Socialist Republic of Vietnam

Ministry of Agriculture and Rural Development（MARD）

Socialist Republic of Vietnam
the Preparatory Survey for the Project for
Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System

February 2017

Japan International Cooperation Agency (JICA)
Foundation of River & Basin Integrated Communications, Japan
Incorporated Administrative Agency Japan Water Agency
CTI Engineering Co., Ltd.

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Preface

Japan International Cooperation Agency (JICA) decided to conduct the preparatory survey for the project for emergency reservoir operation and effective flood management using water related disaster management information system and entrust the survey to the Joint Venture Consultant consist of Foundation of River & Basin Integrated Communications, Japan, Incorporated Administrative Agency Japan Water Agency and CTI Engineering Co., Ltd.

The survey team held a series of discussions with the officials concerned of the Government of the Socialist Republic of Vietnam, and conducted a 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 the two countries.

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

February, 2017

Mr. Kunihiro Yamauchi
Director General,
Global Environment Department
Japan International Cooperation Agency

Summary

■Outline of the Country

Located on the eastern end of the Indochina Peninsula, Vietnam is bordered on the north by the People's Republic of China (China) and on the west by the Lao People's Democratic Republic (Laos) and the Kingdom of Cambodia (Cambodia). The nation's territory extends 1,650 km from north to south between the latitudes of 8°30' and 22°22'N. Because it is mainly located to the east of the Annamite Range, which extends north to south in parallel with the Pacific coast of the Indochina Peninsula, it is only 50 km from east to west at its narrowest point. The land area is 332,000 km2, making it about 88% the size of Japan. Both Hanoi in the north and Ho Chi Minh City in the south are located in vast deltas formed by the Red River and Mekong River, respectively, while three-fourths of Vietnam is hilly or mountainous. About 45% of the nation's total population of 93,400,000 (as of 2015) live at elevations of 5 m or lower, subjecting them to a high possibility of water-related disasters. These are similar to Japan's conditions.

The Huong River basin (which covers an area of about 2,800 km2) is included in the Thua Thien-Hue Province (5,062 km2) of central Vietnam. In terms of climate, Thua Thien-Hue Province is classified as a tropical monsoon region. About 75% of its annual precipitation occurs in the rainy season taking place from September to December. The province is sometimes hit directly by typhoons originating in the area around the Philippines. Annual precipitation averages about 3,500 mm, roughly double the amount found in Japan. However, there is also a drought risk, as there are many months during the dry season when precipitation is less than 100 mm per month.

■Background and Outline of the Project

The central coastal provinces of Vietnam that are situated in a so-called typhoon-prone zone are particularly affected by flooding and landslides every year. This is a pressing challenge the country must address by implementing disaster management and emergency measures for the purpose of protecting people's lives as well as preventing the loss of social/economic assets. The water utilization dams built on the major waterways are not well managed as to the appropriate release timing for flood control, resulting in man-made disasters in the lower river regions, or causing small-sized earthfill dams to overflow and flood the lower river regions during heavy rainfall. These disasters are attributed to an insufficient framework for collecting information on rainfall measurements, river water levels/volumes, dam water levels, etc. and transmission of information on flooding, as well as to the lack of timely and appropriate storage/release into and from these dams.

By establishing the Disaster Prevention/Mitigation Act in 2013 (33/2013), the Vietnamese government placed priority on the appropriate management and operations of dams, and in the same year the Prime Minister directed the MARD (Ministry of Agriculture and Rural

Development) to enhance appropriate management and safety measures in response to the recent disasters caused by the Huong River to its downstream areas (PM Directive 21/CH-TTg). The completion of Ta Trach Dam designed to control flooding is slated for 2018. In 2014, the Vietnamese government set forth, under a Prime Minster directive (1497/QD-TTg), the Integrated Flood Management Rules for the three major water utilization dams (including Binh Dien Dam and Huong Dien Dam) along the Huong River that also function as water power supply sources; and in 2015 supplemented the Rules with drought measures. Currently, however, there is only one rainfall observing station per each basin of 400km2, far from the standard requirement - “one per each area of 50km2” for flood forecasting. Even the number of existing water level observation stations is inadequate, with only one at the upstream location serving all six of the locations needing to observe dam inflows. Thus, there is an inadequate amount of water level data needed to understand flooding situations downstream. Neither does any system exist, either real-time or forecast, that allows analysis of floods across basins. Specifically, information systems needed to implement operations in compliance with the Prime Minister’s directed Operation Rules are not in place.

Under such circumstances, improving the safety of the dams and basins by making proper decisions with regard to controlling the timing and quantity of storage and discharge of the dams, and accurately understanding and disseminating flood disaster risk information to the downstream areas, high accuracy observation and sharing of real-time hydrological data in order to improve flood forecasting are indispensable. Therefore, the development of a Disaster Prevention Information System has become an urgent matter.

Based on these background, Vietnamese Government requested Japanese Government a grant aid ‘the Project for Emergency Operation and Effective Flood Managemnt using Water related Disaster Management Information Ssystem’ (hereinafter ‘the Project’) The project aims at mitigating flood damage in the Huong River basin, by effective management oif exsiting dams (Huong Dien, Binh Dien and Ta Trach) and appropriate river management using hydrological observation network and water related disaster management information system.

■Outline of the Survey results and Contents of the Project

This project is for establishing a water-related disaster management information systems where rain gauges including X-band radar rain gauges and level meters for measuring river and dam reservoir water level are installed on the Huong River basin in Vietnam's Hue Province and observation data is captured in real time via telemeters and that data is processed and presented as forecast information necessary for appropriate operation of dam reservoirs and downstream water related disaster management, evacuation activities, etc. Furthermore, necessary transfer of expertise and human resources development are conducted in order for the water-related disaster management information systems to be effectively used long-term continuously and to help in the prevention and alleviation of water-related disasters in the Huong River area.

Based on the field survey including electric wave propagation test, appropriate location and

specification of of equipments were designed and implementationschedule was considered for various facilities, such as observation stqtions, telemeter facilities and water related disaster management information system.

The content of this project is as shown in the table below.

Table 1 Project Content

Category	Content/scope
Equipment for collection of observation data in the Huong River basin	X band radar: 1 Hydrological observation stations: 10 locations CCTV (downstream regions): 8 locations
Dam supervision facilities at management offices of three dams	Real-time dam management systems: 3 (1 set for each of the 3 dams) CCTV (3 dams): 6 locations (2 locations for each of the 3 dams) Communication lines: 3 (1 set for each dam) Dam water level metering system (3 dams) Dam gate opening indicators (2 dams)
Water-related disaster management information systems of Hue Province PCC-NDPCSR	Information management equipment (for collection, analysis and output): 1 set Multiple information display system: 1 Information disclosure web system/alarm mail system: 1 set Communication devices: 1 set
Water-related disaster management information systems of CSC-NDPC (Hanoi)	Multiple information display system: 1 Communication devices: 1 set
Basic data collection	Terrain surveying using Lidar data, etc.: 1 set Cross-sectional river surveying: 1 set
Operating manuals	Operating manuals and training
Consulting services and soft components	(1) Supervision of procurement and construction (2) Technical training in procedures for responding to trouble in the hydrological observation station equipment and water-related disaster management information systems, inspection and maintenance, display data monitoring, transmission of flood risk information, parameter identification method of runoff analysis model of X band radar, parameter identification method of runoff analysis model, and the creation and use of water level and flow volume curves

■Term of the Project

Total project term is about 35 months including 6 months for contract process and detailed design and 29 months for procurement and installation of equipments and soft component (technical assistance). It takes about 24 months from the contract to the delivery of equipments as a completion of the project.

■EvaProject Evaluation (Relevance and Effectiveness)

This Project is designed to alleviate flood disasters in central Vietnam through the installation of hydrological observation equipment, dam management equipment, and water-related disaster management information systems. Consistent with the development policies of Vietnam as well as with the JICA cooperation policies/analyses of Japan, the Project is expected to contribute to SDGs Goal-I “To eradicate poverty of all types,” and Goal-II “To

build comprehensive, safe and well-protected cities/human settlements." In addition, efforts to respond to natural disasters are in high demand from a humanitarian standpoint. Though the "Sendai Initiatives for Disaster Prevention" released at the United Nations World Conference on Disaster Reduction (WCDR) of March 2015, Japan pledged to make a contribution to the world by leveraging its knowledge and technologies. In this respect, it is reasonable and highly worth supporting the execution of this Project from a diplomatic viewpoint,

Quantitative results of this Project include: improvement of hydrological observation data density, mitigation of downstream flooding through appropriate dam operations, and faster sharing of information on rainfall amounts and water levels.

Table 2 A List of Quantitative Effects

Indicator Name		Baseline (Actual 2016)	Target (2022) [In 3 yrs of Completion]
Hydrological Data Density	Rainfall data useful for Systems (Measuring Points/km^2)	1/400	1/0.1
	River WL/Flow Rate Measuring Points (# of Points)	6	16
Downstream Flood Volume Reduction by dam (m^3/s)		-1,480（25% reduced）*	-3,130（55% reduced）*
Frequency of data on rainfall/WL (Interval)		60 min	10 min

* Estimates for the Hue city center (Kim Long) in the event of a flood equivalent to the record heavy flood of Sep. 2009.

On the other hand, qualitative effects are as follows:

i) To contribute in enhancing the appropriate management/operation of dams along the Huong River;

ii) To contribute in preventing/mitigating water-related disasters across the Huong River basins.

iii) To contribute in providing forecast data on the areas likely to be inundated along the Huong River, and helping local people in establishing appropriate evacuation measures.

Contents

Location Map

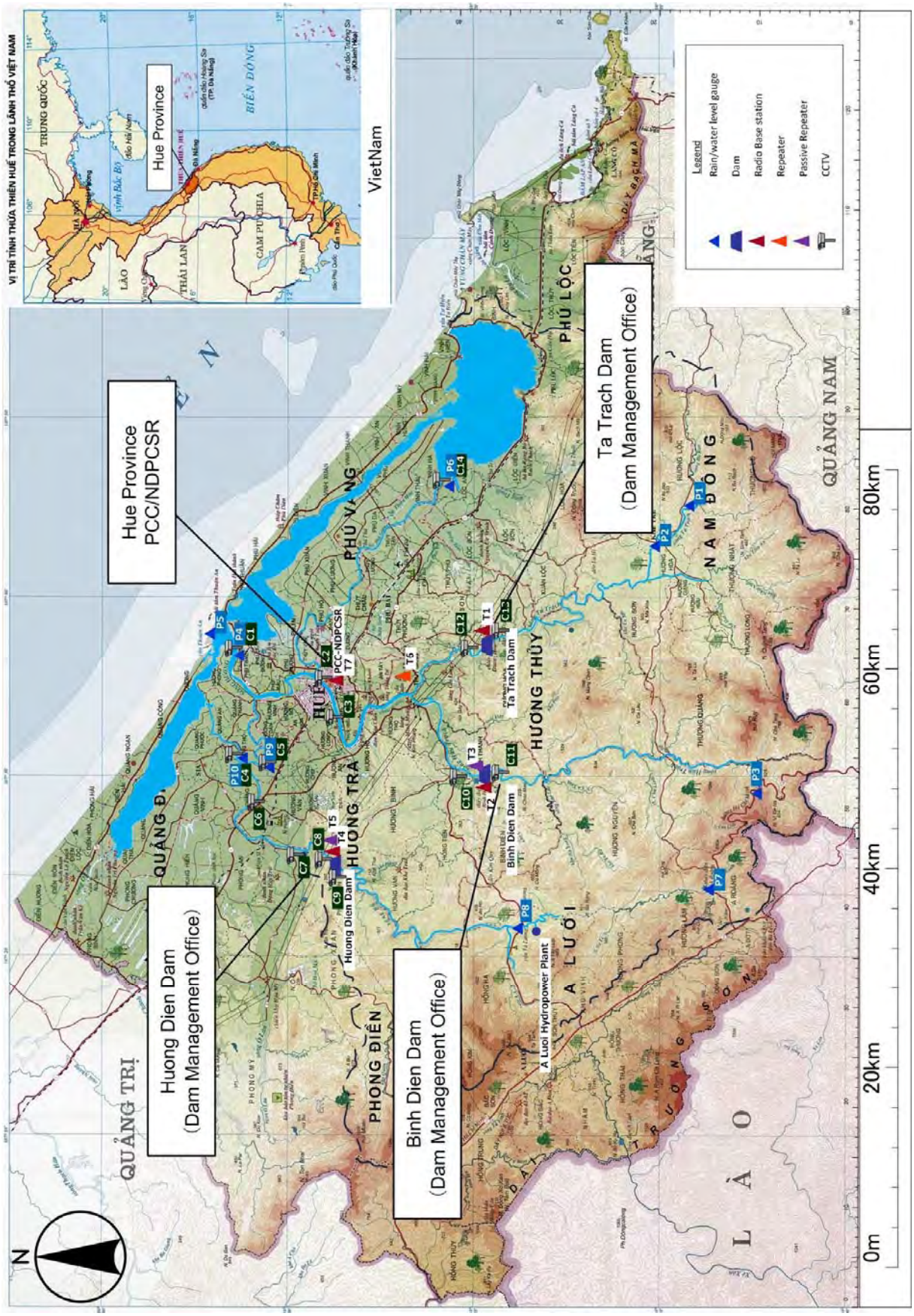

Fig. 1 Huong River Basin Map and Dams Applicable to Project (1/60000)

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Abbreviations

AMO	Aero-Meteorological Observatory (under MoNRE)
CSC-NDPC	Central Steering Committee for Natural Disaster Prevention and Control
DARD	Department of Agriculture and Rural Development
DMC	Disaster Management Center (under MARD)
DMHCC	Department of Meteorology ,Hydrology & Climate change (under MoNRE)
DNDPC	Department of Natural Disaster Prevention & Control (under MARD)
DoNRE	Department of Natural Resources and Environment
DSTIC	Department of Science Technology and International Cooperation (under MARD)
DWR	Directorate of Water Resources (under MARD)
HMC	Thua Thien Hue Hydro- Meteorological Center (under MoNRE)
LiDAR	Light Detection and Ranging / Laser Imaging Detection and Ranging
MARD	Ministry of Agriculture and Rural Development
MCRHMC	Mid-Central Regional Hydro-Meteorological Center (under MoNRE)
MoNRE	Ministry of Natural Resources and Environment
NCHMF	National Center for Hydro-Meteorological Forecasting (under MoNRE)
NHMS	National Hydro-Meteorological Service (under MoNRE)
PCC-NDPCSR	Provincial Commanding Committees for Natural Disaster Prevention and Control, Search and Rescue
T.T.Hue PPC	Thua Thien Hue Provincial People's Committee
VAWR	Vietnam Academy of Water Resources (under MARD)

1. Background of Project

1-1 Background/Historical Path and Overview of Grant Aid Efforts

In August 2014, the Vietnamese government requested that the Japanese government provide a grant aid to the "Project for Effective Dam Operations and Flood Control in Emergency Situations using a Water Disaster Prevention Information System" (hereinafter "the Project") with the aim of mitigating flood damage through appropriate river management and effective operation of the three currently existing dams (Huong Dien Dam, Binh Dien Dam, and Ta Trach Dam). This would be accomplished by implementing rainfall and water-level monitoring systems and water-related disaster management information systems in the heavy-rainfall-prone Huong River basins of the Hue Province in the central region of Vietnam. Vietnam requested provision of the following equipment:

X-band radar rain gauge (one set),Hydrological observation stations (10 locations); CCTV (14 locations = 2 for each of the three dams + 8 for others); Real-time dam management system (one set for each of the three dams, including reservoir water level meters and gate opening indicators); Telecommunication lines (7 pylons); Data processing devices (for data collection/analysis/output)(one set per dam); Multi-data-display systems (one set for each of Hue & Hanoi); Web-based information release system/Alarm mailing system (one set); telecommunication systems (one set for each of Hue and Hanoi); Aerial laser measurement system (one set); and River cross profile measurement system (one set).

1-2 Natural Conditions

Located on the eastern end of the Indochina Peninsula, Vietnam is bordered on the north by the People's Republic of China (China) and on the west by the Lao People's Democratic Republic (Laos) and the Kingdom of Cambodia (Cambodia). The nation's territory extends 1,650 km from north to south between the latitudes of 8°30' and 22°22'N. Because it is mainly located to the east of the Annamite Range, which extends north to south in parallel with the Pacific coast of the Indochina Peninsula, it is only 50 km from east to west at its narrowest point. The land area is 332,000 km^2, making it about 88% the size of Japan. Both Hanoi in the north and Ho Chi Minh City in the south are located in vast deltas formed by the Red River and Mekong River, respectively, while three-fourths of Vietnam is hilly or mountainous. About 45% of the nation's total population of 93,400,000 (as of 2015) live at elevations of 5 m or lower, subjecting them to a high possibility of water-related disasters. These are similar to Japan's conditions.

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Thua Thien-Hue Province (5,062 km^2) of central Vietnam. In terms of climate, Thua Thien-Hue Province is classified as a tropical monsoon region. About 75% of its annual precipitation occurs in the rainy season taking place from September to December. The province is sometimes hit directly by typhoons originating in the area around the Philippines. Annual precipitation averages about 3,500 mm, roughly double the amount found in Japan. However, there is also a drought risk, as there are many months during the dry season when precipitation is less than 100 mm per month.

The Huong River forms where the rivers Ta Trach (originating in the Bach Ma mountains) and the Huu Trach have their confluence. Subsequently, the Huong River flows through the urban area of the city of Hue and joins the Bo River. Downstream from there, it drains into Vietnam's largest lagoon, and from the mouth of the lagoon it enters the South China Sea. The short distance from mountains to plain areas helps form relatively steep river channels, and most plans low and flat with smooth surfaces. In the event of a heavy rain, therefore, flooding runs downstream in a short time, inundating the lower river plain and inflicting enormous damage. Flood concentration time from the uppermost area to Hue city is about a half day and about 2 hours from dam site to the city, which situation is likely to Japan. Worsening the situation is a huge volume of sediment transported from upstream mountains created by land development for initiatives involving harvesting wood for pulp. Transported sedimentation piles up in downstream river channels and low lying l areas, causing frequent flood damage. In particular, the basin of the Bo River is prone to flood damage, as earth and sand from not only the Bo River but also the Huong River pour there and keep accumulating. The Bo River does not have enough capacity to carry all of this sedimentation as the flow does not enter the Huong River, and such sedimentation changes the shape of the Bo River. Although the Huong River and the Bo River in the mountainous terrain follow a natural, uncontrolled course, villages in such mountainous areas are located higher than the river banks, and there is no record of noticeable water-related disasters in these areas. There are few levees in the plain areas along the Huong River and the Bo River, which is the reason these areas are inundated and affected by water-related disasters when the river level rise. The Huong River goes right through the Hue City urban area, dividing the old town, where the former palace is located, from the new town, where the French colonists lived. A number of bridges, including the Truong Tien and Phu Xuan, connect the new and old towns, but homes in the new town often have flooding on the ground floor during the rainy season. Additionally, wet-rice farming is practiced in the low-lying areas downstream, as are fishing and aquaculture in the lagoons there. Therefore, the manufacturing base in these areas is also prone to flood damage.

In recent times, particularly significant flood damage occurred in November and December 1999 as a result of typhoon-like rainfall events. In November of that year, the entire central Vietnam region tallied 621 deaths and $269 million in damage

because of floods. In December, there were 322 deaths and $66 million in damage as a result of flooding. In the central part of Hue City, 1 to 2m inundation was recorded in a wide range of area and it reached 2 to 3m at the emerging point of Huong River and Bo River. In September 2009, Typhoon No. 9 (aka. Ketsana), moving directly westward from the Pacific Ocean, hit the Quang Ngai province located to the south of the Hue Provvincee, killing 163, leaving 11 missing, injuring 629, destroying 21,611 houses, and inundating 294,711 houses. In 2013, Hue Province was affected by 4 flooding events in succession (Sep. 19, Oct. 3 and 15, and Nov. 15-17), resulting in damages of approximately $28 million. Just recently in October 2016, it was reported that heavy rainfall hit Tỉnh Quảng Bình and Tỉnh Hà Tĩnh, located to the north of the Hue Province, killed 21 and destroyed 27,000 houses.

1-3 Environmental and Social Considerations

In the Project, land necessary for constructing each observation station is small(35~100m^2) and there would be no land shape change by cut and fill nor large cut of trees. Land for the Project is basically publicly owned and unused, so the impact to social and natural environment can be restricted to minimum

The “JICA Guidelines for Environmental and Social Considerations” determines that the adverse impact this Project could have on the environment is minimal. Therefore, this Project shall be rated Category C.

2. Project Content

2-1 Outline of Project

This project is for establishing a water-related disaster management information systems where rain gauges including X-band radar rain gauges and level meters for measuring river and dam reservoir water level are installed on the Huong River basin in Vietnam's Hue Province and observation data is captured in real time via telemeters and that data is processed and presented as forecast information necessary for appropriate operation of dam reservoirs and downstream water related disaster management, evacuation activities, etc. Furthermore, necessary transfer of expertise and human resources development are conducted in order for the water-related disaster management information systems to be effectively used long-term continuously and to help in the prevention and alleviation of water-related disasters in the Huong River area.

The content of this project is as shown in the table below.

Table 2-1 Project Content

Category	Content/scope
Equipment for collection of observation data in the Huong River basin	X band radar: 1 Hydrological observation stations: 10 locations CCTV (downstream regions): 8 locations
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Water-related disaster management information systems of Hue Province PCC-NDPCSR	Information management equipment (for collection, analysis and output): 1 set Multiple information display system: 1 Information disclosure web system/alarm mail system: 1 set Communication devices: 1 set
Water-related disaster management information systems of CSC-NDPC	Multiple information display system: 1 Communication devices: 1 set
Basic data collection	Terrain surveying using LiDAR* data, etc.: 1 set Cross-sectional river surveying: 1 set
Operating manuals	Operating manuals and training
Consulting services and soft components	(1) Supervision of procurement and construction (2) Technical training in procedures for responding to trouble in the hydrological observation station equipment and water-related disaster management information systems, inspection and maintenance, display data monitoring, transmission of flood risk information, parameter identification method of runoff analysis model of X band radar, parameter identification method of runoff analysis model, and the creation and use of water level and flow volume curves

*LiDAR:Light Detection and Ranging/Laser Imaging Detection and Ranging
Can remotely detect the distance and the nature of the target using Laser wave, which is applied to land survey for a wide area using aircraft

2-2 Outline Design of Business Applicable for Cooperation

2-2-1 Design Policy

Design is to be proceeded based on the following basic principles.

2-2-1-1 Basic Policy

Basic policy 1: To construct a system that is capable of determining and sharing information for accurate integrated management of rivers and dams in the river basin.

This system will be designed as an integrated water related disaster management information system, which is needed for accurate implementation of the Prime Minister's 2014 notification concerning integrated management of the Huong River basin (partially revised in 2015). To allow accurate integrated management of rivers and dams in the basin, we will construct the system to display information systematically and with the necessary timing, including the basin's rainfall distribution, water levels and flow rates at main points of the rivers, the water level, water storage volume, inflow volume, and discharge volume of each dam, future rainfall predictions, predictions for river water levels and flow volumes, predictions of inundated areas, proposals for appropriate dam operation, and changes in dam volume figures.

Basic policy 2: To construct an information system that benefits users, with consideration for coordinating with forecasts and warnings for residents as well as appropriate river management and dam operation.

Mere enumerations of data are not beneficial to users; instead, information needs to be understandable by recipients and helpful for making decisions and taking action. Therefore, we will design a user-friendly system that does not merely collect the necessary types of data, but also facilitates decision-making for accurate river management and dam operation by the Central Steering Committee for Natural Disaster Prevention and Control (NDP-CSR) of the Party Central Committee (PCC) of Hue Province, which determines flood control measures for the basin as a whole, and the dam managers who operate each of the dams.

The system will also be designed with content and communication methods for use in providing forecasts and warnings to the residents of downstream cities and other communities, with information that is easily understood by residents and helps them in making decisions and taking action.

Basic policy 3: To construct a system that is capable of continuous, stable collection of rainfall, water levels, flow volumes, and dam storage volume figures in the basin.

For accurate determination of the overall situation in the basin with regard to rainfall, water levels and flow rates, and dam storage volume figures, etc., new

observation stations will be established in areas that currently have fewer stations, and the system will be designed for accurate collection of data in real time, including dam storage volume figures.

Surface rainfall data is extremely important for a water related disaster management information system, but there are limits concerning the installation of ground rainfall observation stations due to local circumstances. Therefore, we will plan and design a continuous, stable overall rainfall observation system, with radar rain gauges to be installed as the primary means of rainfall observation, as well as ground rain gauges which will be installed to ensure the accuracy of the radar gauges.

Basic policy 4: To construct a system that enables quick and accurate flood prediction.

Quick and accurate flood forecasting will be indispensable for reliable implementation of the Prime Minister's instructions concerning river and dam management. We will design the system using the latest technologies that are suitable for the Huong River basin, drawing on Japan's past experience with construction of flood forecasting systems both within Japan and abroad.

For predicted rainfall values, one of the most important types of data for this purpose, we will identify the technologies that are most precise and best suited to the Huong River basin.

Basic policy 5: To establish a communications environment that supports stable collection and transmission of observation data and distribution of information to each related organization institution.

Not only under normal circumstances, but also during concentrated torrential rains or other natural conditions, the information system needs to operate reliably and in real time to send various types of observation data, regardless of the local communications environment or power outages.

It is essential to ensure a stable communications environment with adequate line capacity to reliably transmit various types of data in real time from radar gauges and observation stations to each dam, and then from each dam to the Hue Province PCC-NDP-CSR along with dam volume figures; and to reliably transmit the information produced by analysis and processing of that data from the Hue Province PCC-NDP-CSR to each dam, along with dam operation instructions.

However, the current communications environment and power supply situation are extremely vulnerable, not only in the areas around the dams but also around the city of Hue. Therefore, we will design dedicated communications lines, with consideration for ensuring the power supply and making effective use of existing facilities.

Basic policy 6: To include consideration for accurate operation, maintenance, and management in the design.

After the system equipment is installed, it will need to be properly maintained and managed in order to keep the system operational, and even if it is operational, to ensure an adequate level of accuracy.

In addition to consideration for ease of operation, the system will be designed to allow quick responses to various types of trouble. Consideration will also be given to keeping the costs of maintenance and management to a feasible level.

Basic policy 7: To support effective technology transfer and collaboration for broader application in Vietnam.

The Prime Minister has issued instructions on ensuring dam safety in 13 other basins besides the Huong River basin, and the government of Vietnam has requested technology transfers so that it can use knowledge from the Huong River basin's water related disaster management information system in those basins as well.

We will ensure that the content of this system is readily applicable in other basins as well, and consideration for equipment maintenance and calibration work will be included, incorporating processes that will contribute to technical advancement.

2-2-1-2 Scope and Contents of Project

Based on requests from the government of Vietnam, we have performed field surveys, carefully examined the locations for installation and other details concerning the observation facilities, communications facilities, information processing systems, and other equipment needed for goal attainment, and coordinated with related persons in Vietnam. As a result, the project has been configured with the following equipment, etc.

Table 2-2 Project configuration

Equipment for collection of observation data in the Huong River basin	(1) X band radar: 1 set (2) Hydrological observation stations: 10 locations (3) CCTV (downstream regions): 8 locations
Dam supervision facilities at management offices of three dams	(1) Real-time dam management systems: 3 (1 set for each of the 3 dams) (2) CCTV (3 dams): 6 (2 locations for each of the 3 dams) (3) Communications lines: 3 (1set for each of the 3 dams) (4) Water level gauge (1set for each of the 3dams) (5) Dam gate opening measuring equipment (1set each for Huong Dien Dam and Binh Dien Dam)
Water related disaster	(1) Information management equipment (for collection,

management information system of the flood management information center (Hue)	analysis and display of data): 1 set (2) Information management equipment for analysis: 1 set (3) Information management equipment for output: 1 set (4) Multi-information display system: 1 set (5) Online information release system and emergency email system: 1 set (6) Communications devices: 1 set
Water related disaster management information system of the central disaster prevention information center (Hanoi)	(1) Multi-information display system: 1 set (2) Communications devices: 1 set
Basic data collection	(1) Terrain surveying using LiDAR data, etc. 1 set (2) Cross-sectional river surveying: 1 set
Operating manuals	Operating manuals and training
Consulting services and soft components	(1) Supervision of procurement and construction (2) Technical training in procedures for responding to trouble in the hydrological observation station equipment and water related disaster management information systems, inspection and maintenance, display data monitoring, transmission of flood risk information, parameter identification method of runoff analysis model of X band radar, parameter identification method of runoff analysis model , and the creation and use of water level and flow volume curves

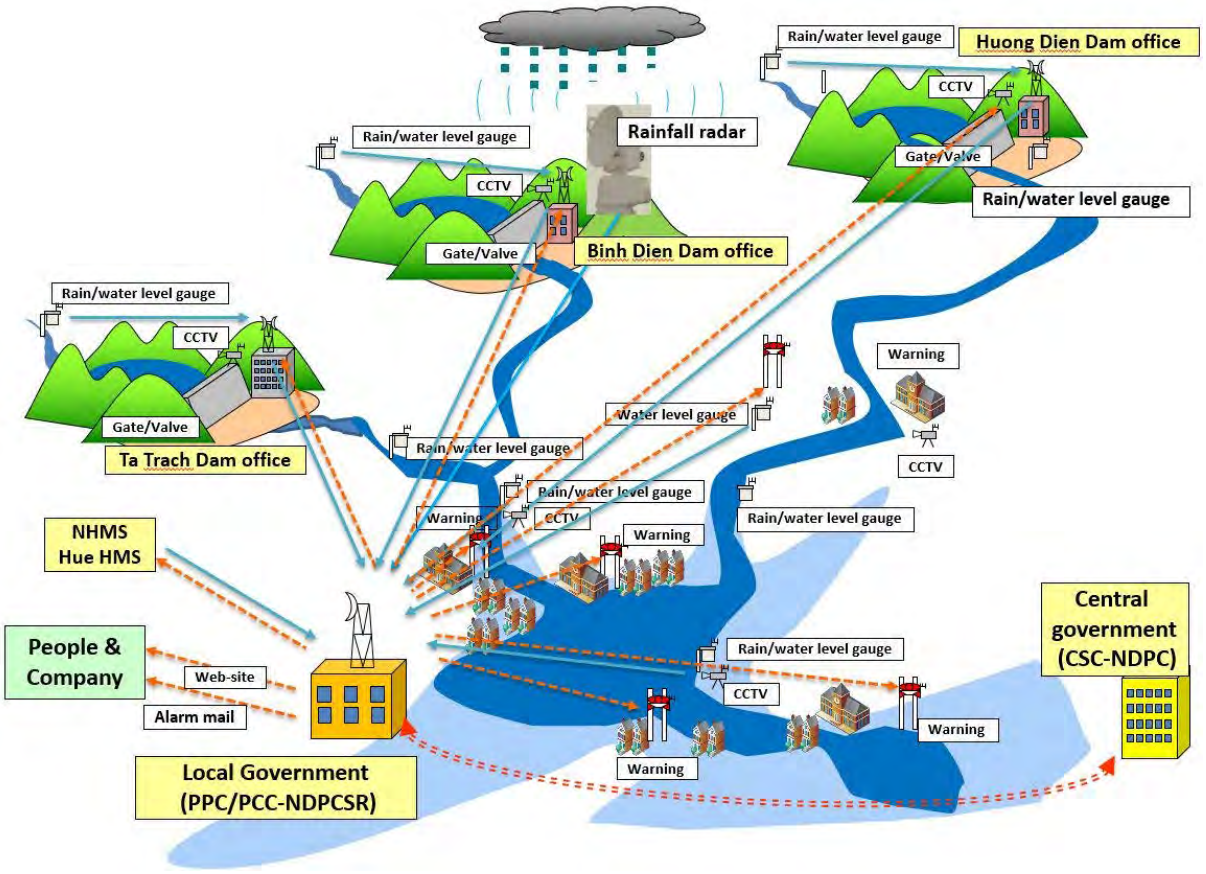


Fig. 2-1 Overall diagram of the water related disaster management information system and observation equipment, etc.

2-2-1-3 Basic Policy of Overall Project Structure and Equipment and Material Selection

(1) Policy on configuration of the water related disaster management information system and observation equipment, etc.

To attain the goals of this project, the overall design of the observation and communications equipment related to water-related disaster information systems will provide the following capabilities for analysis and display of information.

1. Capability to determine and display the situations of rainfall, rivers, and dams in the Huong River basin in real time
   - Local rainfall (ground rain gauges) and rainfall distribution (radar rain gauges)
   - Water levels and flow volumes at major points of rivers (water level gauges)
   - Situation of river water levels and inundation in urban areas (CCTV images)
   - Water levels, reservoir levels, inflow volume, outflow volume, release volume, and degree of gate opening at each dam (dam information)
   - Safety checks in downstream areas related to releases from each dam (CCTV images)

2. Capability to forecast and display flooding and inundation at 10-minute intervals based on a series of heavy rainfall predictions
   - Predicted rainfall distribution on 5-km mesh
   - River flow volume predictions at major points
   - Prediction of inundated areas in the basin (inundated areas and depth of inundation)

3. Capability for study and decisions concerning optimal dam operation to reduce flood damage and ensure dam safety
   - Prediction of downstream river water levels, flow volumes, and inundated areas if dam discharge volumes are changed
   - Presenting optimal dam discharge proposals based on dam operation guidelines under the Prime Minister's Decision
     (Dam operation considering river water level downstream to mitigate flood damage (see 2-2-1-2) and appropriate timing and volume of strategic release in advance)

4. Capability for study and decisions concerning drought countermeasures and water use for power generation, agriculture, etc.

