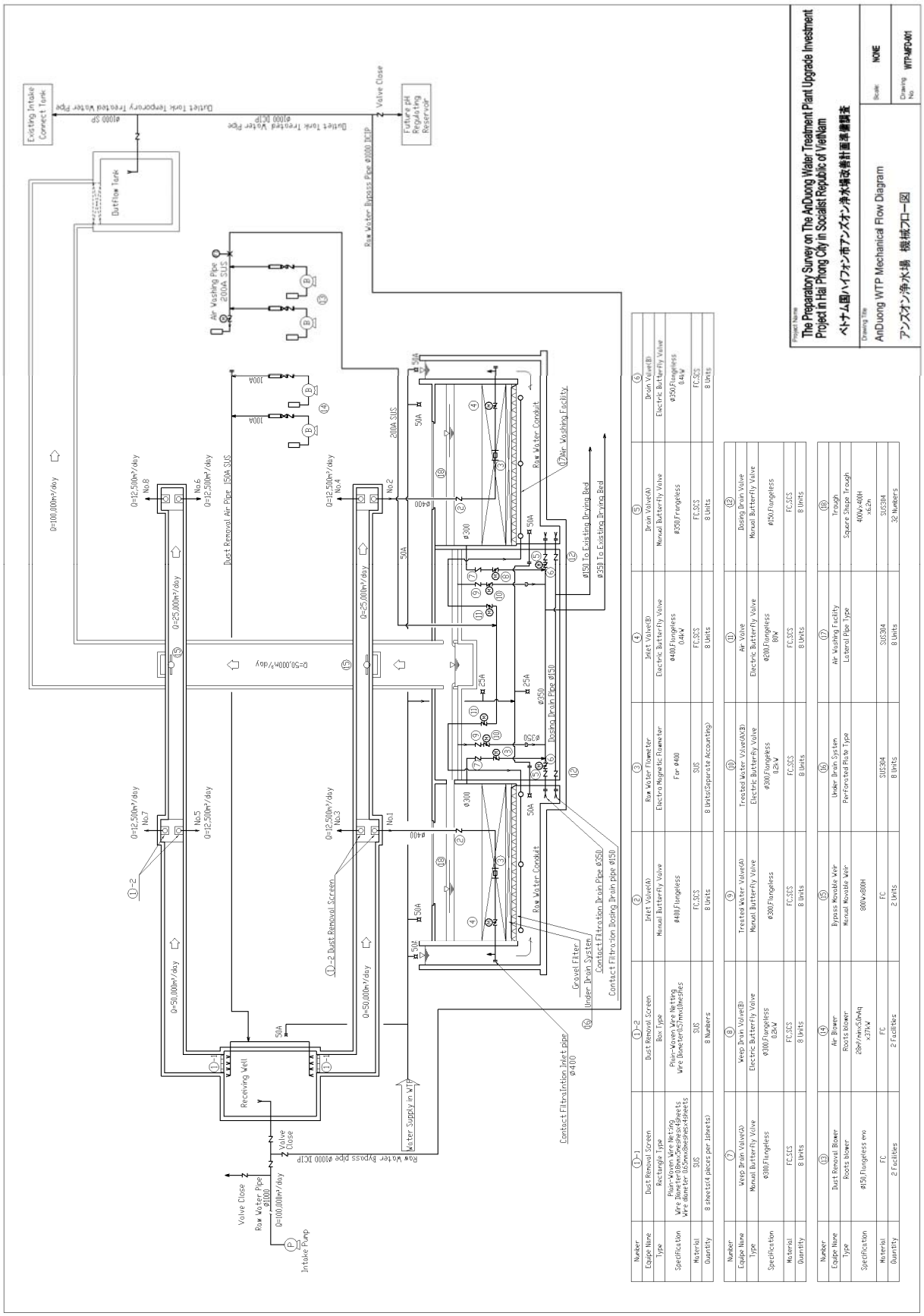
Source: JICA Study Team (Based on local survey)

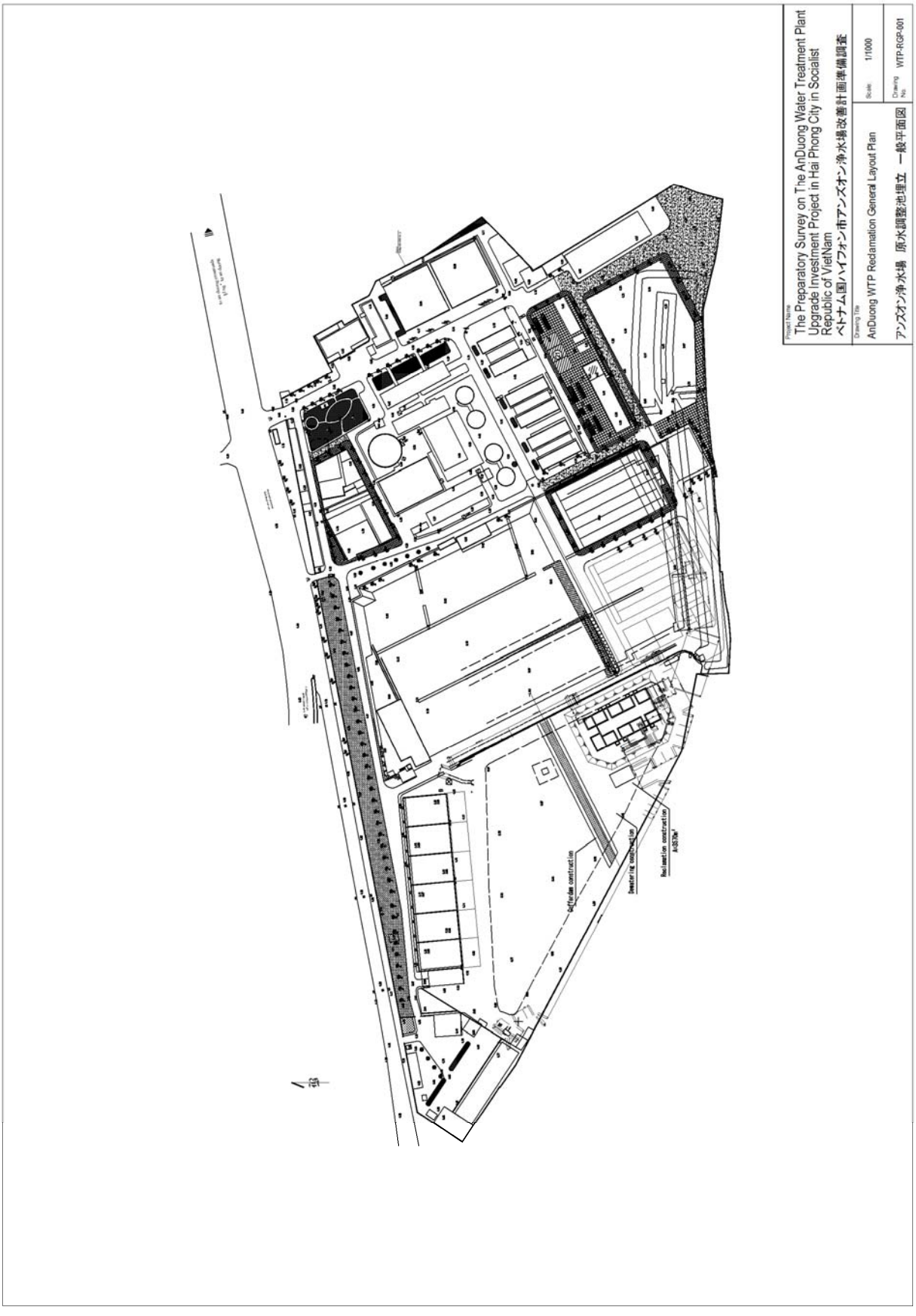

Project Name
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Drawing Title
AnDuong WTP General Layout Plan
アンズオン浄水場 一般平面図
Scale 1/1000
Drawing No. WTP-GLP-001

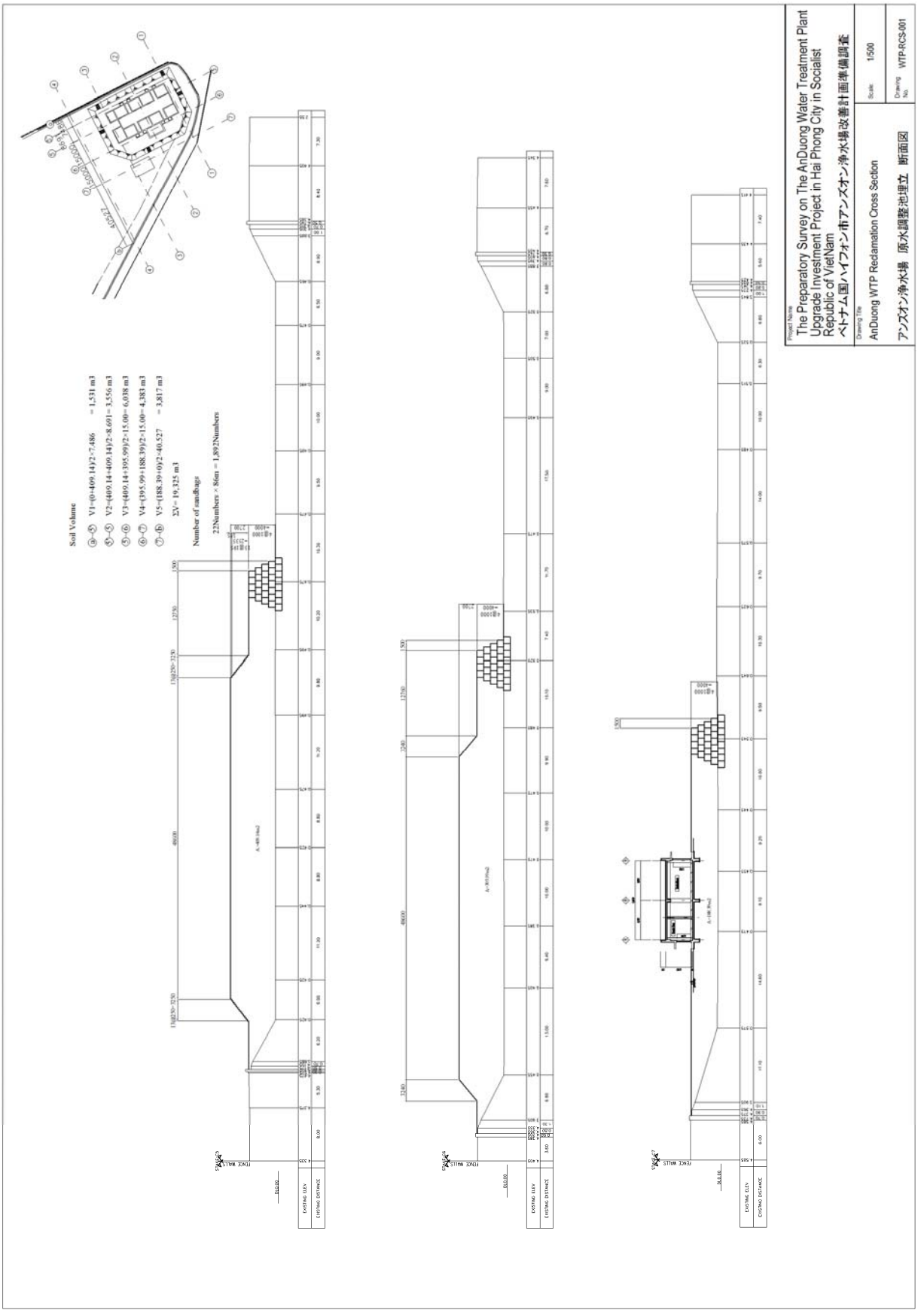

Intake Pump Specification
Replacement Double Suction Volute Pump Q=160 kW x 1,389m³/h x 28.0m x 4Unit
Existing Double Suction Volute Pump Q= 90 kW x 1,710m³/h x 13.5m x 3Unit
取水ポンプ仕様
更新 両吸込渦巻ポンプ Q=160 kW × 1,389m³/時 × 28.0m × 4台
既設 両吸込渦巻ポンプ Q= 90 kW × 1,710m³/時 × 13.5m × 3台
Raw Water Volume Q=100,000m³/day
ø1000mm
Water Flow Velocity V=1.157m/s
Pipe Loss H=0.57m
Raw Water Pipe ø1000
ADB Project
Recieving Tank
ADB Project
Mixing Tank
/Sedimentation Tank
Existing Mixing Tank/Flocculation Tank
Distribution Pipe ø400
Granual Activated Carbon
Proposed Raw Water Pipe
DIP ø1000
L=168m
Calculation Condition:
Proposed Intake Pump 3Unit Operating
Raw Water Volume Q=100,000m³/day
ø1000mm,Hydraulic Gradient I=2.79 ‰
Water Flow Velocity V=1.47m/s, Pipe Loss H=11.7m
HWL ▽+3.500
GL ▽+8.000
Raw Water Transmission Pipe RCP SP ø1000, L=1.05/m
Raw Water Transmission Pipe SP-DIP ø1000, L=3.67/m
Pre Sedimentation Pond
Inlet Channel
Recieving Tank
Activicted Carbon Treatment Facility
Upward Flow Biological Contact Filtration (U-BCF)
Outlet Channel
Outlet Tank
Intake Pump Station
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
AnDuong WTP Hydraulic Profile
アンズオン浄水場 水位関係図
Scale 1/100
Drawing No. WTP-HDP-001
標高(m)

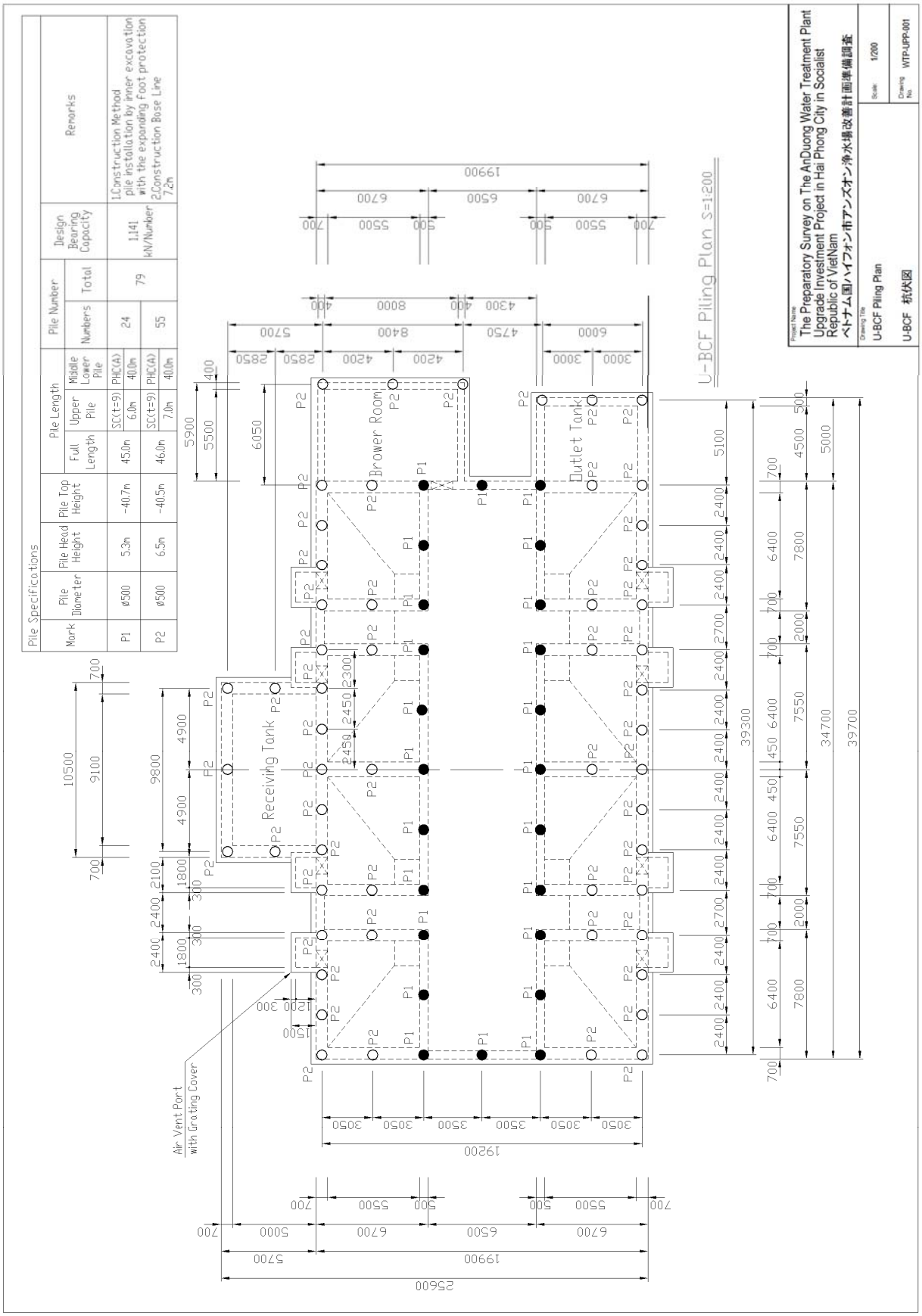


Water Treatment Volume	Q= 100,000 m³/d = 4167 m³/h= 69.44 m³/min
Space Velocity	S= 10 h-1
Linear Velocity	LV= 13.5 m/h = 324 m/d
Necessity Area	A0= 100,000 m³/d / 324 m/d= 308.6 m²
Unit Number	n= 8 Unit
Water Treatment Volume per Unit	V1= 100,000 m³/d / 8 Unit = 12,500 m³/d
Necessity Area per Unit	A1= 308.6 m² / 8 Unit = 38.6 m²
Geometries	W= 6.8 m
	L= 5.7 m
Actual Area per Unit	A1-1= 38.8 m²