- Variations in dam reservoir volume throughout the year
- Future situation of dam reservoir volume if dam discharge volumes are changed

These types of information display equipment will be designed with the capability for communicating understandable information to the respective information recipients according to their needs.

- Comprehensive information display equipment at information stations for overall management (Hue Province PCC-NDP-CSR)
- Information display equipment at each dam
- Comprehensive information display equipment at the CSC-NDPC in Hanoi
- Development of online information release and emergency email systems to display information to residents

(2) Policy on equipment selection

Equipment will be selected according to the following policy.

- Because the system needs to function stably and reliably, the hydrological observation equipment, CCTV equipment, rainfall radar and communications equipment, and information processing system equipment, etc. must have quality assurance and a proven track record.
- The equipment must withstand the high temperatures and high humidity of the natural environment in Vietnam and must be highly reliable to ensure dependable operation.
- The equipment must be appropriate for the maintenance and management capabilities of the recipient country.
- Maintenance and management must be easy, with consideration for a low level of budgeted funds for maintenance and management.

2-2-1-4 Policy on Natural Environment Conditions

(1) Natural characteristics

The Huong River basin (basin area: approximately 2,800 km²), situated in Hue Province, central Vietnam, is classified as a tropical monsoon area and has high temperatures and high humidity all year. About 75% of annual rainfall occurs during the rainy season from September to December, and the area is sometimes struck directly by typhoons occurring near the Philippines.

Although annual rainfall is approximately 3,500 mm on average, nearly twice as high as Japan's annual rainfall, the area also has drought risk, and monthly

rainfall is sometimes less than 100 mm in the dry season.

In addition, the effects of climate change in recent years have led to concentrated torrential rains throughout the year, causing flood damage in downstream areas of the river.

Therefore, air conditioning facilities will need to be installed for stable equipment operation at the locations where equipment will be installed.

(2) Lightning protection

Every possible measure will be taken to prevent lightning damage, since lightning could cause enormous damage to every system.

- Lightning resistant transformers
- Coaxial lightning arrestors
- Protection for signal lines of water level gauges and rain gauges
- Lightning rods and grounding

(3) Ground

Structural calculations will be performed based on the results of geological surveys subcontracted to local contractors in Vietnam for investigation of natural conditions.

2-2-1-5 Policy on Social Economic Conditions

The government of Vietnam has difficulty budgeting the funds for maintenance and management, and the new hydrological observation stations, CCTV equipment, and wireless relay stations will be operated unmanned. Therefore, each station building will be surrounded by a fence to protect the facilities and equipment from theft and damage, and strong measures will be taken to prevent theft, such as installing solar cells on the rooftops and locating CCTV control panels as high as possible.

Instead of general commercial lines, which may be vulnerable to interruption by power outages and congestion, private lines will be secured as the vital communication pathways for transmitting observation data from the hydrological observation stations to the Hue Province PCC-NDP-CSR. Specifically, telemetry wireless lines and multiplex wireless lines will be installed to provide data transmission in real time by linking the observation stations with the Hue Province PCC-NDP-CSR.

To minimize the amount of land acquisition that will be needed for installation of the new hydrological observation stations and CCTV equipment, the use of public land and public facilities will be requested whenever possible for construction of station buildings, steel towers, utility poles, and so on, and efficient facility arrangement will also help to minimize the required land area.

2-2-1-6 Policy on Construction Situation / Procurement Situation, or Special Conditions / Commercial Practices of Industry

(1) Environmental and Social Considerations

Environmental and social considerations for the Project include points related to land use permission for the construction of hydrological observation stations, CCTV, wireless relay broadcast stations, etc. However, because the space required for construction of each of these stations is only several dozen meters (approximately 35 to 100m^2) and public unused land will be used for most of this, there will be almost no impact on the social environment, nor will there be any natural environment issues as basically unused land will be used. While private sector land will be used in some cases, a local government agency (DARD) is observing and confirming land use during the field survey, and there have not been any issues yet. However, final confirmation is required for project implementation.

(2) Permissions

Permissions that are required for project implementation include permission for the use of radio wave frequency for radar, telemetry, and multiplex wireless signals, and permission for LiDAR measurement. For the use of radio wave frequency for radar, there are no issues as adjustments have been made with ARFM (Authority of Radio Frequency Management) that is the permission authority and the response was gained that receipt of frequencies and permissions could be expected if formal applications for the radio wave frequencies required for each facility were submitted. For LiDAR measurement, while adjustments have been made with the Ministry of Public Security regarding taking data outside of the country, advance adjustments were not possible because it is necessary to make adjustments after specifying the contractors (vendors) that will be taking data outside of the country. For this reason, this work is planned to be conducted in Vietnam as of the time of the Report. Adjustments will be made with the Ministry of Public Security again when contractors are specified. If permission is granted at this point, it would be considered to take out the data from Vietnam to Japan for data analysis work.

Permissions related to land and construction will be based on Vietnamese laws, standards, etc. for project implementation.

2-2-1-7 Policy Concerning Utilization of Local Contractors (Construction Companies, Consultants)

For facilities construction, resources that can be procured locally and local general construction methods will be used as much as possible.

Although there are not a large number of companies throughout Vietnam that are

capable of tower construction work, Vietnam Posts and Telecommunications Group (VNPT) affiliated companies have a recent track record in the construction of high towers as is apparent in the presence of wireless networks nationwide, and accordingly there are no issues concerning the technical capabilities or order acceptance capabilities of local contractors.

2-2-1-8 Action Policy on Operation and Maintenance Management

(1) Easy-to-use system

Conduct design that enables swift data processing, analysis, display, transmission, etc. with few complex operations so that Hue PCC-NDPCSR can appropriately operate, maintain, and manage the water related disaster management information system.

(2) System that enables easy checks and maintenance with low maintenance and management costs

Conduct planning that minimizes equipment replacement parts and consumables, and conduct equipment planning so that regular checks are easy and replacement parts can be replaced in a short period of time.

2-2-1-9 Policy Concerning Setting of Grades for Facilities, Equipment and Materials

The water related disaster management information system needs to function during floods, and continual operations during strong winds or lightening accompanying a typhoon, etc. is a requirement. The policy is to aim for grades of facilities and equipment that are resilient against strong winds and lightning, and that can be operated 24 hours a day throughout the year.

2-2-1-10 Policy Concerning Construction / Procurement Methods and Construction Period

For facilities construction, resources that can be procured locally and local general construction methods will be used as much as possible. Other water related disaster management information system related equipment will all be Japanese-made and capable of fulfilling the required functions for the system overall in terms of observation accuracy, reliability and durability.

The water related disaster management information system will be composed of a hydrological observation station, CCTV system, radar system, multiplex wireless system, telemetry system, information processing and display system, dam water level metering system, and dam gate opening indicator, and individual procurement policies will be established for each of these classifications.

A construction plan that also gives consideration to the natural environment will be formulated for the basic process structure of the Project including parts procurement, materials procurement, construction of local station buildings, and equipment installation adjustments.

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

2-2-2-1 Hydrological Observation Station Layout Plan

It is essential to have a real-time understanding of accurate rainfall amounts and distributions and the river water level and flow in the basin for the analysis of river flows, forecast of floods and inundations, consideration of dam operations, etc.

However, it is ordinarily difficult to observe river flow in real time in flooding; and in Japan as well river level and river flow observation data is accumulated and correlation curves for water level and flow (HQ curves) are prepared. As real-time data used, river level is observed and river flow is calculated applying the river water level to an HQ curve. In this Project as well, rainfall and river water level are observed and values calculated from HQ curves are used for river flow. It is desirable to observe flood flow at all water level observation stations, including newly implemented in the Project (7 stations) and also existing stations, among which flow observation is only at Yhuong Nhat stqtion. Consulting team requested NHMS to execute flow observation at least at Kim Long and Phu Oc, important point for Huong River management.

As a hydrological observation station layout plan for accurately identifying hydrological status and analyzing runoff, first of all real-time data of existing observation stations will be used as much as possible, and an observation structure will be developed for the Project for areas and river sections that are lacking.

Observation stations were installed taking into account the necessities in accurate analysis of data; but it is important for rainfall observation stations and water level observation stations to be in locations where they are easy to install and maintenance can be done, so selection was made as follows from those perspectives as well.

[Location of water level observation stations]

To perform highly accurate runoff analysis, flood forecast, and inundation forecast, installation as noted below is needed as a rule, and an observation station structure for that was planned. (See Tables 2-3, 2-4, and Fig. 2-2 for observation station numbers)

(1) Install observation stations so river level changes can be identified from upstream to downstream (overall)

(2) Install upstream of dam lakes and directly downstream of dams because it is important to accurately identify dam inflow and discharge (In addition to the existing N4, N5, and N10, install new observation station P2 upstream of Ta Trach Dam and P8 upstream of Huong Dien Dam. It is desirable to install upstream of Binh Dien Dam, but there is no access road and installation and

maintenance is so difficult, so the flow rate there is to be estimated based on runoff analysis and dam reservoir water level, storge volume and outflow.)

(3) If there is a substantially large tributary, install at the tributary as well in order to reflect runoff characteristics of the tributary (Install new observation station P6 in order to identify runoff to lagoon.)

(4) Install at important locations seen from river flooding characteristics, such as locations that flood easily (Install new observation stations P9 and P10 at downstream region of Bo River where the river meanders and easily floods due to the effect of sediment carried by the Huong River, not just at lowlands along the river.)

(5) Install at locations important in terms of disaster management such as where major damage is anticipated if flooding occurs (Existing N7 and N11)

(6) Install at locations where water level and tide level near river mouths, which greatly affect runoff characteristics of lowlying drainage basin rivers, can be accurately observed (Install new observation station P5 for tide level observation. Install new observation station P4 upstream of river mouth barrier, which may affect hydraulic transport status from that tide level.)

(7) The Prime Minister's decision was issued in 2014 regarding integrated management of the three dams in the Huong River basin, and A Luoi Aqueduct was added at time of revision on 2015, but that flow volume data was obtained directly from A Luoi power plant without adding a new hydrological observation station.

(8) Also, based on 'the Technical Guideline –survey section- for river and sediment management' compiled by the Japan Ministry of Land, Infrastructure, Transport and Tourism, long and accurate observation considering possibleriver bed change and river way change after large flood was also taken in mind for selecting the candidate sites.

[Types of water level gauges]

The most common types of water level gauges are those with pressure and ultrasonic sensors, and those are easy to procure. Both have sufficient track records of use and no issues in terms of accuracy.

Pressure type water level gauges are contact types having sensors installed directly in the water, and they are laid over river walls, etc. and installed in pipes installed at riversides. While there is a high degree of freedom in selecting the installation location, sensors may be damaged in times of flooding by force of water flow or contact with driftwood and other debris, cables may be severed due to river bed scour, or sensors may be buried due to sediment accumulation. For that reason, measures such as installing sturdy protective pipes would be necessary.

Ultrasonic type water level gauges are contactless types that emit ultrasonic

waves to the water surface from a location higher than the water surface and measure the reflected waves, and they are installed on bridges and arm cables. While equipment damage, etc. due to force of water flow, debris, river bed changes, etc. in times of flooding can be avoided, there is a low degree of freedom in terms of installation location.

Both are used with connection from sensors to data recorders, etc. installed on the ground.

Type of water level gauge (pressure type or ultrasonic type) was decided based on the site characteristics including easiness of setting and effect of river flow.

For pressure-type water level gauges, there are also low-price Vietnamese products with sufficient accuracy, so specifications that Vietnamese products meet were set.

For P5 at a river mouth, redundant water gauges of differing types were used in order to continue observation by promptly switching to a backup when observations cannot be made due to mechanical breakdown, etc. as this is an important location providing the starting water level in hydraulic calculations. For other locations, redundancy would be desirable in order to prevent missing data, but water level gauges are not redundant in this report, that being an item for future improvement. In river management in Japan as well, water level observation equipment is made redundant at important water level observation stations.

[Basic concept of rainfall observation structure]

Observation of rainfall data of sufficient density is indispensable for performing runoff analysis that has the required accuracy. In Japan, it is generally assumed that rainfall data of density of one location per 50 km^2 is necessary. In the Vietnam middle region with similar terrain conditions as well as weather conditions such as being impacted by typhoons, about the same observation density would be preferable. As a result of rainfall simulations locally based on recent rainfall data, it was found that a rainfall observation network with an observation density of at least one location per 100 km^2 is necessary. However, existing ground rain observation stations in the Huong River basin are installed at about one location per 400 km^2, and in particular there is an extreme lack of ground rain observation stations in the upstream area important for analysis.

New ground rain observation stations can only be installed in a limited number of places, taking into account conditions such as access roads for installation and maintenance as with water level observation stations, and observation in the important upstream area is particularly difficult.

In light of the above, a rainfall observation structure centering on radar rain gauges was decided on as necessary observation density cannot be met with ground rain gauges alone. Even in this case, a certain amount of ground rain observation

data will be needed for radar rain gauge coefficient identification and to overcome signal shielding, so a decision was made to install new ground rain observation stations at 10 locations in addition to utilizing existing rain observation stations. In order to efficiently set up these new observation stations, a decision was made to install rain gauges too at all new water level observation stations and install new rain observation stations at rain observation locations considered in past JICA projects (autographic recording, not real time).

Ground rain gauges require certification in Vietnam, so those that have received certification will be used.

Newly planned hydrological stationis are shown in Table 2-3, and existing stations to use the data in the Project are in Table 2-4 Location of the stations are in Figure 2-2.

Table 2-3 Newly Installed Hydrological Observation Stations

No.	Site Name	Observation elements		Highs of Antenna Pole	Area needed for candidate station	Equipments
		Type of water level sensor	Railfall			
P1	Thuong Lo	—	○	10m	5m x 7m	・Water level sensor ・Rainfall gauge ・DC Power supply (Solar panel) ・Telemetering equipments ・Station house ・Antenna
P2	Khe Tre	Ultrasonic	○	10m	5m x 7m	
P3	Sao La	—	○	10m	5m x 7m	
P4	Thao Long	Ultrasonic	○	10m	5m x 7m	
P5	Thuan An	Pressure & Ultrasonic	○	10m	5m x 7m	
P6	Quan Culvert	Ultrasonic	○	10m	5m x 7m	
P7	A Roang	—	○	10m	5m x 7m	
P8	Ta Luong	Ultrasonic	○	10m	5m x 7m	
P9	Thanh Luong	Pressure	○	10m	5m x 7m	
P10	Niem Pho	Pressure	○	10m	5m x 7m	

Table 2-4 Existing Hydrological Observation Stations Using Data

Owner	No.	Site Name	Observation elements	
			Water level	Rain fall
NHMS	N1	Cau Truoi	○	○
	N2	Bach Ma	–	○
	N3	Nam Dong	–	○
	N4	Thuong Nhat	○	○
	N5	Binh Dien (Binh Thanh)	○	○
	N6	Hue	–	○
	N7	Kim Long	○	○
	N8	A Luoi	–	○
	N9	Ta Luong	–	○
	N10	Co Bi	○	○
	N11	Phu Oc	○	○
	N12	Phong Dien	○	○
Binh Dien Hydropwer Joint Stock Company	B1	BDU		○
	B2	Binh Dien Dam		○
Huong Dien Investment Corporation	H1	Hong Van		○
	H2	A Roang		○
	H3	Hong Ha		○
	H4	Thuong Luu		○

Fig. 2-2 Hydrological Observation Station Location Diagram

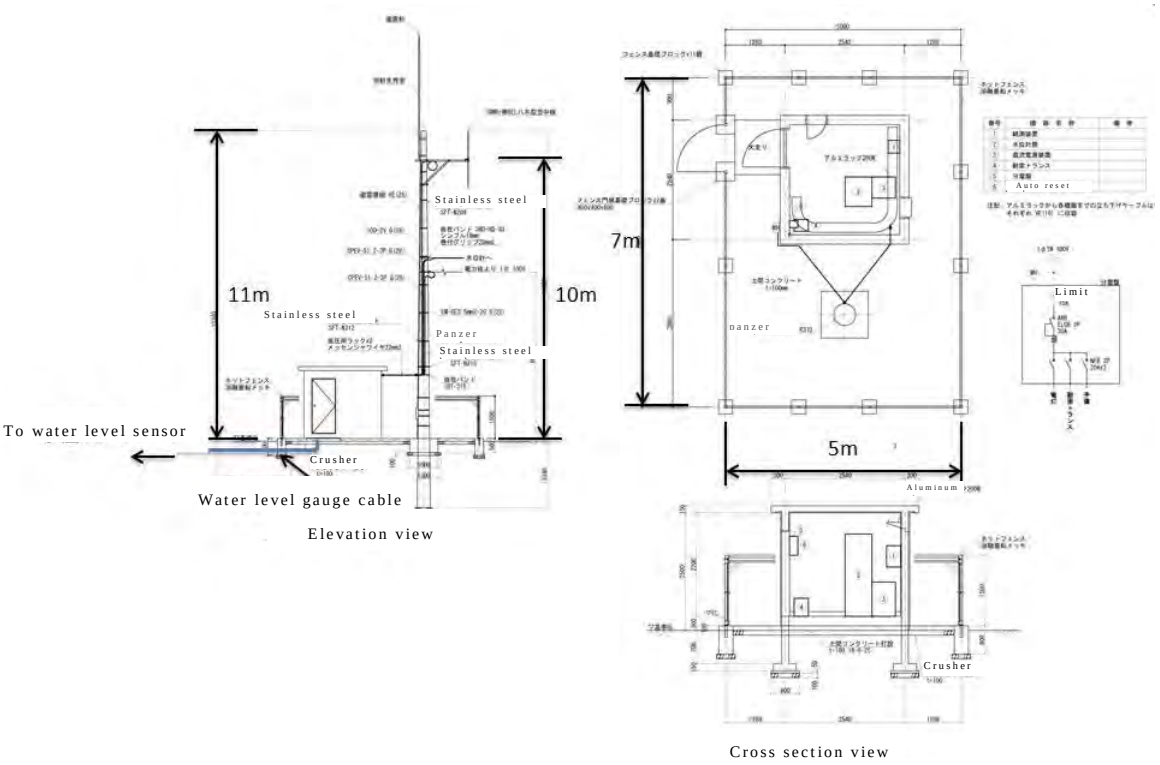


Fig. 2-3 Hydrological Observation Station General Diagram

Table 2-5 List of Equipment for Procurement

No	Equipment number	Constitution equipment number	Name of the equipment	Quantity	Unit	Spares Unit	Total
1-01	1	01	Ultrasonic water level gauge	Unit	5	1	6
1-02		02	Relay box (for ultrasonic water level gauge)	Unit	5	1	6
1-03		03	Line space arrestor (for ultrasonic water level gauge)	Unit	5	1	6
1-04		04	Transformer (for ultrasonic water level gauge)	Unit	5	1	6
1-05		05	Installation ball for ultrasonic water level gauge (for trave)	Unit	2		2
1-06		06	Installation ball for ultrasonic water level gauge (for self-support)	Unit	3		3
1-07		07	Sensor cable for ultrasonic water level gauge	m	460		460
1-08		08	Inside housing (for ultrasonic water level gauge)	Unit	5		5
1-09		09	Pressure-type water level gauge	Unit	3	1	4
1-10		10	Sensor cable (for pressure-type water level gauge)	Reel	3		3
1-11		11	Sensor protective tube (for pressure-type water level gauge)	Unit	3	1	4
1-12		12	Relay box (for pressure-type water level gauge)	Unit	3	1	4
1-13		13	Transformer (for pressure-type water level gauge)	Unit	3	1	4
1-14		14	Inside housing (for pressure-type water level gauge)	Unit	3		3
1-15		15	Rainfall gauge	Unit	10	2	12
1-16		16	Data logger (for rain gauge)	Unit	10	2	12
1-17		17	Mount (for rain gauge)	Unit	10		10

The installation location for new hydrological observation station are as follows.

P1 Hydrological observation station (Rainfall)

No.		P1
Site Name		Thuong Lo
Location		Nhà máy thủy điện Thượng Lộ
Observation elements	Type of water level sensor	-
	Railfall	○
Highs of Antenna Pole		10m
Area needed for candidate station		5m x 7m
Equipments		・Rainfall gauge ・DC Power supply (Solar panel) ・Telemetering equipments ・Station house ・Antenna
Lat		16°08'34.9"N
Long		107°45'00.5"E

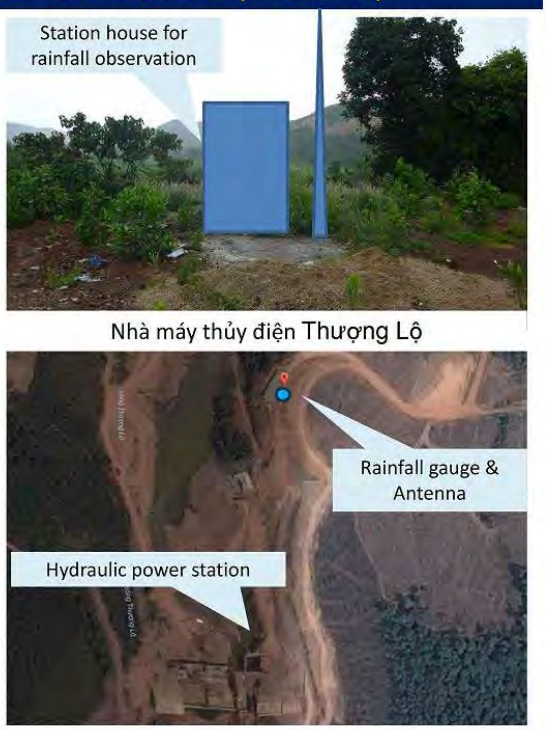


Fig. 2-4(1) Hydrological Observation Station (P1)

P2 Hydrological observation station

No.		P2
Site Name		Khe Tre
Location		Khe Tre Bridge, Ta Track River
Observation elements	Type of water level sensor	Ultrasonic
	Railfall	○
Highs of Antenna Pole		10m
Area needed for candidate station		5m x 7m
Equipments		・Water level sensor ・Rainfall gauge ・DC Power supply (Solar panel) ・Telemetering equipments ・Station house ・Antenna
Lat		16°09'58.1"N
Long		107° 43'09.9"E

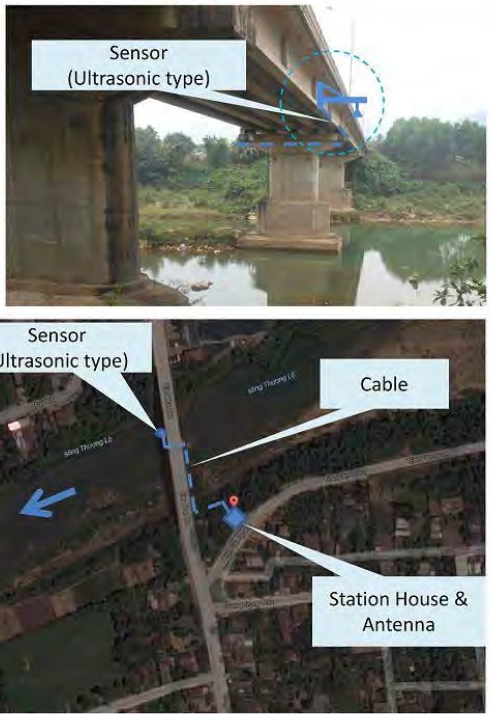


Fig. 2-4(2) Hydrological Observation Station (P2)

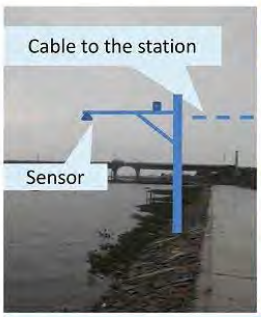
P3 Hydrological observation station (Rainfall)

No.		P3
Site Name		Sao La
Location		Hue Forestry Administration Bureau／Sao La Ecological Conservation Area Management Committee
Observation elements	Type of water level sensor	-
	Railfall	○
Highs of Antenna Pole		10m
Area needed for candidate station		5m x 7m
Equipments		・Rainfall gauge ・DC Power supply (Solar panel) ・Telemetering equipments ・Station house ・Antenna
Lat		16°04'37.0"N
Long		107°29'17.8"E

Fig. 2-4(3) Hydrological Observation Station (P3)

P4 Hydrological observation station

No.		P4
Site Name		Thao Long
Location		Thao Long Weir, Lower end of Huong River
Observation elements	Type of water level sensor	Ultrasonic
	Railfall	○
Highs of Antenna Pole		10m
Area needed for candidate station		5m x 7m
Equipments		・Water level sensor ・Rainfall gauge ・DC Power supply (Solar panel) ・Telemetering equipments ・Station house(Piloti type) ・Antenna
Lat		16°32'36.1"N
Long		107°36'58.5"E



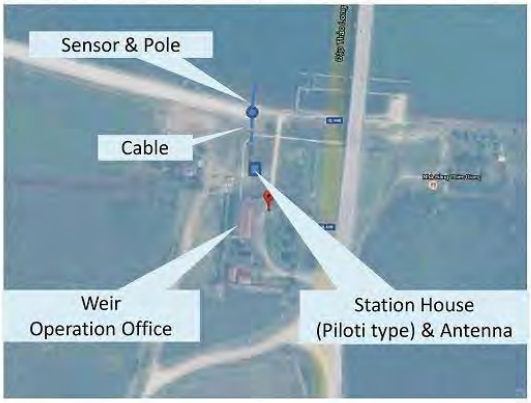


Fig. 2-2(4) Hydrological Observation Station (P4)

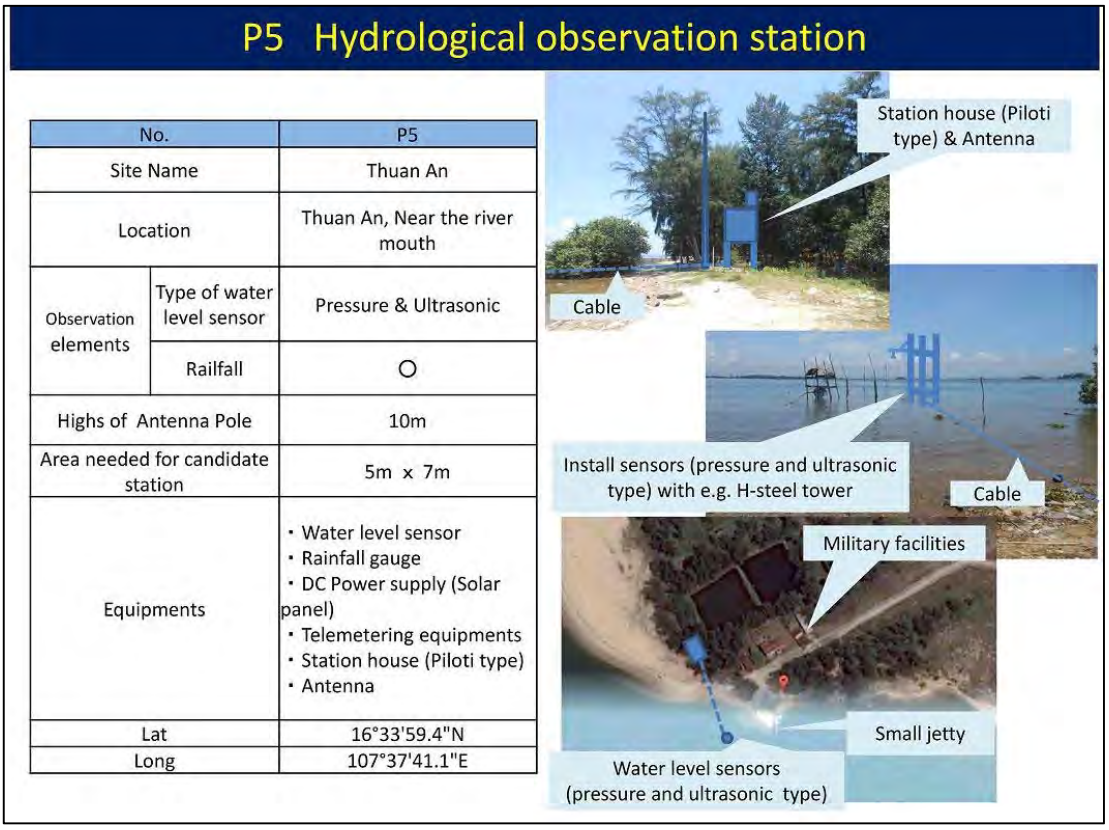


Fig. 2-4(5) Hydrological Observation Station (P5)

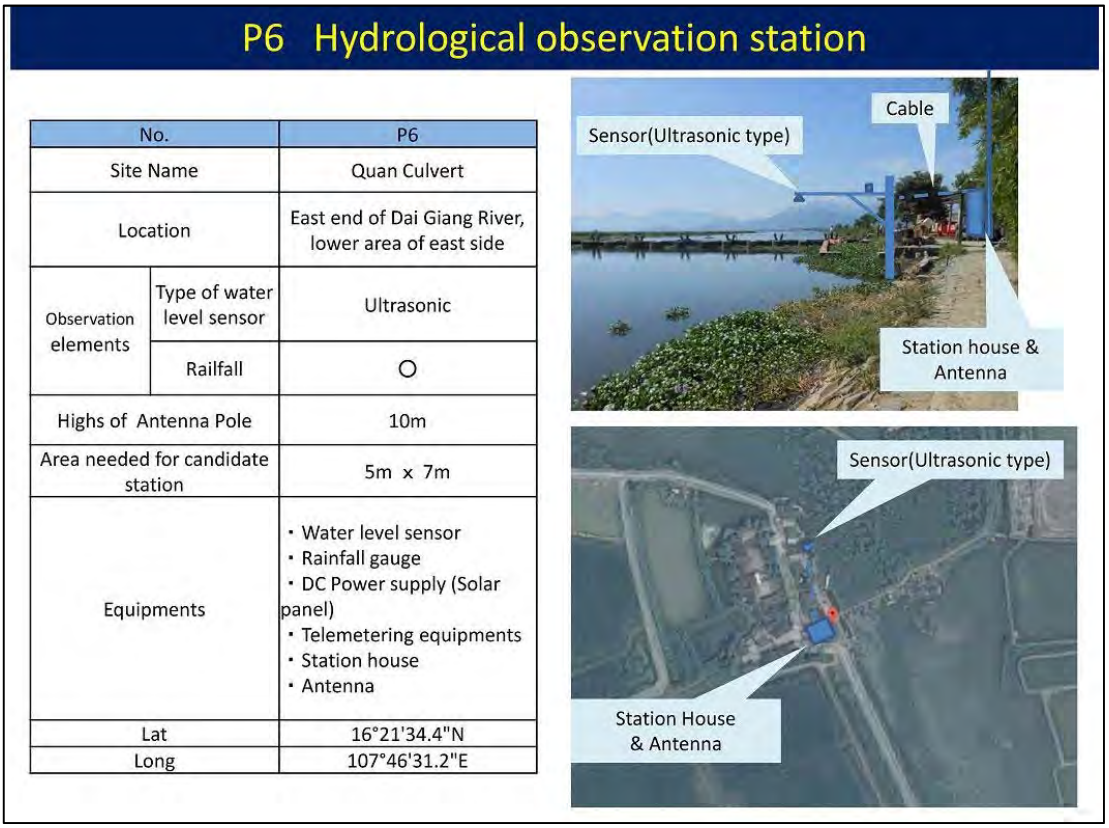


Fig. 2-4(6) Hydrological Observation Station (P6)

P7 Hydrological observation station (Rainfall)

No.		P7
Site Name		A Roang
Location		A Roàng Hydropower Plant
Observation elements	Type of water level sensor	–
	Railfall	○
Highs of Antenna Pole		10m
Area needed for candidate station		5m x 7m
Equipments		・Rainfall gauge ・DC Power supply (Solar panel) ・Telemetering equipments ・Station house ・Antenna
Lat		16°07'21.1"N
Long		107°23'50.2"E

Xí nghiệp thủy điện A Roàng

Fig. 2-4(7) Hydrological Observation Station (P7)

P8 Hydrological observation station

No.		P8
Site Name		Ta Luong
Location		Ta Luong Bridge, Upper reach of Huong Dien Dam
Observation elements	Type of water level sensor	Ultrasonic
	Railfall	○
Highs of Antenna Pole		10m
Area needed for candidate station		5m x 7m
Equipments		・Water level sensor ・Rainfall gauge ・DC Power supply (Solar panel) ・Telemetering equipments ・Station house ・Antenna
Lat		16°17'20.3"N
Long		107°21'40.1"E

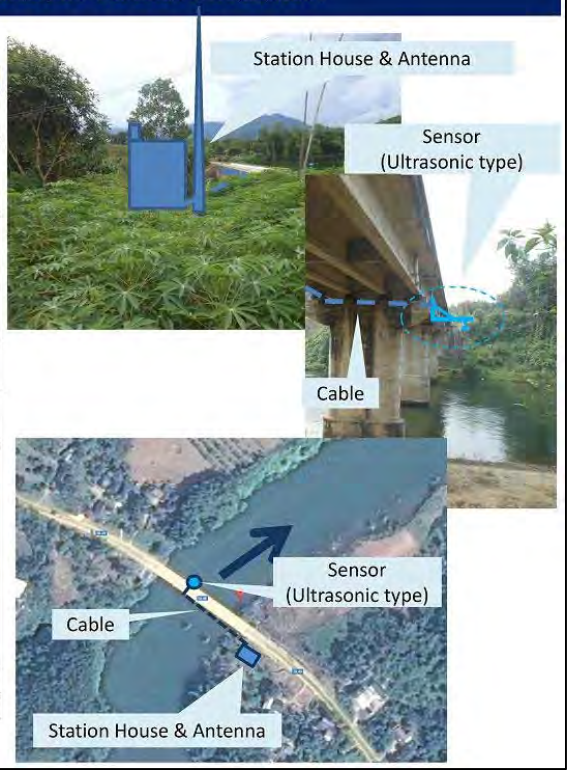


Fig. 2-4(8) Hydrological Observation Station (P8)

P9 Hydrological observation station

No.		P9
Site Name		Thanh Luong
Location		Thanh Luong Bridge, Right branch, Lower area of Bo River
Observation elements	Type of water level sensor	Pressure
	Railfall	○
Highs of Antenna Pole		10m
Area needed for candidate station		5m x 7m
Equipments		・Water level sensor ・Rainfall gauge ・DC Power supply (Solar panel) ・Telemetering equipments ・Station house(Piloti type) ・Antenna
Lat		16° 31'01.5"N
Long		107°30'45.5"E

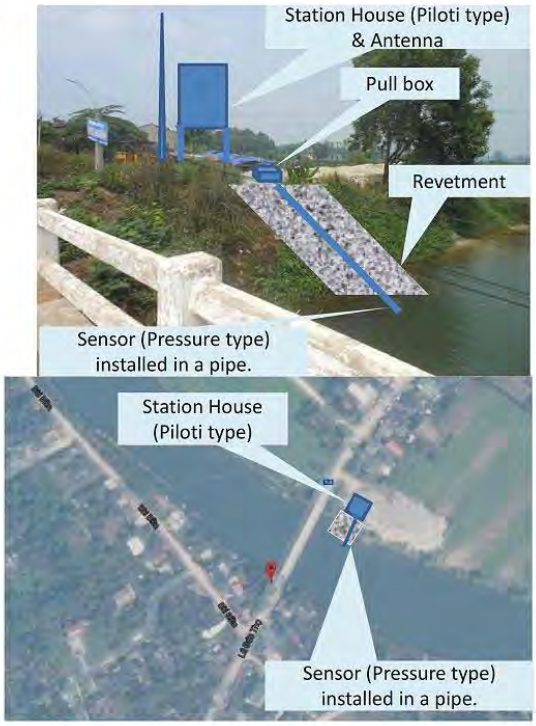


Fig. 2-4(9) Hydrological Observation Station (P9)

P10 Hydrological observation station

No.		P10
Site Name		Niem Pho
Location		Niem Pho Bridge, Lower area of Bo River
Observation elements	Type of water level sensor	Pressure
	Railfall	○
Highs of Antenna Pole		10m
Area needed for candidate station		5m x 7m
Equipments		・Water level sensor ・Rainfall gauge ・DC Power supply (Solar panel) ・Telemetering equipments ・Station house(Piloti type) ・Antenna
Lat		16°32'31.2"N
Long		107°31'36.7"E

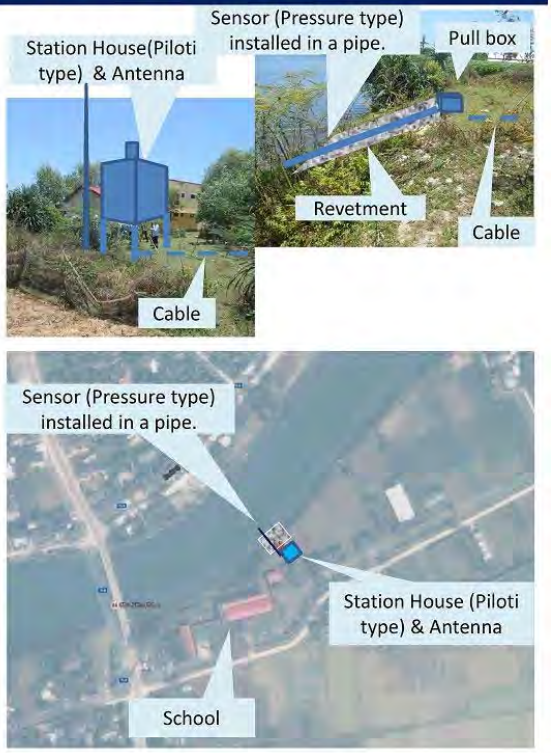


Fig. 2-4(10) Hydrological Observation Station (P10)

2-2-2-2 Radar Layout Plan

(1) Objectives and stance towards observation structure

Rainfall gauges at a certain density within the basin are essential for assessment of rainfall distribution, outflow analysis, flood forecast, etc. in the Huong River basin.

Currently, particularly in mountain areas upstream, there are not many rainfall gauges installed, and new installation would also be difficult due to topographical and road conditions. For that reason, an observation structure for the entire region through rainfall radar will be developed.

Note that it is necessary to secure an appropriate rainfall observation structure that is combined with ground rain gauges.

1) Ground rain gauge data is necessary for determining the rainfall radar constant.
2) As there is an observation shielded area with rainfall radars, complement them with ground rain gauges.

(2) Type of rainfall radar

The area of the Huong River basin is approximately 2,800km2, which is approximately the same area of a concentric circle of an X band radar observation area (radius of 30km to 60km). (While a C band is cable of wider observation, it is huge.)

While there are concerns of shielding by mountains, buildings, etc., because the radar elevation angle is approximately 3° it is possible to keep it lower than the altitude of the lowest height of the fusion layer (approximately 3,000m in Japan, even higher altitude in the case of Vietnam), and it will be possible to observe nearly the entire basin. Figure 3-5 shows expected shield area by the tpographical effect by yellow colour in case of 2.5° and 3.0° , which is to be covered by interpolation using surrounding data.

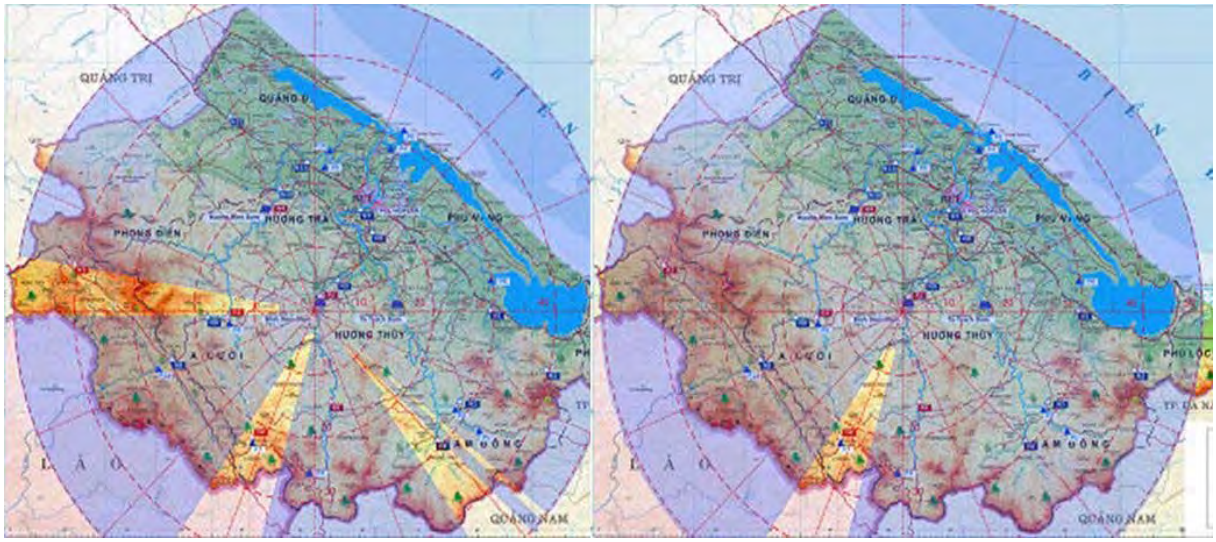
By using a multiparameter (MP) radar that uses horizontal/vertical dual polarized waves, high resolution (250m mesh unit) and highly accurate rainfall observation without calibrating with ground observed data is obtained.

In consideration of the above, an X band MP radar was planned to be used.

(3) Rainfall radar installation location

1) Location in the center of the Huong River basin
2) Location with little shielding from mountains, buildings, etc.
3) Location where rainfall radar equipment installation and work is possible

As a result of consideration of the left bank of the Binh Dien Dam and adjacent to the mobile phone radio relay station near Chùa Phật Đứng, and confirmation of management aspects and the shielding circumstances on site, the Binh Dien Dam will be used.



elevation angle is 2.5° elevation angle is 3.0°

Fig. 2-5 Rainfall Radar Observation Range and Shielded Area

(4) Countermeasures in response to rainfall radar shielded areas

Rainfall radars are subject to shielding due to topographical conditions and damping of radio waves behind areas with heavy rain. For thid reason, as is shown in the following figure, shielded area can be interpolated by the neibouring data and spot abnormal or missed data are to be interpolated by averaging filteration of surrounding data during data processing, which enables to get appropriate rainfall data for grasping rainfall situation and for input to rainfall-runoff analysis.

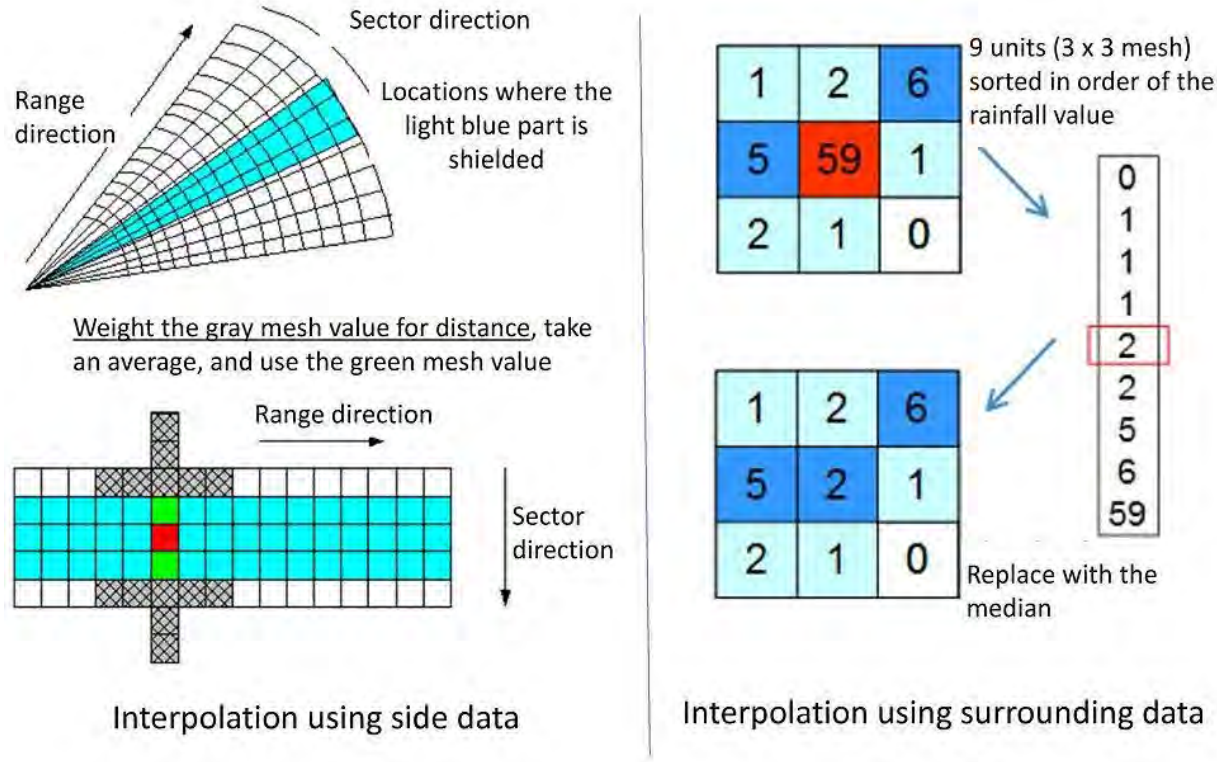


Fig. 2-6 Interpolation method example

System constitution and outline figure of radar raingauge is shown in Table 2-6 and Figure 2-7.

Table 2-6 Rainfall Radar Equipment Configuration Details

No.	Product name	Specs
1	Xmp radar rain gauge equipment	Total weight: no more than 2.5t
1.1	Radome	Materials: polyurethane, dimensions: diameter of no more than 4.5m, wind resistance load: no more than 60m/s
1.2	Antenna equipment	Format: parabolic, dimensions: diameter of no more than 2.2m, gain: 38dB or above, plane of polarization: vertical, horizontal
1.3	Antenna control equipment	Elevation angle: -2° to +90°
1.4	Transmission equipment	Frequency: Wave specified from 9.7GHz to 9.8GHz. Pulse width: 1.0μ sec, observation range: radius of 80km or above Operating temperature: (outdoor) -20°C to 50°C, (indoor) 15°C to 35°C Operating humidity: (outdoor) no more than 95% at under 40°C, (indoor) 40% to 80% Power consumption: no more than 5KVA at 100V to 240VAC 1ϕ2W 50/60Hz (excluding air conditioning equipment)
1.5	Receiving and signal processing equipment	Signal processing: A/D conversion quantization of 14 bit or above
1.6	Data conversion and accumulation processing equipment	Output data: received power (PH, PV), velocity (VH), velocity width (WH), polarization phase difference (ϕDP), polarization correlation coefficient (Phv (0))
2	Data processing and communication equipment	
2.1	Remote operations and display equipment	Server (1) LCD (1), radar workstation software Radar rain gauge equipment remote monitoring and control operations
3	Power source equipment	
3.1	Lightning resistant transformer	10KVA or above
3.2	UPS	5 KVA or above rack-type in-rack server, power outage compensation for PC of 10 minutes or above
3.3	AVR	10KVA or above
3.4	Power generation facilities	10KVA or above (fuel tank of 200L or above)

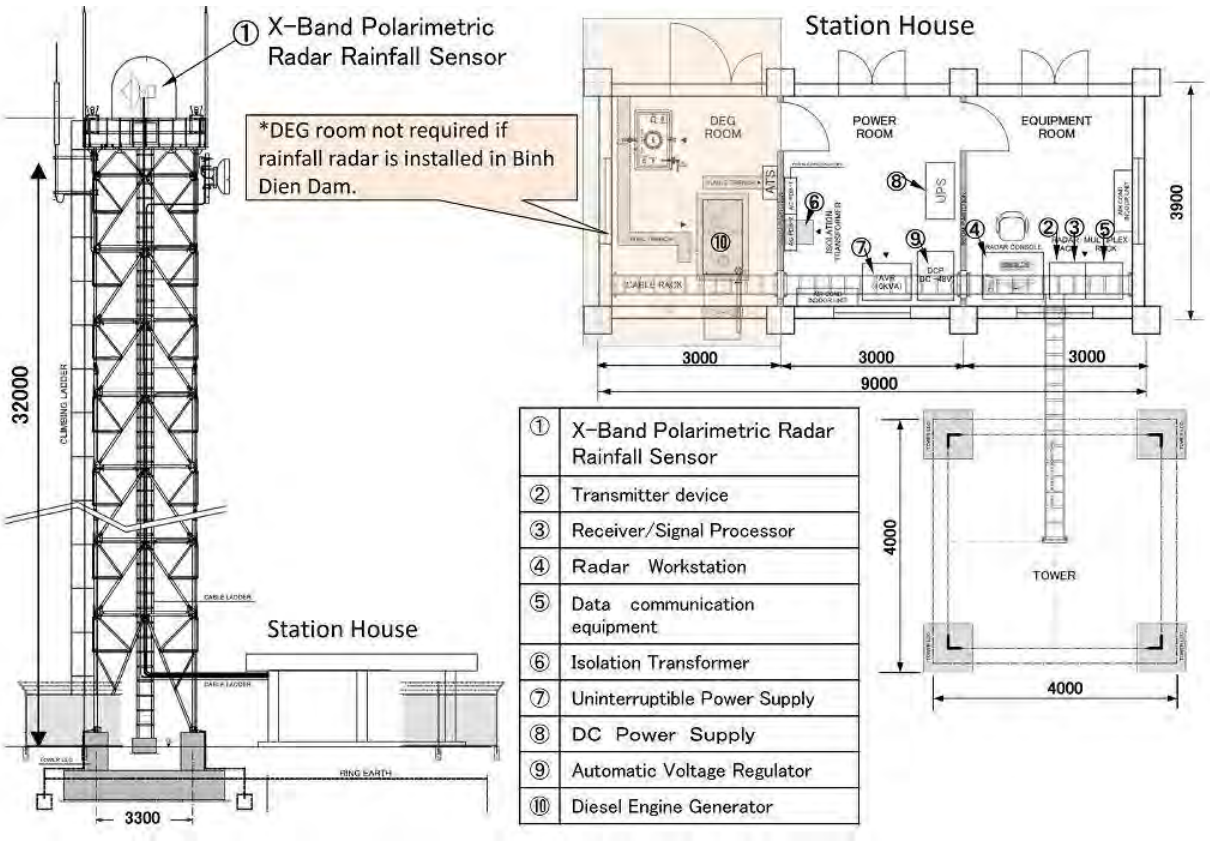


Fig. 2-7 Rainfall Radar Installation Overview Diagram
(details stated in Outline Design Drawing)

The list of equipments for procuring a radar raingauge is as shown in Table 2-7.

Table 2-7 List of Equipment for Procurement

Equipment number	Constitution equipment number	Name of the equipment	Quantity	Unit	Spares Unit	Total
3	01	X band radar rain gauge equipment	Unit	1		1
	02	Radome	Unit	1		1
	03	Antenna equipment	Unit	1		1
	04	Antenna control equipment	Unit	1		1
	05	Transmission equipment	Unit	1		1
	06	Receiving and signal processing equipment	Unit	1		1
	07	Radar Workstation	Unit	1		1
	08	LCD	Unit	1		1

	09	Radar workstation software	Set	1		1
	10	L3 switch and L2 switch	Item	1		1
	11	Media inverter (for sending radar data)	Item	1		1
	12	Rack for data transmission	Item	1		1
	13	Radar product server (radar image generation server)	Unit	1		1
	14	Radar product server software	Set	1		1
	15	Radar processing server	Unit	1		1
	16	Radar processing server software	Set	1		1
	17	Signal processing section	Unit		3	3
	18	Power supply unit	Unit		3	3
	19	Control processing section	Unit		3	3
	20	Amplification section	Unit		3	3
	21	Motor part	Unit		4	4
	22	HDD for radar image generation server	Unit		1	1
	23	HDD for radar signal processing server	Unit		1	1
	24	HDD for radar work station	Unit		3	3
	25	Media converter	Unit		3	3
	26	SPD for switch board	Unit		3	3
	27	P valve for earthquake-resistant transformer	Unit		10	10

2-2-2-3 CCTV System Layout Plan

Because it will not be possible to sufficiently access local conditions with numeric information alone such as the river water level and reservoir water level, establish a structure for a more accurate understanding of the situation through camera images from CCTV at main locations.

The camera should rotate 360° for monitoring hard situation of flooding and should have function to enlarge image 20 times to be able to monitor the river water level. Concerning power supply, adoption of solar panel is desirable for use in the local area without commercial power supply. Control box should be installed at least 2m apart from the ground surface to prevent flooding damage and to prevent residents' easy access.

[Installation locations]

Main river positions: Adjacent to water level observation stations in order to

confirm (1) the state of river flow, (2) the risk of a rising water level, and (3) flood situations.

Each dam: Install upstream of the dam body to confirm the water storage situation, gate situation, etc., and directly downstream of the dam for confirm the gate discharge situation and the safety situation directly downstream after discharge.

CCTV equipment would be installed along river channel to be able to monitor the river flow situation. It should be installed higher than the river dike height so as to prevent damage by flooding.

Location, specification, outline image and procuring list of equipments are shown in Fig. 2-8, Table 2-8, Fig. 2-9 and Table 2-9.

Fig. 2-8 CCTV Installation Location

Table 2-8 Installation Locations and Specs

No.	Location	Type of CCTV	Highs of Pole	Equipments
C1	Đập Thảo Long Hương Phong	• Situations: Day/Night • View: 360 degree • Data transmission: frame by frame* *The display interval depends on communication capability of cell-phone.	5m	• CCTV Camera • DC Power supply (Solar panel) • 3G Module & Antenna • Control box
C2	Nguyễn Đình Chiểu tp. Huế		5m	
C3	212 Bùi Thị Xuân Phường Đúc		5m	
C4	Cầu Niêm Phò A Cầu Nguyễn Chí Thanh		5m	
C5	Lê Đức Thọ		5m	
C6	Cầu Tứ Phú Quảng Phú		5m	
C7	Phong Sơn		5m	
C8	Lower of Huong Dien Dam		5m	
C9	Upper of Huong Dien Dam		5m	
C10	Lower of Binh Dien Dam		5m	
C11	Upper of Binh Dien Dam		5m	
C12	Lower of Ta Trach Dam		5m	
C13	Upper of Ta Trach Dam		5m	
C14	Dai Giang Weir		5m	

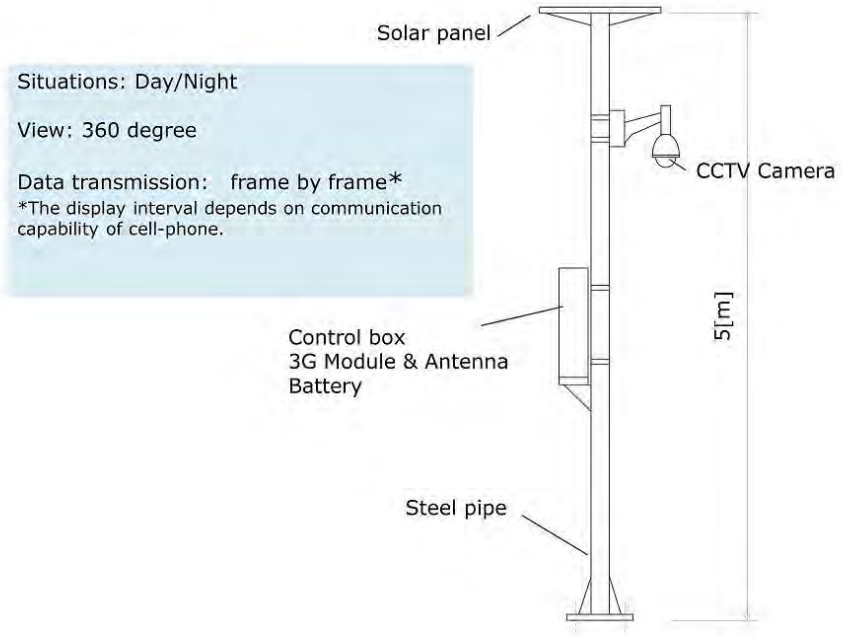


Fig. 2-9 CCTV System General Diagram

Table 2-9 Equipment to be Procured

No.	Equipment number	Constitution equipment number	Name of the equipment	Quantity	Unit	Spares Unit	Total
2-01	2	01	CCTV camera	Unit	14	1	15
2-02		02	Control box	Unit	14	1	15
2-03		03	Power supply equipment (solar panel)	Unit	14	1	15
2-04		04	Server	Unit	1	1	2
2-05		05	Computers	Unit	1	1	2

The CCTV installation locations and specs are as follows.

C1 CCTV

No.	C1
Location	Đập Thảo Long Hương Phong
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	16° 32'36.6"N
Long	107° 37'00.0"E

Fig. 2-10(1) CCTV Camera (C1)

C2 CCTV

No.	C2
Location	Nguyễn Đình Chiểu tp. Huế
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	16° 28'01.9"N
Long	107° 35'21.4"E

Fig. 2-10(2) CCTV Camera (C2)

C3 CCTV

No.	C3
Location	212 Bùi Thị Xuân Phường Đúc
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	16° 27'16.8"N
Long	107° 33'53.8"E

Fig. 2-10(3) CCTV Camera (C3)

C4 CCTV

No.	C4
Location	Cầu Niêm Phò A Cầu Nguyễn Chí Thanh
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	16° 32'31.2"N
Long	107° 31'36.7"E

Fig. 2-10(4) CCTV Camera (C4)

C5 CCTV

No.	C5
Location	Lê Đức Thọ
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	16° 31'01.2"N
Long	107° 30'45.3"E

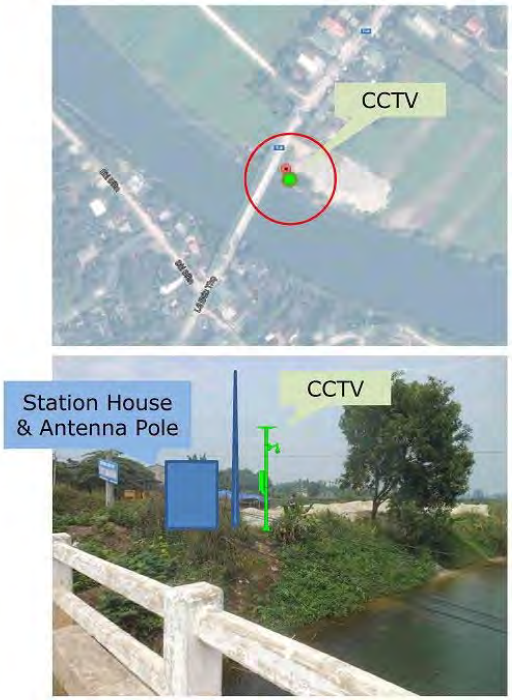
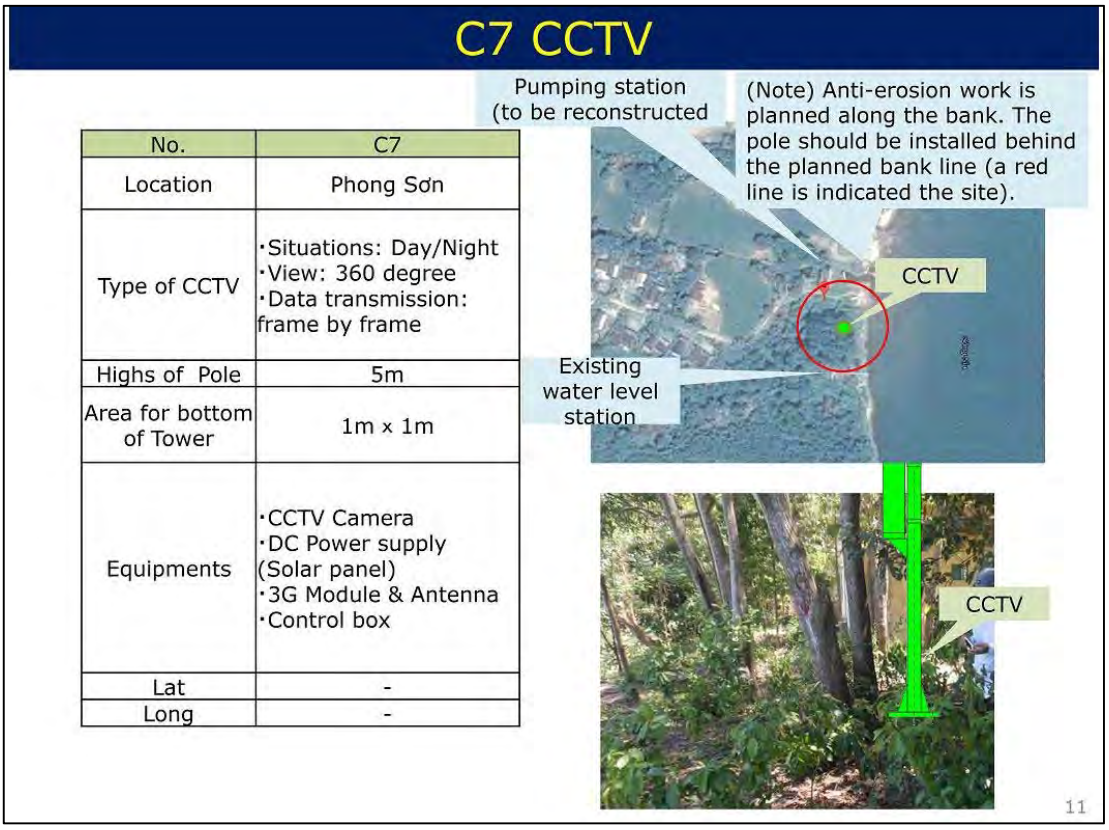


Fig. 2-10(5) CCTV Camera (C5)

C6 CCTV

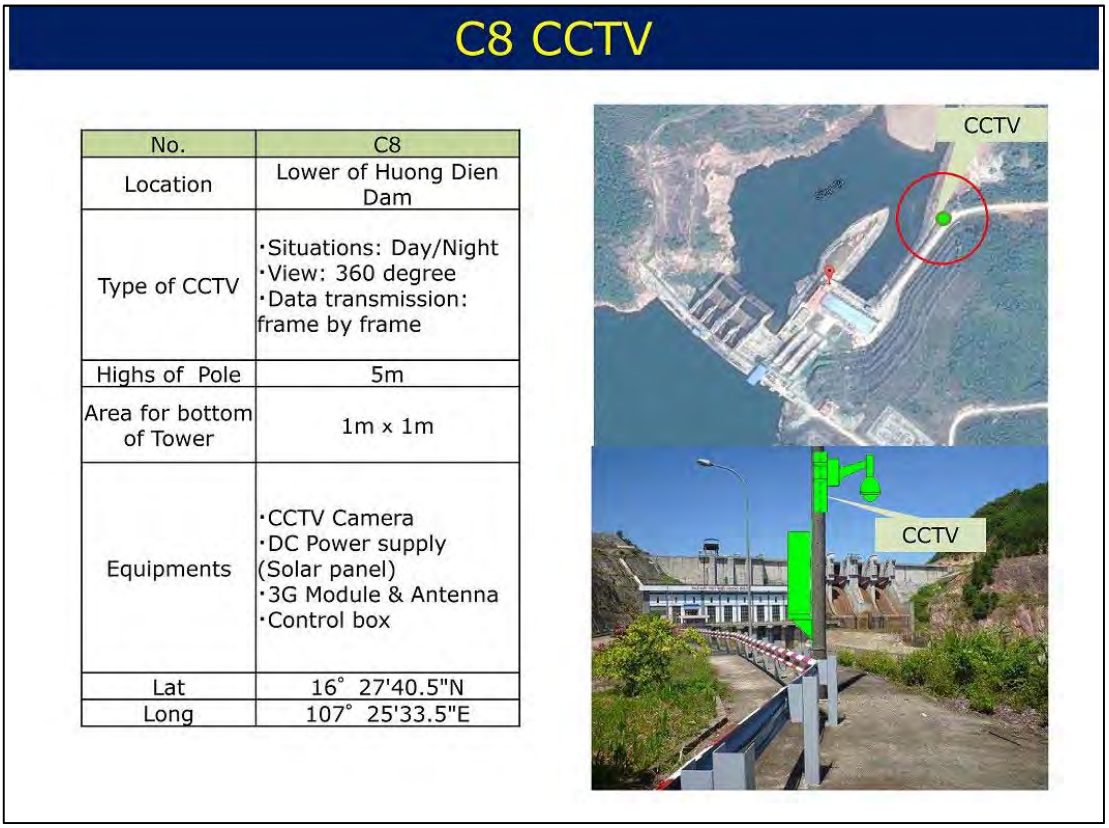
No.	C6
Location	Cầu Tứ Phú Quảng Phú
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	16° 31'27.3"N
Long	107° 29'02.7"E

Fig. 2-10(6) CCTV Camera (C6)



No.	C7
Location	Phong Sơn
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	-
Long	-

Fig. 2-10(7) CCTV Camera (C7)



No.	C8
Location	Lower of Huong Dien Dam
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	16° 27'40.5"N
Long	107° 25'33.5"E

Fig. 2-10(8) CCTV Camera (C8)

C9 CCTV

No.	C9
Location	Upper of Huong Dien Dam
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	16° 27'32.8"N
Long	107° 25'27.4"E

Fig. 2-10(9) CCTV Camera (C9)

C10 CCTV

No.	C10
Location	Lower of Binh Dien Dam
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	16° 19'11.9"N
Long	107° 30'00.1"E

Fig. 2-10(10) CCTV Camera (C10)

C11 CCTV

No.	C11
Location	Upper of Binh Dien Dam
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	16° 18'58.2"N
Long	107° 30'06.3"E

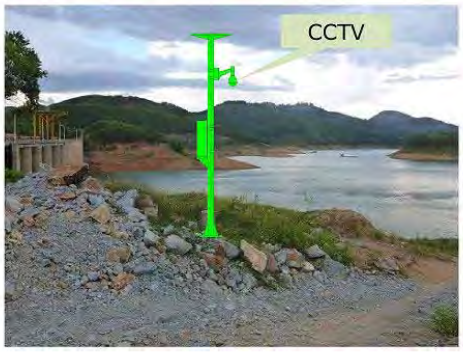


Fig. 2-10(11) CCTV Camera (C11)

C12 CCTV

No.	C12
Location	Lower of Ta Trach Dam
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	16° 18'34.0"N
Long	107° 37'39.1"E

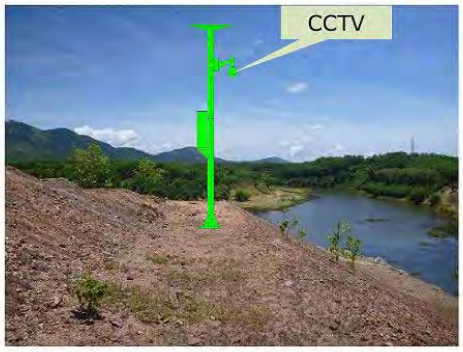


Fig. 2-10(12) CCTV Camera (C12)

C13 CCTV

No.	C13
Location	Upper of Ta Trach Dam
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	16° 18'38.4"N
Long	107° 37'42.7"E

Fig. 2-10(13) CCTV Camera (C13)

C14 CCTV

No.	C14
Location	Quan Culvert
Type of CCTV	·Situations: Day/Night ·View: 360 degree ·Data transmission: frame by frame
Highs of Pole	5m
Area for bottom of Tower	1m x 1m
Equipments	·CCTV Camera ·DC Power supply (Solar panel) ·3G Module & Antenna ·Control box
Lat	16° 21'34.4"N
Long	107° 46'31.2"E

Fig. 2-10(14) CCTV Camera (C14)

2-2-2-4 Dam Water Level Meter and Gate Opening Indicator Layout Plan

(1) Objective and Installation Approach

In order to obtain real time and precise measurements of the reservoir water level, the storage capacity, and the discharge of each of Huong Dien, Binh Dien, and Ta Trach dams, we will install water level meters to measure reservoir water levels in these 3 dams, as well as gate opening indicators at Huong Dien and Binh Dien dams.