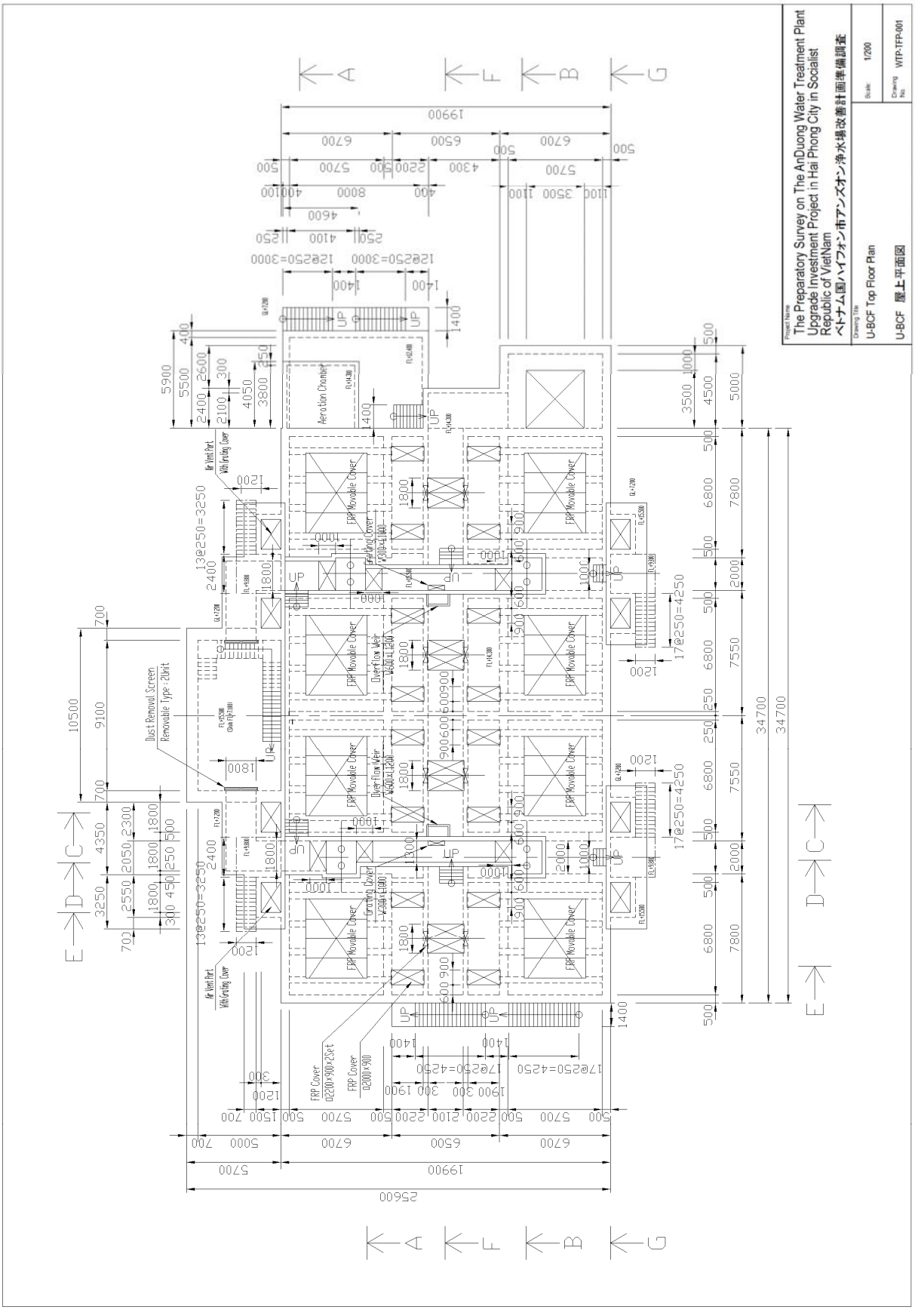

Project Name
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Drawing Title
AnDuong WTP Mechanical Flow Diagram
アンズオン浄水場 機械フロー図
Scale NONE
Drawing No WTP-MFD-001
Existing Intake Connect Tank
Outlet Tank Temporary Treated Water Pipe
Outlet Tank Treated Water Pipe
Future pH Regulating Reservoir
Valve Close
Raw Water Bypass Pipe
Air Washing Pipe 200A SUS
Dust Removal Air Pipe 150A SUS
Raw Water Conduit
Dosing Drain Pipe
Air Washing Facility
Receiving Well
Water Supply in WTP
Gravel Filter
Under Drain System
Contact Filtration Drain Pipe
Contact Filtration Dosing Drain pipe
Contact Filtration Inlet pipe
Raw Water Pipe
Intake Pump
Number
Equipe Name
Type
Specification
Material
Quantity

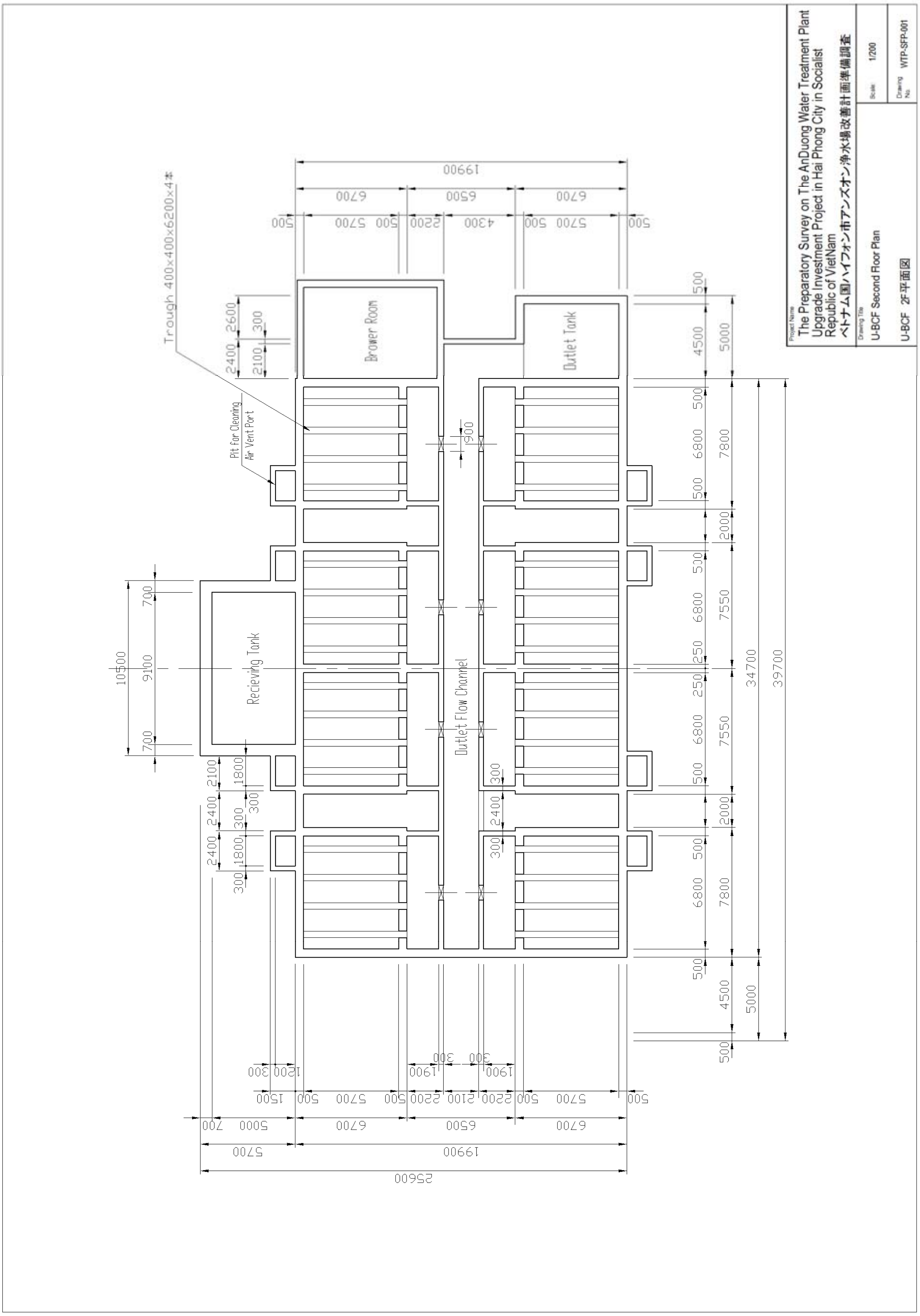

Project Name
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Drawing Title
AnDuong WTP Redamation General Layout Plan
アンズオン浄水場 原水調整池埋立 一般平面図
Scale 1/1000
Drawing No WTP-RGP-001
Cofferdam construction
Dewatering construction
Reclamation construction
A=357m²

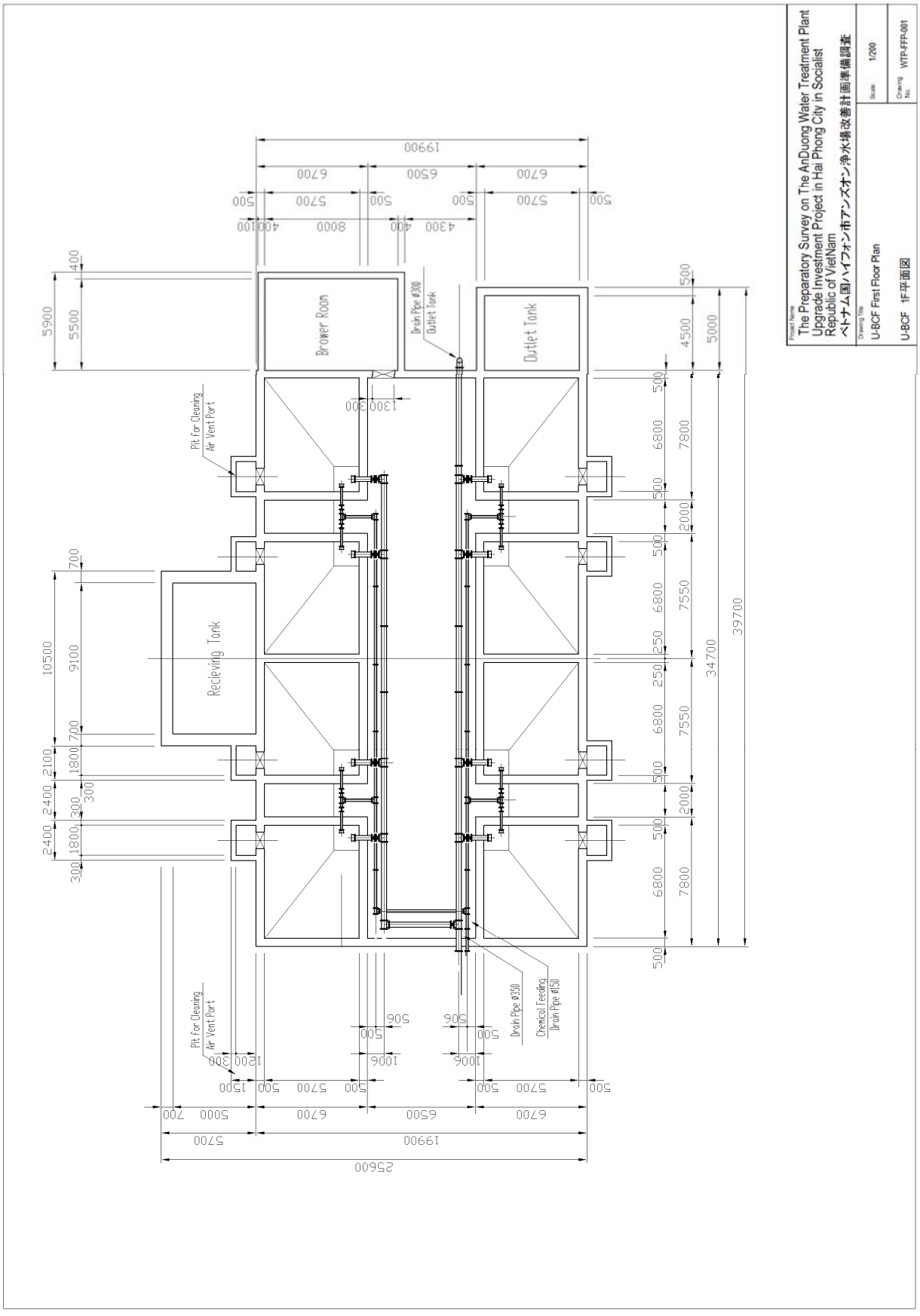

Soil Volume
⑨–⑤ V1=(0+409.14)/2×7.486 = 1,531 m3
⑤–⑤ V2=(409.14+409.14)/2×8.691= 3,556 m3
⑤–⑥ V3=(409.14+395.99)/2×15.00= 6,038 m3
⑥–⑦ V4=(395.99+188.39)/2×15.00= 4,383 m3
⑦–⑥ V5=(188.39+0)/2×40.527 = 3,817 m3
ΣV= 19,325 m3
Number of sandbags
22Numbers × 86m = 1,892Numbers
Project Name
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Drawing Title
AnDuong WTP Redamation Cross Section
アンズオン浄水場 原水調整池埋立 断面図
Scale 1:500
Drawing No. WTP-RCS-001

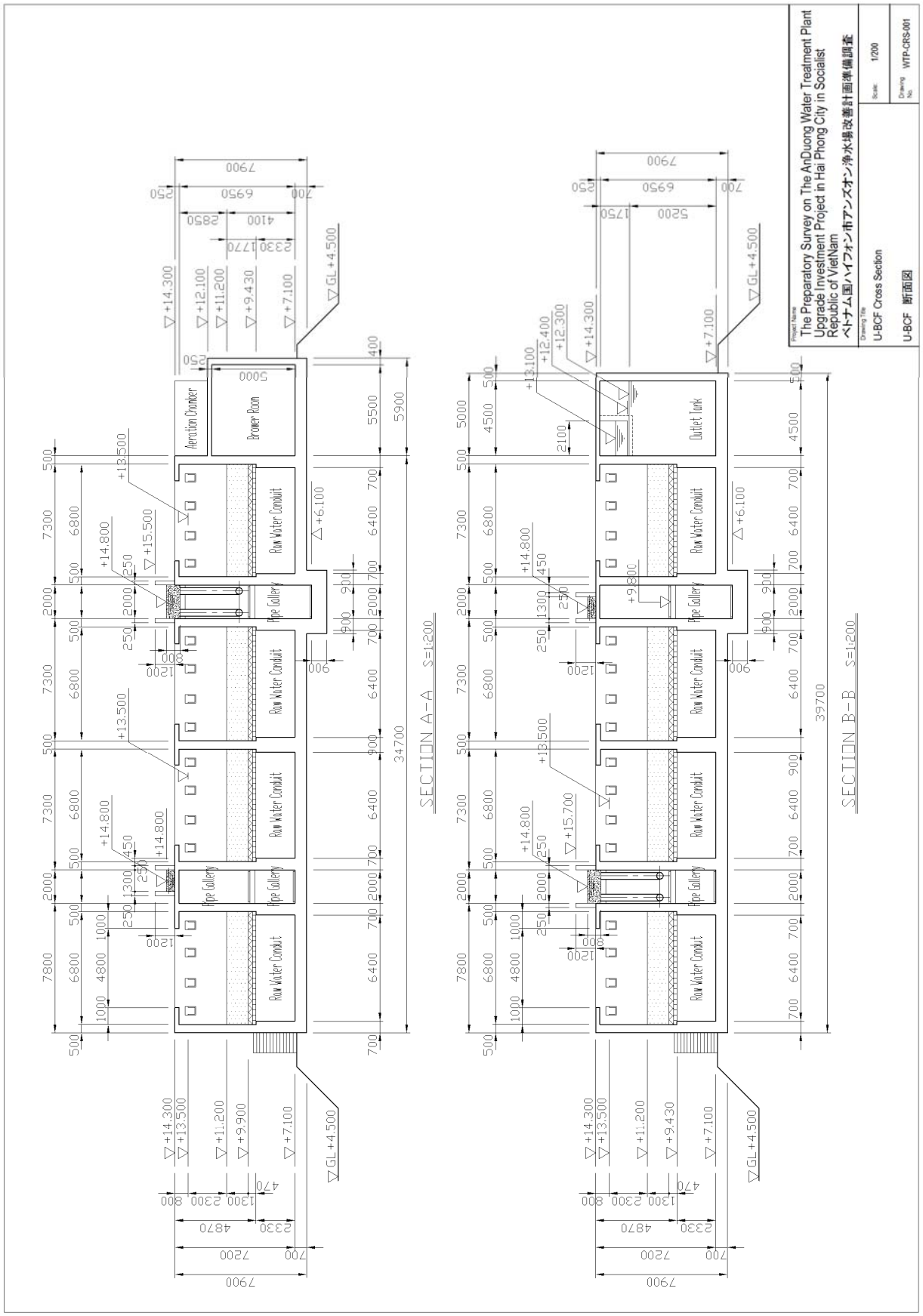


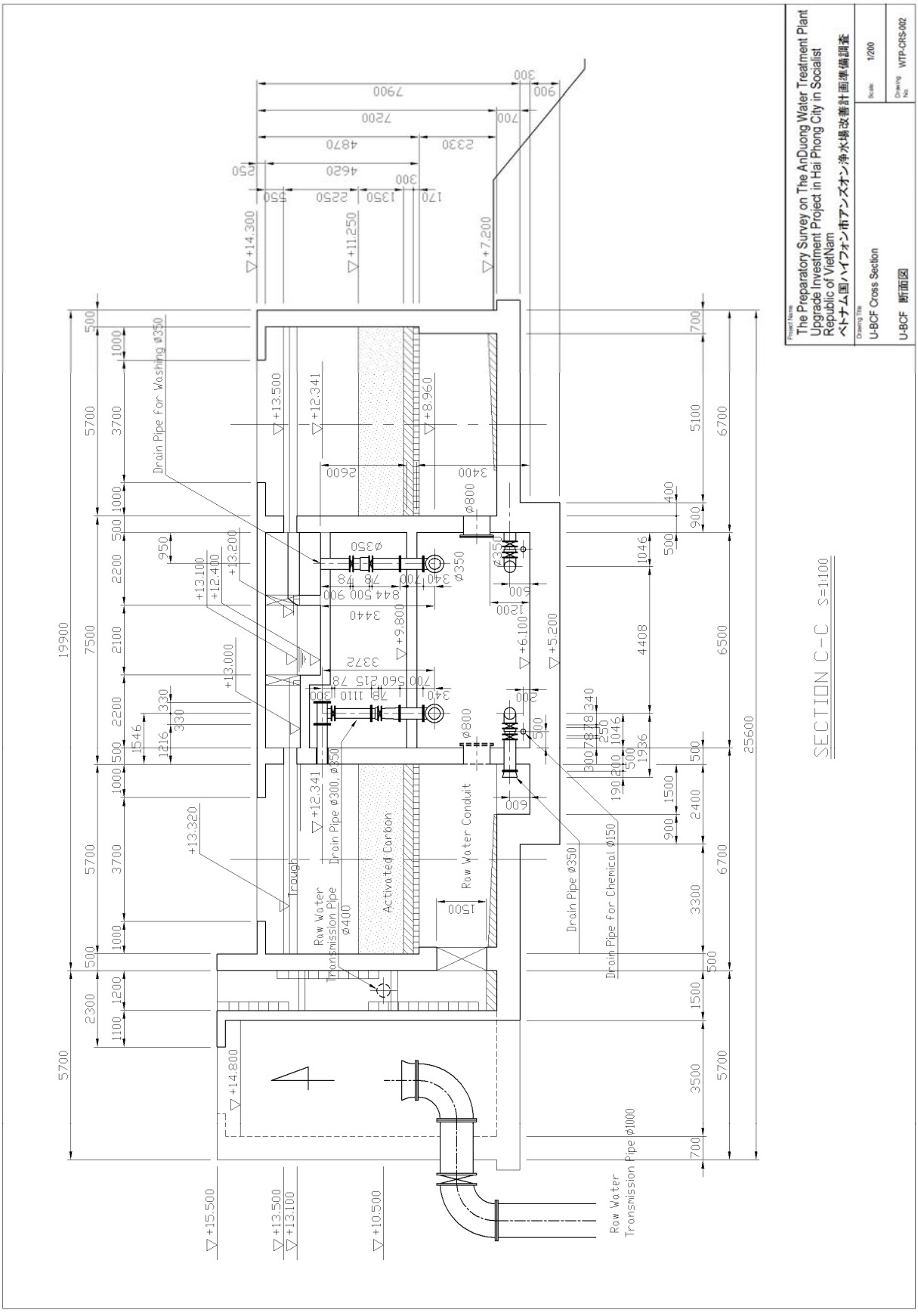
Pile Specifications														
Mark	Pile Diameter	Pile Head Height	Pile Top Height	Pile Length			Pile Number			Design Bearing Capacity	Remarks
				Full Length	Upper Pile	Middle Lower Pile	Numbers	Total			
P1	ø500	5.3m	-40.7m	45.0m	SC(t=9) 6.0m	PHC(A) 40.0m	24	79		1,141 kN/Number	1.Construction Method pile installation by inner excavation with the expanding foot protection 2.Construction Base Line 7.2m
P2	ø500	6.5m	-40.5m	46.0m	SC(t=9) 7.0m	PHC(A) 40.0m	55				

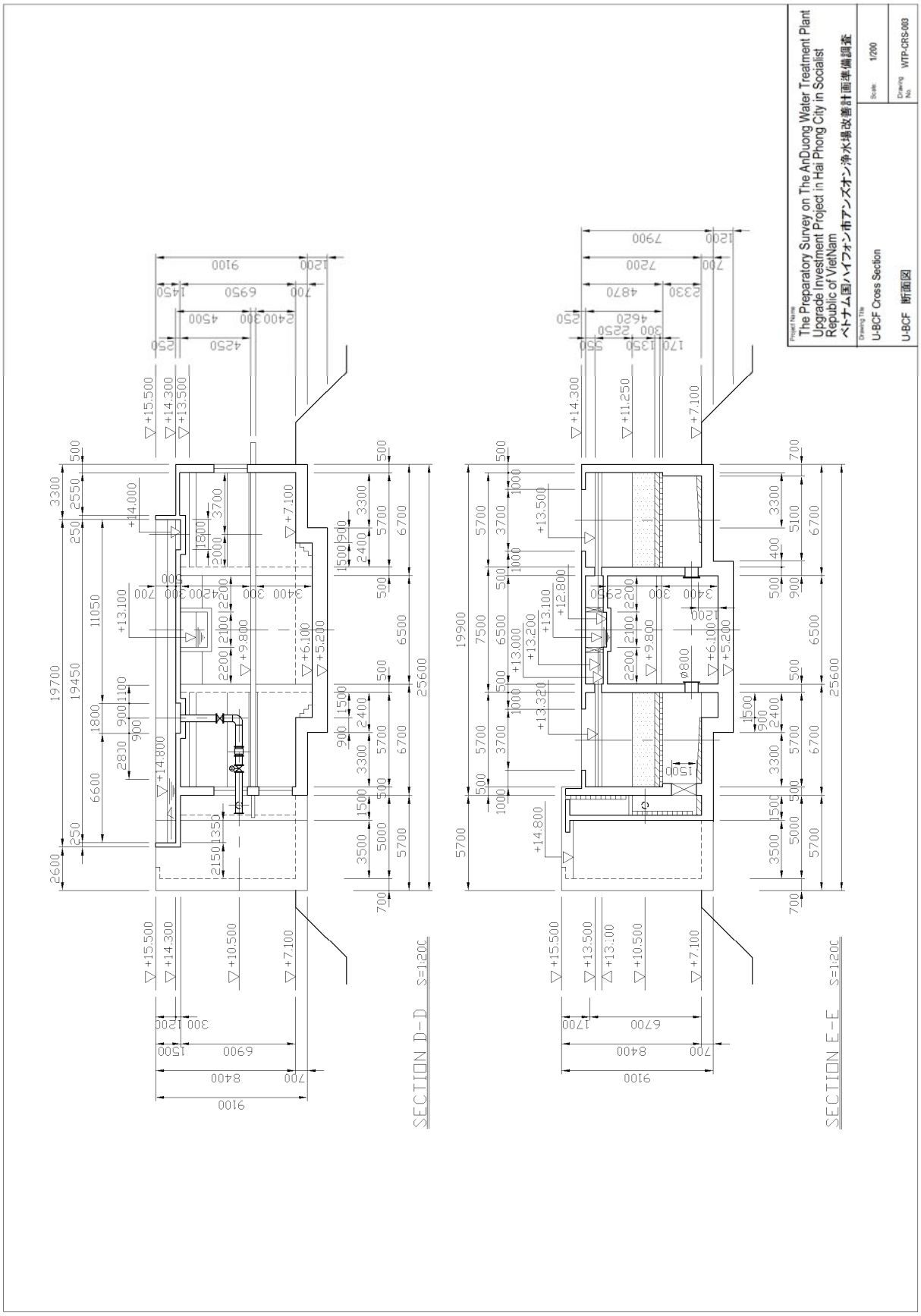

The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
U-BCF Top Floor Plan
U-BCF 屋上平面図
1/200
WTP-TFP-001
Aeration Chamber
FRP Movable Cover
Dust Removal Screen
Removable Type : 2Unit
Over Flow Weir
Grouting Cover
FRP Cover
Air Vent Port
With Grating Cover
UP
EP
19900
25600

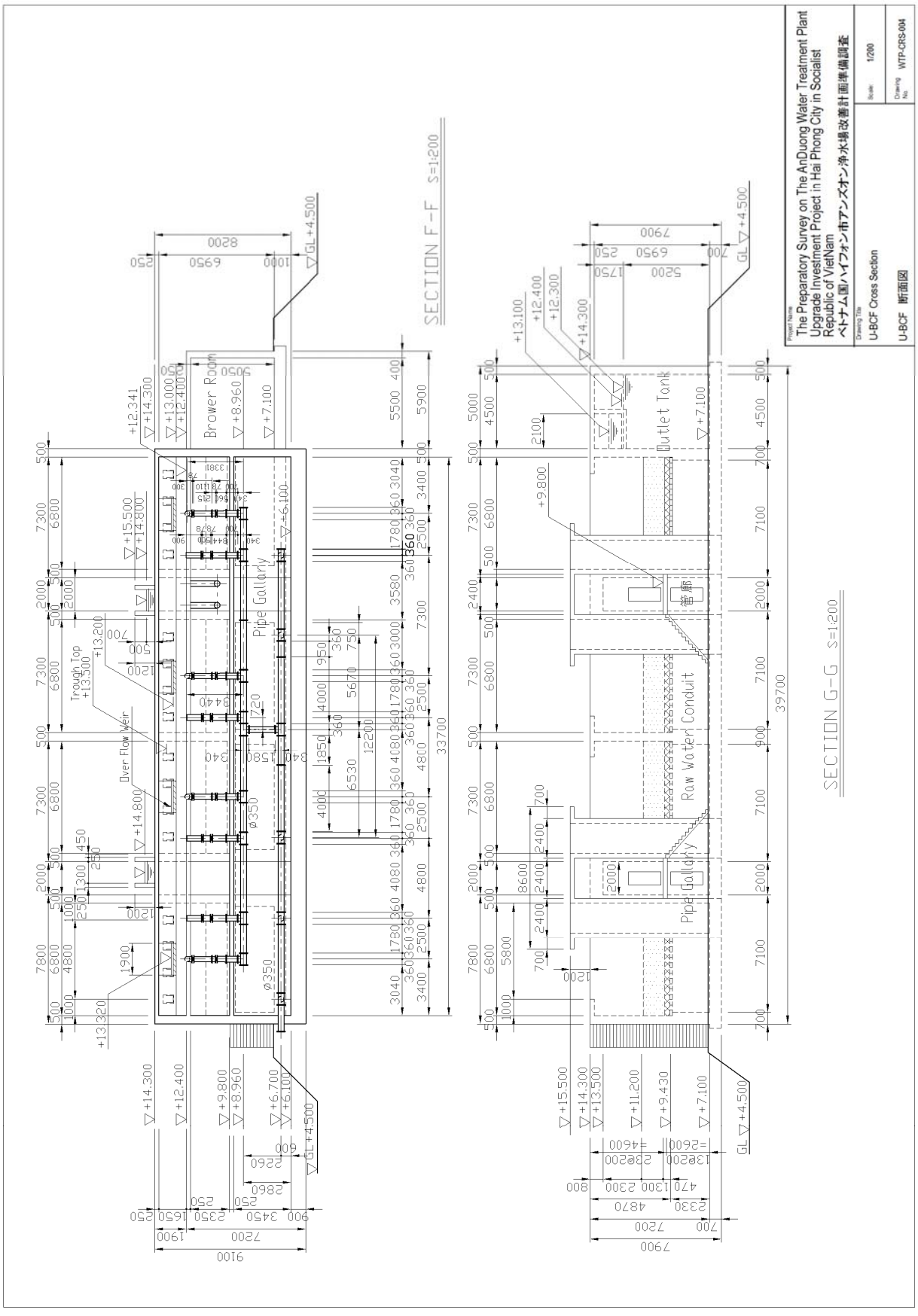

The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
U-BCF Second Floor Plan
U-BCF 2F平面図
1/200
WTP-SFP-001
Brower Room
Outlet Tank
Recieving Tank
Outlet Flow Channel
Trough 400×400×6200×4本
Pit for Cleaning
Air Vent Port

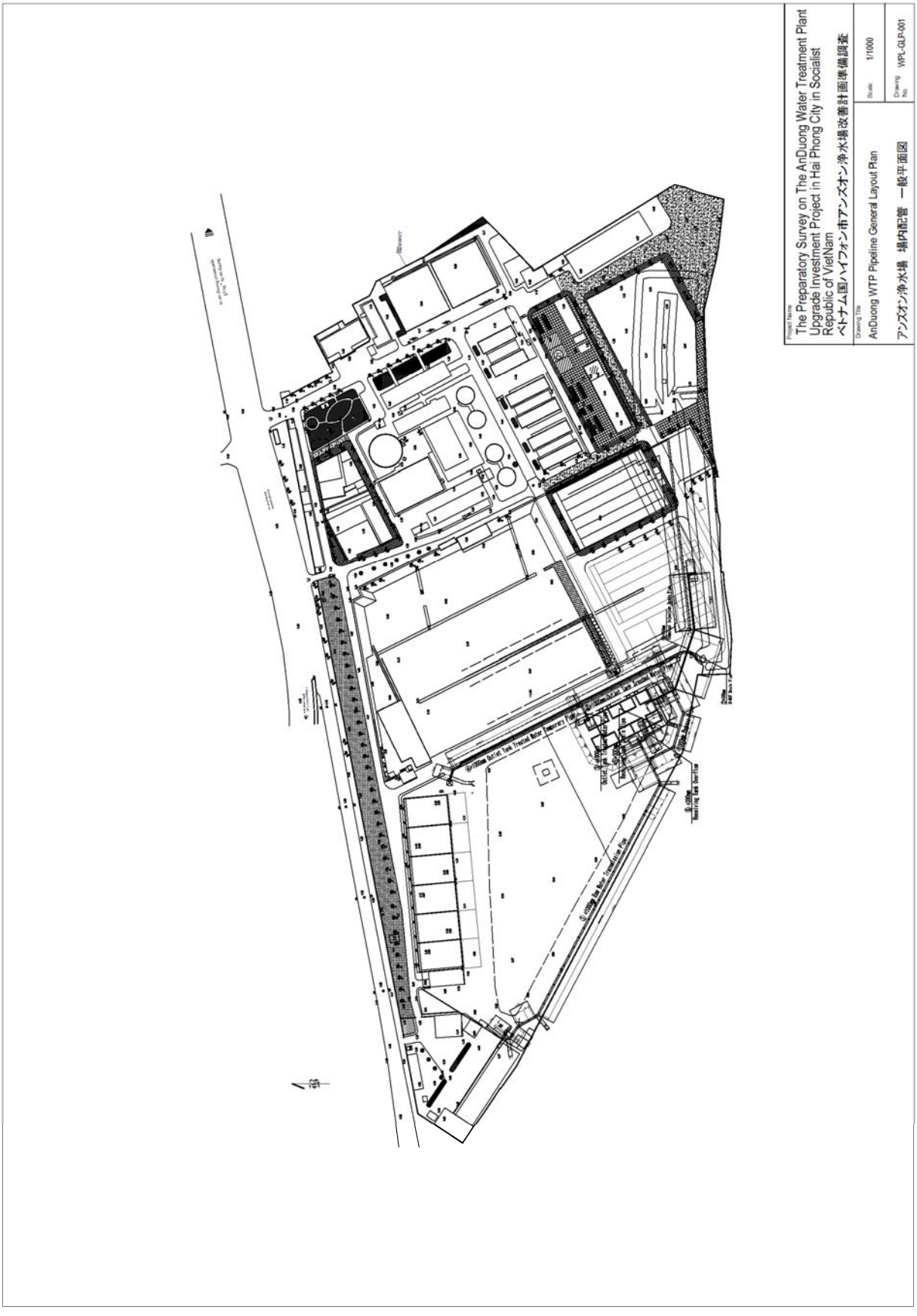

Project Name
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Drawing Title
U-BCF First Floor Plan
U-BCF 1F平面図
Scale 1/200
Drawing No. WTP-FFP-001
Brower Room
Outlet Tank
Recieving Tank
Drain Pipe Ø300
Outlet Tank
Pit for Cleaning
Air Vent Port
Drain Pipe Ø350
Chemical Feeding
Drain Pipe Ø150
19900
25600
39700
34700

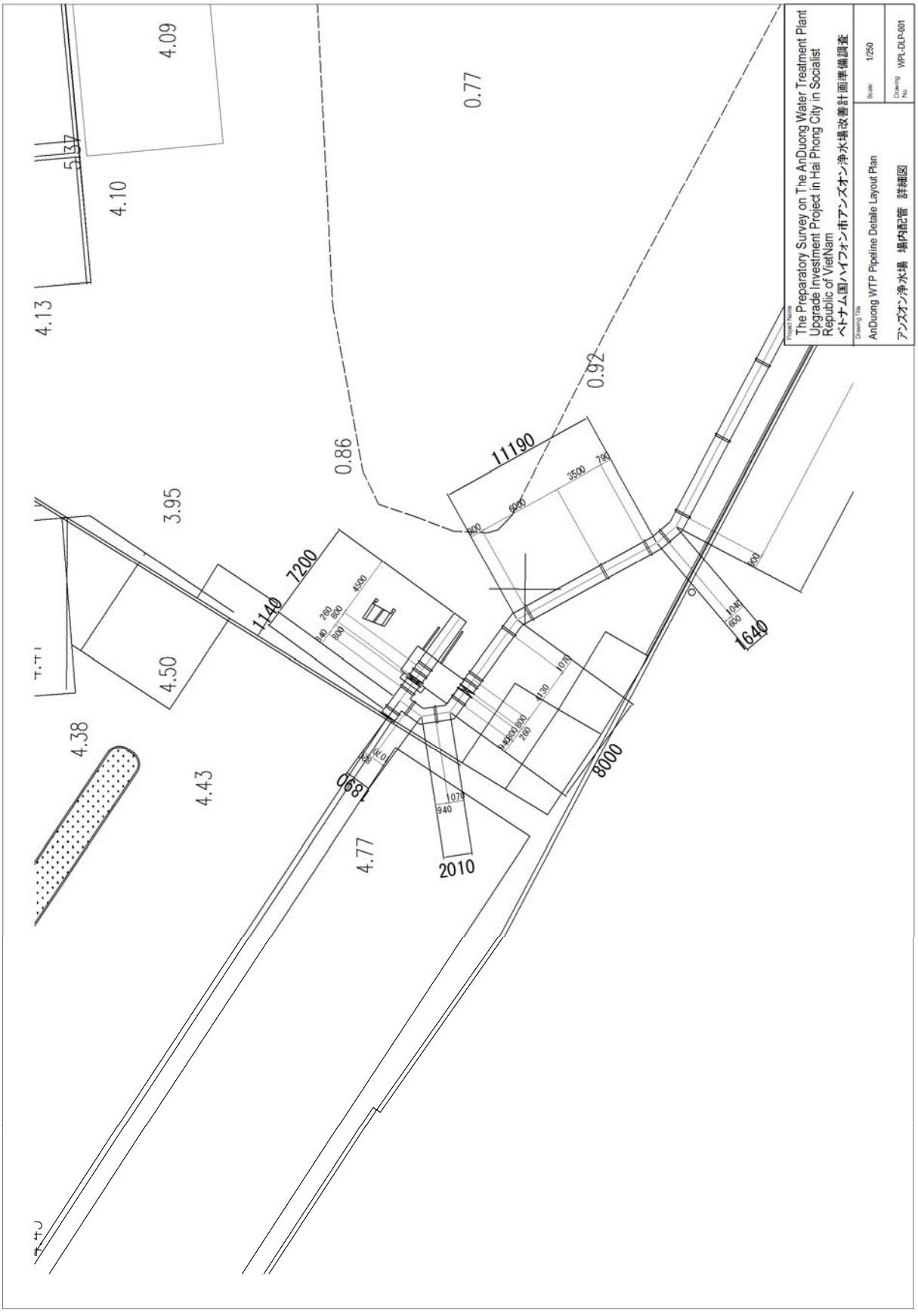

Project Name
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Drawing Title
U-BCF Cross Section
U-BCF 断面図
Scale: 1/200
Drawing No. WTP-CRS-001
SECTION A-A S=1:200
SECTION B-B S=1:200
Aeration Chamber
Blower Room
Outlet Tank
Raw Water Conduit
Pipe Gallery
GL+4.500
+14.300
+13.500
+12.100
+11.200
+9.430
+7.100
+6.100
+15.500
+14.800
+15.700
+12.400
+12.300
+13.100
+9.800
34700
39700

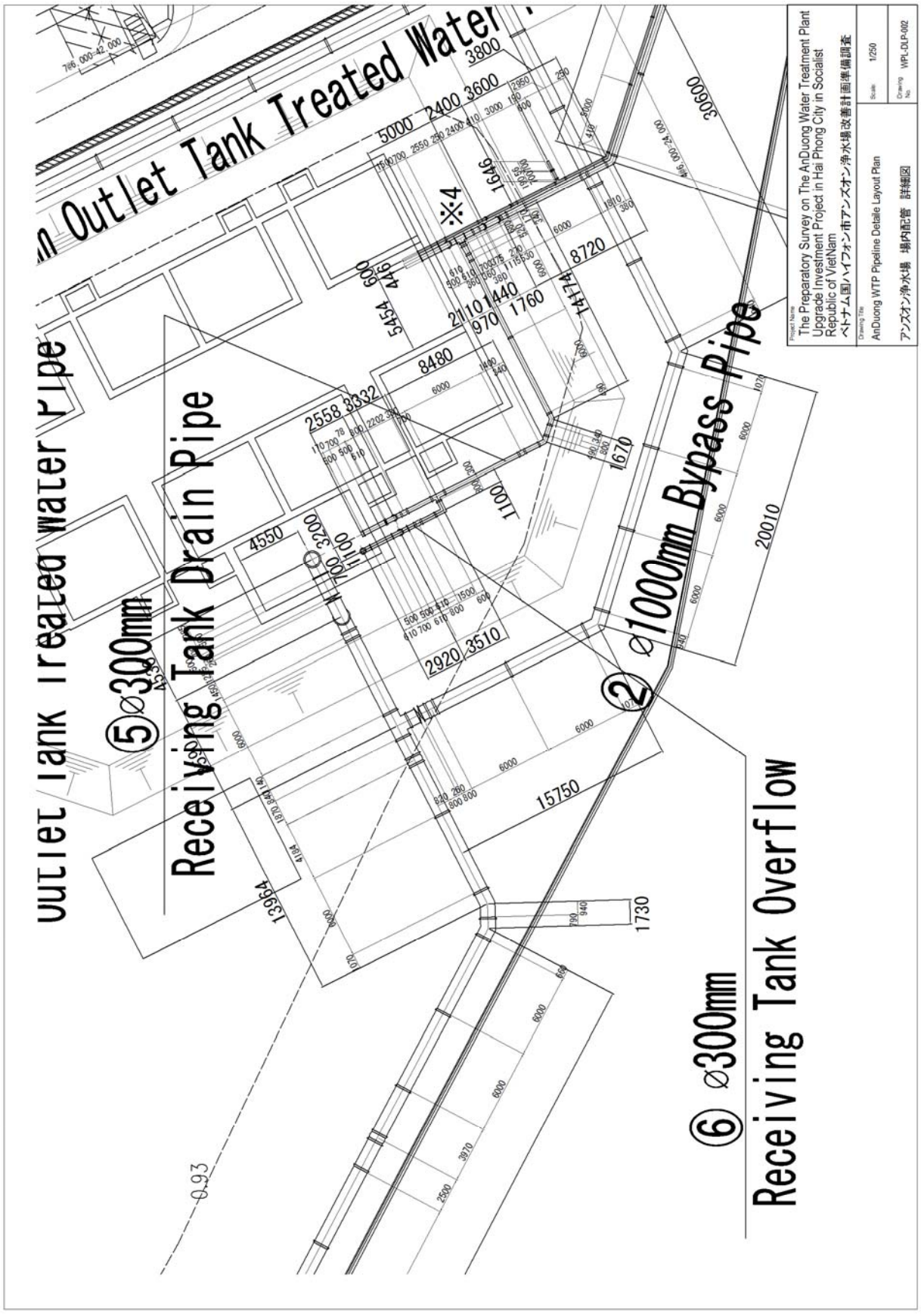

Project Name
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Drawing Title
U-BCF Cross Section
U-BCF 断面図
Scale 1/200
Drawing No. WTP-CRS-002
SECTION C-C S=1:100
Drain Pipe For Washing ø350
Trough
Row Water Transmission Pipe ø400
Activated Carbon
Drain Pipe ø300, ø350
Raw Water Conduit
Drain Pipe For Chemical ø150
Drain Pipe ø350
Row Water Transmission Pipe ø1000
+15.500
+14.800
+14.300
+13.500
+13.320
+13.200
+13.100
+13.000
+12.400
+12.341
+11.250
+10.500
+9.800
+8.960
+7.200
+6.100
+5.200
19900
25600