Each dam's management is focusing on independent operation and management, so, for example, observed reservoir water level data is manually input in the table, not transmitted realtime. Equipment installation for real time observation and data transmission is necessary for effective dam management.

Concerning dam gate divergence meter, gate divergence itself can be measured at Huong Dien Dam and Binh Dien Dam, but not observed and transmitted realtime. So equipment installation for real time observation and transmission is necessary。 For Ta Trach Dam, gate divergence meter is already installed, which data is to be transmitted together with other data.

(2) Device Types

Water level meters to be installed are the same type as defined in "Hydrological Observation Station Layout Plan," while gate opening indicators to be installed are of messenger wire type that is widely applied for its post-construction installability.

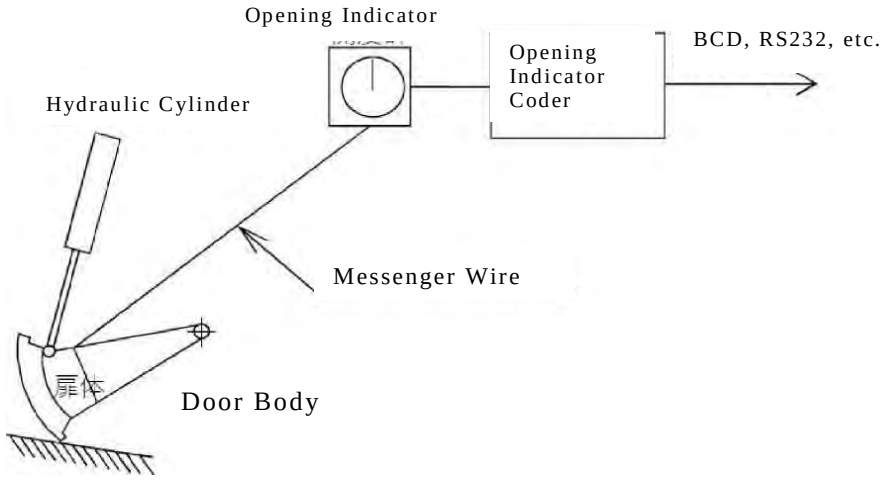


Fig. 2-11. Messenger Wire Type Gate Opening Indicator

(3) Data Transmission

The indicator will be connected by cable to the IT devices at each dam, in the same manner as the control system network for each dam.

2-2-2-5 Multiplex Wireless Equipment Layout Plan

(1) Objectives and development contents

The stable transmission of dam upstream observation data and various data for each dam to Hue PCC-NDPCS, and the stable transmission of basin-wide information processed at Hue PCC-NDPCSR and information required for dam information to each dam.

Therefore, it is necessary to secure dedicated lines that will not be affected by disasters, power outage, or mobile phone communication interruption, as well as lines that have the capacity to stably transmit large volumes of data consisting of various types of data and images. To address this need, multiplex wireless lines will be newly established.

(2) Wireless network

The most effective relay stations will be installed in consideration of topographical conditions for transmission from the mountain area where the dams are to Hue PCC-NDPCSR.

Binh Dien Dam and Huong Dien Dam are in a valley, and they will be supported with the combination of inexpensive low steel tower base stations and passive relay stations.

7.5GHz multiplex wireless that has a track record and is capable of stable operation and stable supply will be used.

Following Figure shows multiplex radio line distribution diagram to connect multiplex radio base stations (T1~T7).

Fig. 2-12 Line System Diagram

Table 2-10 List of Wireless Radio Base Stations

No.	Category	Location	Type of Antenna		Highs of Tower	Area for Tower	Equipments
			Sleeve Antenna	Parabolic Antenna			
T1	Radio Base Station	Ta Trach Dam	1	1	32m	10m x 10m	(Raduo Base Station) ・Multiplex transmission ・Telemetering equipments ・DC Power supply ・Station house ・Antennas (Repeater) ・DC Power supply ・Station house ・Antennas ・Generator (Passive Repeater) ・Antennas
T2	Radio Base Station	Binh Dien Dam	1	1	32m	10m x 10m	
T3	Passive Repeater	Binh Dien Dam	–	2	6m	5m x 5m	
T4	Radio Base Station	Huong Dien Dam	1	1	32m	10m x 10m	
T5	Passive Repeater	Huong Dien Dam	–	2	6m	5m x 5m	
T6	Repeater	Near Chùa Phật Đứng	–	3	32m	10m x 10m	
T7	Radio Base Station	PCC-NDPCSR	1	2	32m	Existing Area in PCC-NDPCSR	

*Radar installation location is a tower with height of 36m

(3) Radio wave transmission test

1) Objectives

A propagation path mirror test was conducted to confirm that there was sufficient clearance on a multiplexed propagation path.

2) Equipment used in the test

The equipment used in the test is as follows.

Table 2-11 List of Survey Equipment

No.	Product name	Specifications type	Quantity
1	Transit	Horizon HET 5 theodolite	2 sets
2	Mirror	Including angle change reflection	2 sets
3	Camera		2 sets
4	Binoculars	With compass feature	2 sets
5	Other	Mobile phone (for contacts), GPS	Number required

3) Experiment procedures

The mirror test consists of positioning workers at each of the planned steel tower construction sites or planned adjacent location, using mirror to mutually reflect sunlight between the experiment target areas and mutually confirming the other party. For this confirmation, a worker will contact the other party by telephone to confirm that the light reflected from the mirror was received as light. If there are buildings, etc. between the other party's light emitting point (target) and the view from the other station, the angle of direction and elevation/depression angle with the building, etc. (ridge) will be measured, visually confirmed, and photographed.

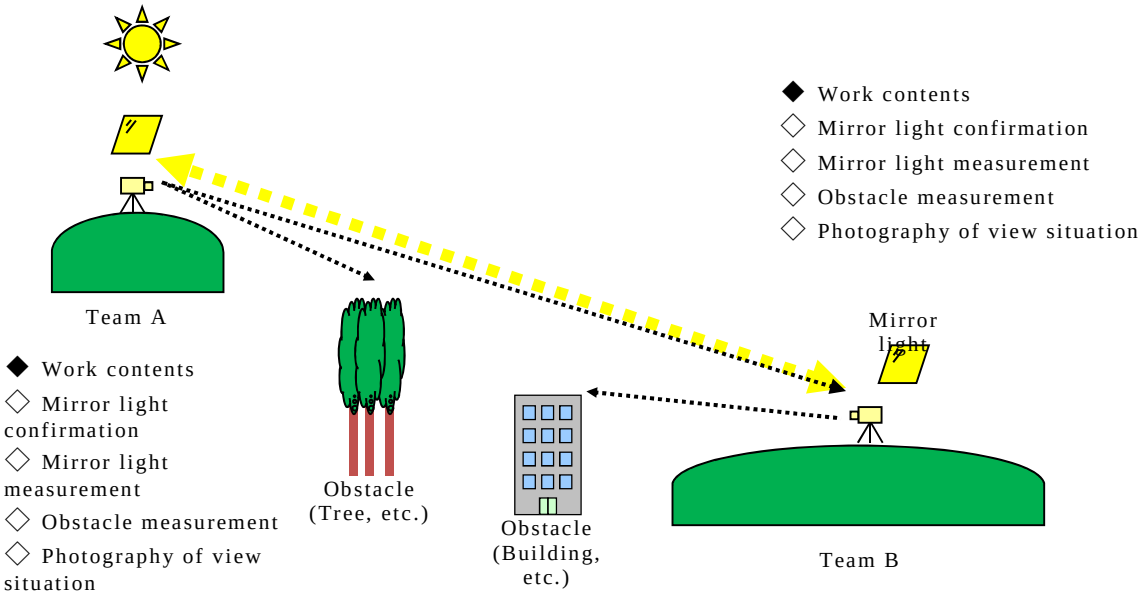


Fig. 2-13 Multi-Line Mirror Test Overview Diagram

*Because it was not possible to conduct work at an existing steel tower for PCC-NDPCSR(T7), work was conducted instead on the side veranda of a restaurant on the ninth floor of the Park View Hotel.

4) Test results

The results of the mirror test are as follows.

Span No.	Radio Base stations Name	Connecting Master stations Name	Result ◎:OK, ×:NG	Remarks
1	TA TRACH DAM(T1)	REPEATER(T6)	◎	
2	BINH DIEN DAM(T2)	PASSIVE REPEATER(T3)	◎	
3	PASSIVE REPEATER(T3)	REPEATER(T6)	◎	
4	HUONG DIEN DAM(T4)	PASSIVE REPEATER(T5)	◎	
5	PASSIVE REPEATER (T5)	PCC-NDPCSR(T7)	◎	
6	REPEATER (T6)	PCC-NDPCSR(T7)	◎	

There were not any issues at any locations in the multi-line mirror test.

However, ground clearance of 6m is planned for passive repeaters (T3, T5). Because the trees planted in the peripheral are will have a height of 10-15m, periodic felling is

required so that the radio wave propagation path does not interfere with radio waves (shielding).

(4) Installation Details

The table below shows the equipment to be procured, the specifications thereof, and the installation locations at each wireless/radio station.

Table 2-12 List of Equipment to be Procured

Equipment No.	Component No.	Equipment Name	Units	Body Quantity	Backup Quantity	Total
4	01	Parabolic Antenna (0.9φ)	Units	4		4
	02	Parabolic Antenna (1.2φ)	Units	2		2
	03	Parabolic Antenna (1.8φ)	Units	3		3
	04	Parabolic Antenna (02.4φ)	Units	3		3
	05	7.5GHz Multiplex Wireless Equipment (1+1)	Units	8		8
	06	Rack for Communication Equipment	Units	5		5
	07	Junction Box	Units	2		2
	08	DC48V Direct Power Supply Equipment	Units	5		5
	09	Battery	Units	5		5
	10	Inverter	Units	1		1
	11	Inverter	Units	4		4
	12	Lightning Resistant Transformer (50kVA or above)	Units	1		1
	13	Lightning Resistant Transformer (20kVA or above)	Units	3		3
	14	Lightning Resistant Transformer (7.5kVA)	Units	1		1
	15	Lightning Resistant Transformer (3kVA or above)	Units	4		4
	16	UPS (1kVA or above, stationary type)	Units	9		9
	17	UPS (1kVA or above, rack type)	Units	1		1
	18	UPS (2.2kVA or above, rack type)	Units	3		3
	19	UPS (3kVA or above, rack type)	Units	2		2
	20	UPS (1.5kVA or above, rack type)	Units	1		1
	21	AVR (20kVA or above)	Units	2		2
	22	AVR (7.5kVA or above)	Units	3		3
	23	Incoming Panel	Units	3		3
	24	Incoming Panel (Radar)	Units	1		1
	25	AC Distribution Board (for Dam Operation Room)	Units	3		3
	26	AC Distribution Board (for Multi-facility Use)	Units	4		4
	27	AC Distribution Board (for Radar)	Units	1		1
	28	AC Distribution Board	Units	1		1
	29	Generator	Units	1		1
	30	Auto-starting Board	Units	1		1
	31	Fuel Tank (200L)	Units	1		1
	32	Switch Box	Units	1		1

	33	Radio Tester	Units	1		1
	34	Field Intensity Meter	Units	1		1
	35	Passage Type Wattmeter	Units	1		1
	36	Level Meter	Units	2		2
	37	Digital Tester	Units	2		2
	38	Portable Motor	Units	1		1
	39	Battery Charger	Units	1		1
	40	Battery Checker	Units	1		1
	41	Maintenance Tool	Units	1		1
	42	Container	Units	2		2
	43	Multiplex Wireless Equipment	Units		2	2
	44	DC Power Supply Control	Units		4	4
	45	Inverter	Units		4	4
	46	AVR Control	Units		2	2
	47	SPD (for Distribution Board)	Units		5	5
	48	Control for Generator/Auto-Starting Panel	Units		1	1
	49	Generator Parts	Units		1	1
	50	P Valve (for Lightning Resistant Transformer)	Units		45	45

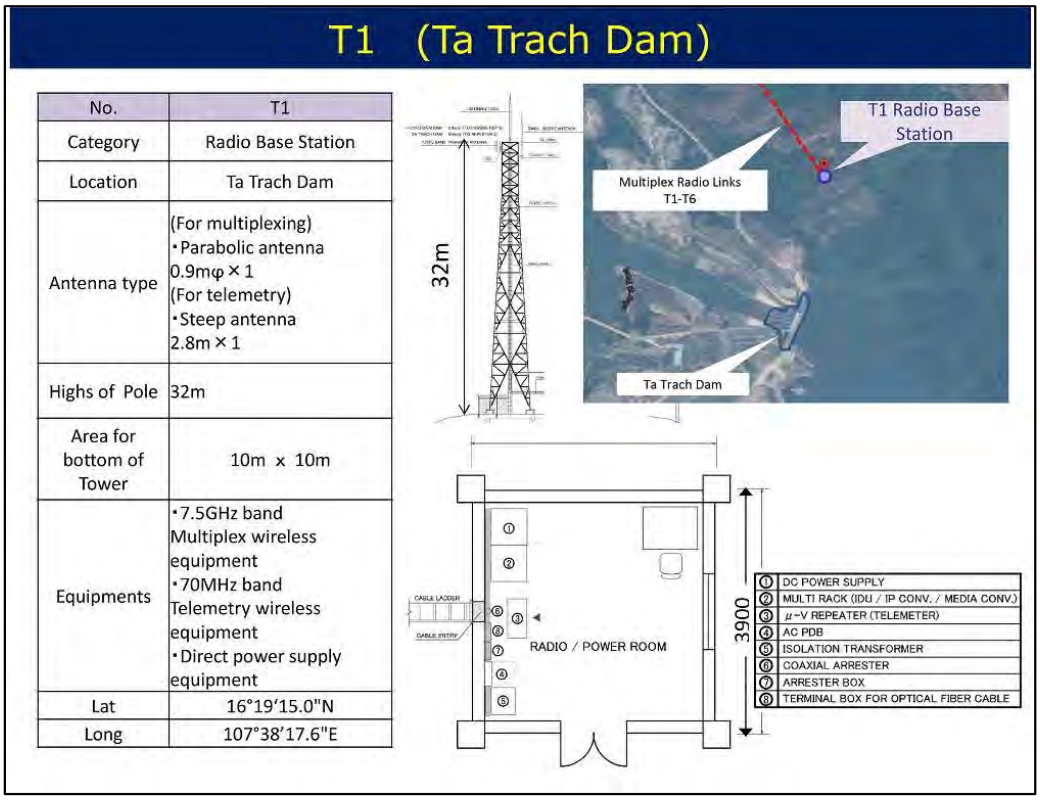


Fig. 2-14(1) Wireless Radio Base Station (T1)

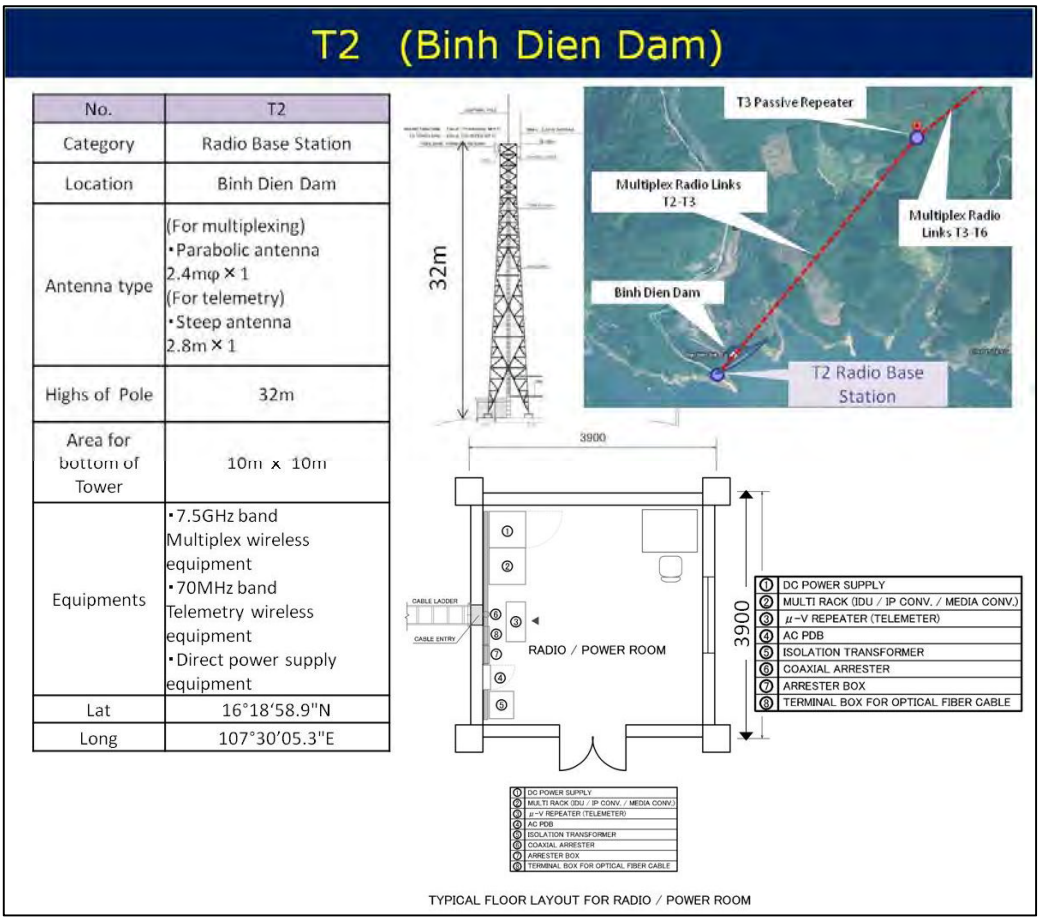


Fig. 2-14(2) Wireless Radio Base Station (T2)

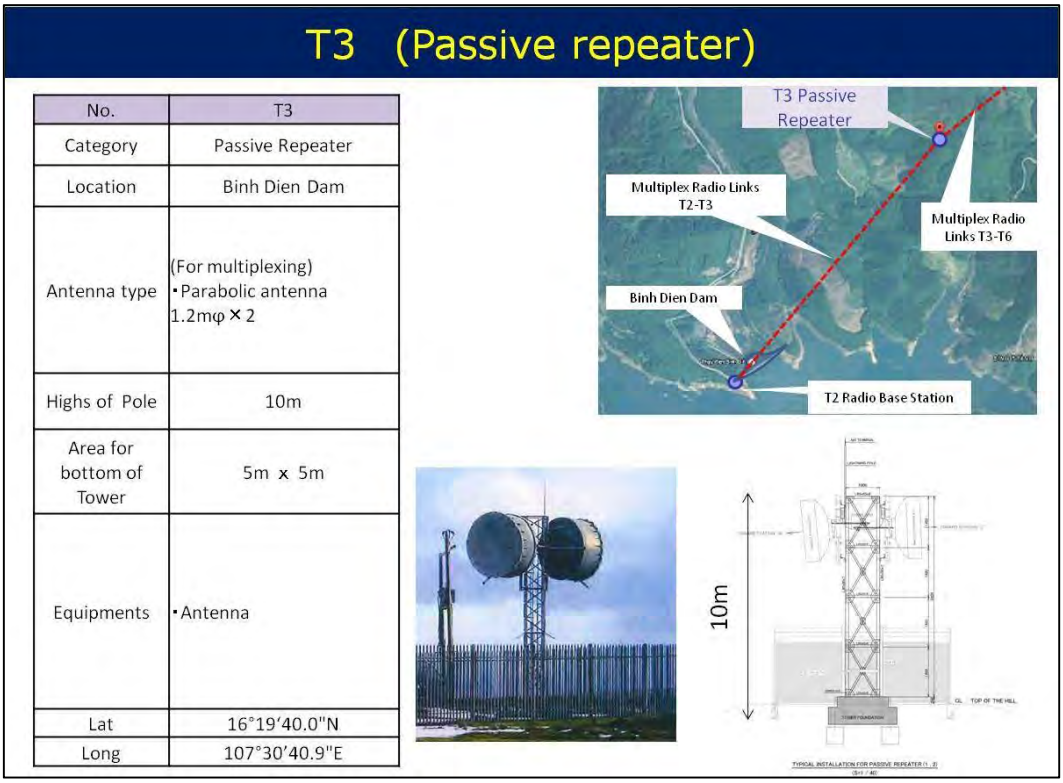


Fig. 2-14(4) Passive Relay Station (T3)

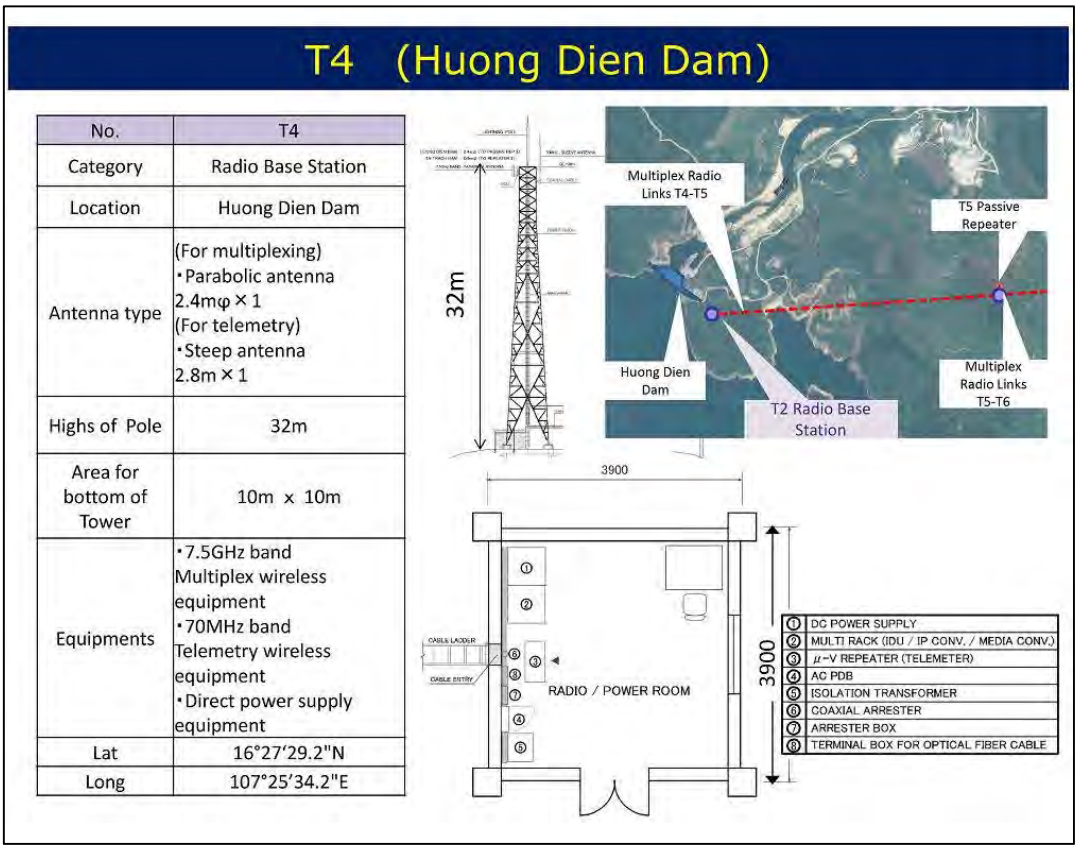
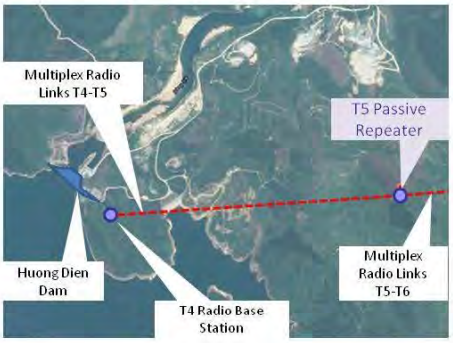


Fig. 2-14(5) Wireless Radio Base Station (T4)

T5 (Passive repeater)

No.	T5
Category	Passive Repeater
Location	Huong Dien Dam
Antenna type	(For multiplexing) ・Parabolic antenna 1.8mφ × 2
Highs of Pole	10m
Area for bottom of Tower	5m x 5m
Equipments	・Antenna
Lat	16°27′31.6"N
Long	107°26′35.2"E



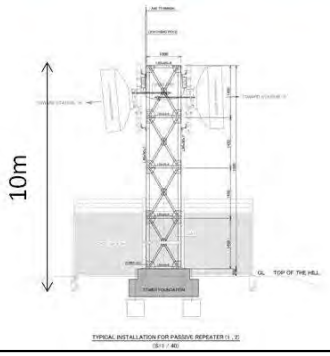
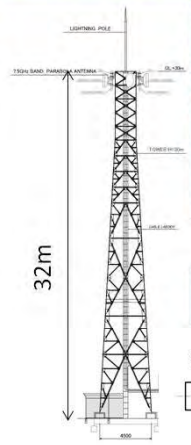


Fig. 2-14(5) Passive Relay Station (T5)

T6 (Near Chùa Phật Đứng)

No.	T6
Category	Repeater
Location	Near Chùa Phật Đứng
Antenna type	(For multiplexing) ・Parabolic antenna 0.9mφ × 2 1.8mφ × 1
Highs of Pole	32m
Area for bottom of Tower	10m x 10m
Equipments	・7.5GHz band Multiplex wireless equipment ・Direct power supply equipment ・Station buildings ・Antenna ・Motion generator
Lat	16° 23′29.5"N
Long	107° 35′9.5"E



①多重無線装置
②直流電源装置
③発動発電機
④屋内燃料タンク

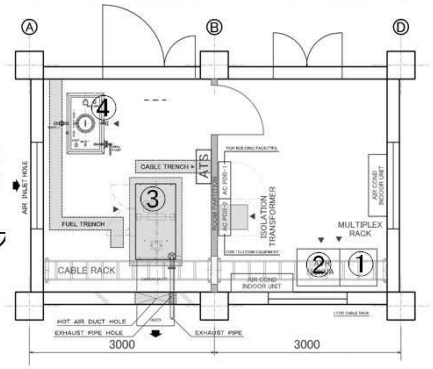


Fig. 2-14(6) Relay Station (T6)

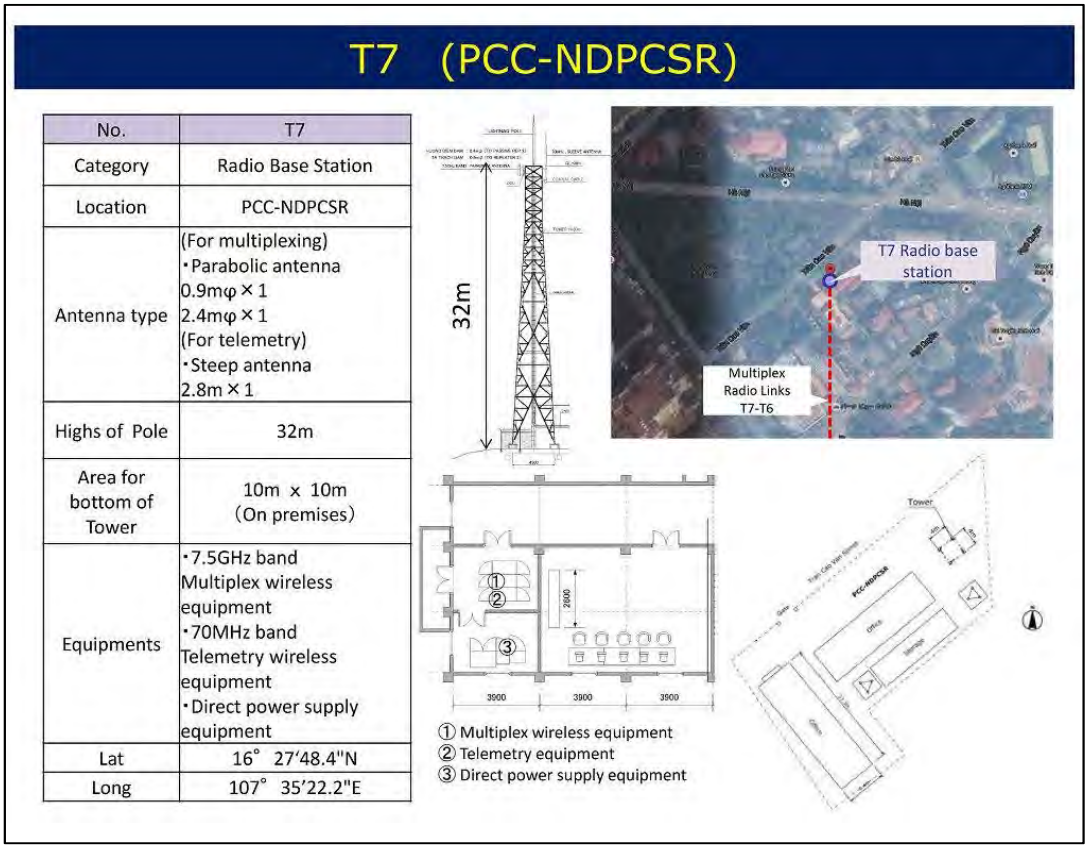


Fig. 2-14(7) Wireless Radio Base Station (T7)

2-2-2-6 Telemetry and related System Layout Plan

(1) Objectives and development contents

A telemetry system will be installed to transmit hydrological observation station small capacity data from hydrological observation stations to each dam control station and Hue PCC-NDPCSR by telemetry line.

Note that in consideration of the result of the radio wave transmission test that is described below, substitution with mobile phone lines, etc. will be used for locations where there is no telemetry radio wave transmission.

(2) Design policy of wireless network

A line with stable communication quality in mountainous areas and that does not require relay stations will be used.

70MHz multiplex wireless that has a track record and is capable of stable operation and stable supply will be used as it fulfills these conditions.

(3) Location plan

Between each hydrological observation station and data collection spot, an electric wave propagation test (mentioned in more detail later) was carried out and resulted in confirmation of stable wave propagation in all sections except P11-T4.

1) About P7

Based on field propagation test, it was confirmed tbat electric wave propagation is not enough between P7 and P14, due to nearby hill shielding the wave. Consulting team considered a change of the observation site and installation of relay facility, but construction of new road is necessary for station construction and conveyance of equipments. So, as a next best solution, the team proposed to use mobile phone line \, same as in Italian ODA project. This point is within X band radar raingauge observation area, so when mobile phone line is in trouble, radar observation would be used in place.

Concerning the data transmission from P7, cell phone line is to be used with satellite based mobile phone line to secure redundancy.

2) About P11

Based on the field propagation test, it was confirmed electric wave propagation is not enough between P11 and P14. It was also confirmed after the field survey, that outflow data can be directly received with permission from the power staion, which would be more precise.

Data from P11 is water flow volume from the power station, so it is to be directly transmitted from the power plant management system rather than transforming observed water level to flow volume.

Same kind of data transmission as used in power station and cell phone line would be used. New road construction is necessary forinstallation of relay

facility. Consultant team proposed to use mobile phone line for data transmission from P11 and satellite cell phone line is also prepared for backup purpose.

【Radio wave transmission test】

1) Objective of the test

The telemetry line radio wave transmission test is conducted to confirm the characteristics of radio wave propagation paths by conducting radio propagation that exceeds a viewable distance by launching test radio waves and conducting a counter test.

The measurement items are as follows.

・Received input measurement
・S/N measurement
・Horizontal/vertical pattern measurement
・Extraneous noise measurement

2) Equipment used in the test

Table 2-13 List of Equipment Used in the Test

No.	Product name	Specifications type	Quantity
1	Wireless radio	Transmission output 10W, specified frequency 72.1MHz	2 sets
2	Field intensity meter	Specified frequency response	1 set
3	Measuring receiver	Specified frequency response	1 set
4	Level gauge	With signal generator	2 sets
5	Passage type wattmeter	Specified frequency response	2 sets
6	Antenna	Three element Yagi, specified frequency 72.1MHz	1 set
7	Antenna	Vertical dipole type, specified frequency 72.1MHz	1 set
8	Antenna pole	10m	2 sets
9	Coaxial cable	5D-FB(20m), 5D-2V	2 sets
10	Coaxial switching device		2 sets
11	Standard signal generator	Specified frequency response	1 set
12	Recorder	For noise data recording	1 set
13	Camera		2 sets
14	Compass		2 sets
15	Other	Power supply battery, charger, generator, mobile phone (for contact), GPS, recorder	Number required

3) Radio wave transmission test sections

Radio wave transmission tests were conducted on the following 11 sections.