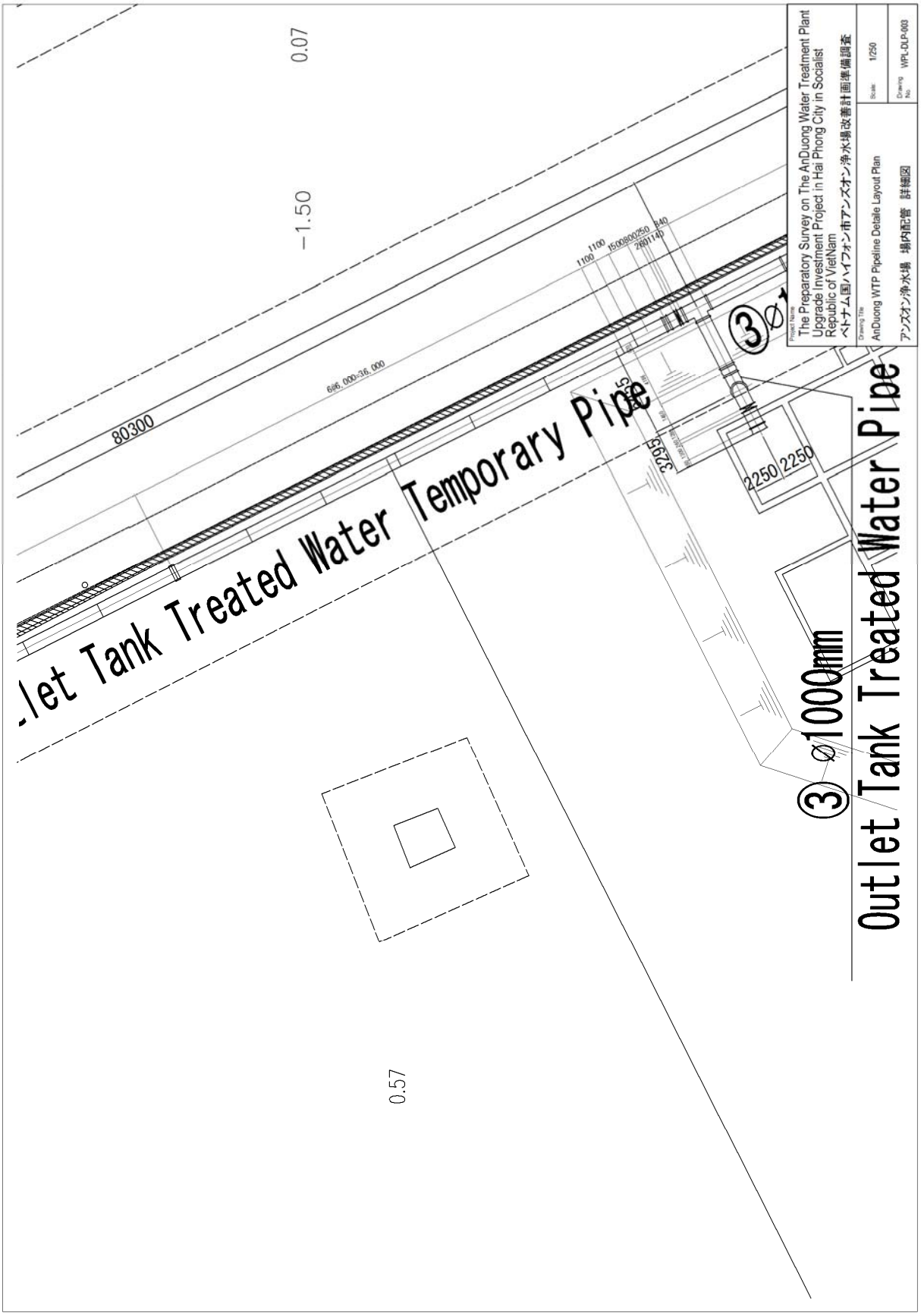

Project Name
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Drawing Title
U-BCF Cross Section
U-BCF 断面図
Scale: 1/200
Drawing No: WTP-CRS-003
SECTION D-D S=1:200
SECTION E-E S=1:200

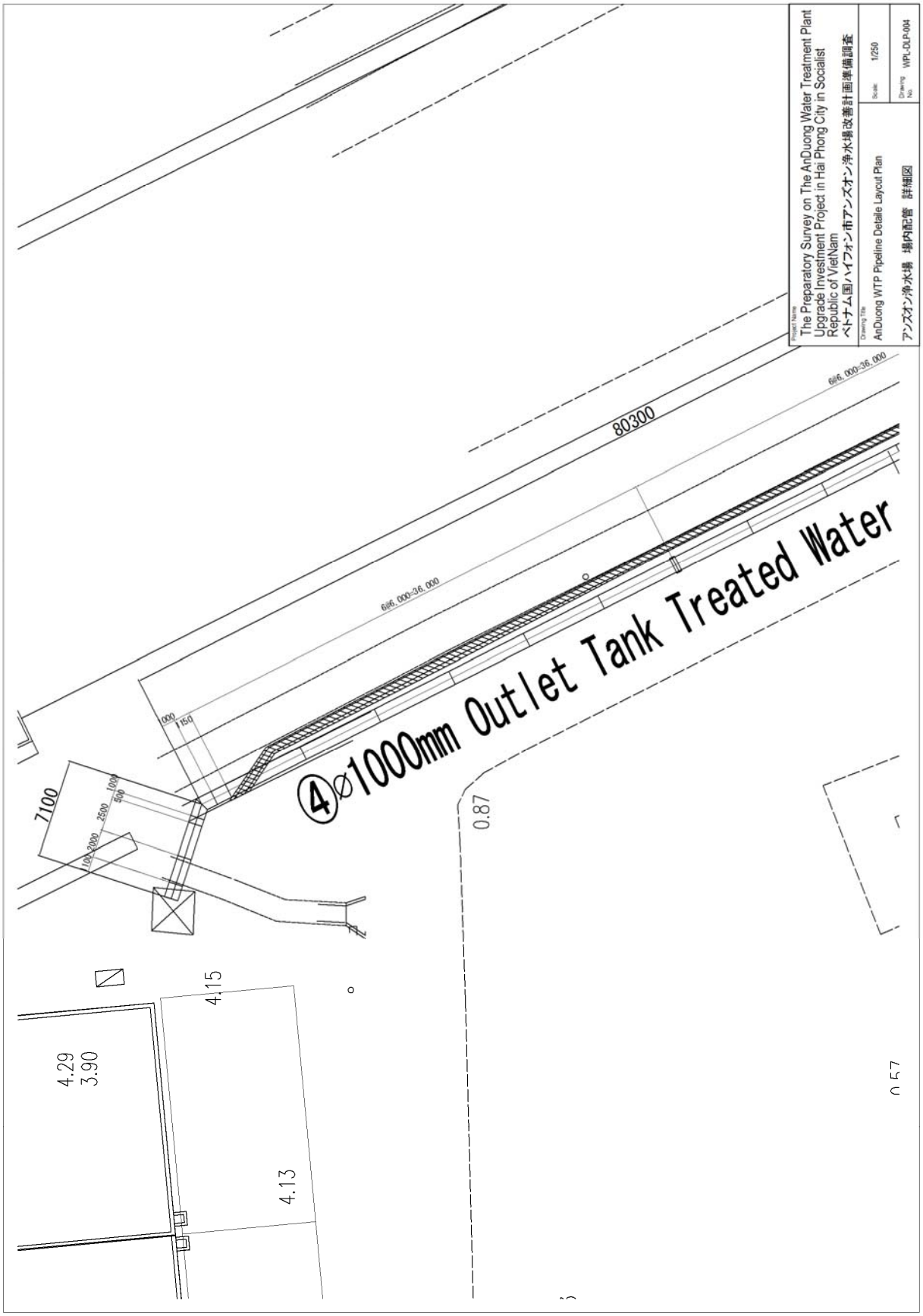

SECTION F-F S=1:200
SECTION G-G S=1:200
Project Name
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Drawing Title
U-BCF Cross Section
U-BCF 断面図
Scale 1/200
Drawing No. WTP-CRS-004
Brower Room
Pipe Gallary
Over Flow Weir
Trough Top
Outlet Tank
Raw Water Conduit
Pipe Gallary

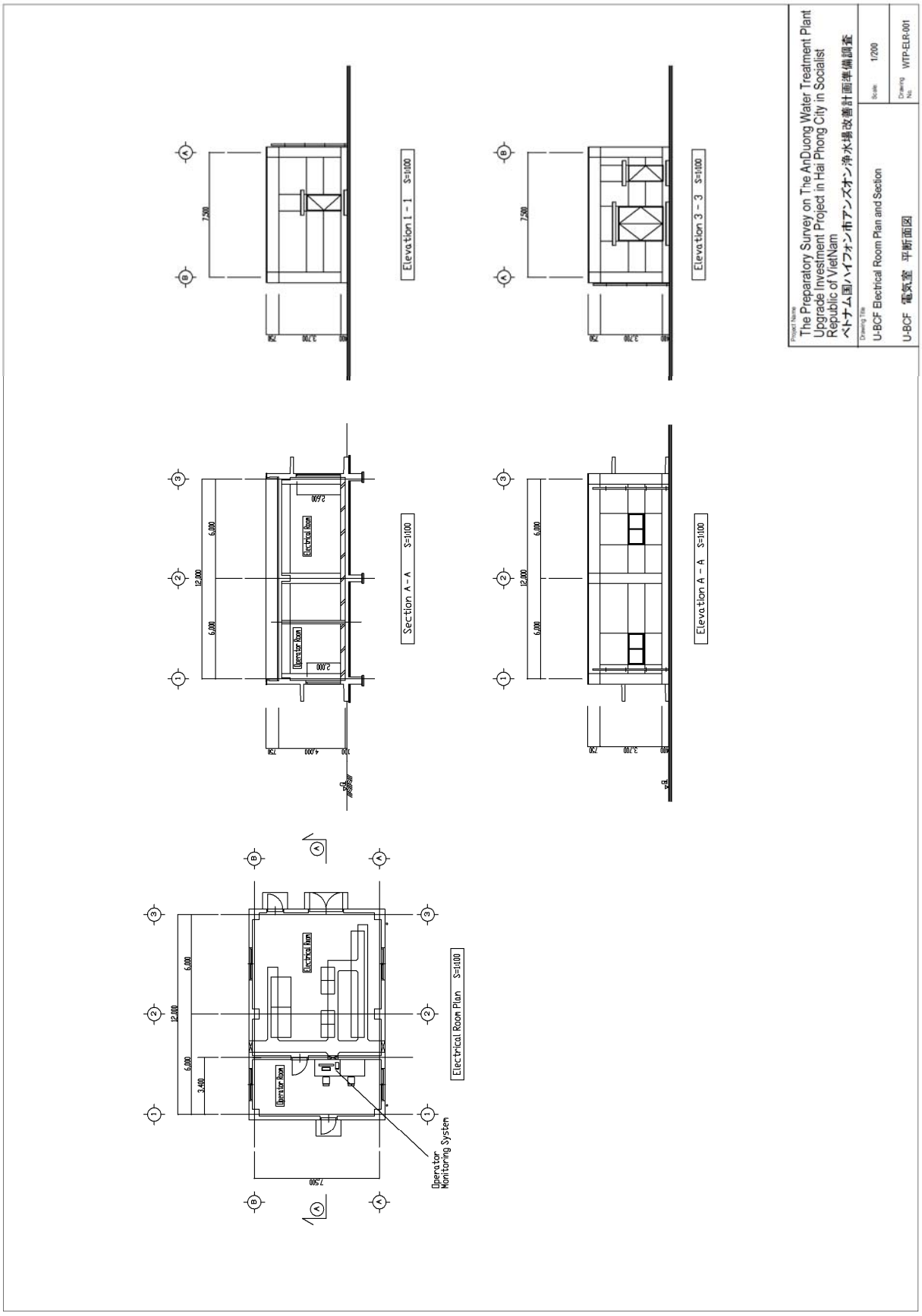

Project Name
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Drawing Title
AnDuong WTP Pipeline General Layout Plan
アンズオン浄水場 場内配管 一般平面図
Scale: 1/1000
Drawing No: WPL-GLP-001

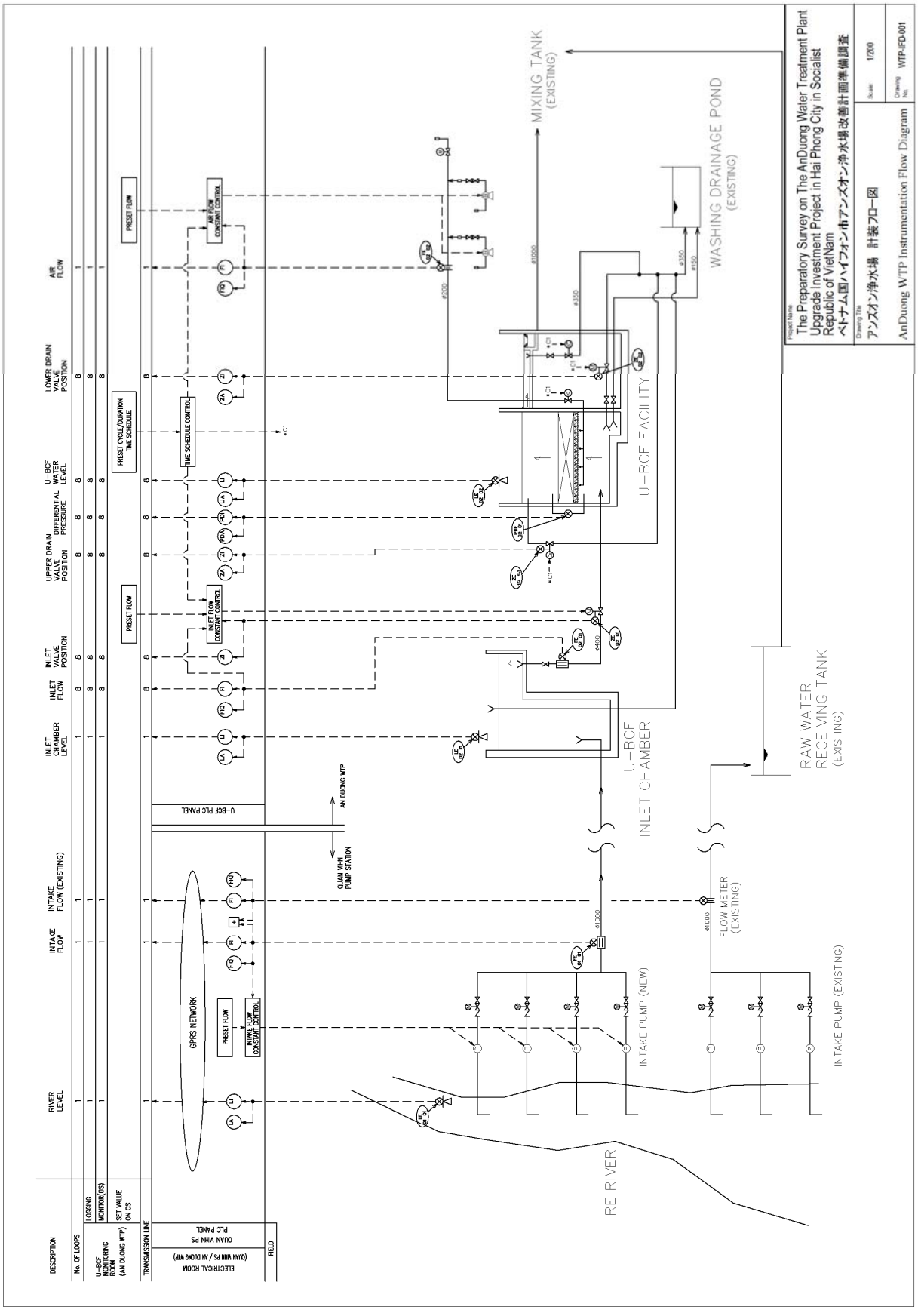

The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
AnDuong WTP Pipeline Detaile Layout Plan
アンズオン浄水場 場内配管 詳細図
1/250
WPL-DLP-001
4.09
4.10
4.13
0.77
0.92
0.86
3.95
4.50
4.38
4.43
4.77
11190
7200
1140
1640
8000
1890
2010
3500
4500
1070
940

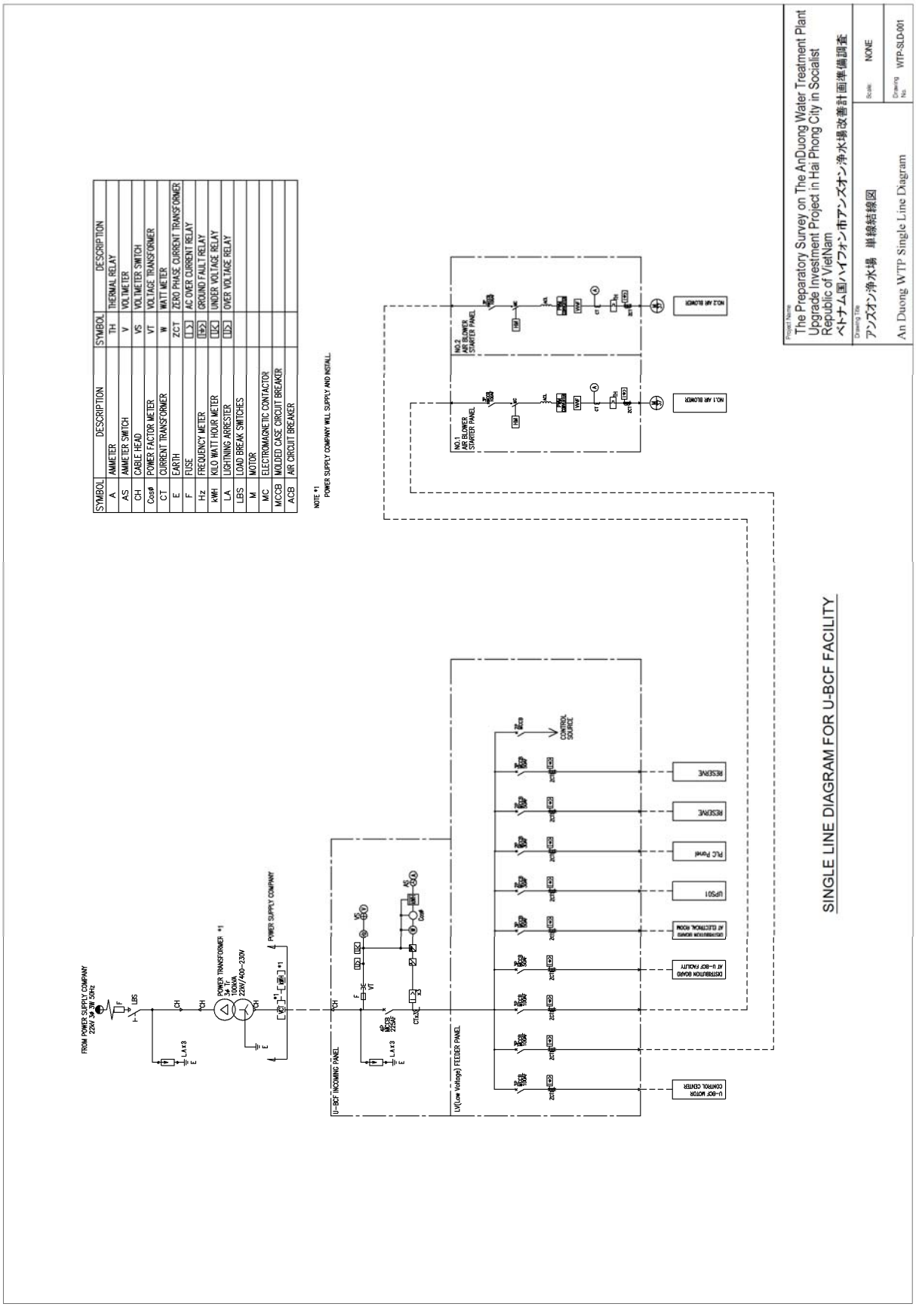

Outlet Tank Treated Water Pipe
⑤ ⌀300mm
Receiving Tank Drain Pipe
② ⌀1000mm Bypass Pipe
⑥ ⌀300mm
Receiving Tank Overflow
※4
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
AnDuong WTP Pipeline Detaile Layout Plan
アンズオン浄水場 場内配管 詳細図
Scale 1/250
Drawing No. WPL-DLP-002

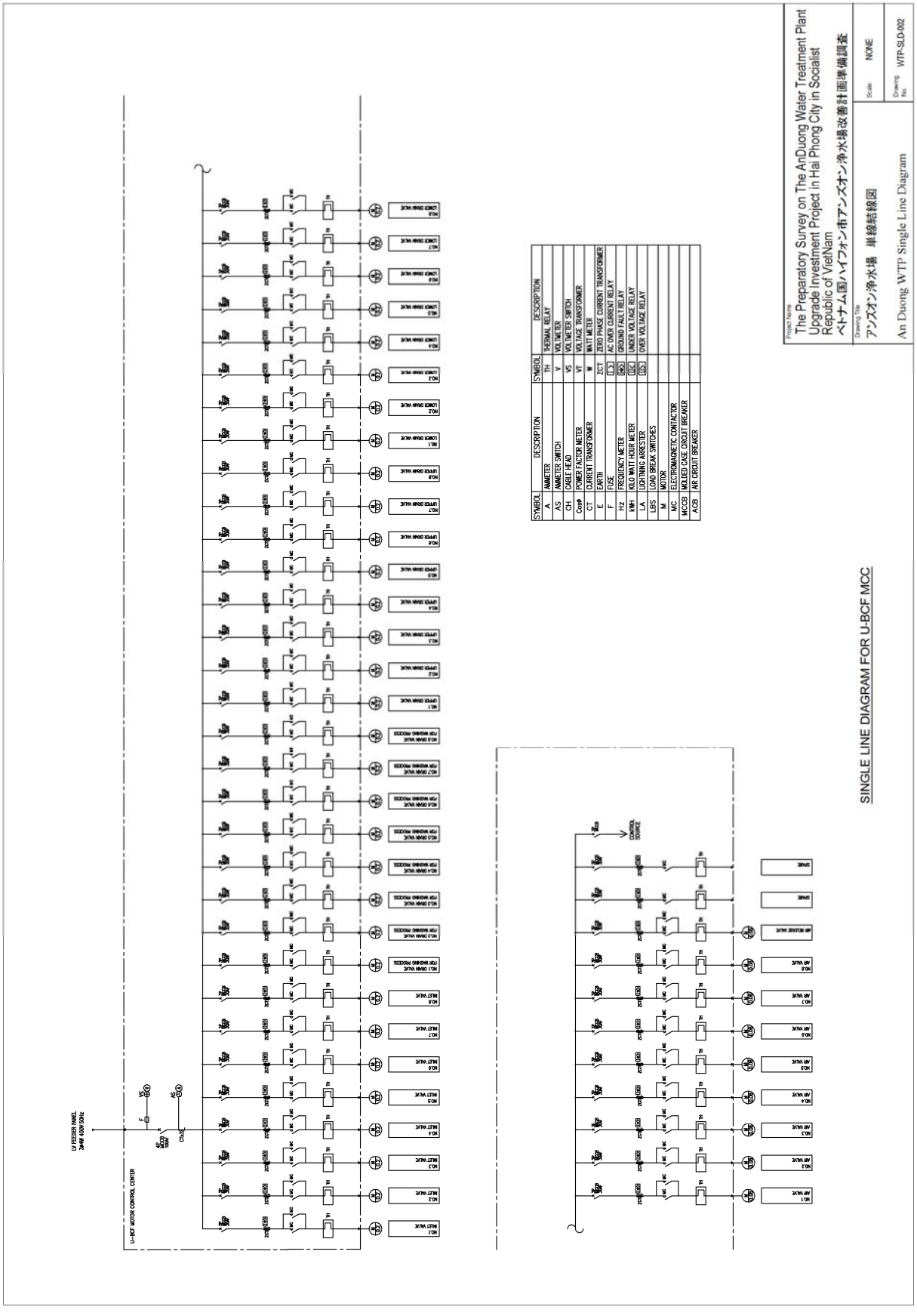

0.07
-1.50
80300
6@6,000=36,000
1100
1100
1500
900
250
340
2601140
3293
2250
2250
③ ⌀1000mm
Outlet Tank Treated Water Pipe
0.57
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
AnDuong WTP Pipeline Detaile Layout Plan
アンズオン浄水場 場内配管 詳細図
1/250
WPL-DLP-003

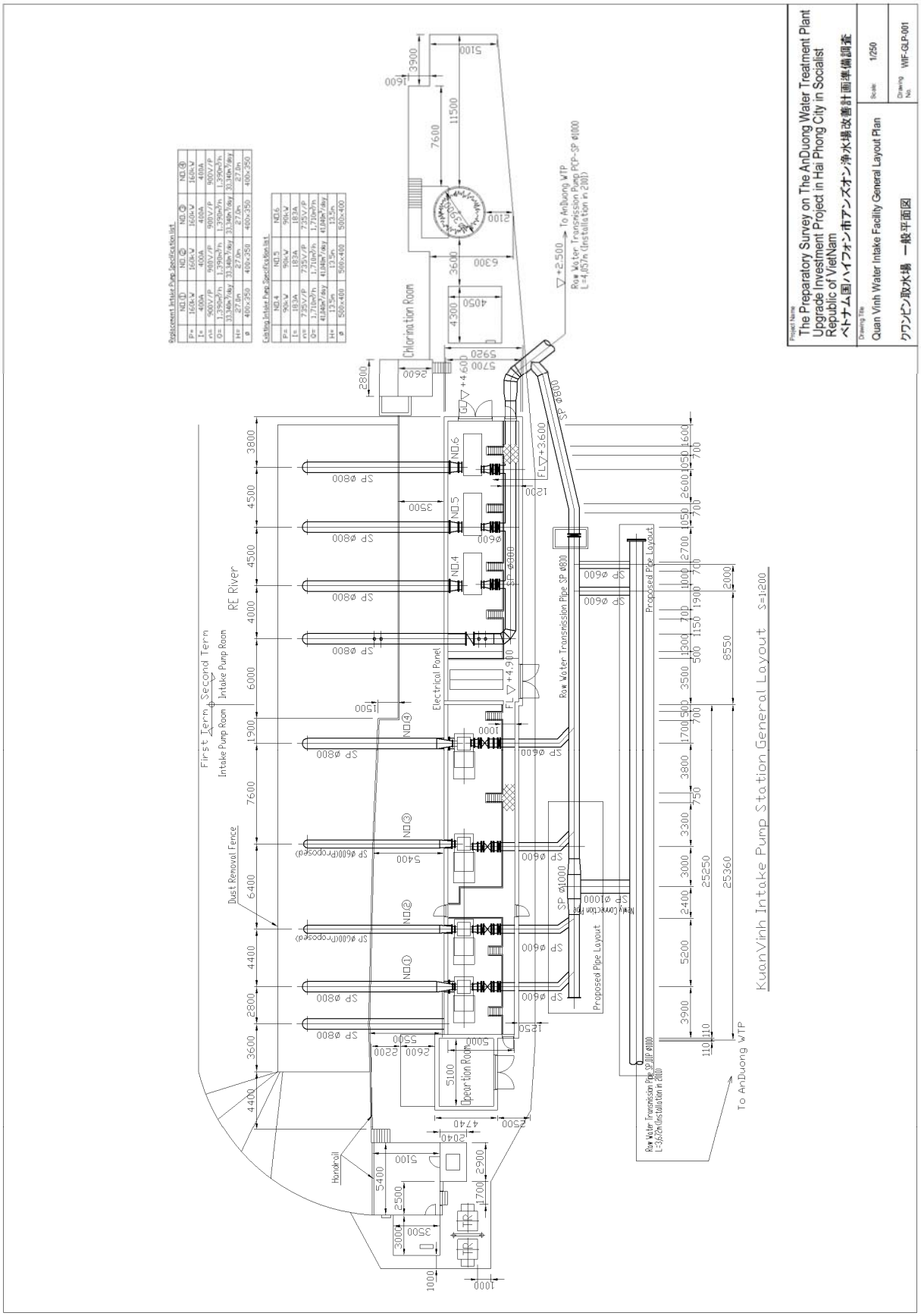

The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
AnDuong WTP Pipeline Detaile Laycut Plan
アンズオン浄水場 場内配管 詳細図
1/250
WPL-DLP-004
④ø1000mm Outlet Tank Treated Water
80300
6@6,000=36,000
7100
4.29
3.90
4.15
4.13
0.87

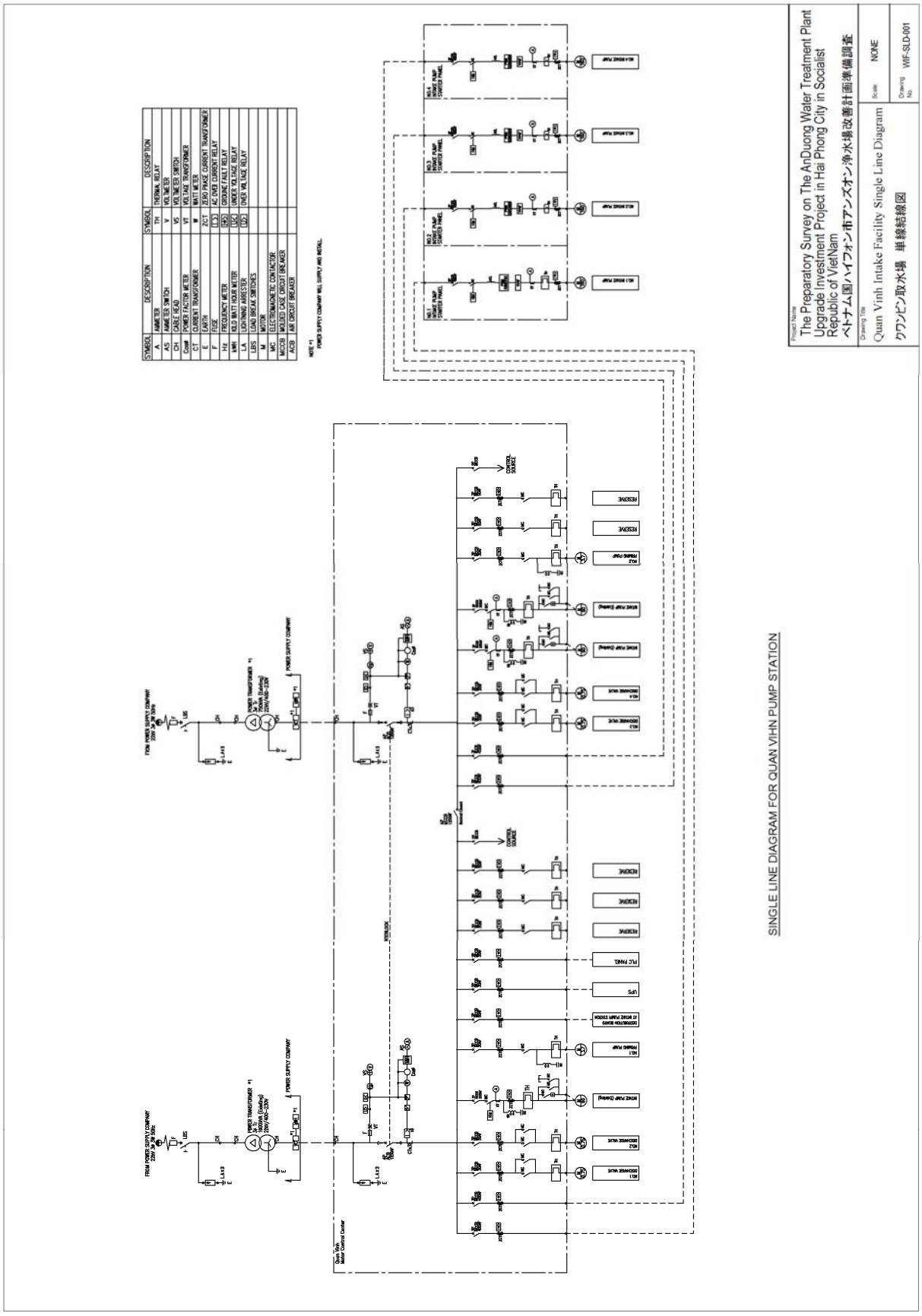

Project Name
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Drawing Title
U-BCF Electrical Room Plan and Section
U-BCF 電気室 平断面図
Scale 1/200
Drawing No. WTP-ELR-001
Elevation 1 - 1 S=1:100
Elevation 3 - 3 S=1:100
Section A - A S=1:100
Elevation A - A S=1:100
Electrical Room Plan S=1:100
Electrical Room
Operator Room
Operator Monitoring System

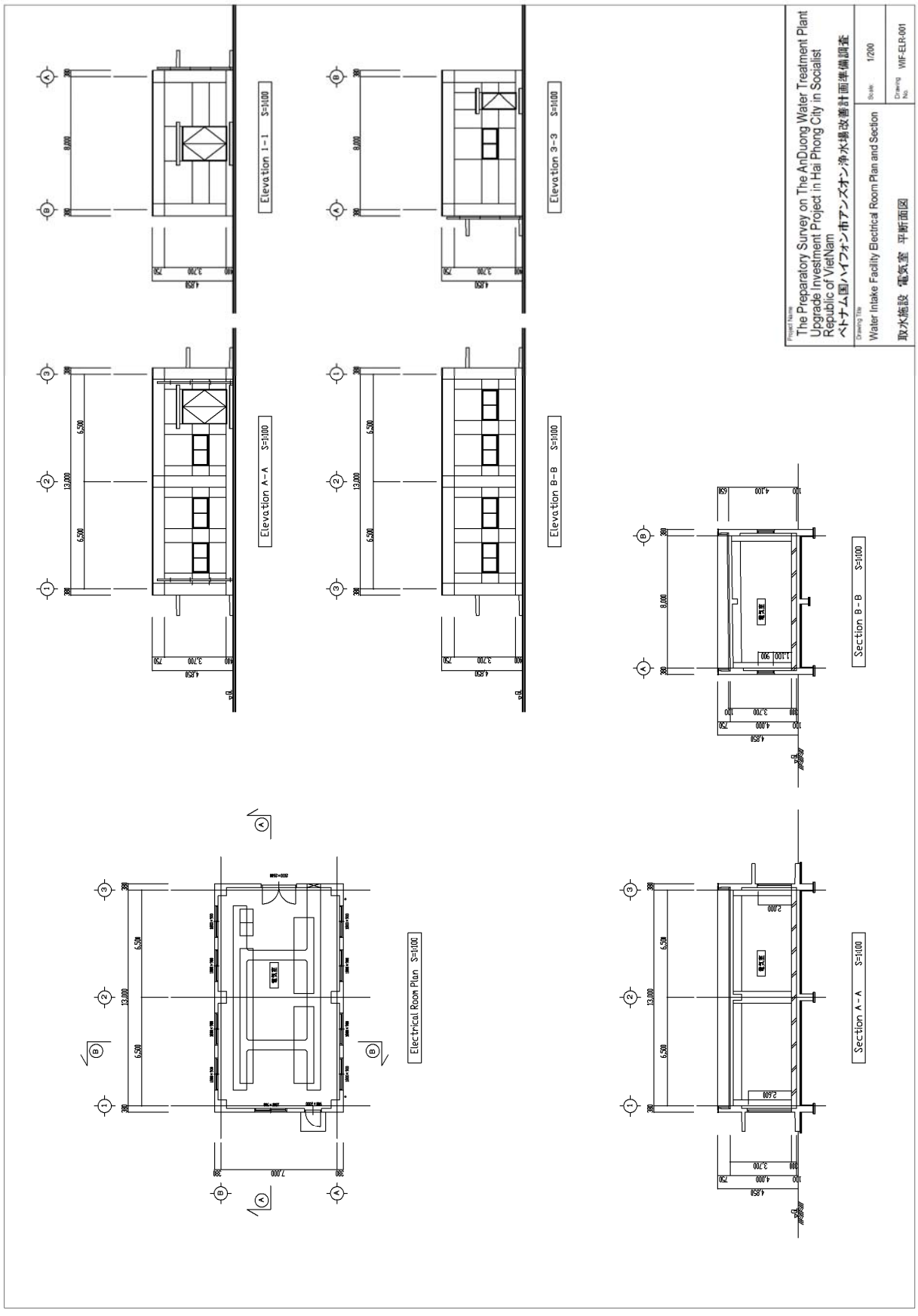

The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
アンズオン浄水場 計装フロー図
AnDuong WTP Instrumentation Flow Diagram
1/200
WTP-IFD-001
MIXING TANK (EXISTING)
WASHING DRAINAGE POND (EXISTING)
U-BCF FACILITY
U-BCF INLET CHAMBER
RAW WATER RECEIVING TANK (EXISTING)
FLOW METER (EXISTING)
INTAKE PUMP (NEW)
INTAKE PUMP (EXISTING)
RE RIVER
QUAN WHN PUMP STATION
AN DUONG WTP
U-BCF PLC PANEL
GPRS NETWORK
PRESET FLOW
INTAKE FLOW CONSTANT CONTROL
INLET FLOW CONSTANT CONTROL
AIR FLOW CONSTANT CONTROL
TIME SCHEDULE CONTROL
PRESET CYCLE FOUNATION TIME SCHEDULE
ELECTRICAL ROOM (QUAN WHN PS / AN DUONG WTP)
QUAN WHN PS PLC PANEL
U-BCF MONITORING ROOM (AN DUONG WTP)
TRANSMISSION LINE
FIELD
No. OF LOOPS
LOGGING
MONITOR(OS)
SET VALUE ON OS
RIVER LEVEL
INTAKE FLOW
INTAKE FLOW (EXISTING)
INLET CHAMBER LEVEL
INLET FLOW
INLET VALVE POSITION
UPPER DRAIN VALVE POSITION
DIFFERENTIAL PRESSURE
U-BCF WATER LEVEL
LOWER DRAIN VALVE POSITION
AIR FLOW


SINGLE LINE DIAGRAM FOR U-BCF FACILITY
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
アンズオン浄水場 単線結線図
An Duong WTP Single Line Diagram
NONE
WTP-SLD-001
SYMBOL DESCRIPTION
A AMMETER
AS AMMETER SWITCH
CH CABLE HEAD
Cos# POWER FACTOR METER
CT CURRENT TRANSFORMER
E EARTH
F FUSE
Hz FREQUENCY METER
kWh KILO WATT HOUR METER
LA LIGHTNING ARRESTER
LBS LOAD BREAK SWITCHES
M MOTOR
MC ELECTROMAGNETIC CONTACTOR
MCCB MOLDED CASE CIRCUIT BREAKER
ACB AIR CIRCUIT BREAKER
SYMBOL DESCRIPTION
TH THERMAL RELAY
V VOLTMETER
VS VOLTMETER SWITCH
VT VOLTAGE TRANSFORMER
W WATT METER
ZCT ZERO PHASE CURRENT TRANSFORMER
AC OVER CURRENT RELAY
GROUND FAULT RELAY
UNDER VOLTAGE RELAY
OVER VOLTAGE RELAY
NOTE *1
POWER SUPPLY COMPANY WILL SUPPLY AND INSTALL.
FROM POWER SUPPLY COMPANY
22kV 3φ 3W 50Hz
POWER TRANSFORMER *1
3 PHASE
100kVA
22kV/400-230V
POWER SUPPLY COMPANY
U-BCF INCOMING PANEL
LV(Low Voltage) FEEDER PANEL
CONTROL SOURCE
RESERVE
RESERVE
PLC Panel
UPS01
DISTRIBUTION BOARD AT ELECTRICAL ROOM
DISTRIBUTION BOARD AT U-BCF FACILITY
U-BCF MOTOR CONTROL CENTER
NO.2 AIR BLOWER STARTER PANEL
NO.1 AIR BLOWER STARTER PANEL
NO.2 AIR BLOWER
NO.1 AIR BLOWER