1	THUONG LO(P1)	TA TRACH DAM(T1)
2	KHE TRE(P2)	TA TRACH DAM(T1)
3	SAO LA(P3)	BINH DIEN DAM(T2)
4	THAO LONG(P4)	PCC-NDPCSR(T7)
5	THUAN AN(P5)	PCC-NDPCSR(T7)
6	DAI GIANG WEIR(P6)	PCC-NDPCSR(T7)
7	A ROANG(P7)	HUONG DIEN DAM(T4)
8	TA LUONG(P8)	HUONG DIEN DAM(T4)
9	THANH LUONG(P9)	PCC-NDPCSR(T7)
10	NIEM PHO(P10)	PCC-NDPCSR(T7)
11	A LUOI RESERVOIR(P11)	HUONG DIEN DAM(T4)

Additional test

	THUONG LO(P1)	KHE TRE (P2)
	A ROANG(P7)	TA LUONG(P8)
	A LUOI RESERVOIR(P11)	TA LUONG(P8)

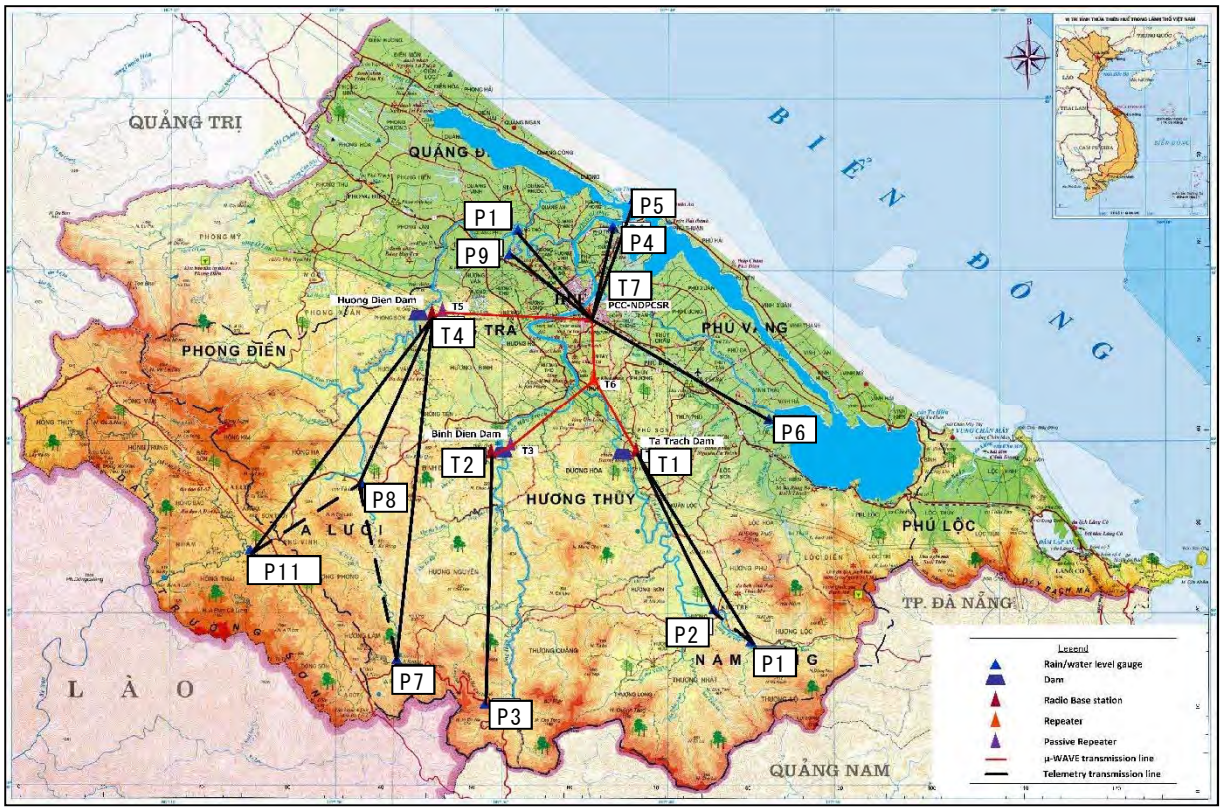


Fig. 2-15 Telemetry Line System Diagram

4) Radio wave transmission test overview

The radio wave transmission test consists of conducting propagation and transmission measurement and measuring loss, etc. on radio wave propagation paths at the 11 hydrological observation stations (locations) that are scheduled to be established.

In addition, extraneous noise (city noise) measurement will also be conducted to consider line construction at the newly constructed observation stations.

5) Radio wave transmission test method

5)-1 Reception input, horizontal/vertical pattern measurement

Install a temporary antenna for tests in the monitoring station and emit experimental radio waves using a wireless radio for tests. Install a temporary antenna for tests (three element Yagi) in the observation station, and measure the received power that is received from experimental radio waves emitted from the monitoring station (counter station). The true direction received power will be measured by the opposite station.

[Survey method]

- A temporary antenna will be installed in the monitoring station, and test radio waves will be sent from the wireless radio in the monitoring station.
- The test radio waves from the monitoring station will be received by the observation station, and the received input (horizontal pattern, vertical pattern) will be measured.

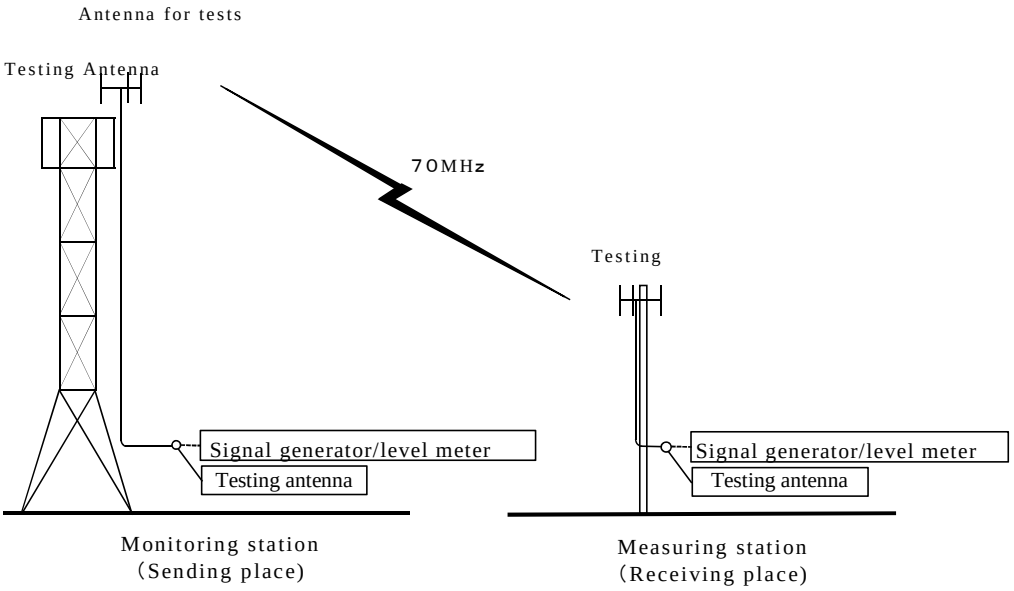


Fig. 2-16. Radio Wave

5)-2 S/N counter test

Use the temporary antenna for tests in the monitoring station to send test signals from a wireless radio for tests. The test signals sent from the counter

station (monitoring station) will be received by the observation station, and the signal level will be measured. The signal will be stopped, a non-modulating signal will be sent from the monitoring station, and the noise level will be measured by the observation station. The same measurement will also be conducted in the opposite direction. The difference between these received signals and the noise level will be recorded as S/N(dB).

[Survey method]

- A temporary antenna will be installed in the monitoring station, and modulating test radio wave through test signals (1kHz) will be sent from the wireless radio.
- The test signals sent from the monitoring station will be received by the observation station, and the receipt level will be measured.
- Non-modulating test radio waves will be sent from the wireless radio in the monitoring station, and the reception (noise) level will be measured.
- The same measurement will be conducted in the opposite direction.

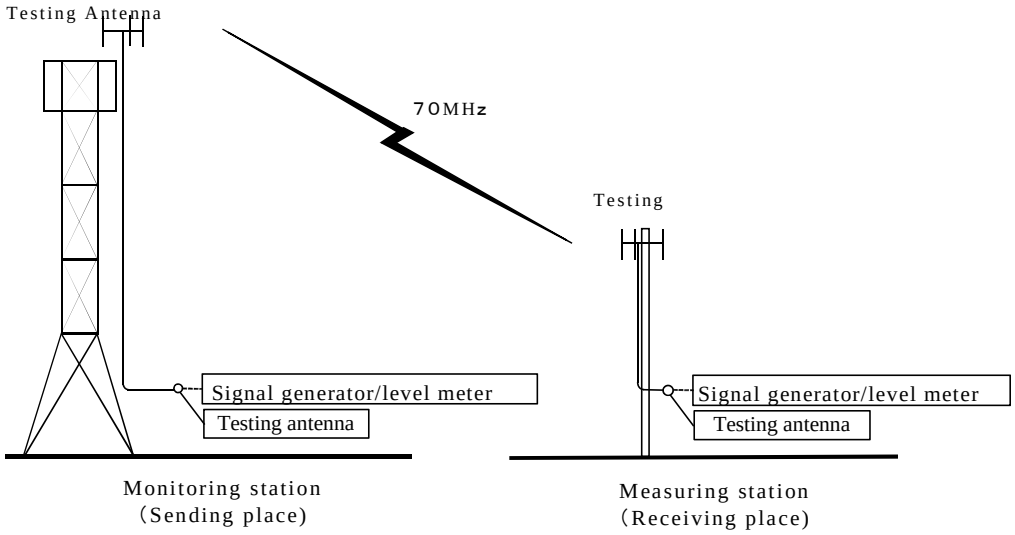
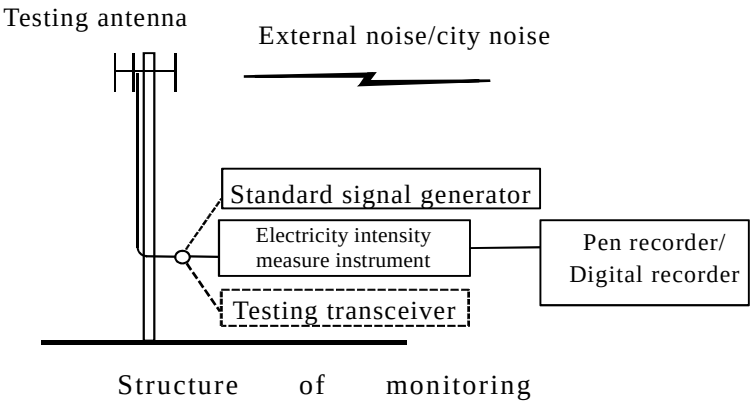


Fig. 2-17. S/N Counter Test Overview Diagram

5)-3 Extraneous noise (city noise) measurement

A temporary antenna for tests installed in the observation station will be used to measure extraneous noise (city noise).



Structure of monitoring

Fig. 2-18 Extraneous Noise (City Noise) Measurement Overview Diagram

[Survey method]

- Install a temporary antenna for tests in the observation station.
- Measure and record extraneous noise (city noise) using a field intensity meter and recorder.

6) Circuit design study results

The telemetry line circuit design study results based on the radio wave transmission test are shown below.

Span No.	Gauging stations		Antenna type	Transmission power (W)	Connecting Master		Antenna type	Distance (km)	Transmission direction (UP／DOWN)	Nomal Condition S/N ① (dB)	Result	Note
	ID	Station Name			ID	Station Name						
01	P1	Thuong Lo	5EL Yagi (N)	10W	T1	Ta Trach DAM	5EL Yagi(N)	23.2	Up Link	49.0	◎	
									Down Link	46.7		
02	P2	Khe Tre	5EL Yagi (N)	10W	T1	Ta Trach DAM	5EL Yagi(N)	19.08	Up Link	49.7	◎	
									Down Link	47.7		
03	P3	Seo La	5EL Yagi (N)	10W	T2	Binh Dien Dam	5EL Yagi(N)	26.9	Up Link	38.7	◎	
									Down Link	35.6		
04	P4	Thao Luong	5EL Yagi (N)	10W	T7	PCC-NDPCRS	Sleeve Antena	9.29	Up Link	57.4	◎	
									Down Link	56.7		
05	P5	Thuan An	5EL Yagi (N)	10W	T7	PCC-NDPCRS	Sleeve Antena	12.14	Up Link	61.2	◎	
									Down Link	59.7		
06	P6	Quan Cuivertr	5EL Yagi (N)	10W	T7	PCC-NDPCRS	Sleeve Antena	22.94	Up Link	40.6	◎	
									Down Link	38.5		
07	P7	A Roang	5EL Yagi (N)	10W	T4	Huong Dien DAM	5EL Yagi(N)	37.23	Up Link	8.2	×	UpLink:NG DownLink:OK
									Down Link	32.6		
08	P8	Ta Luong	5EL Yagi (N)	10W	T4	Huong Dien DAM	5EL Yagi(N)	19.95	Up Link	38.5	◎	
									Down Link	37.9		
09	P9	Thanh Luong	5EL Yagi (N)	10W	T7	PCC-NDPCRS	Sleeve Antena	10.14	Up Link	58.6	◎	
									Down Link	57.4		
10	P10	Niem Pho	5EL Yagi (N)	10W	T7	PCC-NDPCRS	Sleeve Antena	11.0	Up Link	65.6	◎	
									Down Link	64.6		
11	P11	A Luoi Reservoir	5EL Yagi (N)	10W	T4	Huong Dien DAM	5EL Yagi(N)	31.29	Up Link	28.1	×	UpLink:NG DownLink:OK
									Down Link	38.8		

◎ :OK × :NG

6)-1 Stance towards circuit design study

A circuit design study was conducted based on the following conditions as prescribed in “Ministry of Land, Infrastructure and Transport VHF Band (70MHz.400MHz Band) Simplex Fixed Circuit Standards (Draft)”.

Circuit design conditions: Normal condition S/N will be at least 30dB.

Normal condition S/N: An S/N that includes wireless radio modulated input level decline, peak noise, and waveform distortion margin is indicated to secure the reliability of communication circuits (communication speed of 1200bps with bit error rate of no more than 1×10^{-5}).

6)-2 Circuit design study for P7 and P11

The normal condition S/N values calculated for P7 (A Roang) and P11 (A Luoi Reservoir) were 8.2 dB and 28.1 dB, respectively. As this is under the standard value of 30 dB, it was determined that it would not be possible to construct a telemetry circuit for this section.

Table 2-14 Equipment to be Procured

Equipment No.	Component No.	Equipment name	Unit	Body Quantity	Backup Quantity	Total
5	01	70MHz-band Radio Equipment (10W)	Units	16		16
	02	Yagi Antenna 5x2.5 3EI	Units	0		0
	03	Yagi Antenna 5x2.5 5EI	Units	9		9
	04	Sleeve Antenna (2.8m)	Units	4		4
	05	Telemetry Supervisory Equipment	Units	1		1
	06	Telemetry Supervisory Equipment 1 (rainfall amount)	Units	3		3
	07	Telemetry Supervisory Equipment 2 (water level/rainfall amount)	Units	7		7
	08	Coaxial Lightning Arrester	Units	12		12
	09	Server (Telemetry Console)	Units	1		1
	10	LCD	Units	1		1
	11	Telemetry Operating Console Software	Sets	1		1
	12	Telemetry IP Interchange Device	Units	6		6
	13	Call Operation Device	Units	1		1
	14	Repeater Equipment (48V Input) (Telemetry Relay Device)	Units	3		3
	15	Storage-type Relay Function (only P2 & P8 Stations)	Units	2		2
	16	Antenna Distributor (only P2 & P8 Stations)	Units	2		2
	17	Relay Box (Arrester)	Units	10		10
	18	Data Logger	Units	10		10
	19	Solar Battery (for Rainfall Observing Station)	Units	3		3
	20	Solar Battery Power Board (for Rainfall Observing Station)	Units	3		3
	21	Battery (for Rainfall Observing Station)	Units	3		3
	22	Solar Battery (for Rainfall/Water Level Observing Stations)	Units	7		7
	23	Solar Battery Power Board (for Rainfall/Water Level Observing Stations)	Units	7		7
	24	Battery (for Rainfall/Water Level Observing Stations)	Units	7		7
	25	CPU Substrate	Units		3	3
	26	LAN Substrate	Units		3	3
	27	External I/F Substrate	Units		3	3
	28	Power Supply Unit	Units		3	3
	29	Wireless Radio	Units		2	2
	30	Telemetry IP Interchange Device	Units		1	1
	31	Call Operation Device	Units		1	1
	32	Telemetry Console HDD	Units		1	1
	33	Server Power Supply Unit	Units		1	1
	34	Observation System	Units		3	3
	35	Solar Battery Power Board	Units		3	3
	36	Current/Standby Switching Control	Units		3	3
	37	Power Supply Unit	Units		3	3
	38	Wireless Radio	Units		3	3
	39	Telemetry IP Interchange Device	Units		3	3

2-2-2-7 Information Processing and Display System Layout Plan

(1) Water disaster prevention information system functions

The water related disaster management information system has the following functions necessary for information processing and notification in order to enable consideration and decision making to reduce flood damage, ensure dam safety, and realize optimum dam operation for water use and drought measures as well as to accurately deliver information to related organizations and residents so as to alleviate damage.

1. Enable grasping of the situation of rainfall, rivers and dam reservoirs in the Huong River basin in real time
   - Point rainfall amount (ground rain gauge data) and rainfall distribution (radar rain gauge data)
   - Water level and discharge (water level gauge data) at major points of the river
   - Situation of river water level and inundation of urban areas (by CCTV images)
   - Water level, storage volume, inflow, discharge, and gate opening of dam reservoirs (dam information)
   - Safety confirmation of downstream area in dam discharge (by CCTV images)
2. Enable flood forecasting and inundation forecasting to be conducted every 10 minutes
   - Rainfall amount forecast (50 km meshes for all of Vietnam and 5 km meshes for Huong River basin)
   - River flow forecast (flood forecast by New RRI model based on rainfall amount forecast)
   - Inundation forecast (inundated area and inundation depth forecast by New RRI model based on rainfall amount forecast)
3. Enable consideration and decision making for optimal dam operation to reduce flood damage and ensure dam safety
   - Downstream river water level, flow, and inundation forecast when discharge of the three large-scale dams is changed
   - Provision of optimal dam discharge proposals based on integrated management guidelines for the three dams decided by the Prime Minister.
   - Display of current and forecast flow at major medium-size dam locations
4. Enable consideration and decision making for optimal dam operation for drought countermeasures and water use for power generation, agriculture, etc.
5. Make information display system to be helpful and easy to understand for accurate decision making by residents and related organizations
   - Equip information station managing the basin as a whole with comprehensive information display equipment (Hue Province PCC-NDPCSR)

・Equip each dam with information display equipment that performs dam operations
・Equip CSC-NDPC, which considers disaster management measures from a nationwide perspective, with comprehensive information display equipment
・Provide NHMS, MCRHMC, and Hue HMC with information to closely coordinate with weather-related organizations
・Provide VAWR with information to help with research on water disaster prevention
・Put in place information disclosure web system and alarm mail system for residents in the Huong River basin

6. There might be missed data due to various reasons, whichi is to be covered in this system automatically, for example, by using nearby data for interpolation. When system is in trouble due to power shut down and datamissing etc., situation would be informed to to the system manager and message would be issued to related agencies and residents to avoid misunderstanding. Early cause investigation and coping method are to be trained in the soft component (technical assistance) and other opportunities. Knowhow of FRICS, which is in charge of same kind of information treatment and service, would be helpful in this field.

In response to flooding that occurred in 2016 in the middle region of Vietnam, the PMU (Project Management Unit) made up of related organizations in Vietnam for the Project strongly requested that alarm devices such as speaker, silen and warning signage be installed in the area around the Huong River and methods of transmitting information related to flooding to residents otherwise be enhanced. Also, NHMS requested direct network connection of radar rain gauge and other data in addition to providing information of the water related disaster management information system via the Internet in order to help advance weather forecasting in Vietnam.

All of those are deeply connected to this Project, but there are limits to their implementation in this Project and they are not originally included in its menu, so they will be issues to handle in the future, not implemented in this Project.

(2) Utilization of the water related disaster management information system for integrated management of the three dams based on the Prime Minister's decision

What is most expected in the Project is to be able to obtain information necessary for accurate integrated management of the three large-scale dams in the Huong River basin based on the Prime Minister's decision so as to effectively reduce flood damage in the Huong River basin.

In order to do that, necessary hydrological observation systems and a system for communication between observation equipment and related organizations shall be

developed, and content of the information processing and display system for information collection, organization, analysis, processing, and notification shall reliably meet objectives.

In order to effectively perform integrated management of the three dams based on the Prime Minister's Decision on operating rules of dam reservoirs, the water related disaster management information system must be utilized and accurate response to the following enabled.

1. As was shown in 2-2-1-2, dam operation rule based on the Prime Minister's Decision each dam is to be operated using the information of downstream reiver water level and water level of dam reservoir, which requires various real time data and its analysis for appropriate decision making. The water related disaster management system to be implemented in the Project can be usedjust for this purpose.As is described later in 3., the system would process and display various data and information and serve for supporting selection of most sutable operation, considering various effects including flow down time along the river channel.
2. Water is discharged from the dams in advance in order to secure capacity to adjust for flooding (commonly called "preliminary release") when heavy rain is expected, but it is currently not known how much to release at what time, which is a problem for hydroelectric dams in particular. The timing to start this preliminary release and the volume to release can be determined by finding the maximum value with total preliminary release volume and total adjustment for flooding being the same volume as in figure XX based on values obtained in flood forecasting. Ta Trach Dam has capacity to adjust for flooding, so response can be done by superimposing adjustment rules.

   With the water related disaster management information system, those considerations are done automatically and information such as calculation processes is displayed in order to enable applied operations with human judgment.
3. The second difficulty in application of the Prime Minister's decision on operating rules of dam reservoirs is the fact that there is substantial distance between dam locations and downstream urban areas and flow between those takes 2~4 hours time difference. Even if dam release and storage is done based on downstream water level, there is a risk that effects cannot be realized as stated in the Prime Minister's decision due to time lag.

   With the water related disaster management information system, simulations taking into account such time lag can be done; so suggested operations with actual effect downstream in mind shall be displayed.
4. Forecasting of natural phenomena always entails uncertainty, and prompt response to later situational changes (unexpected volume of inflow to dams, etc.) is extremely important.

With the water related disaster management information system, a mechanism is possible where corrections as needed are made from observation values obtained in real time, unlike with human consideration, and that shall assist in effective dam reservoir operation according to the actual situation.

The following figure clearly show the above mentioned (2, 3, 4) dam operation procedure, the right hand side of which is the graph of changing reservoir water level and outflow volume. Red line in the graph shows the inflow into the reservoir and blue line shows outflow from it. If the inflow water voliume with red colour is stored by dam storage operation, peak flow at dam site is to be decreased from red line level to blue line level, which contribute to reduce downstream peak river flow. For effective flod management, cut volume (red colured area) should be maximum, which requires to enlarge the pocket for storage by releasing water in advance. The water related disaster management system is helpful to find most suitable release timing and release volume based on real time data and simulation calculation.

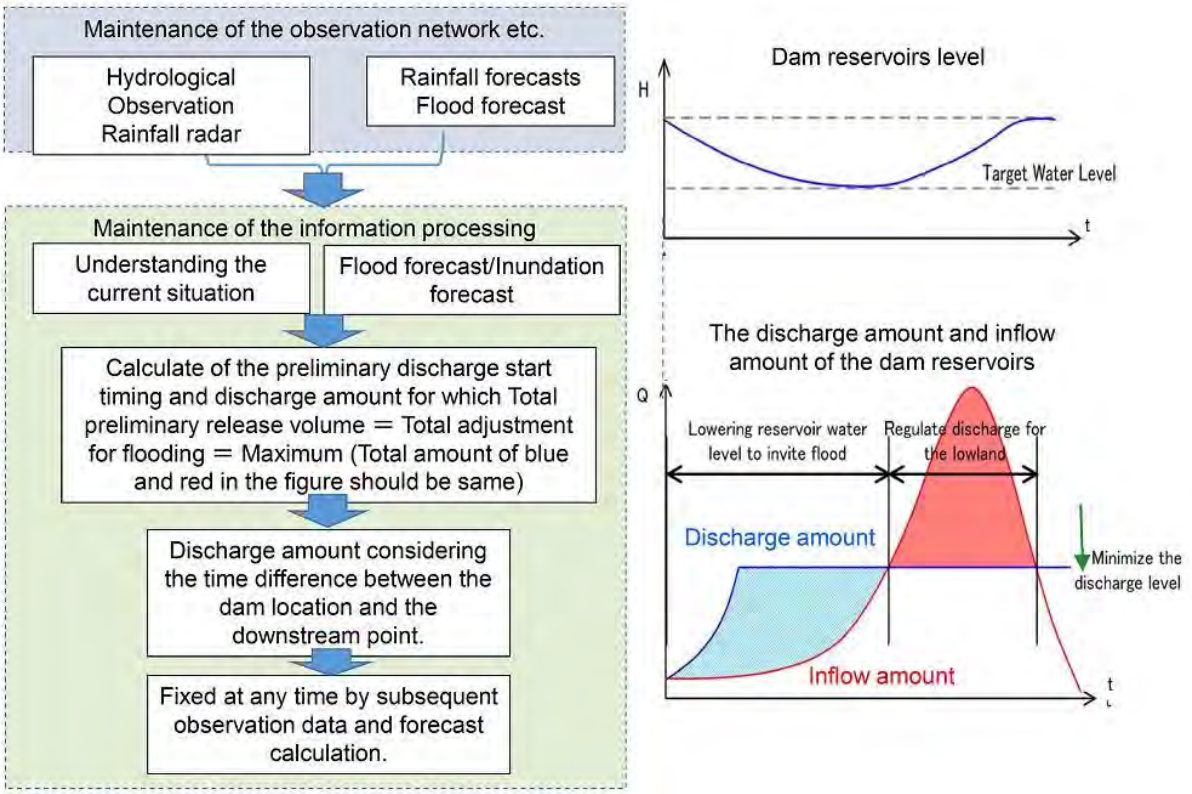


Fig. 2-19 Dam operation using the water disaster prevention information system

(3) Water related disaster management information system display contents

1) Screen related to determination of the current state of the whole river basin and individual spots

・Capability to determine the overall situation of the whole river basin, such as which areas of the river basin are receiving high amounts of rainfall, which part of the river is affected by rising water level or what is the situation at each dam

・Ability to determine (even without a forecast) future concerns, based on knowledge about the current state and changes so far

・Capability to use information, such as water level rising over caution values, as the basis for warning messages

【Display screens】(Bracketed numbers denote screen numbers)

a. Determining the state of the whole river basin

[1] Basin-wide rainfall distribution (radar image of rainfall amounts)

[2] Water level and flow volume of the river, spots where water level is higher than the caution values, dam storage volume figures (inflow volume, overall outflow volume, reservoir level percentage)

b. Values at observation spots (displayed when [2] is clicked)

[3] Rainfall amount and changes in rainfall amount at each observation spot (graph/tabular data)

[4] Recent values of hourly rainfall at observation spots within the river basin (tabular data)

[5] Hourly rainfall records for each observation spot for the previous 7 days

[6] Water level and flow volume of the river at observation spots within the river basin (list)

[7] Water level and flow volume of the river at each observation spot for the previous 7 days (tabular data)

[8] CCTV images of each spot

c. Values showing the state of each dam (displayed when [2] is clicked)

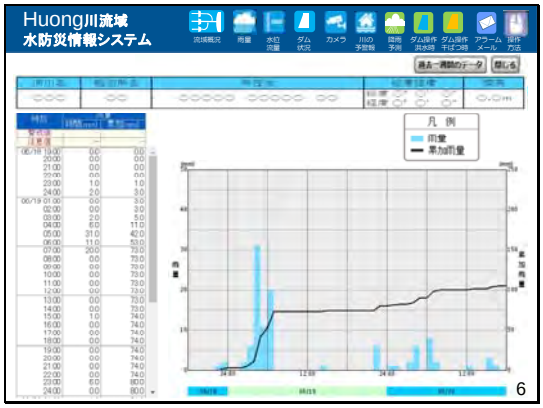
[9] Inflow volume, overall outflow volume, power generation outflow volume, gate outflow volume, degree of gate opening, reservoir water level, reservoir water volume, reservoir level percentage

[10] Changes in reservoir water level and volume in the previous 48 hours for each dam (graph)

[11] Records of various data for each dam (as mentioned in [9]) (tabular data)

[1] Basin-wide rainfall distribution (radar image of rainfall amounts)

[2] Water level and flow volume of the river, spots where water level is higher than the caution values, dam storage volume figures

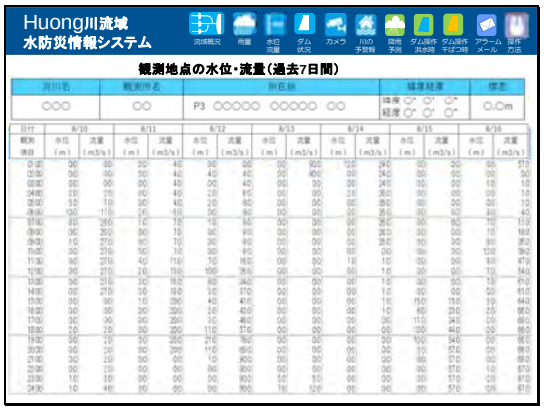


[3] Rainfall amount and changes in rainfall amount at each observation spot (graph/tabular data)

[4] Recent values of hourly rainfall at observation spots within the river basin (tabular data)

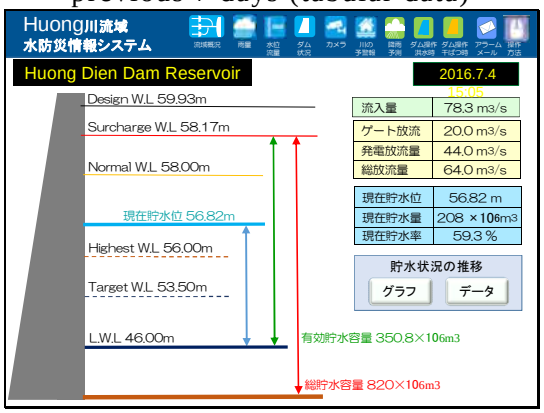
[5] Hourly rainfall records for each observation spot for the previous 7 days

[6] Water level and flow volume of the river at observation spots within the river basin (list)

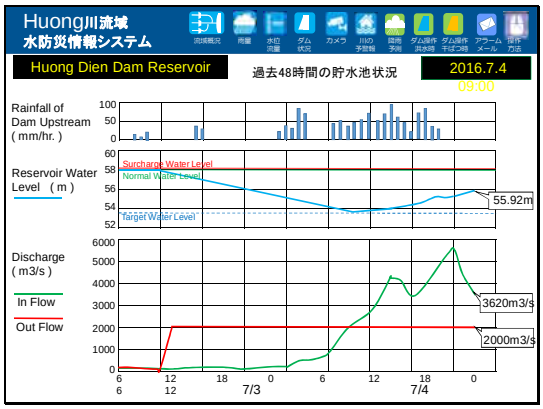


[7] Water level and flow volume of the river at each observation spot for the previous 7 days (tabular data)

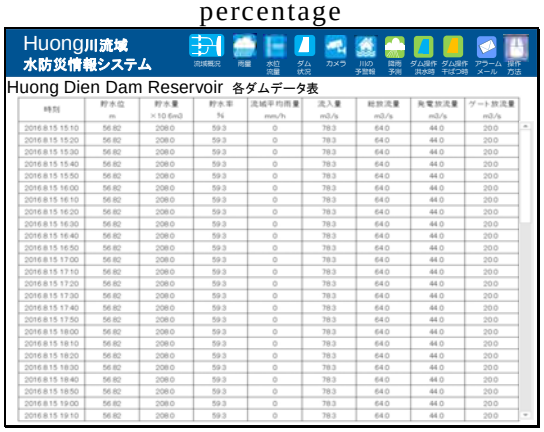
[8] CCTV images of each spot



[9] Inflow volume, overall outflow volume, power generation outflow volume, gate outflow volume, degree of gate opening, reservoir water level, reservoir water volume, reservoir level percentage



[10] Changes in reservoir water level and volume in the previous 48 hours for each dam (graph)



[11] Records of various data for each dam (as mentioned in [9])(tabular data)

2) Screen related to determination of the current state of the whole river basin and individual spots

・ Capability to determine which areas face potential risks of flooding and inundation from forecasts of future flow volume

・Capability to send out warnings (useful for appropriate preparations for evacuation or water related disaster management activities) to concerned areas after determining the areas that face potential risks of flooding and inundation

・Also display an adequate margin of error to prevent misunderstandings caused due to the inaccurate nature of forecasts

【Display Screens】(Bracketed numbers denote screen numbers)

[12] Map showing country-wide rainfall forecast (GPV data for 50 km mesh)

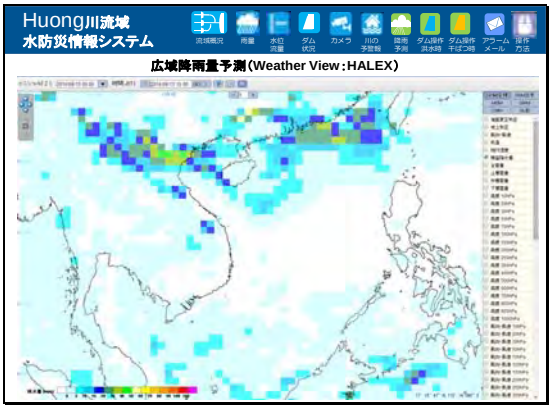
[13] Map showing rainfall forecast for the area around the basin of Huong River (5 km mesh data from NewRRI)

[14] Image showing basin-wide forecast of river water level, flow volume and state of dams

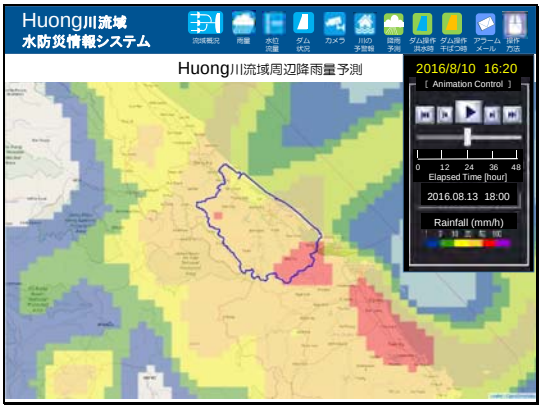
[15] River water level at each observation spot (actual and predicted forecast)