SINGLE LINE DIAGRAM FOR U-BCF MCC
U-MCF MOTOR CONTROL CENTER
LV FEEDER PANEL
3ø4W 400V 50Hz
SYMBOL DESCRIPTION
A AMMETER
AS AMMETER SWITCH
CH CABLE HEAD
Cosø POWER FACTOR METER
CT CURRENT TRANSFORMER
E EARTH
F FUSE
Hz FREQUENCY METER
KWH KILO WATT HOUR METER
LA LIGHTNING ARRESTER
LBS LOAD BREAK SWITCHES
M MOTOR
MC ELECTROMAGNETIC CONTACTOR
MCCB MOLDED CASE CIRCUIT BREAKER
ACB AIR CIRCUIT BREAKER
SYMBOL DESCRIPTION
TH THERMAL RELAY
V VOLTMETER
VS VOLTMETER SWITCH
VT VOLTAGE TRANSFORMER
W WATT METER
ZCT ZERO PHASE CURRENT TRANSFORMER
AC OVER CURRENT RELAY
GROUND FAULT RELAY
UNDER VOLTAGE RELAY
OVER VOLTAGE RELAY
Project Name
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Drawing Title
アンズオン浄水場 単線結線図
An Duong WTP Single Line Diagram
Scale: NONE
Drawing No: WTP-SLD-002


The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Quan Vinh Water Intake Facility General Layout Plan
クワンビン取水場 一般平面図
1/250
WIF-GLP-001
KuanVinh Intake Pump Station General Layout S=1:200
First Term Second Term
Intake Pump Room
RE River
Dust Removal Fence
Chlorination Room
Electrical Panel
Operation Room
Raw Water Transmission Pipe SP ø800
Proposed Pipe Layout
To AnDuong WTP
Handrail


SINGLE LINE DIAGRAM FOR QUAN VINH PUMP STATION
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Quan Vinh Intake Facility Single Line Diagram
クワンビン取水場 単線結線図
NONE
WIF-SLD-001


Elevation 1-1 S=1/100
Elevation 3-3 S=1/100
Elevation A-A S=1/100
Elevation B-B S=1/100
Section B-B S=1/100
Electrical Room Plan S=1/100
Section A-A S=1/100
The Preparatory Survey on The AnDuong Water Treatment Plant Upgrade Investment Project in Hai Phong City in Socialist Republic of VietNam
ベトナム国ハイフォン市アンズオン浄水場改善計画準備調査
Water Intake Facility Electrical Room Plan and Section
取水施設 電気室 平断面図
1/200
WIF-ELR-001

2-2-4 Implementation Plan

Organization for Management and Implementation of the Project

- The modality of organization for management and implementation: Project owner directly manage the project.
- Capacity of Project Owner: Hai Phong Water Supply One Member Limited Company is a 100% state-owned business, has the mission to produce and supply clean water for Hai Phong city. Company has experience in implementation of ODA projects (has been implementing 3 projects using ODA fund of World Bank and preparing to deploy a project using ODA fund of ADB), thus Hai Phong Water has sufficient capability to deploy this project. HAWASU also are a efficient and profitable business in operating water supply.

2-2-4-1 Implementation Policy

① Basic conditions

Hai Phong Water is the Vietnamese side implementation agency for this Project. It is also responsible for the management and O&M of An Duong WTP, including the U-BCF introduced by this Project.

The detail design (drawing and document preparation), tender assistance, construction supervision and machinery procurement are to be managed by a Japanese consultant. After the E/N and G/A for the grant aid Project have been signed, Hai Phong Water shall conclude the consultant contract of consulting services.

A Japanese contractor shall be in charge of the construction works and procurement of this Project. The main portion of this Project is civil works, accompanied with pipe works and mechanical/electrical facility installation. It has been decided that a Japanese general civil work contractor with experience of similar construction shall be selected. The contractor is to be selected by general open bidding, and the bid participation qualification and the selecting criteria shall be discussed and decided with Hai Phong Water during the bidding preparation period.

The consultant shall supervise the construction and procurement managed by the contractor. Hai Phong Water shall approve and issue payment documents to the consultant and contractor, according to the construction and procurement progress.

② Construction method

The construction method for this Project is to be selected considering the local construction circumstances and technical standards. A method which can effectively utilize local workers and materials, and can create working opportunities and technical transfer promotion shall be recommended.

③ Effective use of local contractors

An engineer from the Japanese contractor shall reside at the construction site during the construction period for guidance and supervision. Many tall buildings and bridges are being constructed in Viet Nam, which indicates the sufficient improvement of the local construction industry. Malfunctions and accidents can be prevented by appropriate quality/safety management.

④ Procurement conditions

It is recommended to deliver pipe materials in accordance with the progress of the works as the area of temporary yards is limited. Accurate comprehension of construction developments and schedule shall be required. Since it is difficult to establish a raw concrete batch for this Project in the site or neighbouring area, raw concrete is basically to be procured from factories in Hai Phong city and its suburbs. To secure the procurement, it shall be necessary to maintain close contact with the factories to keep the related parties updated about the construction schedule.

2-2-4-2 Construction/Procurement Conditions

(1) Construction conditions

① Reclamation works

The reclaiming land is to be enclosed with large sandbags and drained by underwater pumps. Later it is to be filled by soil to the planned ground height. Geotextile is to be installed under the electrical room and the embankment around the U-BCF. Hai Phong Water is planning to expand the reclaiming area by an independent plan after this Project; therefore the revetment installed by this Project will be required for only a short period. Hence said large sandbags shall be left after the construction until the expansion construction as a temporary revetment.

The large sandbags are to be installed using backhoe from the bank of the regulation reservoir toward the center. The revetment is to be built so that sandbags are arranged in four (4) rows at the top to secure a width of approximately 4.4 m.

The sand used for reinforcement construction of the raw water reservoir is to be procured from the four sand yards of Hai Phong city, and to be carried to An Duong WTP by ships (refer to Figure 2-2-14).

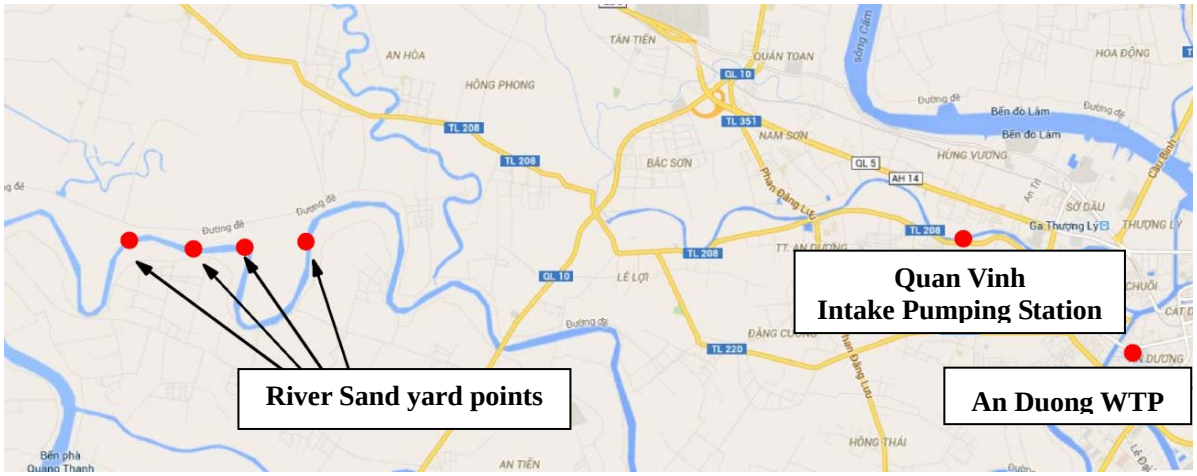


Figure 2-2-14 River Sand Yard Locations for Reclamation

Source: JICA Study Team (Based on local survey)

② Foundation works

Regarding the circumstances, PHC piles which are produced locally at an affordable price shall be adopted for the U-BCF. For the electrical room, which is considerably lighter than the U-BCF, a spread foundation based on the reinforced soil with geotextile is adopted.

③ Piping works

The pipe diameter for the in-site piping varies from φ300mm to φ1000mm and the laying construction shall be carried out mainly by machinery. Sufficient road width is to be secured for the construction works.

The geotechnical test showed that the groundwater level was 1.0m from the ground surface. In the excavation tests however, groundwater did not appear immediately when the excavation depth exceeded 1.0m. From these results, it has been concluded that the groundwater amount is large, and it may be necessary to drain the excavation locations by sumping in case the water should affect the works.

④ Transportation inside Viet Nam should be made by vehicles. Construction traffic except small or medium vehicles shall enter and exit through the new gate that is to be built on the southwest side of the site of An Duong WTP, as 4m-width roads and acute-angled curves are inevitable if a car accesses the site from the existing main gate to reach to the U-BCF site.

Although the new gate is faced to a two-lane road, four-wheeled vehicles can proceed only north-westward on this road (Photo 2-2-1).

Outdoor bazaars are occasionally held on the road just outside of the northwest edge of An Duong WTP. Construction traffic cannot go through this road when the bazaar is held. Transportation plans

are to be made taking said situations into consideration.

⑤ Construction works of the ADB-loaned project may be commenced while this Project is in progress. Usage of temporary yards in the site of An Duong WTP shall be discussed with the manager of the ADB-loan Project and Hai Phong Water so that the consensus is reached among the concerned parties.

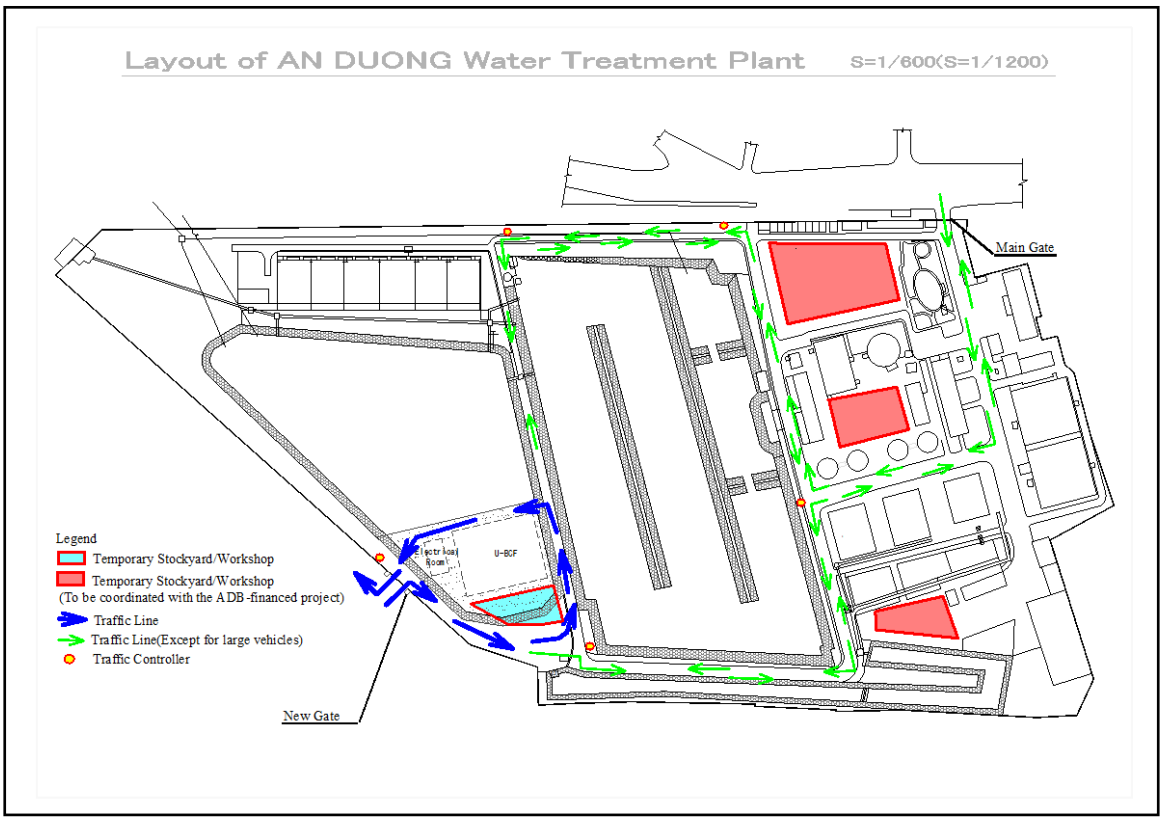


Figure 2-2-15 Schematic Drawing of Traffic Line and Temporary Stockyard

Source: JICA Study Team (Based on local survey)

Photo 2-2-1 The Road the New Gate is Faced

(The wall pictured right is the boundary of An Duong WTP site)

Photo 2-2-2 Bazaar held just Outside of An Duong WTP

(2) Points to be considered for construction period setting

① Average annual rainfall in Hai Phong is around 1,600mm, a little higher than Tokyo. It is inferred that impact on construction work by rainfall is not very large. Average monthly rainfalls through May to September exceed 200 mm. Heavy rains may fall during these months. From May to September, the average highest temperature exceeds 30^{o}C, and temperature at night is not likely to fall below 25^{o}C. Usually it gets coldest in January. Average highest and lowest temperatures in January are 20^{o}C and 13^{o}C respectively. The rainfall is not expected to affect the works, but during

the rainy season it will be necessary to make the work plans considering time for curing works necessary for material transportation, civil works, banking works and concrete placing works.

(3) Compliance with Labour Law

① Most construction sites in Viet Nam start operation in 7 am and finish around 6 pm, including a lunch break for 2 hours in the daytime. The working hours are different from the Japanese construction sites.

② Sundays and national holidays are public holidays.

③ Public offices and general shops are closed for about a week during Tet (Lunar New Year) vacation, which usually comes in early February. It should be kept in mind that most people leave the office longer than a week for a return to their home or a travel around Tet season.

(4) Security Management

Security-related information in Hai Phong and its surrounding areas shall be collected from JICA Viet Nam Office, Embassy of Japan and other organizations. Security measures shall be taken with attention to the following items:

① Advices for safe and smooth work implementation shall be obtained from Vietnamese counterpart organizations.

② Close contact should be kept with donor agencies working around Hai Phong, if any, to share security-related information.

③ Generally Hai Phong and its surrounding area are safe places. However, anti-Chinese demonstration arose elsewhere across Viet Nam in May 2014, and several Japanese-affiliated companies were subjected to attack. It shall be considered that a similar demonstration may arise again.

④ A large number of motorcycles are running on roads, and it is difficult for foreigners to drive a car. Commuting shall be by a car with a local driver or on foot.

(5) Procurement Plan

1) Concrete

In Hai Phong and its suburbs, fresh concrete is manufactured at the batching plants owned by companies, and provided for public use. As of August 2014, at least one factory with a production capacity of 120m^3/h and three factories with a capacity of 60m^3/h were in operation in this area. It is judged that the batching plants in this area are capable of providing this Project with necessary amount of concrete. However, these plants would also have to provide concrete to other sites during the construction works of this Project. It would be important to communicate with the plants and to inform the construction schedule of this Project so the necessary amount of concrete is delivered timely for the Project.

2) Reinforcing Bar

Reinforcing bars satisfying standards such as JIS(Japanese Industrial Standards), ASTM(American Society for Testing and Materials)and BS(British Standards) as well as TCVN (Vietnamese standard) are

manufactured in Viet Nam. Reinforcing bars satisfying one of these standards shall be used.

3) Precast Pile

Precast piles are manufactured and sold in Viet Nam. Ones that satisfy standards of JIS, ASTM and BS shall be used.

4) Pipe Material

Most ductile iron pipe materials distributed in Viet Nam are made in China, and valves are imported from other countries including Germany and Malaysia. However, for these materials, there is concern over the leakage from connection parts, water tightness of the valves and pressure resistance. Thus, ductile iron pipes and valves which are to be used in important sections of the water supply system shall be imported from Japan or a Japanese-affiliated factory in another country for this Project.

Steel tubes for water service are manufactured in Viet Nam, has been used at many construction sites and the quality is sufficient, therefore procurement in Viet Nam is possible.

5) Granular Activated Carbon

Granular activated carbon manufactured in Viet Nam has been used at the U-BCF in Vinh Bao Water Treatment Plant (managed by Hai Phong Water), and no quality issues have occurred.

After the operation of U-BCF starts, it will be necessary to replenish the granular activated carbon lost by flow. Considering the future maintenance, continuous operation of U-BCF shall be possible by using granular activated carbon distributed in Viet Nam. Therefore, granular activated carbon is to be procured in Viet Nam.

2-2-4-3 Scope of Works

Table 2-2-11 shows the demarcation of construction works to be executed by the Japanese and Vietnamese sides. Table 2-2-12 summarizes the major obligations of each of the Japanese and Vietnamese Governments. These obligations were confirmed with the Vietnamese side so that the division of works does not deviate from the policy of the Japanese grant aid.

Table 2-2-11 Work Demarcation

Work Items	Work Contents	Japanese Side	Vietnamese Side
Renewal of Intake Pumps	Procurement	○	
	Installation	○	
Extension of Transmission Pipe (raw water regulating reservoir to U-BCF entrance)	Procurement	○	
	Construction Works	○	
Construction of U-BCF and electrical room (at intake pumping station and An Duong WTP)	Procurement	○	
	Construction Works	○	
	Installation	○	
In-site Piping works (Bypass pipes, U-BCF to chemical mixing basin, U-BCF to drying bed, U-BCF to future branch pipes)	Procurement	○	
	Construction Works	○	
Common	Installation of New Gate for Construction Traffic		○
	Construction of Temporary Road	○	
	Relocation of overhead electrical wires (which interfere with U-BCF construction site)		○
	Acquisition of permit and approval		○

Source: JICA Study Team (Based on local survey)

Table 2-2-12 Major Obligations of Each Government

No.	Obligations	Grant Aid	Viet Nam
1	Construction of Electrical, Waterworks, Drainage and Other Subsidiary Facilities		
	① Power Supply		
	Distribution Line to the Site		●
	Main Circuit Breaker and Transformer		●
	Wiring within the Site	●	
	② Water Supply (within the Site)	●	
	③ Storm Drainage (within the Site)	●	
	④ Telephone		
	Telephone Trunk Line from Site Office to Main Distribution Panel		●
	Office Cable	●	
	⑤ Furniture and Equipment		
	General Furniture		●
	Equipment for Office Use	●	
2	Payment of the Following Commissions Based on the Banking Arrangement (B/A)		
	Advising Commission of Authorization to Pay (A/P)		●
	Payment Commission		●
3	Disembarkation and Custom Clearance Procedure at the Port of Discharge		
	Marine or Air Transportation of Products from Japan to Viet Nam	●	
	Tax Exemption and Prompt Custom Clearance at the Port of Discharge		●
	Transportation from the Port of Discharge to the Project Site	●	
4	According the Japanese nationals whose service may be required under a verified contract such facilities as may be necessary for their entry into Viet Nam and stay therein for the performance of their works		●
5	Exemption of Japanese nationals from custom duties, internal taxes and other fiscal levies which may be imposed with respect to supply of products and services under a verified contract		●
6	Necessary expenses to maintain and use properly and effectively the materials and equipment provided under the grant aid		●
7	Necessary expenses for installing and other activities on materials and equipment not provided under the grant aid		●

Source: JICA Study Team (Based on local survey)

2-2-4-4 Consultant Supervision

After completion of the preparatory survey, a cabinet approval of GoJ on the grant aid would be executed. After the approval, signing on Exchange of Note (E/N) related to grant aid assistance on this Project commences the proposed Project.

(1) Detailed Design

Detailed design documents shall be prepared based on the natural condition survey (measurement survey, ground survey, etc.) carried out during the Preparatory Survey and the additional detailed field study

carried out for the detail designing (additional measurement survey, boring survey, etc.). The detailed design shall be made to ensure consistency for Viet Nam design standards and Japanese and/or international standards.

After E/N, the consultant shall contract with Hai Phong Water for the detailed design. The designing work would be commenced after obtaining certification by GoJ. At the beginning of the detailed design, the consultant shall conduct a detailed field survey including geotechnical investigation and topographic survey. Design, cost estimation and preparation of tender documents will be done in Japan after the field survey.

(2) Tendering Procedure

All tender documents shall be approved by Hai Phong Water (approval requires approximately one month). After the approval, the works related to tendering would be started immediately. The tendering procedure is as follows:

① Set an acceptance period of one week from the tender announcement to receive a tender participation application from tenderers.
② Evaluate tenderer's qualification with the least delay after receiving the applications.
③ Distribute the tender documents to eligible tenderers. The tender meeting is held with participation of persons involved after a preparation period for 1.5 months.
④ The tenderer that offers the lowest price is recommended to Hai Phong Water as a successful tenderer. Contracting for the construction works is promoted.

(3) Construction Supervision

The construction works consist of a wide-range of works such as civil work, piping work, mechanical work and electrical work. The consultant shall assign a civil engineer as a resident supervisor and also dispatch other civil engineers, a mechanical engineer and an electrical engineer several times for spot supervision in accordance with the progress of the construction works. Local engineers shall be employed as assistants of the resident supervisor.

The supervisory work shall be implemented in parallel with intimate meetings among Hai Phong Water and the contractor. Monthly progress reports shall be submitted to Hai Phong Water, JICA Viet Nam Office and JICA Headquarters. Reporting to concerned parties, and communicating and meeting with them shall not be delayed.

2-2-4-5 Quality Control Plan

The consultant shall request the contractor to conduct the following tests shown in Table 2-2-13 and reflect the results to quality control.

Table 2-2-13 Tests Related to Quality Control

Materials/Parts	Test Items	Test Methods	Standards
Pipe Materials	Strength Dimensions Appearance	Confirmation of factory inspection report Dimension measurement, Gauge Visual inspection	Japanese Standard
Pipe Installation	Torque Leakage Coating	Torque wrench Water pressure test Coating thickness gauge, Visual inspection	Japanese Standard
Foundation	Bearing capacity	Loading test	Japanese Standard
Concrete	Aggregates, Cement Water Fresh concrete Strength	Physical test, Chemical test, Grain size test Chemical test Slump test, Air content test, Chloride content test Compressive strength test	Japanese Standard Vietnamese Standard
Reinforcing Bar	Strength Bar arrangement	Tensile strength test Dimension measurement, Bar arrangement inspection	Japanese Standard Vietnamese Standard ASTM, BS
Structural Appearance	Dimensions	Dimension measurement	Japanese Standard
Waterproofing Work	Material quality Paint thickness, Adhesion Finishing appearance Leakage	Confirmation of certificate of quality Thickness test, Tensile test Visual inspection Water filling test	Japanese Standard
Electrical/Mechanical Equipment	Installation precision Functions	Measurement Loading operation test	Japanese Standard

Source: JICA Study Team (Based on local survey)

2-2-4-6 Procurement Plan

Regarding the Grant Aid Cooperation Project Policy, the procured materials and equipment are to be made in Japan or Viet Nam. To make maximum use of repair/maintenance services, local procurement is recommended if possible. However, for commodities not available or not distributed steadily in the aspect of quantity and/or price in Viet Nam should be procured from Japan. In addition, procurement from Japanese-affiliate factory in a third country is recommended if it has more advantage than procurement from Japan. Points to be considered upon procurement are mentioned in article 2-2-4-2.

1) Civil Materials

Main civil and building materials such as reinforcing bars, fresh concrete, timber, cement, crushed stone, sand, bricks, precast piles, petrol, and light oil shall be procured in Viet Nam. Fresh concrete shall be procured from the working batching plants in Hai Phong or its suburbs, because it is difficult to build a batching plant for exclusive use for this Project.

2) Pipe Materials

There are manufacturers of steel pipes for water services in Viet Nam, and it is possible to procure from them. However, regarding ductile iron pipes, stain less pipes and valves, most materials distributed in Viet Nam are made in other countries. Hence it is judged that procuring ductile iron pipes, stain less pipes and valves made in Viet Nam would be difficult, and shall be imported from Japan or a Japanese-affiliated factory in a third country.

3) Mechanical and Electrical Equipment

The mechanical and electrical equipment procured in this Project is for the WTP and the intake pumping station. Therefore equipment with low failure rate is expected. Therefore, equipment shall be procured from Japan to secure the reliability in quality.

4) Filtering Medium

Sand for filtration and granular activated carbon is to be procured in Viet Nam.

5) Heavy Machinery

Heavy machinery including backhoes and crane trucks has been well marketed in Viet Nam. Procurement of heavy machinery in Viet Nam shall not be very difficult. In addition, since many construction machineries are produced by Japanese manufactures and have less quality issues, they shall be procured in Viet Nam.

Photo 2-2-3 Stockyard of Heavy Machinery Dealer

Photo 2-2-4 Working Concrete Pumping Truck (Hai Phong City)

2-2-4-7 Operation Guidance Plan

Between the complementation and the handover of the facilities for this Project, test operation and function/operation confirmation of the intake pump in intake pumping station and blower for washing of U-BCF shall be carried out. During this test period, the contractor shall carry out operation guidance for the Hai Phong Water technical staff as a part of facility handover.

Initial operation guidance outline is shown in Table 2-2-14.

Table 2-2-14 Initial Operation Guidance

Facilities	Major Guidance
Intake	Intake pump: Confirm functioning status, ON-OFF operation, Water amount setting, Receiving tank water level setting Inspection method, Water quality abnormal case measurement
	Various valve: Confirm functioning status, Open-close operation, Water quality abnormal case measurement, Inspection method
U-BCF	Periodic washing operation: Confirm functioning status, ON-OFF operation, Air amount and water amount setting, Inspection method
	Periodic sludge operation: Confirm functioning status, Cleaning method, Inspection method
	Various valve: Confirm functioning status, Open-close operation, Inspection method
	Electrical equipment: Confirm functioning status, Inspection method, Operation method
Pipeline in An Duong WTP	Various valve: Confirm functioning status, Open-close operation, Inspection method
SCADA	Function confirmation, Operation method, Abnormal case measurement

Source: JICA Study Team (Based on local survey)

From the test plant experiment of An Duong WTP during the grassroots technical cooperation project, it

has been revealed that the biological membrane required 1.5 – 2 months to form. Therefore, for the U-BCF performance confirmation of this Project, raw water shall be passed through the activated carbon treatment tank two months prior to the construction completion. The soft component is to be started two months after, and after a specialist for U-BCF O&M confirms the acclimatization conditions, the test operation and adjustment will start.

2-2-4-8 Soft Component (Technical Assistance) Plan

(1) Hai Phong Water Technical Level

During the grass roots project conducted by Kitakyushu City Water and Sewer Bureau, Hai Phong Water had opportunities to send staff to Kitakyushu City Water and Sewer Bureau for visiting WTPs including U-BCF, and to undergo trainings of O&M. In addition, Vinh Bao WTP introduced a small scale U-BCF (5,000m^3/day) in 2013.

Therefore, the current a part of Hai Phong Water staffs have a certain level of U-BCF knowledge.

(2) Necessity of Soft Component Plan

The trainings are required as soft component plan for the following reasons:

① The U-BCF of this Project is the first U-BCF facility introduced to An Duong WTP.
② The treatment method (chemical feeding) is different from the general biological treatment by Hai Phong Water.
③ Basic training is required for staffs including the operators regarding the O&M of biological treatment because the capacity of the U-BCF of this Project is considerably larger than that of Vinh Bao WTP.

The actual training shall be mainly based on countermeasures for accidents and other emergencies.

Careful correspondence will be required in case the raw water turbidity increases rapidly by rainfall (first flush), therefore correspondence methods for first flush shall also be provided.

Also, since the introduction of U-BCF shall result in a change of the water quality which flows to the latter treatment facilities, the operation method for said facilities will require adjustment. Specifically, it will be necessary to comprehend the rate of reduction by U-BCF treatment (ammonium nitrogen, organic matters, manganese, etc.) and adjust the feeding rate of the chemicals such as coagulant and chlorine. Ammonium nitrogen is a quantitative measure factor to determine the effectivity of U-BCF for this Project, and it shall be necessary to be able to make correct and accurate measurements.

Under these circumstances, to realize appropriate WTP O&M and water quality control after the Project, soft component is planned to support the smooth operation and to secure persistence of the cooperation achievements.

The two targets of soft component planning are shown in Table 2-2-15.

Table 2-2-15 Soft Component Target

Target Item	Objective
1. Technical guidance for U-BCF O&M	1.Understanding the biological treatment method of U-BCF 2.Understanding the structure/objective of U-BCF 3.Reinforcement of O&M abilities 4. Reinforcement for handling accidents/emergencies
2. Technical guidance for water quality management	1. Learning appropriate water quality management (chemical feeding etc.)

Source: JICA Study Team (Based on local survey)

(3) Conduct of Soft Component

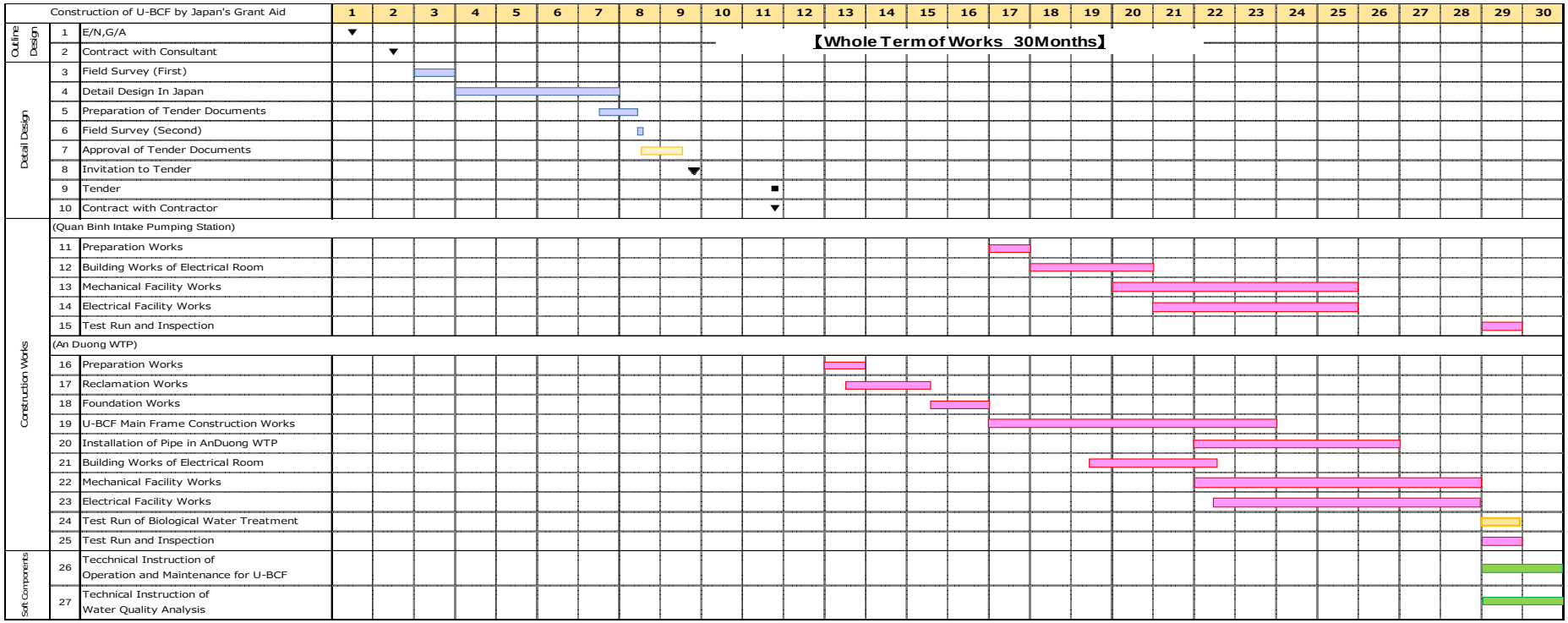
Soft component will be conducted under cooperation from Kitakyushu City Water and Sewer Bureau to fully utilize their knowledge and experience.

2-2-4-9 Implementation Schedule

This Project is classified as a Single-fiscal-year Project, whose term from the E/N to the completion of construction works is planned as 24 - 30 months.

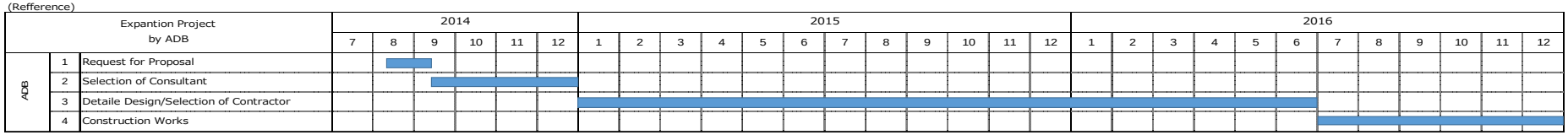
An appropriate implementation schedule shall be drawn up in accordance with the contents of “2-2-4-2 Construction/Procurement Conditions”. Since the Project period may overlap with the construction period of the ADB-loan project, the schedules of the both projects are shown in Table 2-2-16.

Table 2-2-16 Provisional Implementation Schedules of Both Projects



※1 Drawings and documents of Outline Design and Detail Design will be confirmed by Department of Construction (DOC)
※2 Confirmation of drawings and documents by DOC would take approximately one month

(Refference)

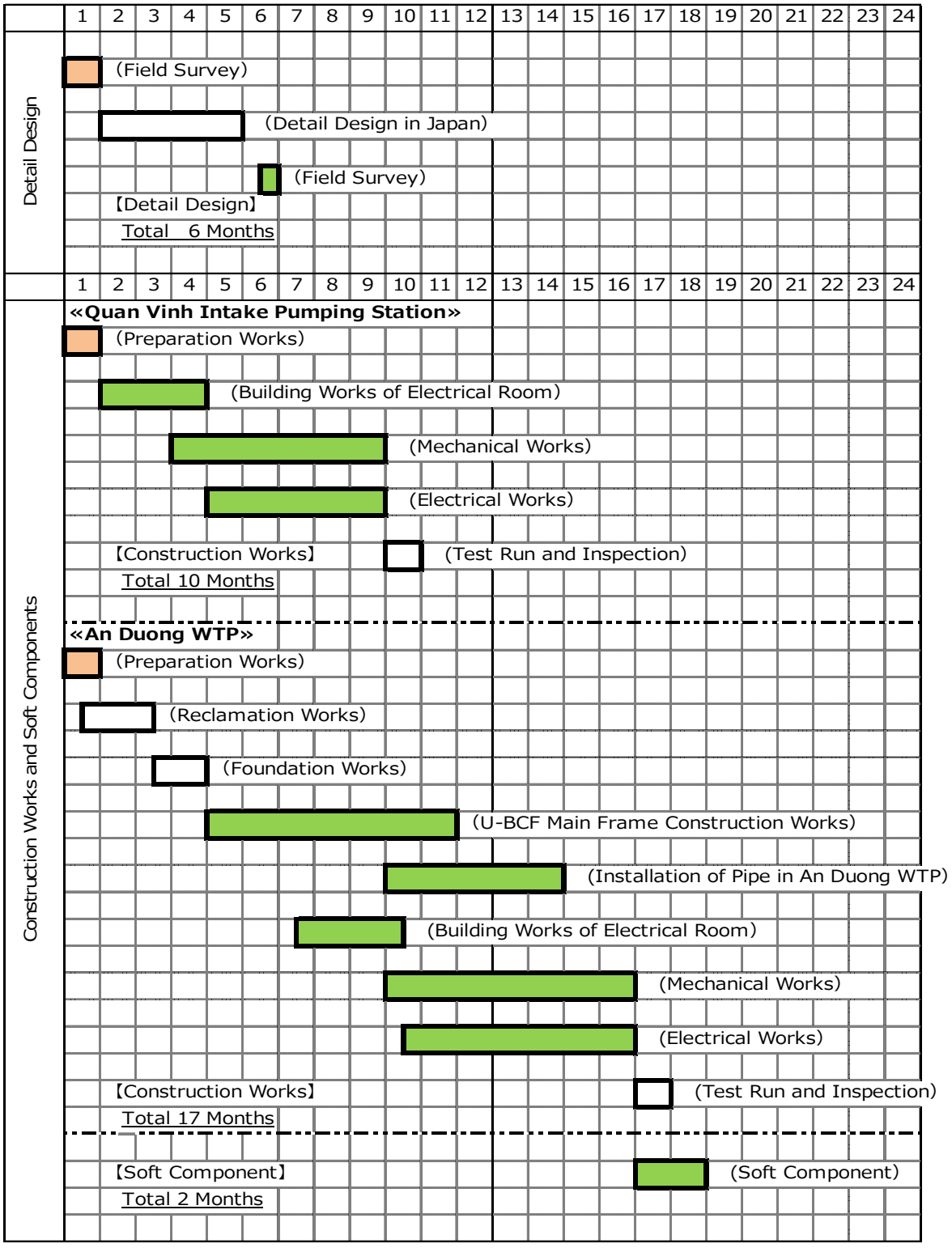


Source: JICA Study Team (Based on local survey)

The Contract with Consultant is still not conclusive, since it requires approval from GOJ

Table 2-2-17 shows the schedule of the work periods of the detailed design and the construction works for implementation of the Japanese side obligations. As this table shows, the planned work periods of the detailed design, the construction works in Quan Vinh intake pumping station, the construction works in An Duong WTP and the soft component are 6 months, 10 months, 17 months, and 2 months, respectively.

Table 2-2-17 Implementation Schedule



Source: JICA Study Team (Based on local survey)

2-3 Obligation of Recipient Country

The obligations of GoV and Hai Phong Water for this Project are mentioned in "2-2-4-3 Scope of Works". The details are shown in the following table:

Advanced Activities

Project Management Unit: Has an available PMU with full ability under the Hai Phong Water.

Table 2-3-1 Undertaking by GoV and Hai Phong Water

No.	Work Items	Description	Unit	Quantity	Implementation scheduled deadline (After conclusion of E/N)
1	Construction of construction site gate	New construction of the access gate for construction machineries	Gt	1	9 months later
2	Relocation of electrical lines	Relocation of electrical lines above the U-BCF proposed construction site and new gate for construction traffic.	Ls	1	9 months later
3	Acquisition of permission/approval	1. Construction permission for U-BCF 2. Road usage approval of surrounding roads for large vehicles 3. Approval for environmental impact issues (noise/vibration)	Ls	1	7 months later
4	Land Rental	Construction camp, stock yard etc., 17 months	m^2	1,500	11 months later
5	Banking Arrangement Commission(B/A)		Ls	1	1 month later
6	Commission fee for VAT	5% of total cost for construction material, equipment procurement, subcontract services will be subject to taxation as VAT, hence Hai Phong Water shall implement refund process. 10% of total cost for construction works will be subject to taxation as VAT, hence Hai Phong Water shall implement refund process.	Ls	1	17 months later
7	Installation of power receiving	Electric poles, high voltage cable, transformer, electric power volume meter, transformer foundation, fence	Ls	1	18 months later

Source: JICA Study Team (Based on local survey)

Although all the items above are important, especially No.1 to No.3 and No.5 are required for the construction works, and must be completed before the commencement of the construction. The schedule for undertakes to be made by GoV and Hai Phong Water is shown in Table 2-2-16. However, this schedule may change due to the timings of the cabinet meetings and/or E/N.