[16] IRiver flow volume at each observation spot (actual and predicted forecast)

[17] Inundation forecast map

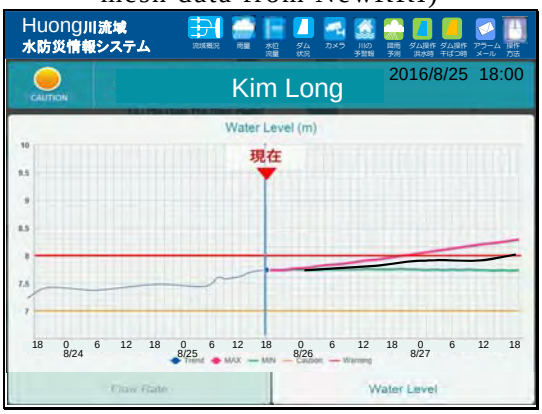


[12] Map showing country-wide rainfall forecast (GPV data for 50 km mesh)



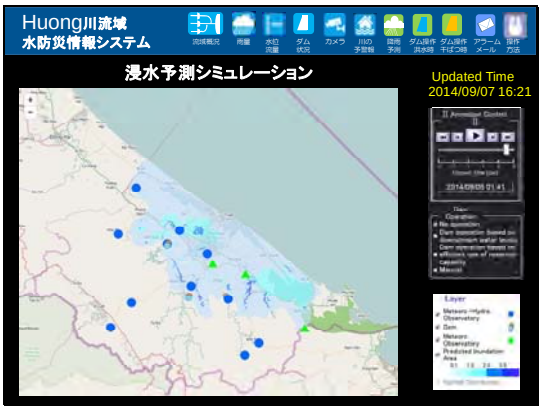
[13] Map showing rainfall forecast for the area around the basin of Huong River (5 km mesh data from NewRRI)

[14] Image showing basin-wide forecast of river water level, flow volume and state of dams



[15] River water level at each observation spot (actual and predicted forecast)

[16] River flow volume at each observation spot (actual and predicted forecast)



[17] Inundation forecast map

3)Assistance for operation of each dam based on dam reservoir operation rules in accordance with the Prime Minister's decision

- Capability to decide outflow volume of each dam based on the situation of downstream reference points
- Capability to decide the timing for starting preliminary discharge and discharge volumes for the two power generating dams
- Capability to decide the prospects of recovery of reservoirs after floods (effective operation for securing power generation volume and drought countermeasures)
- Capability to study effective medium to long-term reservoir operation as a countermeasure for droughts

【Display Screens】(Bracketed numbers denote screen numbers)

[18] Study of proposals for optimal dam operation (proposals for the timing for starting preliminary discharge and discharge volumes, water level, water level and water volume in dam reservoirs in each case: graphs, values)

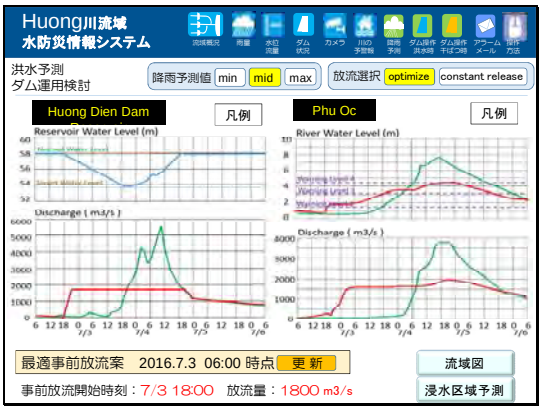
[19] Image showing basin-wide forecast of river water level, flow volume and state of dams after dam operation

[20] River water level at each observation spot after dam operation (actual and predicted forecast)

[21] River flow volume at each observation spot after dam operation (actual and predicted forecast)

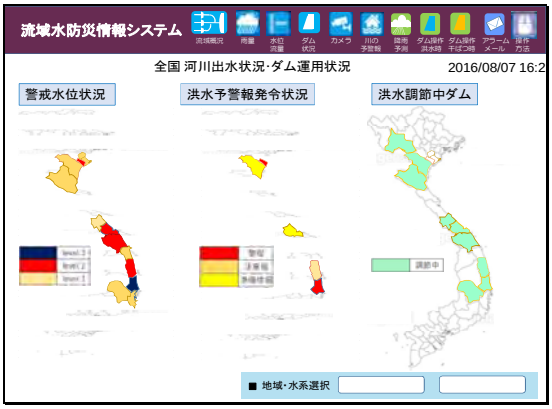
[22] Inundation forecast map after dam operation

[23] Image showing forecast for droughts due to rainfall and water use situation (yearly changes in reservoir water levels and volumes during past droughts and future simulations: graph, tabular data)

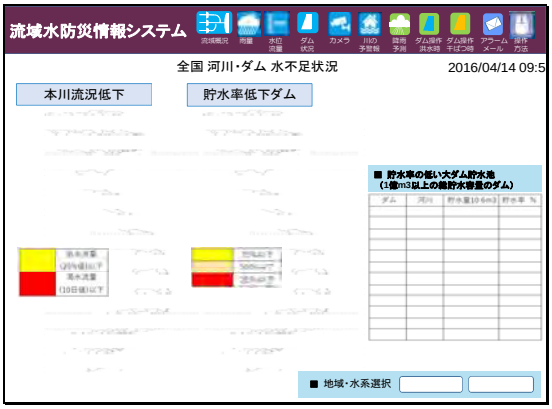


[18]Study of proposals for optimal dam operation (proposals for the timing for starting preliminary discharge and discharge volumes, water level, water level and water volume in dam reservoirs in each case: graphs, values)

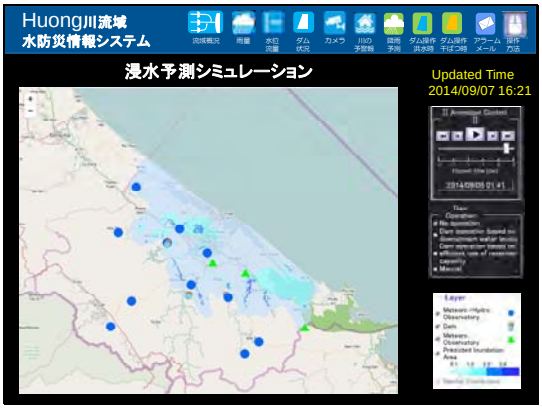
[19] Image showing basin-wide forecast of river water level, flow volume and state of dams after dam operation



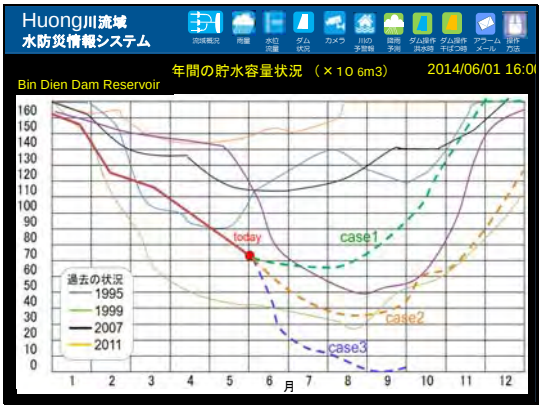
[20] River water level at each observation spot after dam operation (actual and predicted forecast)



[21] River flow volume at each observation spot after dam operation (actual and predicted forecast)



[22] Inundation forecast map after dam operation



[23] Image showing forecast for droughts due to rainfall and water use situation (yearly changes in reservoir water levels and volumes during past droughts and future simulations: graph, tabular data)

4) Others

・Make a screen to determine country-wide situation to prepare for a country-wide information system in the future

・The screen showing information such as the state of the river and warnings issued will also provide information to residents through the Internet

・Notify residents about caution level of river water and warnings using alarm e-mails

・Make a management function screen for the system

・Display status when data is missing and during system inspection or failure etc.

Design the display screen menu in accordance with the needs of individual users receiving the information so that each user finds the information easy to understand and use.

PCC-NDPCSR (Hue)	Information station performing over all system management including all information display related to Huong river, display for equipment operation and display for information dissemination to residents (vis public website and alarm mail)
Each dam management office	Display information necessary for dam operation
CSC-NDPC (Hanoi)	Display all information related to Huong river and for grasping situation all over Vietnam
Residents	(public Web) Display information to grasp overall situation of Huong river basin (E-mail)river water level exceeding caution values, status of warnings issued, etc.

Observed hydrological data including rainfall and water level will be mutually shared with NHMS and local HMC via Internet dedicated line. And displayed information in the system will be delivered via Internet to NHMS, local HMC and VAWR.

(4) Flow of data and information in the water related disaster management information system

In order to show the above mentioned screen display, the flow of data and information in the water related disaster management information system, as shown in the following figure, includes collection, analysis and transmission function.

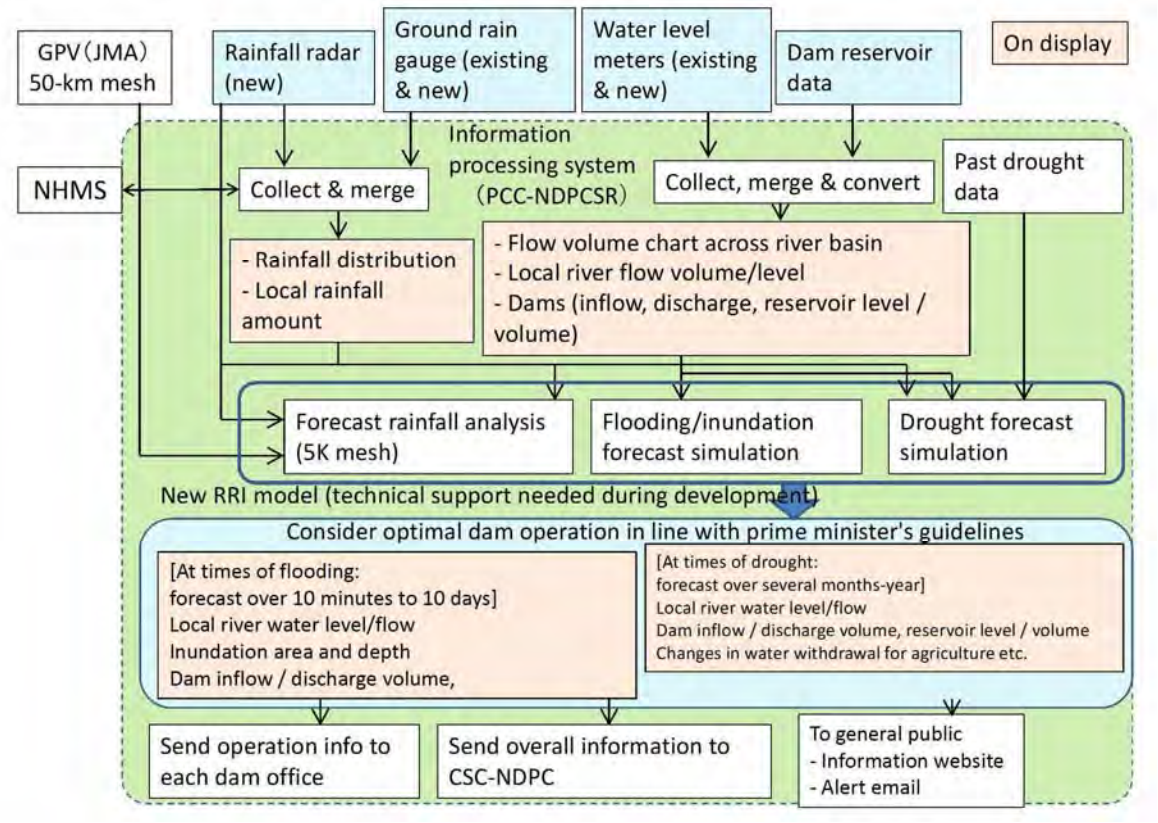


Fig. 2-20 Flow of data and information in the water related disaster management information system

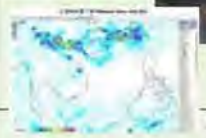
The software functions required in the water related disaster management information system can be divided into two groups: A) basic system functions such as online acquisition and processing of telemetry and other data, display of data on screen, transmission of information and management of the system operation status; and B) functions that carry out rainfall forecasting, conversion from rainfall to the volume of runoff into rivers, inundation forecasting for downstream lowlands, forecasting of reservoir water volume and the flow volume and water level of rivers downstream. following table shows the list (outline) of functions required in the water related disaster management information system.

“NewRRI”, in the figure above, refers to a system based on the RRI model software developed by Japan’s Public Works Research Institute to analyse rainfall-

runoff and flood inundation simultaneously. NewRRI applies a 5km mesh predicted rainfall calculations scheme to the RRI model for making continuous realtime simulated calculations, such as predicted rainfall, predicted runoff and predicted floods.

As far as transmitting information to residents is concerned, initially there was a request for setting up an information display board such as a digital signage, but during local survey in Vietnam, the country expressed its wish for a system that uses cellphones and smartphones, which are becoming widespread among residents as a means of information transmission. It has been decided to change the information transmission system accordingly.

Table 2-15. List of functions of water related disaster management information system

Category	Description	Main displays
Water related disaster prevention manegement system		
a) Measurement data acquisition & display functions		
Hydrological data	Collects and stores actual ground rainfall, radar rainfall, river level and dam reservoir measurement data real time through newly built network (telemetry etc.) and displays in various forms (schematics, time series graphs, tables, etc.).	
CCTV images	Displays CCTV images from CCTV installation points.	
b) Forecast data acquisition & display functions		
Rainfall forecast (initial)	Retrieves and stores Japan Meteorological Agency's GPV (grid point value) forecast data for Vietnam and surrounding areas based on global spectral model via Internet, and displays as 2D chart.	
Rainfall forecast (analysis result)	Displays rainfall forecast (5-km grid) analyzed by the rainfall forecast analysis function of the new RRI model in various forms (2D distribution chart, time series graphs with measurement data, tables, etc.).	
Water level/volume/optimal discharge volume forecast	Can display river level/flow volume and dam data (inflow volume, reservoir level/volume) analyzed by the flooding/inundation forecast analysis function of the new RRI model. For dam discharge information, when optimal discharge operation is carried out in line with prime minister's guidelines, timing and volume of preliminary discharge are displayed.	
Inundation area forecast	Displays flood area forecast analyzed by the flooding/inundation forecast analysis function of the new RRI model (includes specified time and animated image).	
Long-term reservoir volume forecast result	Displays dam reservoir volume and flow volume at downstream reference points analyzed by the flooding/inundation forecast analysis function of the new RRI model as time series graphs.	
c) Information transmission transmission functions		
Information to dam administrators	If giving instructions to dams based on the forecast, instructions on discharge and text to use for dam discharge alerts are selected, entered and sent to the dams.	

	Information for public	If water level is expected to exceed the alert trigger level set at each observation point, an alert text is selected, entered and sent to pre-registered email addresses.	
d) National information display functions: system for MARD			
	Reference water level breach status	Displays on the map the rivers where the water level has or is expected (forecast) to exceed the reference water level.	
	Alert status	Shows the rivers that have active alerts on the map.	
	Reservoir volume level	Displays current reservoir levels on the map using color-coding.	
e) Operation status check function			
	Operation status monitor	Shows the operation status of each piece of equipment, data reception status, etc.	
f) Forecast simulation functions (new RRI model)			
	Forecast rainfall analysis	Rainfall is forecast using the cloud resolving storm simulator (CReSS) numerical model (which can analyze the development of cumulonimbus clouds based on topography and land use) with GPV data (rainfall forecast, 50-km grid) as the boundary condition, and further divided into 5-km grid rainfall forecast. The forecast results are presented according to three settings based on accuracy and probability: minimum, median and maximum.	—
	Flooding/inundation forecast simulation	Calculates Hương River basin runoff using rainfall measurements (radar/ground) and computes the expected volume/level at each observation point, inflow/discharge volumes of dam reservoirs and inundation volume and area in downstream lowlands. Discharge volume is defined under two scenarios: without flood adjustments (case 1: constant discharge for power generation) and discharge in line with prime minister's guidelines (case 2: optimal discharge). In case 2, the start time for the preliminary discharge and the discharge volume that will achieve the maximum flood alleviation effect (prevent downstream inundation) is calculated.	—
	Drought forecast simulation	Past rainfall and reservoir volume data (daily) is accumulated, and dam inflow, reservoir volume / level and the flow volume at water level observation points that serve as downstream reference points are calculated. Three rainfall patterns are used: maximum (case 1), average (case 2) and minimum (case 3).	—

(5) System Configuration

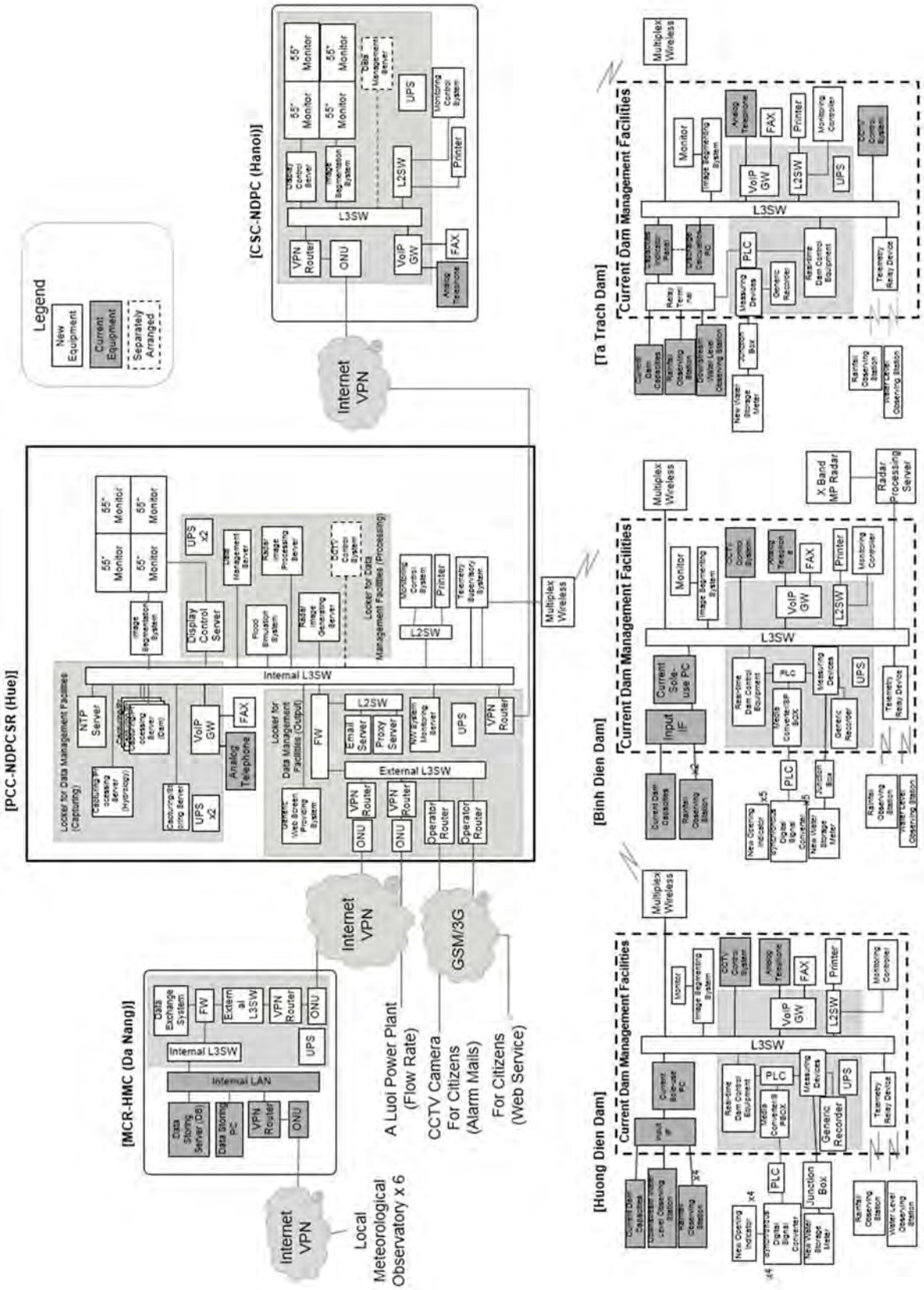


Fig. 2-21. System Structure

(6) Requirements for the Hue PCC-NDPCSR operations room

The operations room needs to fulfill the following requirements, and there are plans for it to be placed on the 3rd floor of the new building at Hue PCC-NDPCSR.

1) The following uses are assumed for the main room that will hold display equipment and operation equipment, so a location and size appropriate for these uses is necessary.
   - Disaster management office for the occurrence disasters such as heavy rains, floods, and inundation damage (where related parties such as executives, etc. gather to make decisions and issue commands on dam operation instructions, flood control mobilization, issuing advance warnings, etc.)
   - Operations office for responding to disasters that don't reach the scale above (where several staff members are stationed to conduct dam operation and advance warning issuing related work as required)
   - Meetings while observing the status of basin river and dams
   - Data confirmation and data gathering work during normal times
2) Operation room should have enough space for storing equipment of the system for collecting, analyzing and displaying data; delivering necessary information to the offices of 3 dams and MARD CSC-NDPC and also to residents in the basin.
3) It is necessary to secure a room for power supply related equipment that serves as a heat source and a dedicated room for server and communication equipment that require a low temperature.

(7) Equipment details and operations room layout in Hue PCC-NDPCSR

A 16 screen (55 inches x 4) multi-display will be installed in the main room as display equipment that allows various information on rivers and dams in the basin to be seen on multiple screens simultaneously at a glance is required.

Five terminal devices will be installed for individual screen display, information processing equipment operations, etc.

A free layout will be used for chairs and desk so that they can be placed as needed depending on the use.

Small rooms including an isolated power supply room and server/communication equipment room will be established, in which the related equipment will be installed.

A communication antenna will be installed on the PCC-NDPCSR premises for data reception from radar and each hydrological observation station, etc., and data transmission with each dam. (See Fig. 2-14(7) Radio base station (T7))

(8) Layout of the system setting in 3 dam management offices and CSC-NDPC (Hanoi)

In each dam management office, the system equipment is to be located in the existing operation room for managing dam and the power station, in order to utilize the system integrally with other operation.

In CSC-NDPC, the system equipment is to be located in the operation room with existing equipment for disaster management, in order to utilize the system integrally. Networking facility is also to be prepared to be able to get the information in other meeting room and work room.

Table 2-16 Equipment to be Procured

Equipment No.	Component No.	Equipment name	Unit	Body Quantity	Backup Quantity	Total
6	01	55” Monitor (4-panel)	Units	2		2
	02	Large Display System	Units	3		3
	03	Screen Split System	Units	11		11
	04	Display Control Server	Units	2		2
	05	Display Controlling Software	Units	2		2
	06	Monitoring Controller	Units	15		15
	07	Cell Phone Monitoring System	Units	4		4
	08	Printer	Units	5		5
	09	FAX	Units	5		5
	10	Locker for Data Management Facilities (Capturing)	Units	6		6
	11	Capturing/Processing Server (for Hydrological Observation Data)	Units	1		1
	12	Capturing/Processing Software (for Hydrological Observation Data)	Units	1		1
	13	Capturing/Processing Server (for Dam)	Units	3		3
	14	Capturing/Processing Software (for Dam)	Sets	1		1
	15	Capturing/Storing Server (DB)	Units	1		1
	16	Capturing/Storing Software (DB)	Units	1		1
	17	Locker for Data Management Facilities (Processing)	Units	1		1
	18	Data Management Server	Units	1		1
	19	Data Management Software	Units	1		1
	20	Flood Simulation Device	Units	1		1
	21	Locker for Data Management Facilities (Output)	Units	2		2
	22	General Web Page Service Equipment	Units	1		1
	23	Web Page Service Processing Software	Units	1		1
	24	Email Server	Units	1		1
	25	Emailing Software	Sets	1		1
	26	Proxy Server	Units	1		1
	27	Proxy Software	Units	1		1
	28	NTP Server	Units	1		1
	29	GPS Antenna	Units	1		1
	30	Network System Monitoring Server	Units	1		1
	31	Monitoring Software	Units	1		1
	32	Real-time Dam Control Equipment	Units	3		3
	33	Junction Box	Units	6		6
	34	DC Power Supply Unit (12V)	Units	3		3

	35	Battery	Units	3		3
	36	Optical Transmission Equipment	Units	24		24
	37	Lightning Resistant Transformer	Units	8		8
	38	Optical Termination Box	Units	11		11
	39	Outdoor Storing Case	Units	8		8
	40	Data Exchange Equipment	Units	1		1
	41	Data Exchanging Software	Units	1		1
	42	External L3 Switch	Units	5		5
	43	55” Monitor (4-panel)	Units	2		2
	44	Large Display System	Units	3		3
	45	Screen Split System	Units	11		11
	46	Display Control Server	Units	2		2
	47	Display Controlling Software	Units	2		2
	48	Monitoring Controller	Units	15		15
	49	Cell Phone Monitoring System	Units	4		4
	50	Printer	Units	5		5
	51	FAX	Units	5		5
	52	Locker for Data Management Facilities (Capturing)	Units	6		6
	53	Capturing/Processing Server (for Hydrological Observation Data)	Units	1		1
	54	Capturing/Processing Software (for Hydrological Observation Data)	Units	1		1
	55	Capturing/Processing Server (for Dam)	Units	3		3
	56	Capturing/Processing Software (for Dam)	Sets	1		1
	57	Capturing/Storing Server (DB)	Units	1		1
	58	Capturing/Storing Software (DB)	Units		0	1
	59	Locker for Data Management Facilities (Processing)	Units		0	1
	60	Data Management Server	Units		0	1
	61	Data Management Software	Units		0	1
	62	Flood Simulation Device	Units		0	1
	63	Locker for Data Management Facilities (Output)	Units		0	2
	64	General Web Page Service Equipment	Units		0	1
	65	Web Page Service Processing Software	Units		0	1
	66	Email Server	Units		0	1
	67	Emailing Software	Sets		0	1
	68	Proxy Server	Units		0	1
	69	Proxy Software	Units		0	1
	70	NTP Server	Units		0	1
	71	GPS Antenna	Units		0	1
	72	Network System Monitoring Server	Units		0	1
	73	Monitoring Software	Units		0	1
	74	Real-time Dam Control Equipment	Units		0	3
	75	Junction Box	Units		0	6
	76	DC Power Supply Unit (12V)	Units		0	3
	77	Battery	Units		0	3
	78	Optical Transmission Equipment	Units		0	24
	79	Lightning Resistant Transformer	Units		0	8
	80	Optical Termination box	Units		0	11
	81	Outdoor Storing Case	Units		0	8
	82	Data Exchange Equipment	Units		0	1
	83	Data Exchanging Software	Units		0	1
	84	External L3 Switch	Units		0	5

2-2-2-8 Equipment performance guarantee

Ground rain gauges and water level gauges that have passed plant inspection shall be installed at the sites and on-site adjustments and test-runs shall be conducted to confirm that the guages meet the requested performance conditions. Moreover, the water level gauges sensor should meet the Vietnamese standard. Plant inspections and test-runs shall be conducted for X-band radar rain gauges, transmission networks and the water related disaster management information system (including display contents and operating procedure) also to confirm that they meet the requested performance conditions.

Handover of instruments is to be done after confirming through plant inspections and on-site test-runs that the instruments meet the requested performance conditions. The tender and specifications document shall contain the description of the requested performance conditions and guarantee for equipment and materials, including the water related disaster management information system.

Performance guarantee will be provided for each equipment separately and not for their comprehensive performance when used in combination. Furthermore, for the following reasons, no guarantee can be provided for the accuracy of observation data gathered using data collection equipment and information provided through the water related disaster management information system.

1) The accuracy of observation data gathered using data collection equipment depends on the method of use and maintenance management of the equipment by the users.
2) Although it has been decided that GPV data (prepared using observation data shared internationally through the WMO framework and Japan Meteorological Agency's Global Spectral Model) provided by the Meteorological Agency will be inputted in the water related disaster management information system until rainfall values predicted by NHMS can be used, the accuracy of such GPV data cannot be guaranteed.

   To prevent misunderstandings and ensure correct usage, the water related disaster management information system will display an anticipated margin of error in the predicted values of the river's flow volume and water level. Furthermore, other information provided by the system, such as prediction of inundation areas, will depend on the accuracy of observation data gathered using data collection equipment.

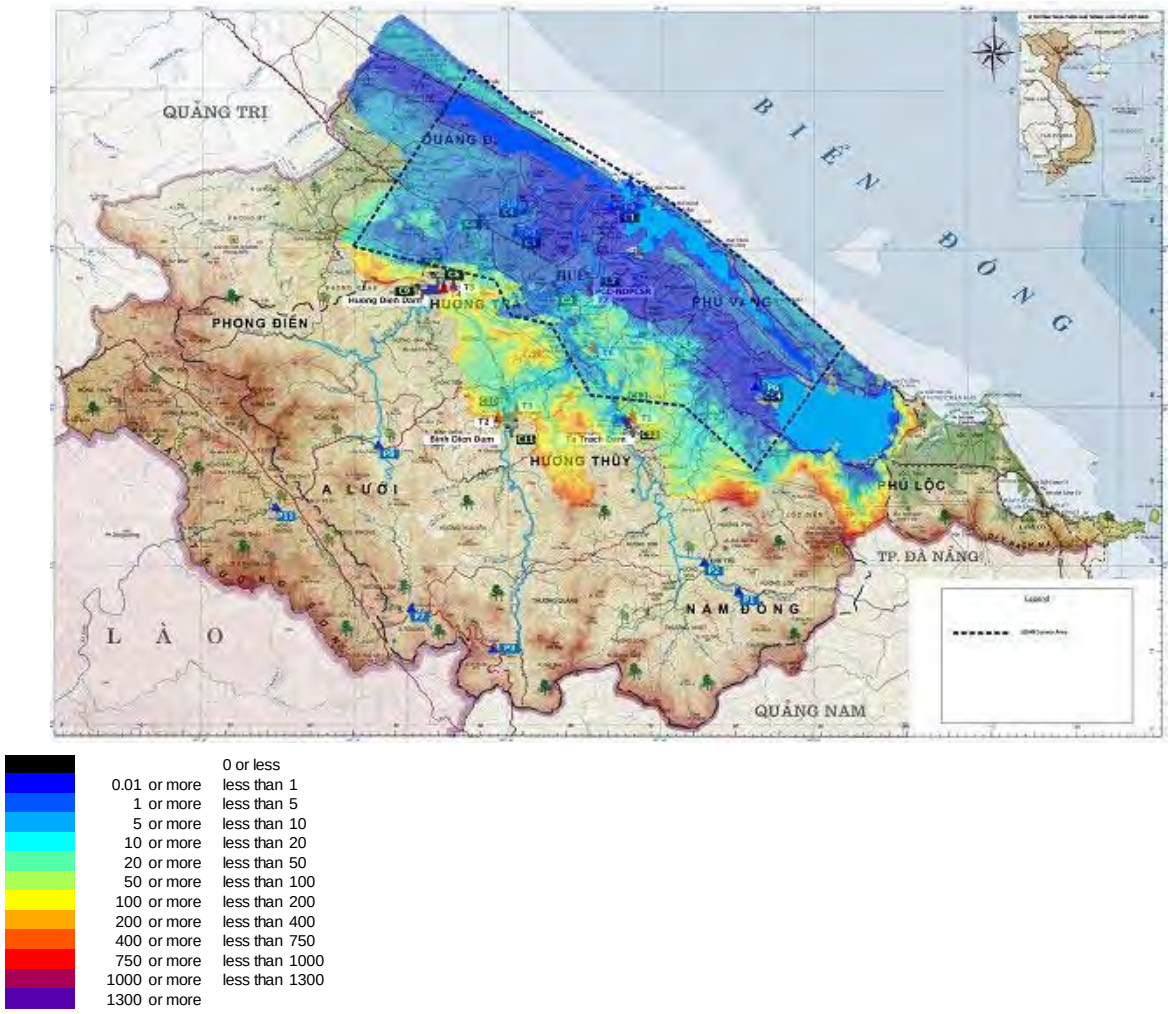
2-2-2-9 LiDAR Survey

(1) Objective

In order to ensure the higher precision of flood forecast simulations that are run using the Comprehensive Disaster Management Information System, we perform Aerial Laser measurements.

Most cities and farms in Hue Province (the district to be measured) are at lowland areas of 5m or lower. Slight variations in altitude have impact on flooding areas and flood depths. Without precise topographical data for performing flood forecast simulations, therefore, it will be impossible to evaluate the appropriateness of evacuation guidance, resulting in a significant problem to disaster management. Although Vietnam has DEM data by means of aerial photogrammetry, the accuracy of altitude measured by aerial photogrammetry is questionable due to discrepancies of several meters that are caused by vegetation, thereby making it difficult for them to perform detailed simulations.

In order to obtain topographical data for high-precision flood forecast simulations, we make LiDAR Survey with the accuracy at an altitude of 20 meters or lower.



* Blue dot-line: Scope of LiDAR-based Measurement

Fig. 2-22 Scope of LiDAR Measurement and Altitudes of In-Scope Areas

(2) In-Scope Tasks

- Hue and its periphery (Vietnam)
- Area measured by aerial photogrammetry: 1000km^2 (Green-framed)
- Rivers subject to lateral profiles: 123.57km (Red-framed)

Fig. 2-23 Scope of Measurement

(3) Descriptions of Tasks

To obtain topographic data of the area within the scope of our tasks, using an aircraft loaded with an aerial laser measurement system; To specify the density range of a scanner so that more than one laser point is applied to each mesh of 2.0m×2.0m; To analyze measured data using GPS/IMU and filter them before using them for creating digital elevation models (DEMs) of ground elevations; To use data from DEMs to create data for river cross profiles; and To perform aerial laser measurements with special attention to safety and health of workers as well as safe operation of aircrafts.