2-4 Project Operation Plan

The total number of staffs working at Hai Phong Water is 1,157 members, including one President and five Vice-presidents. The O&M staffs for An Duong WTP consists of 105 members, including one

Director of Enterprise and two Deputy Directors who are in charge of technical and management matters.

Items for daily O&M works and periodical inspection shall increase by the introduction of U-BCF of this Project. The additional works are shown in Table 2-4-1.

Table 2-4-1 The Additional Works by the Introduction of U-BCF

Items	Contents	Frequency
Washing U-BCF	Back washing of U-BCF	1 time per 1 day
Washing raw water conduit	Removal of shellfish stuck to raw water conduit	1 time per 1 year
Washing course screen	Removal of dust of raw water and shellfish	1 time per 1 week
Washing fine screen	Removal of dust of raw water and shellfish passed through the course screen	1 time per 3 days
Replenishing / changing granular activated carbon	Replenishment of the granular activated carbon lost by cleaning, and changing carbon which list adsorption	every year, 7% of total amount
Monitoring SCADA	Monitor and control of U-BCF conditions	continuous monitoring

Source: JICA Study Team (Based on local survey)

Additional works for periodical inspection are the U-BCF related dust remover, cleaning blower, drainage pump, electric valve, inflow valve, water level meter, operation panels, lighting and fans.

However, as mentioned 2-2-1(4) in the case of Honjyo WTP in Kitakyushu City Water and Sewer Bureau (U-BCF in operation), the introduction of U-BCF did not create works which required new organizations, as the additional works did not change the total work load and could be included in the current operation system. Therefore, the proposed existing operation system is supposed to be capable of operating and maintaining An Duong WTP. The guidance/training for operation/management due to introduction of U-BCF shall be additionally included in the soft component plans, as mentioned above.

2-5 Project Cost Estimation

2-5-1 Initial Cost Estimation

(1) Japanese Grant Aid Costs

This page is closed due to the confidentiality.

(2) Vietnamese Side Costs

The following costs are to be borne by the Vietnamese side to sufficiently provide effects of a grant aid Project.

Domestic Financial Mechanism for project

- With regard to ODA capital: Government budget allocates 100% of total ODA capital.

Table 2-5-1 Cost to be Borne by the Vietnamese Side

No.	Work Items	Description	Unit	Quantity	Total million VND
1	Construction of construction site gate	New construction of the access gate for construction machineries	Gt	1	247.4
2	Relocation of electrical lines	Relocation of electrical lines above the U-BCF proposed construction site and the new gate for construction traffic.	Ls	1	206.2
3	Acquisition of permission/approval	1. Construction permission for U-BCF 2. Road usage approval of surrounding roads for large vehicles 3. Approval for environmental impact issues (noise/vibration)	Ls	1	206.2
4	Land Rental	Construction camp, stock yard etc., 1 year (May 2016 – April 2017)	m^2	1,500	2,309.3
5	Banking Arrangement Commission(B/A)		Ls	1	206.2
6	Commission fee for VAT	5% of total cost for construction material, equipment procurement, subcontract services will be subject to taxation as VAT, hence Hai Phong Water shall implement refund process. 10% of total cost for construction works will be subject to taxation as VAT, hence Hai Phong Water shall implement refund process.	Ls	1	4,515.5
7	Installation of power receiving	Electric poles, high voltage cable, transformer, electric power volume meter, transformer foundation, fence	Ls	1	2886.6
Total					11,539.6

Source: JICA Study Team (Based on local survey)

The estimated cost to be Borne by the Vietnamese Side for this Project is VND 11,540 million (JPY 55 million) as mentioned in Table 2-5-1.

Hai Phong Water registers VND 22,800 million – 25,800 million (JPY 110 million – 120 million) in net profits, therefore the payment for the construction cost of this Project is possible.

2-5-2 Operation and Maintenance Cost

The annual increase estimation for An Duong WTP O&M cost following the implementation of this Project, for both before and after the ADB-loan facility expansion project, are shown in the followings. The difference in the O&M cost between before and after complementation of the ADB project is specified, due to the different operation status of the intermediate pumps.

Table 2-5-2 O&M Cost after Completion of this Project (Before ADB-loan Facility Expansion Project)

Items	Capacity	Unit Number	Operating Time	Annual Power Consumption Volume 365days	Unit Power Cost	Annual Power Consumption Cost
	kw	Number	min・hour/day	kwh/year	VND/kw	VND/year
1. Intake Pump	40	3	24 hours	1,051,200.0	1,388	1,459,066,000
2. Washing Brower	37	1	30 minutes	6,752.5	1,388	9,372,000
3. Drainage Pump	11	2	2 hour	16,060.0	1,388	22,291,000
4. Motor Operated Valve	0.2	3	10 minutes	36.5	1,388	50,700
5. Lighting	0.1	10	2 hour	730.0	1,388	1,013,000
sub-total				1,074,779.0		**1,491,792,700**
Items	Capacity	Activated Carbon Life Span	Annual Activated Carbon Supplement Ratio	Annual Activated Carbon Supplement Volume	Activate Carbon Unit Cost	Annual Activated Carbon Consumption Cost
	m^3	year	%	m^3/year	VND/m^3	VND/year
1. Granural Activated Carbon	420	15	7 %	29.4	17,750,150	521,854,410
sub-total						**521,854,410**
Items	Volume		Annual Treatment Ratio	Annual Consumption Volume	Maintenance Unit Cost	Annual Maintenance Cost
	m^3/day		%	m^3/year	VND/m^3	VND/year
1. Mechanical Maintenance	100,000	—	100 %	36,500,000	20	730,000,000
sub-total						**730,000,000**
Items	Treatment Volume by U-BCF	Average Unit Consumption	Reduction Ratio	Annual Chemical Reduction Volume 365days	Chemical Unit Cost	Annual Chemical Reduction Cost
	m^3/day	g/m^3	%	kg/year	VND/kg	VND/year
1. PAC	100,000	11.54	28.5	120,045	9,150	▲ 1,098,410,000
2. Chlorine	100,000	2.00	27.1	19,783	11,200	▲ 221,570,000
sub-total						**▲ 1,319,980,000**
Total(VND)						**1,423,668,000**
Total(YEN)						**6,905,000**

*Intake pump capacity implies the capacity difference of renewed and existing pumps

Source: JICA Study Team (Based on local survey)

The annual O&M cost increase caused by this Project and before the ADB expansion project is estimated as JPY 7 million due to replace the intake pump.

Hai Phong Water's net profit of year 2009 to 2013 was between VND 22,800 million – 25,800 million (JPY 110 million – 120 million), hence the O&M cost payment increase caused by this Project shall be possible.

Table 2-5-3 O&M Cost after Completion of this Project (After ADB-loan Facility Expansion Project)

Items	Capacity	Unit Number	Operating Time	Annual Power Consumption Volume 365days	Unit Power Cost	Annual Power Consumption Cost
	kw	Number	min・hour/day	kwh/year	VND/kw	VND/year
1． Intake Pump	40	3	24 hours	1,051,200.0	1,388	1,459,066,000
2． Middle Pump	195.6	1.7	24 hours	▲ 2,858,504.2	1,388	▲ 3,967,604,000
3． Washing Brower	37	1	30 minutes	6,752.5	1,388	9,372,000
4． Drainage Pump	11	2	2 hour	16,060.0	1,388	22,291,000
5． Motor Operated Valve	0.2	3	10 minutes	36.5	1,388	50,700
6． Lighting	0.1	10	2 hour	730.0	1,388	1,013,000
sub-total				▲ 1,783,725.2		**▲ 2,475,811,300**
Items	Capacity	Activated Carbon Life Span	Annual Activated Carbon Supplement Ratio	Annual Activated Carbon Supplement Volume	Activate Carbon Unit Cost	Annual Activated Carbon Consumption Cost
	m^3	year	%	m^3/year	VND/m^3	VND/year
1． Granural Activated Carbon	420	15	7 %	29.4	17,750,150	521,854,410
sub-total						**521,854,410**
Items	Volume		Annual Treatment Ratio	Annual Consumption Volume	Maintenance Unit Cost	Annual Maintenance Cost
	m^3/day		%	m^3/year	VND/m^3	VND/year
1． Mechanical Maintenance	100,000	—	100 %	36,500,000	20	730,000,000
sub-total						**730,000,000**
Items	Treatment Volume by U-BCF	Average Unit Consumption	Reduction Ratio	Annual Chemical Reduction Volume 365days	Chemical Unit Cost	Annual Chemical Reduction Cost
	m^3/day	g/m^3	%	kg/year	VND/kg	VND/year
1．PAC	100,000	11.54	28.5	120,045	9,150	▲ 1,098,410,000
2．Chlorine	100,000	2.00	27.1	19,783	11,200	▲ 221,570,000
sub-total						**▲ 1,319,980,000**
Total(VND)						**▲ 2,543,937,000**
Total(YEN)						**▲ 12,339,000**

*Intake pump capacity implies the capacity difference of renewed and existing pumps

Source: JICA Study Team (Based on local survey)

The annual O&M cost decrease caused by this Project and after the ADB expansion project is estimated at JPY ▲12 million due to be abolished the intermediate pump.

The difference in the cost before and after the ADB-loan expansion project is due to the abolishing of the intermediate pumps.

The basic conditions used for O&M cost calculation are as follows.

① Electricity cost

- ✓ Unit price is based on the electricity price list of Electricity of Vietnam in Hai Phong below "Industry: Voltage under 6kV, normal time".
- ✓ The capacity difference with the existing intake pumps shall be an approximately 120kw increase, therefore it is calculated as a 40kw/pump increase.

② Activated carbon management cost

- ✓ The activated carbon life is expected as 15 years by results after running the pilot plant by Kitakyushu City Water and Sewer Bureau .
- ✓ The unit price information has been gathered by enterprises supplying activated carbon to Vinh Bao WTP (operated by Hai Phong Water).

③ Equipment maintenance cost

- ✓ Maintenance cost per $1m^3$ has been set based on results of Honjyo WTP and An Duong WTP operation.
- ✓ Equipment maintenance cost includes grease and oil necessary for the maintenance of pumps and electric motors.

④ Chemical cost

- ✓ Average usage amount of PAC and chlorine is calculated by monthly results of year 2004 to 2014.
- ✓ Chemical cost reduction rate is based on Vinh Bao WTP (operated by Hai Phong Water) results.
- ✓ Unit costs for chemicals refer to the supply information to Hai Phong Water (2014).

⑤ Total

- ✓ The exchange rate is VND 1 = JPY 0.00485, which is the average of June to August, 2014.

Chapter 3

Project Evaluation

Chapter3 Project Evaluation

3-1 Preconditions

The preconditions for the Project are shown below:

The budget to cover the obligations of GoV and Hai Phong Water (refer to Table 2-3-1) is complied, and the payment is proceeded sufficiently according to the implementation schedule.

3-2 Necessary Actions by Recipient Country

The Vietnamese side shall be required to take initiative for the following works of the Project:

① To participate in soft component and to take advantage of the gained skills for accurate O&M of water supply business,

② To inform the users about the temporary water supply failure which shall occur after the Project completion, due to the connections works (distribution pipe (φ1000mm) construction) required for connecting the existing and new facilities, and

③ To establish EPC program for Project implementation although EIA procedure is not required for the Project.

3-3 Important Assumptions

Since many items of the Project as shown below overlap with the WTP expansion project of ADB which is planned in the same period (pipe connection, monitoring facilities, temporary roads/gates, etc.), early arrangements are necessary. External conditions required to be established and maintained for the Project benefits are as follows:

① The security situation of the target site does not affect the Project implementation.
② The residents of the target site do not oppose to the Project implementation.
③ The water supply policy of Viet Nam does not change largely.
④ The ADB-loan facility expansion project water treatment flow and water level is determined.
⑤ The ADB-loan facility expansion project layout is determined.
⑥ The ADB-loan facility expansion project implementation schedule is determined.
⑦ The construction work of connection with the ADB expansion project (various pipe connecting) is to be implemented as scheduled.
⑧ The arrangements (usage of temporary roads and gates) between the Project and the ADB expansion project are to be conducted as planned.

*For the items ④ to ⑧, it shall be necessary for Hai Phong Water to hold discussions with ADB during the Detail Design period of the Project.

3-4 Project Evaluation

Validity and effectiveness of the Project is presented below:

3-4-1 Relevance

As mentioned in the previous chapters, An Duong WTP has several issues regarding the treated water quality and O&M. The main reason is the progressing of water pollution by ammonium nitrogen and organic matters within the water source, Re River, caused by the inflow of domestic wastewater. Large amounts of flocculent and chlorine is required in the water treatment process to treat the polluted raw water because of the issue. Since the ammonium nitrogen concentration of the raw water is exceeding the Vietnamese standard (0.2mg/L) for raw water for drinking water, advanced treatment method is required to deal with the current status. In addition, the quality of Re River water, including the ammonium nitrogen concentration, is assumed to become worse in the future due to the urban development plans along the river basin. The Project aims to contribute to supply safe drinking water through the introduction of U-BCF facilities stabilizing the WTP operation and reduce the chlorine usage.

Viet Nam has announced a national policy regarding the urban water business in the Urban Water Business Development Guideline “Orientation on Water Supply Development of Urban areas and Industrial Zones in Vietnam up to 2020” (1998). This Project aims to contribute to the guideline objectives as to “secure safe water for all urban areas by 2020” and to “reinforce the human resource development system by introduction of advanced technologies and facilities”.

In the Japanese Government Country Assistance Policy for the Socialist Republic of Viet Nam (December 2012) and the JICA Country Analytical Work (March 2014), “Response to fragility” is highlighted. Along the policy, Japan aims to support Viet Nam to address emerging environmental issues (urban environment, natural environment) caused by rapid urbanization and industrialization, and the Project follows this principle.

Necessity and validity of implementation of the Project is justified by the following points: the Project is to introduce U-BCF as an advanced water treatment method to deal with the raw water quality deterioration caused by the urbanization of Hai Phong city. The water quality issue is showing the fragility of the environment which is closely relevant to the Vietnamese national policy, while the Japanese assistance policy and JICA Country Analytical Work priority areas is “response to fragility”.

The U-BCF methods, which is a national patent technology owned by Kitakyushu City Water and Sewer Bureau, shall be introduced to solve the issues of Viet Nam. This Project is also in accordance with the Japanese government programs of the “Japan Revitalization Strategy” and “Export of Infrastructure Systems Strategy” by which further enhances the significance of the Project as a grant aid project.

In addition, this Project represents the accordance with the Japanese government programs of the "Japan Revitalization Strategy" and "Export of Infrastructure Systems Strategy". It can be stated so since the Project shall introduce U-BCF methods, which is a national patent technology owned by the local-governmental Kitakyushu City Water and Sewer Bureau for infrastructure improvement with cooperation of the counterpart's local government.

While this Project is to provide solutions to issues related to national development for the Vietnamese government, it shall also provide an opportunity to Kitakyushu city's business development in Viet Nam. The participation means for Kitakyushu city are detailed in Appendix 6-17.

From the above points, this Project is highly significant as a Grant Aid Project.

3-4-2 Effectiveness

The expected outputs of the Project are the quantitative/qualitative effectiveness described in the followings:

(1) Quantitative Effectiveness

The quantitative effectiveness target for this Project is the reduction of ammonium nitrogen concentration value.

Table 3-4-1 Quantitative Project Effectiveness

Index	Basic Value (2013 to 2014 year actual value)	Target Value Year 2018 (One year after the completion of the Project)	Remarks
Ammonium Nitrogen	0.2 - 1.1mg/L	Below 0.2mg/L at U-BCF exit	National Technical Regulation on Surface Water below 0.2mg/L(QCVN 08:2008/BTNMT)

Source: JICA Study Team (Based on Hai Phong Water data)

However, in case the ammonium nitrogen concentration of the raw water exceeds 1.00mg/L (this may occur during the rainy season), the ammonium nitrogen concentration at the U-BCF exit may exceed 0.2mg/L when using the removal ratio 81.4%, which is the value provided from Kitakyushu City Water and Sewer Bureau U-BCF plant experiments, for calculation.

Continuous monitoring is necessary to comprehend rapid concentration changes. The raw water quality is currently being monitored five times a week at An Duong WTP, so it is possible to monitor the ammonium nitrogen concentration throughout the year as a quantitative effectiveness target value. The water quality measuring methods for quantitative effectiveness monitoring is planned to be included in the soft component to train the An Duong WTP staff.

Table 3-4-2 Monitoring Structure of the Quantitative Project Effectiveness

Executing Agency	Measurement Frequency	Measurement Term	Measurement Method
Hai Phong Water An Duong WTP	One time per week	One year continuation	Coloring Reagent

Source: JICA Study Team (Based on local survey)

The base for setting the target value is mentioned below:

After the water treatment process, generally ammonium nitrogen is not detected in tap water which has proper residual chlorine concentration, and therefore a standard value for the ammonium nitrogen is not regulated in Japan. There are no values set on the WHO guideline of health influence either, but 1.5mg/L is stated as a standard value of the ammonium nitrogen concentration within treated water.

However as mentioned before, when the ammonium nitrogen concentration is high in the raw water, the WTP treatment requires large amounts of chlorine to treat the ammonium nitrogen. This causes a chemical reaction between chlorine and ammonium nitrogen which generates chloramine (cause of bad odor/taste), and also a reaction of chlorine and organic matters in the raw water generates THM. Therefore, the ammonium nitrogen concentration in raw water is considered as an important value for Japanese water treatment methods, and is expected to be lower than 0.3mg/L.

In Viet Nam, the ammonium nitrogen value for standard surface water quality is lower than 0.2mg/L, which indicates that ammonium nitrogen is understood to be a main factor for water treatment problems.

For the above reasons, the ammonium nitrogen concentration is set to be lower than 0.2mg/L in the treated water at the U-BCF exit, which is the target for the performance of U-BCF.

(2) Qualitative Effectiveness

The qualitative effectiveness is expected by the Project as follows:

- **Stability of the operation of An Duong WTP by reducing the ammonium nitrogen concentration of the raw water.**

  An Duong WTP uses a river as the water source, and adopts rapid filter treatment methods using chemicals to remove ammonium nitrogen. For this method, it is necessary for the operator to adjust the chemical injection amount according to the ammonium nitrogen concentration ratio. Water quality of rivers tends to change largely due to rainfall and the basin situation, therefore the chemical injection adjustment is difficult.

  U-BCF is a biological treatment method which reduces the ammonium nitrogen by the potency of microorganisms; hence it is able to correspond to the rapid change of raw water quality. This feature shall improve the water treatment operation stability (facility).

- **Supply of safe drinking water**

  The introduction of U-BCF shall reduce both the chlorine, which is a cause of THM, and organic matters. It is an efficient water treatment method to observe strictly the water quality values related to THM generation when compared to the current treatment method. Chloroform is a THM substance which is a carcinogen and its influence is especially considered dangerous, therefore U-BCF is expected to enable safe water supply to the residents by reducing the THM generation.

- **Improvement of knowledge/technical skills of Vietnamese water business parties by adopting advanced water treatment technology**

  Water quality issue solutions are urgently required not only by Hai Phong Water, but also by many other water business enterprises in Viet Nam whom are troubled by river water pollution. Under

this situation, the success of this Project by providing positive operating results of the U-BCF with low O&M cost is expected to enhance the knowledge and technical levels of the water supply business of the country and to take a part in solving Viet Nam's water pollution problems.