1) Measurement Plan

A measurement plan will be developed so as to cover the entire scope of work and support all the scan density ranges. This project will use an airborne laser scanner (commercial specs are acceptable) that can ensure the height accuracy of 20cm or less (standard deviation). Any approval procedures within Vietnam that require the contractor to be the main applicant must be completed by the contractor. The contractor will provide all data necessary for the Vietnamese side to complete their required approval procedures. The contractor will also respond to any censorship required for their photographed measurement values.

2) Collocations/Observations of GPS Reference Stations on the Ground

For the observation points of the GPS reference stations on the ground, collocations will be performed so as to keep the observation reference line within 50km of the area in scope. For observation, dual-frequency GPS equipment designed for measurement is used to conduct GPS observations every one second. During observations, the number of GPS satellites and data on such satellite locations will be taken into consideration.

3) Collocation and Observation of Calibration Reference Points

Calibration reference points designed to check and adjust 3D measurement data will be selected for collocation and observation. Such collocation/observation points should be at flat locations free of obstructions such as trees or walkway steps. The score is, in principle, determined by dividing the work area (km^2) by 25, and adding 1 to the divided value.

4) Aerial Laser Measurement

To obtain topographic data of the area within the scope of this project, an aircraft equipped with a camera for aerial laser measurement is used. The density range of a scanner is specified to allow for the application of more than one laser point to each mesh of 2.0m×2.0m.

5) 3D Measurement Data Processing

Both data from the aerial laser measurement system and data from each GPS reference points on the ground are integrated and analyzed to create 3D coordinate data on each measurement point. The created 3D measurement data are checked for any missing measurement or irregular value, and calibrated between the measurement courses. Any noise is removed from the data.

6) Creation of Original Data

To create original data, the results of the calibration reference points are extracted from the 3D measurement data, and then examined/calibrated. If any absolute value of the average discrepancy between a calibration reference point and the 3D measurement data is found to be 25cm or more during the examination, the whole data for the relevant area will be corrected.

Results of such examinations and calibrations are submitted in the form of an interim report.

7) Creation of Ground Data

3D data on the measured ground surfaces are created by filtering the original data. The processed data are examined to ensure the data on ground surfaces are correctly segmented by the filtering process.

8) Creation of Digital Elevation Model (DEM)

To create elevation grid data (DEM) of 2m grids, ground data are processed by means of interpolation calculation.

9) Digital Aerial Photography and Creation of Simple Ortho-photo

Basically, a digital camera attached to the aerial laser measurement system is used for aerial photography, the digital images of which are used for producing simple ortho-photos. The pixel resolution should be 40cm or more on the ground, in principle.

10) Creation of River Cross Profile

For the rivers (123.6km long in total) within the scope of the project, river cross profiles are created based on DEM data. The river lateral profile data are created in pitches of 200m. Such created river cross profiles can be loaded into any generic CAD application.

11) Creation of Deliverable Data

All the created data are subjected to logic testing and checked for precision/quality, before being converted to generic formats coordinated with the requirement of the system. Such data are then combined with viewers to allow for data browsing, and stored in digital media for delivery.

■ Quantity of LiDAR Measurements

No.	Type	Unit	Quantity	Remarks
A	Area Measured by Aerial Photogrammetry	km^2	1000	Green-framed in Fig.2-23 Laser Scanning Density (1 point per 2.0 x 2.0m)
B	Rivers subject to Cross Profiles	km	123.6	Red-framed in Fig.2-23
C	Distance Measured	km	2,874	Blue-lined distance in Fig.2-24
D	Measurement Course	km	127	Blue-lines in Fig.2-24
E	Calibration Reference Points	# of Points	41	$1000km^2/25km^2+1$ * As per red circles in Fig.2-24
F	Collocations/Observations of GPS Reference Stations	# of Points	1	

■ Flight Hours *

No.	Type	Unit	Quantity	Remarks *
G	Distance between the Base (Phu Bai) and the Photo Location (Hue)	km	50	
H	Measuring Speed	km/h	200	
I	Round Flight Speed	km/h	250	
(1)	Air Transportation Hours	km	0	
(2)	Round Trip Time (Measurement Base - Target Area)	h	7	(2)' × (8)
(2)'	One Round Trip Time (Measurement Base - Target Area)	h	0.7	(G / I) + Takeoff Time (0.5h)
(3)	Real Measurement Time	h	14.37	C Distance Measured / H Measuring Speed
(4)	Drift Measuring Time	h	3	0.3h/round × (8)
(4)'	Drift Measuring Time per Session	h	0.3	0.3h for regional measurements
(5)	Course Entry Time	h	19.05	(0.15h per course) × # of courses
(6)	Supplementary Measurement Time Frame	h	13.03	((2)+(3)+(4)+(5)) × 30.0%
(7)	Preliminary Flight Hours	h	7	(2)×100.0%
(8)	# of Measurements	Number	10	((3)+(5)) / (4.5-(2)'-(4)')
	Net Flight Hours for Measurements	h	47.35	((3)+(4)+(5)) × 1.3
(9)	Total Flight Hours	h	63.45	(1)+(2)+(3)+(4)+(5)+(6)+(7)
(10)	Days Retained	Days	70.00	(8) × 7 days

■Quantity of Data Created

No.	Type	Unit	Quantity	Remarks
	Creation of 3D Measurement Data and Original Data	km^2	1000	Same as A.
	Creation of Ground Data	km^2	1000	Same as A.
	Creation of Digital Elevation Model (DEM)	km^2	1000	Same as A.
	Creation of Deliverable Data	Region	1	
	Creation of River Cross Profiles	Profile	618	B(123.6km) / 200m

* As per the Estimation Standards for Design Work, etc. of MLIT (2016)

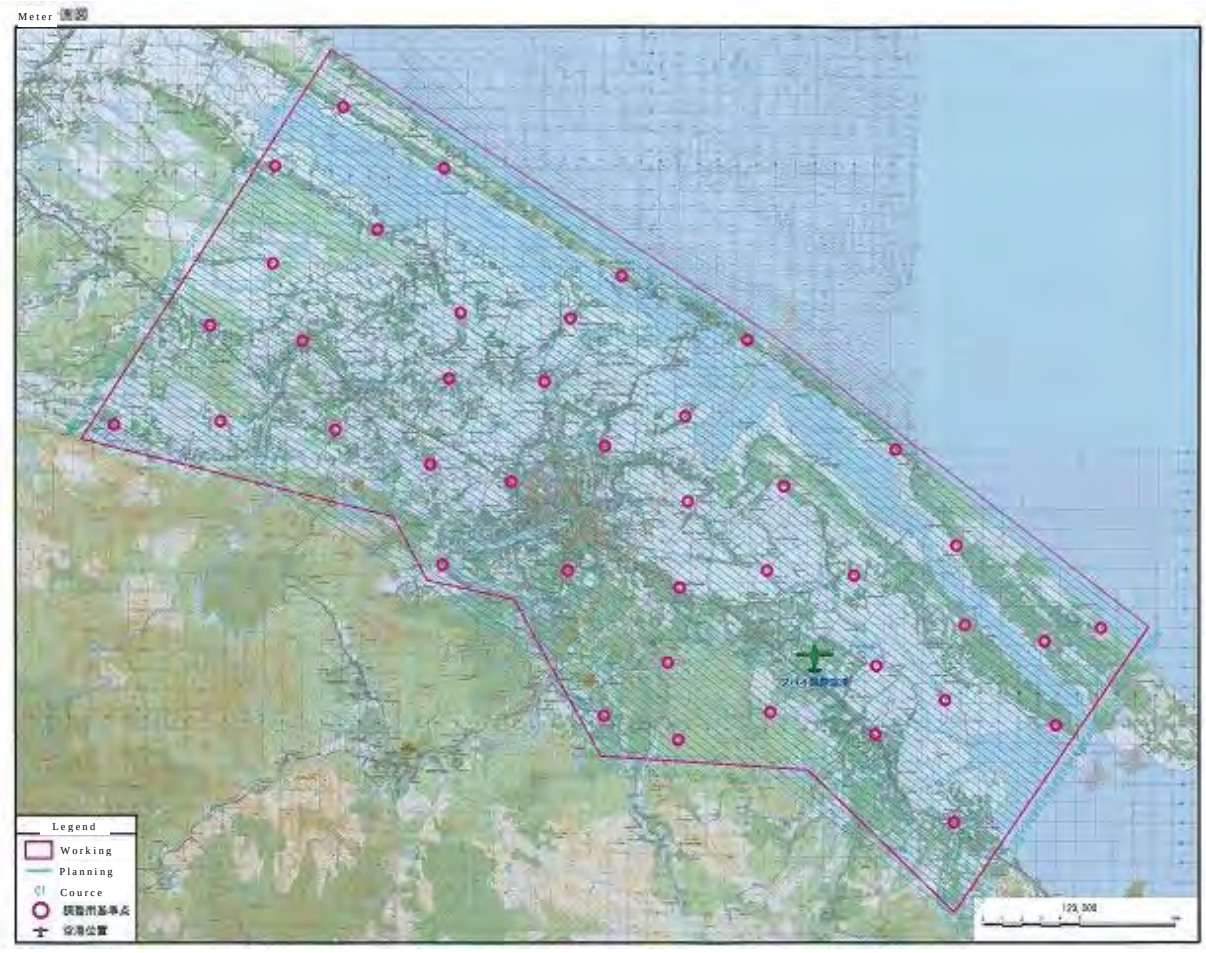


Fig. 2-24 Measurement Courses and Calibration Reference Points

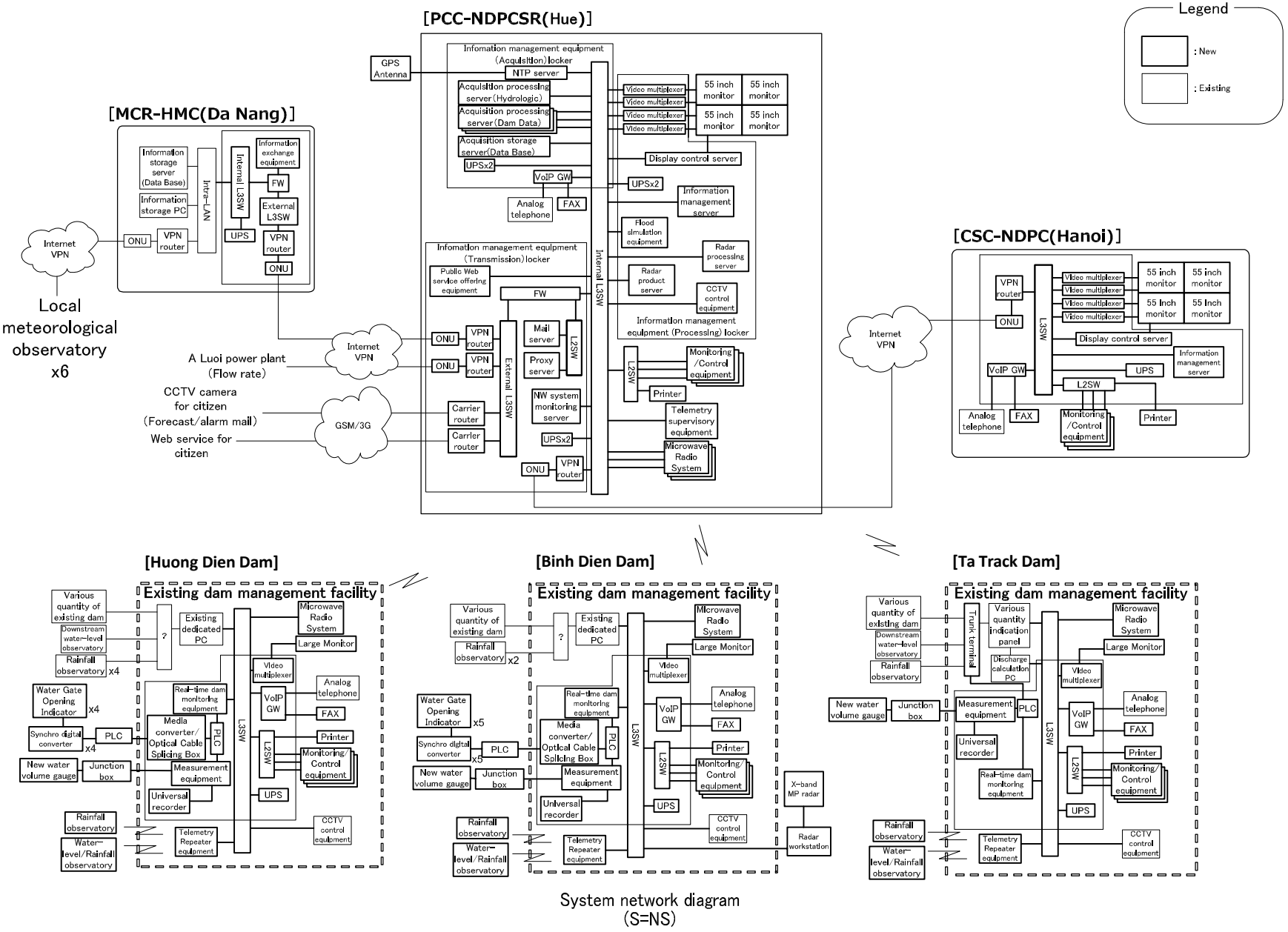
(4) Duration of Project Tasks

This project is expected to require approximately 14 months.

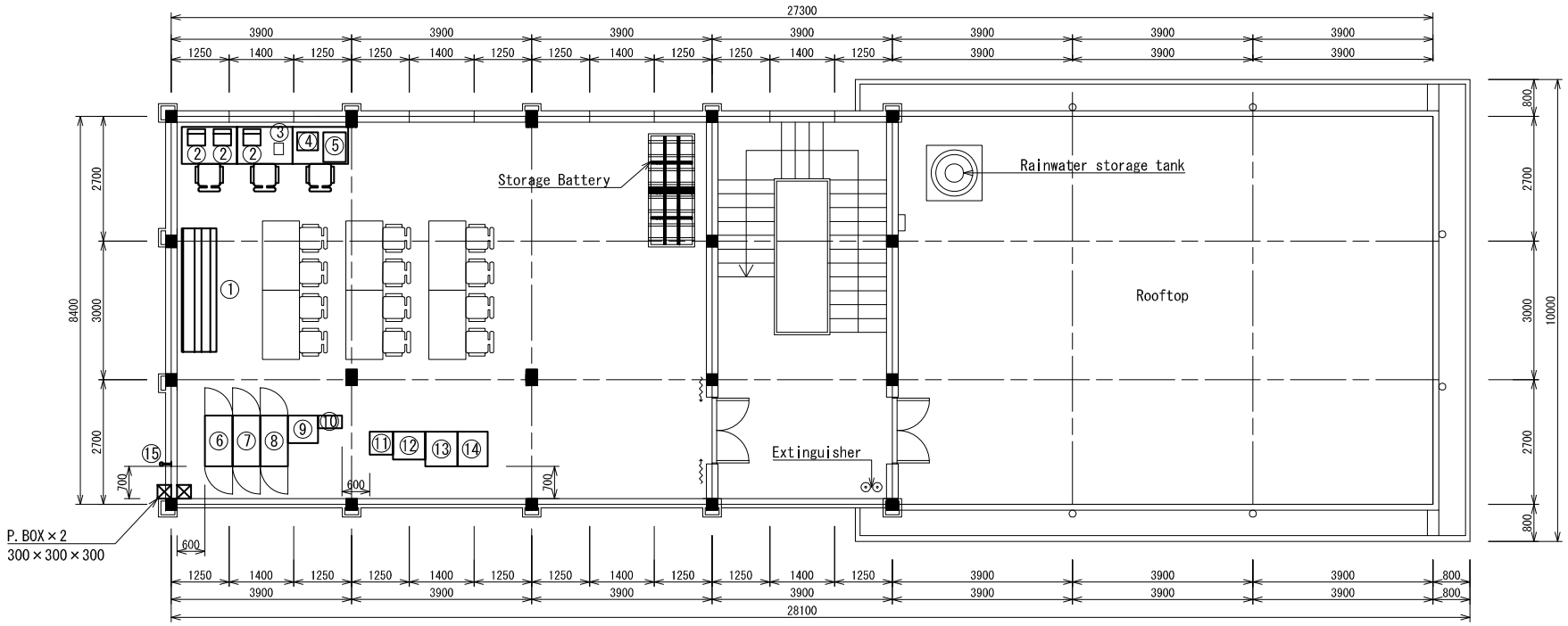
2-2-3 Outline Design Drawing

Table of Drawings

Drawing No.	Title
I-1	System network diagram
I-2	PCC-NDPCSR 3-floor plan view
I-3	PCC-NDPCSR Wiring diagram
I-4	CSC-NDPC 1-floor plan view
I-5	CSC-NDPC Wiring diagram
I-6	Huong Dien Dam Control post 2-floor plan view
I-7	Huong Dien Dam Wiring diagram
I-8	Binh Dien Dam Control post 1-floor plan view
I-9	Binh Dien Dam Wiring diagram
I-10	Ta Trach Dam Control post 1-floor plan view
I-11	Ta Trach Dam Wiring diagram
I-12	Danag HMC Wiring diagram
M-1	Project location
M-2	Station location
M-3	PCC-NDPCSR T7 Site layout and elevation
M-4	PCC-NDPCSR T7 Equipment layout
M-5	PCC-NDPCSR T7 Wiring diagram
M-6	Huong Dien Dam T4 Site layout and elevation
M-7	Huong Dien Dam T4 Equipment layout
M-8	Huong Dien Dam T4 Wiring diagram
M-9	Huong Dien Dam T4 Water level gage and gate opening indicator
M-10	Huong Dien Dam Passive repeater station T5 Site layout , elevation and wiring diagram
M-11	Binh Dien Dam T2 Site layout and elevation
M-12	Binh Dien DAM T2 Equipment layout
M-13	Binh Dien DAM T2 Wiring diagram
M-14	Binh Dien DAM T2 Water level gage and gate opening indicator
M-15	Binh Dien DAM Passive repeater station T3 Site layout , elevation and wiring diagram
M-16	Ta Trach DAM T1 Site layout and elevation
M-17	Ta Trach DAM T1 Equipment layout
M-18	Ta Trach DAM T1 Wiring diagram
M-19	Ta Trach DAM T1 Water level gage and gate opening indicator
M-20	Repeater station T6 Site layout and elevation
M-21	Repeater station T6 Equipment layout
M-22	Repeater station T6 Wiring diagram
M-23	P1 Thuong Lo Rain gauging station Site layout and arrow view
M-24	P1 Thuong Lo Rain gauging station Equipment layout and wiring diagram
M-25	P2 Khe Tre Rain and water level gauging station Site layout and arrow view
M-26	P2 Khe Tre Rain and water level gauging station Equipment layout and wiring diagram
M-27	P3 Sao La Rain gauging station Site layout and arrow view
M-28	P3 Sao La Rain gauging station Equipment layout and wiring diagram
M-29	P4 Thao Long Rain and water level gauging station Site layout and arrow view
M-30	P4 Thao Long Rain and water level gauging station Equipment layout and wiring diagram
M-31	P5 Thuan An Rain and water level gauging station Site layout and arrow view
M-32	P5 Thuan An Rain and water level gauging station Equipment layout and wiring diagram
M-33	P6 Quan Culvert Rain and water gauging station Site layout and arrow view
M-34	P6 Quan Culvert Rain and water level gauging station Equipment layout and wiring diagram
M-35	P7 A Roang Rain gauging station Site layout and arrow view
M-36	P7 A Roang Rain gauging station Equipment layout and wiring diagram
M-37	P8 Ta Luong Rain and water gauging station Site layout and arrow view
M-38	P8 Ta Luong Rain and water level gauging station Equipment layout and wiring diagram
M-39	P9 Thanh Luong Rain and water gauging station Site layout and arrow view
M-40	P9 Thanh Luong Rain and water gauging station Equipment layout and wiring diagram
M-41	P10 Niem Pho Rain and water gauging station Site layout and arrow view
M-42	P10 Niem Pho Rain and water gauging station Equipment layout and wiring diagram
M-43	CCTV C1 Site layout and installation plan
M-44	CCTV C2 Site layout and installation plan
M-45	CCTV C3 Site layout and installation plan
M-46	CCTV C4 Site layout and installation plan
M-47	CCTV C5 Site layout and installation plan
M-48	CCTV C6 Site layout and installation plan
M-49	CCTV C7 Site layout and installation plan
M-50	CCTV C8 Site layout and installation plan
M-51	CCTV C9 Site layout and installation plan
M-52	CCTV C10 Site layout and installation plan
M-53	CCTV C11 Site layout and installation plan
M-54	CCTV C12 Site layout and installation plan
M-55	CCTV C13 Site layout and installation plan
M-56	CCTV C14 Site layout and installation plan
M-57	Water Level Gauge at Dam Huong Dien Dam
M-58	Water Level Gauge at Dam Binh Dien Dam
M-59	Water Level Gauge at Dam Ta Track Dam
M-60	Gate Opening Indicators Huong Dien Dam
M-61	Gate Opening Indicatosr Binh Dien Dam



CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	System network diagram		I-1

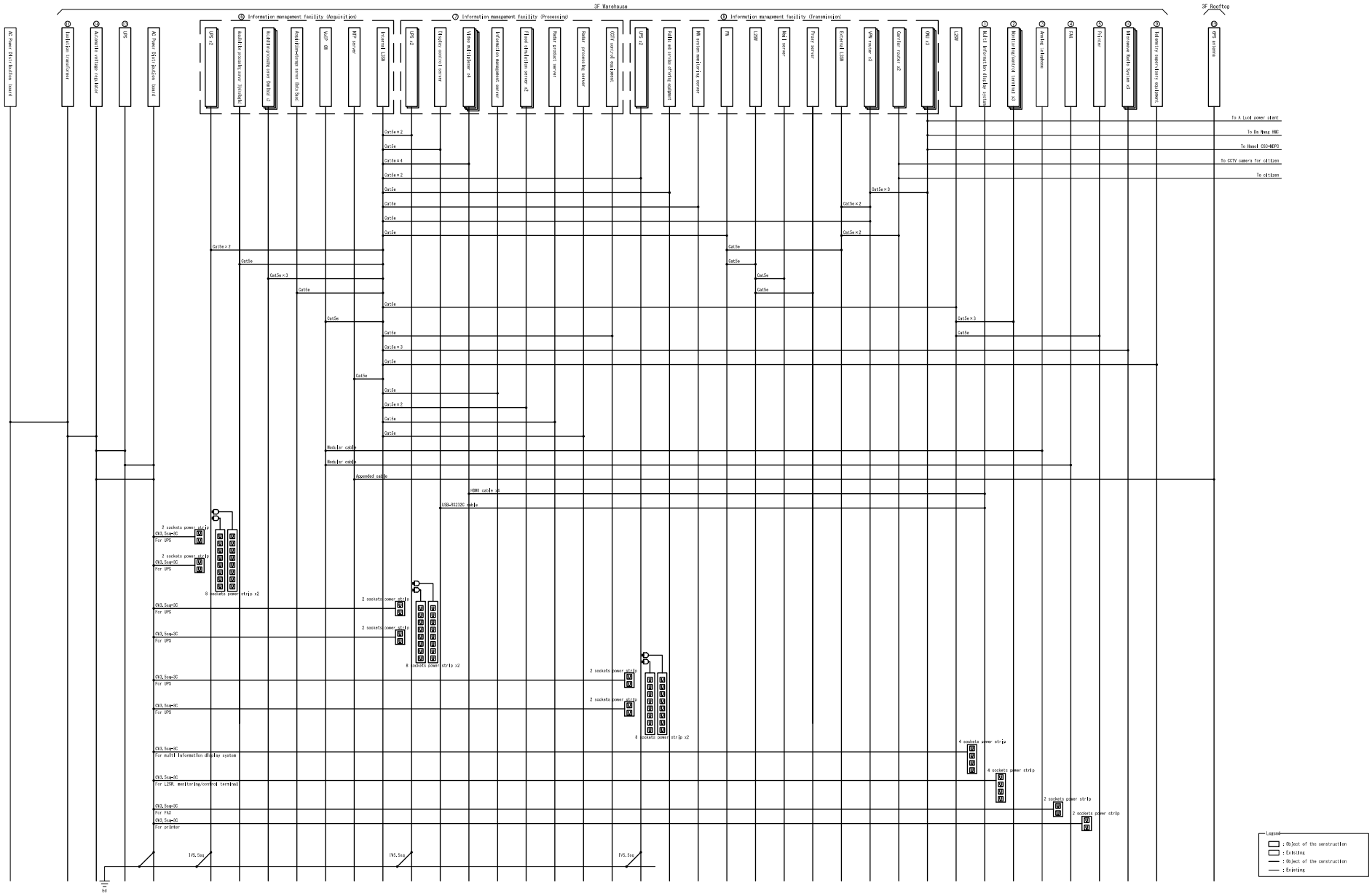


No.	Name
①	Multi Information display system
②	Monitoring/Control terminal x3
③	Analog Telephone
④	FAX
⑤	Printer
⑥	Information management equipment (Acquisition)
⑦	Information management equipment (Processing)
⑧	Information management equipment (Transmission)
⑨	Telemetry supervisory equipment
⑩	Microwave Radio System
⑪	Isolation transformer
⑫	DC power supply for radio
⑬	UPS
⑭	Automatic voltage regulator
⑮	GPS antenna

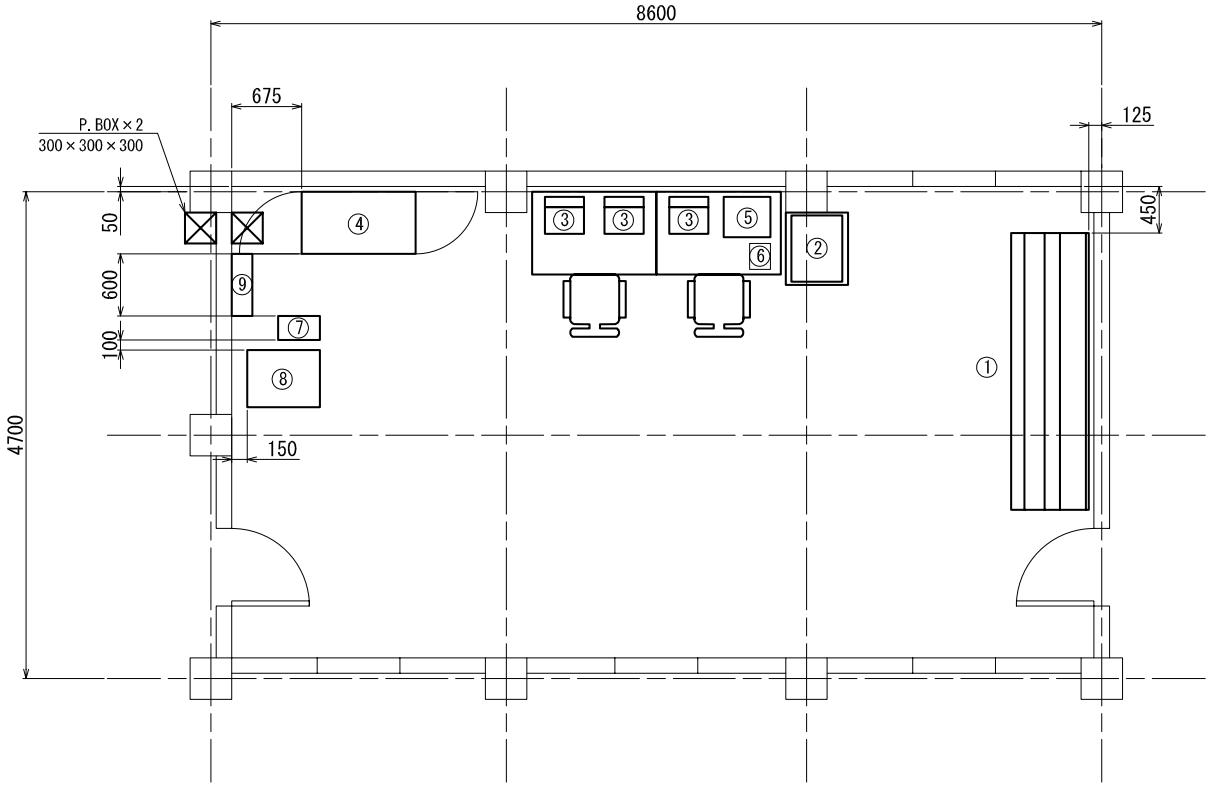
Legend
: Object of the construction
: Existing

3-floor plan view
(S=1/100)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	PCC-NDPCSR 3-floor plan view		I-2



CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	PCC-NDPCSR Wiring diagram		I-3



No.	Name
①	Multi information display system
②	Printer
③	Monitoring/Control terminal x3
④	Information management server
⑤	FAX
⑥	Analog Telephone
⑦	Isolation transformer (15kVA)
⑧	AVR (10kVA)
⑨	Power distribution board

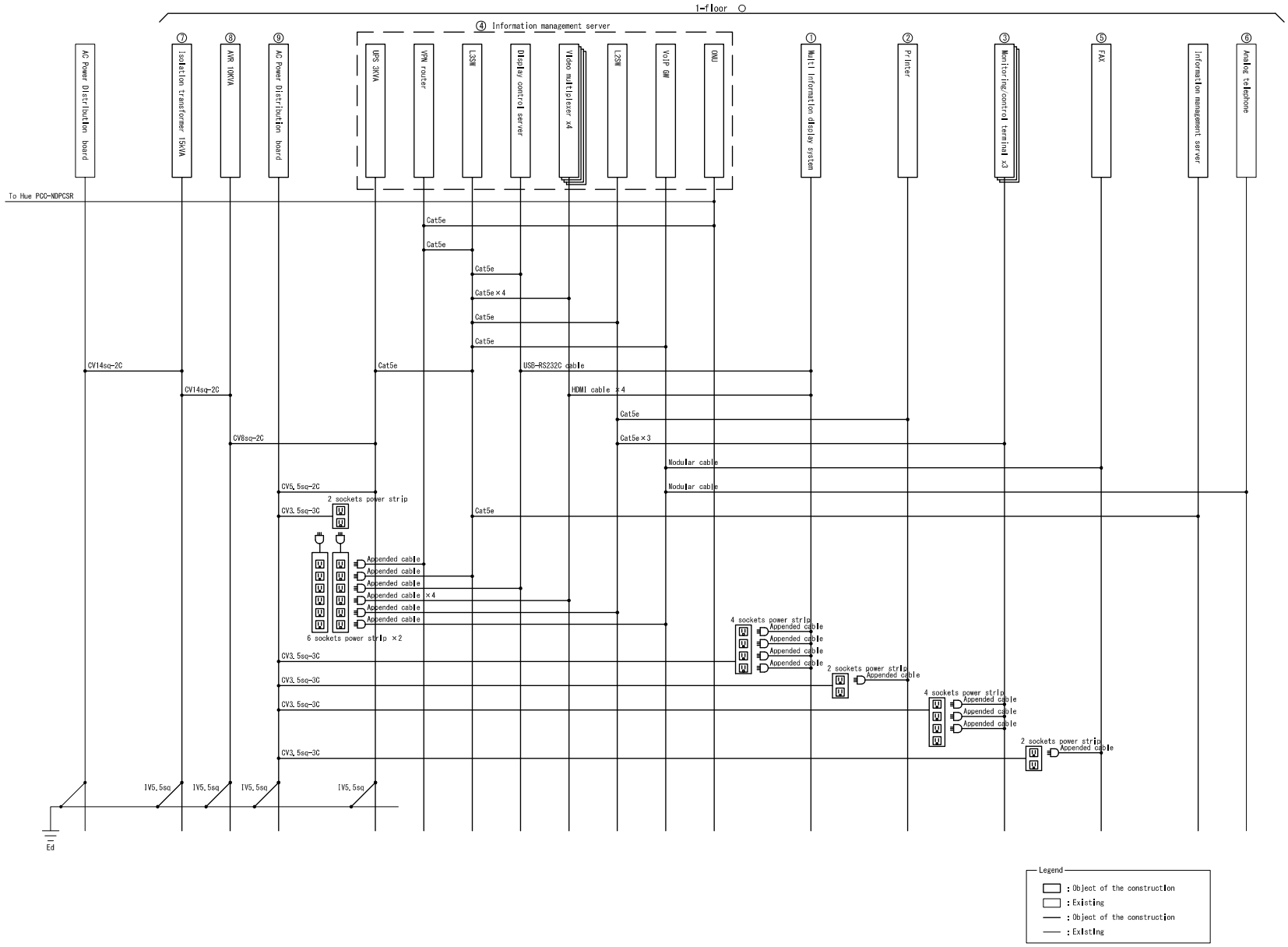
Legend

: Object of the construction

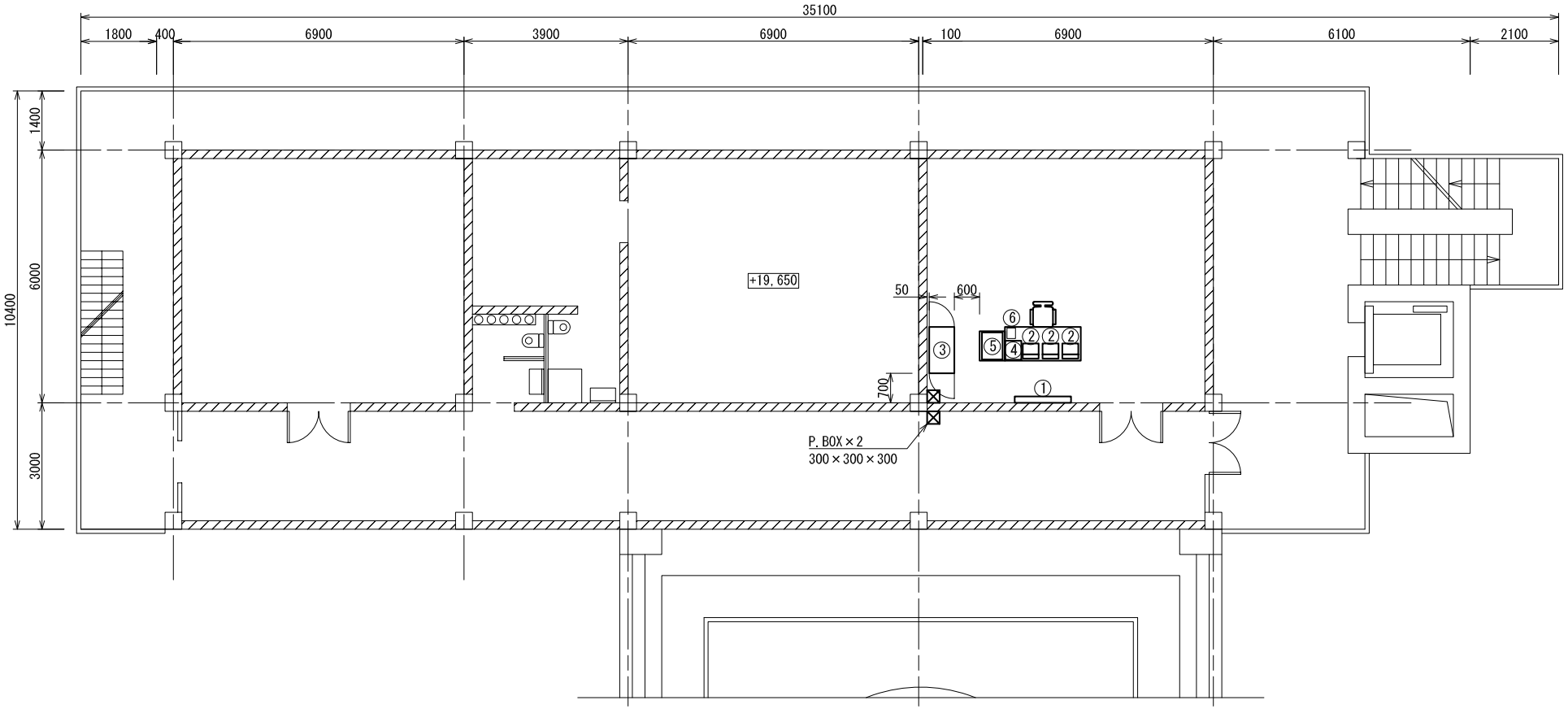
: Existing

1-floor plan view
(S=1/50)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CSC-NDPC 1-floor plan view		I-4



CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CSC-NDPC Wiring diagram		I-5



No.	Name
①	Multi Information display system
②	Monitoring/Control terminal x3
③	Information management facility locker
④	FAX
⑤	Printer
⑥	Analog Telephone

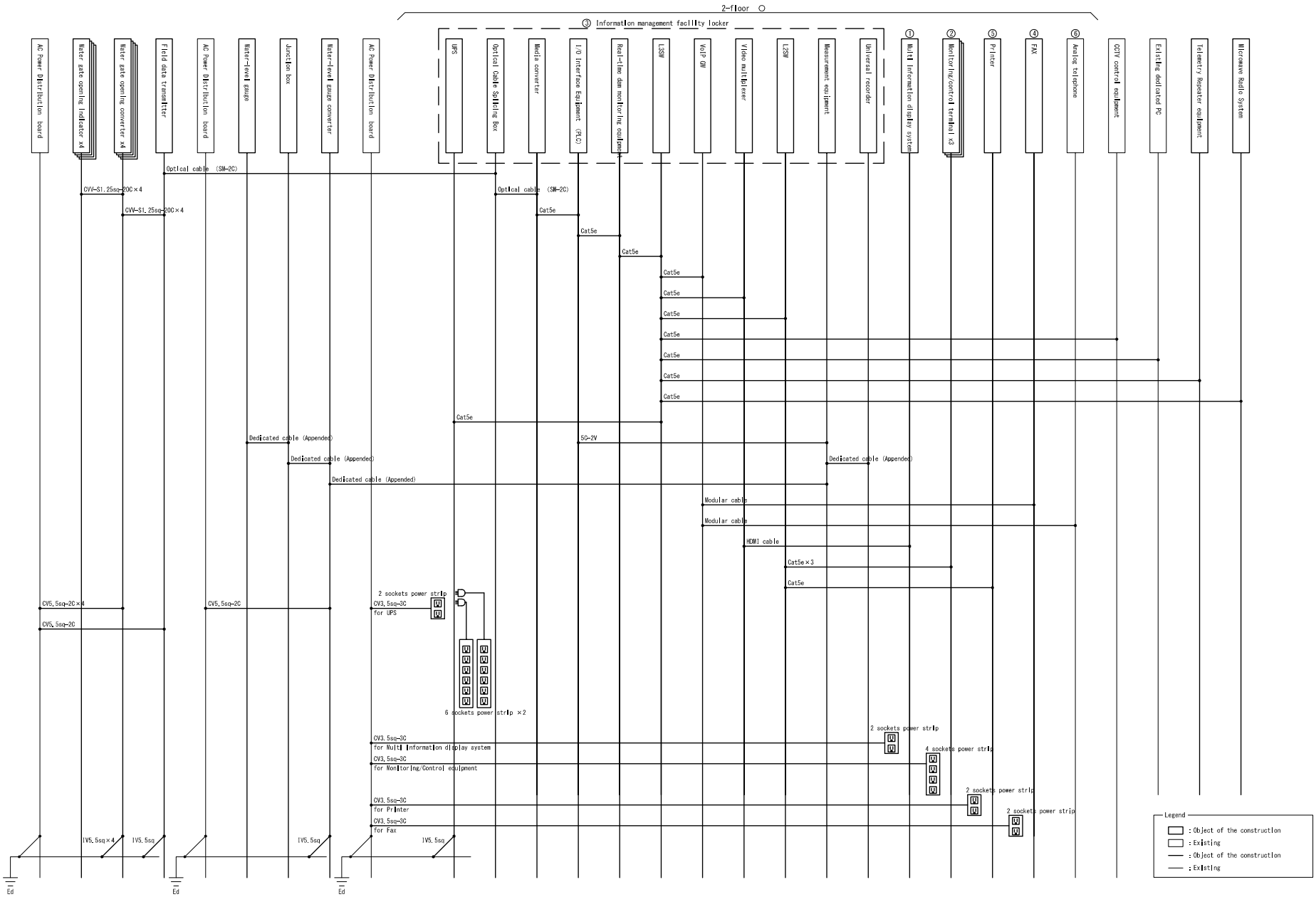
Legend

: Object of the construction

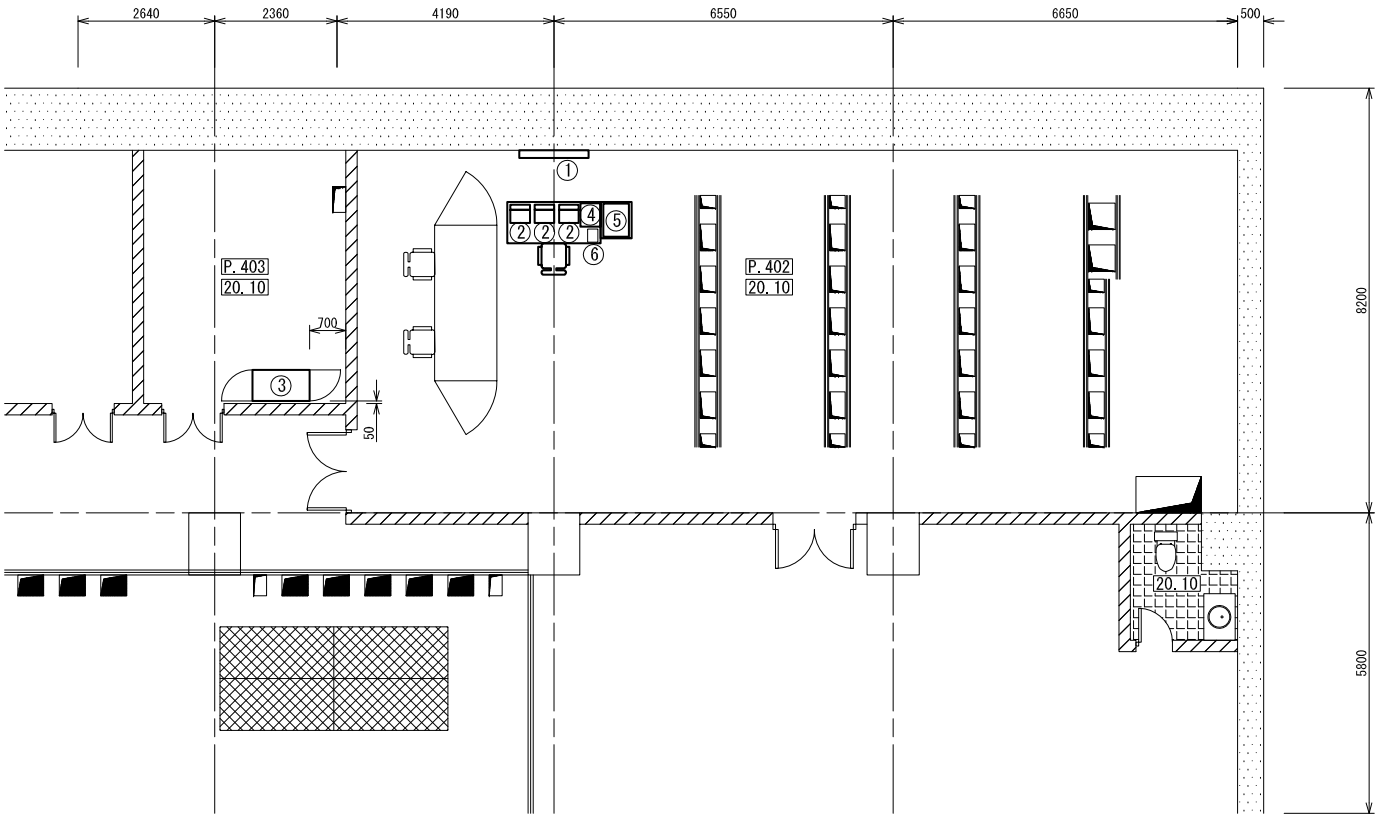
: Existing

2-floor plan view
(S=1/100)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Huong Dien Dam Control post 2-floor plan view		I-6



CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Huong Dien Dam Wiring diagram		I-7

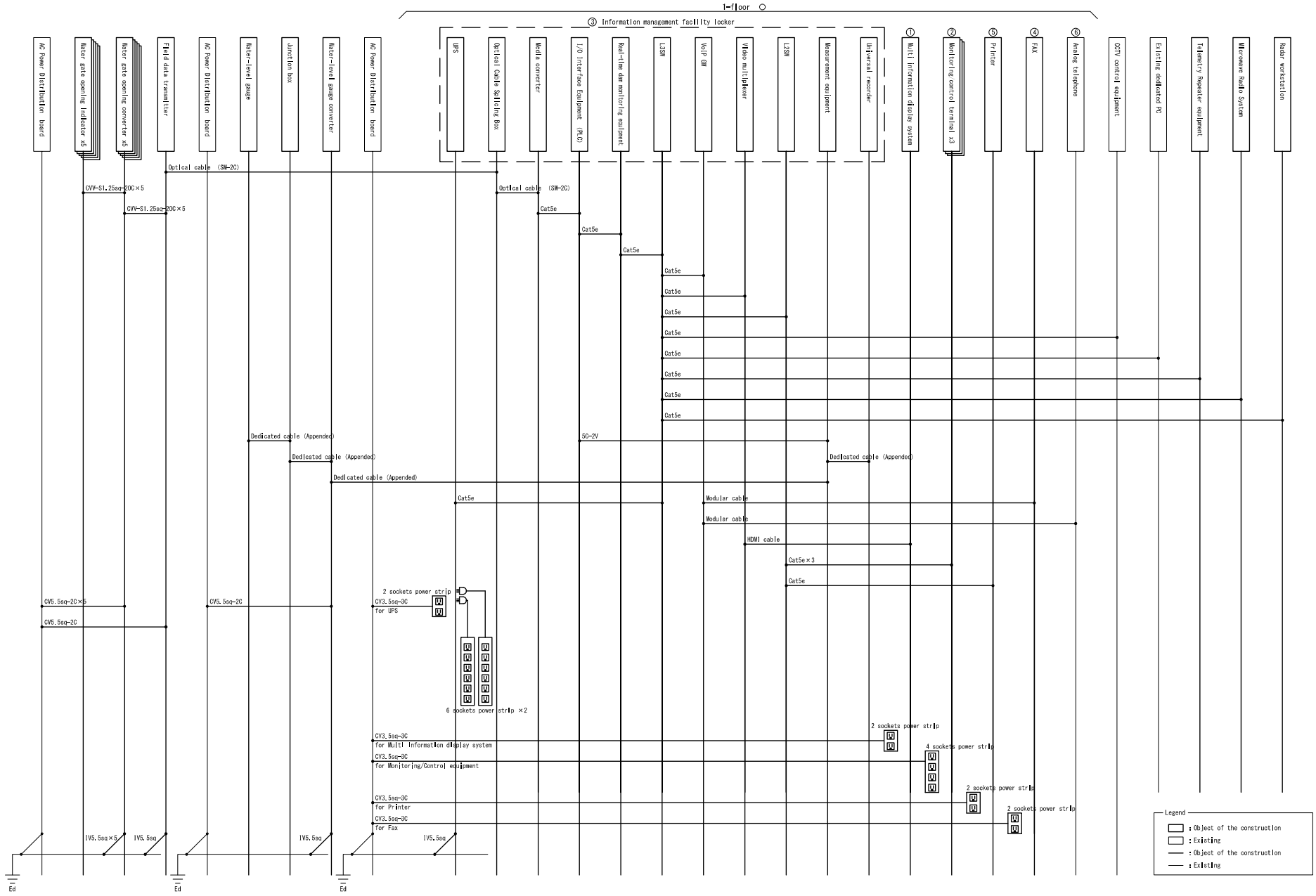


No.	Name
①	Multi information display system
②	Monitoring/Control terminal x3
③	Information management facility locker
④	FAX
⑤	Printer
⑥	Analog Telephone

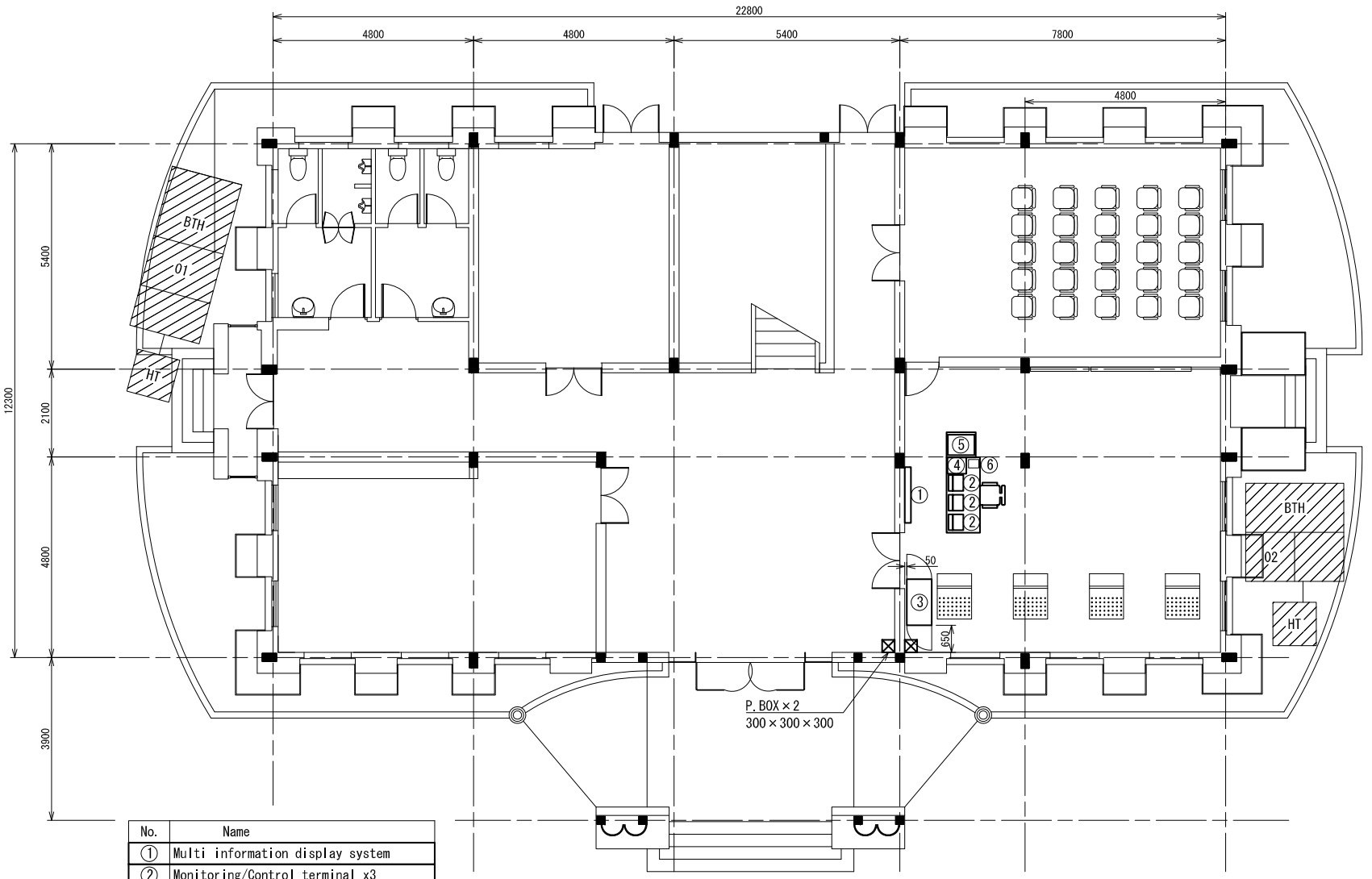
Legend
: Object of the construction
: Existing

1-floor plan view
(S=1/100)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Binh Dien Dam Control post 1-floor plan view		I-8



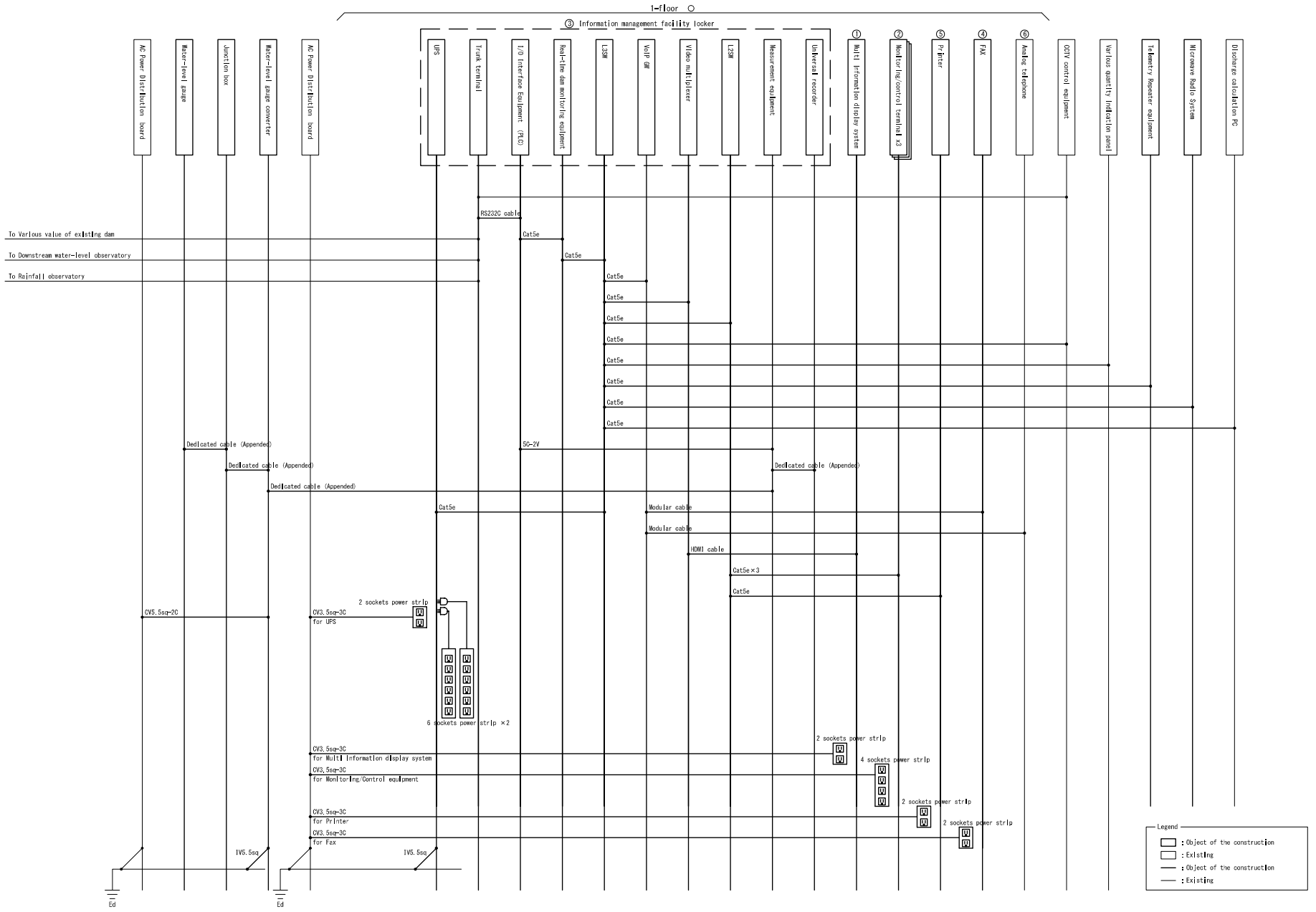
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Binh Dien Dam Wiring diagram		I-9



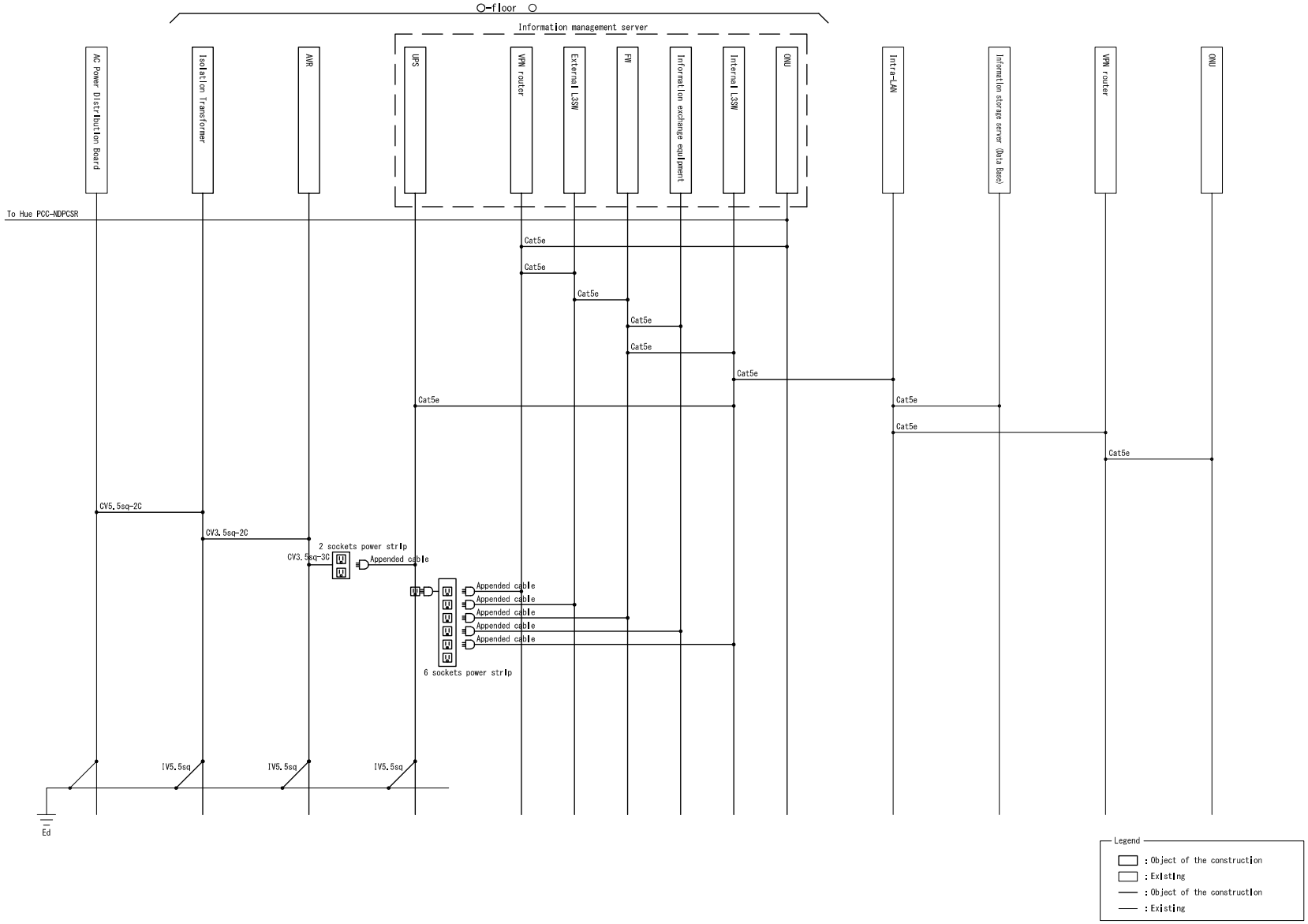
No.	Name
①	Multi information display system
②	Monitoring/Control terminal x3
③	Information management facility locker
④	FAX
⑤	Printer
⑥	Analog Telephone

1-floor plan view
(S=1/100)

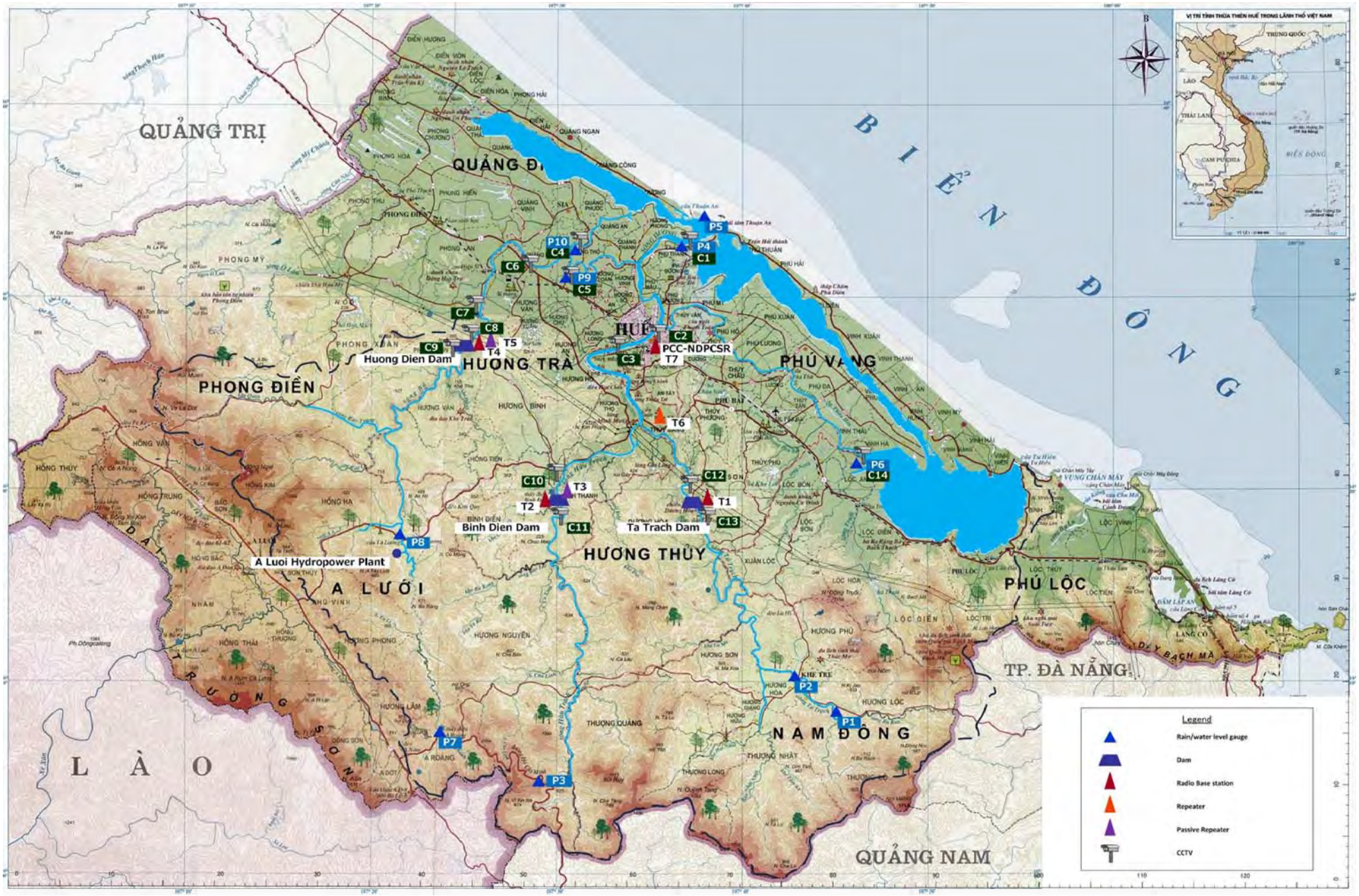
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Ta Trach Dam Control post 1-floor plan view		I-10



CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Ta Trach Dam Wiring diagram		I-11

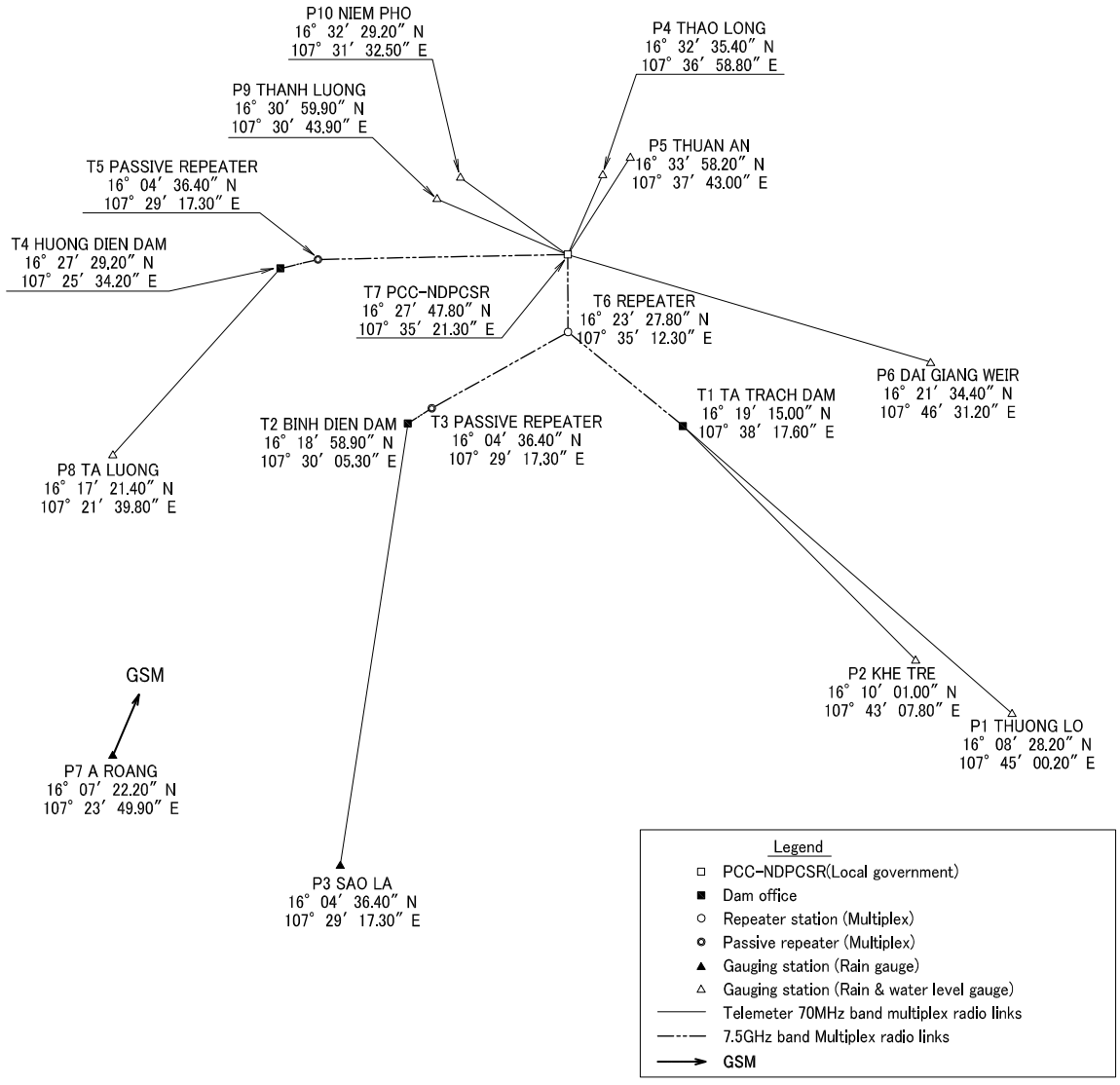


CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Danang HMC Wiring diagram		I-12



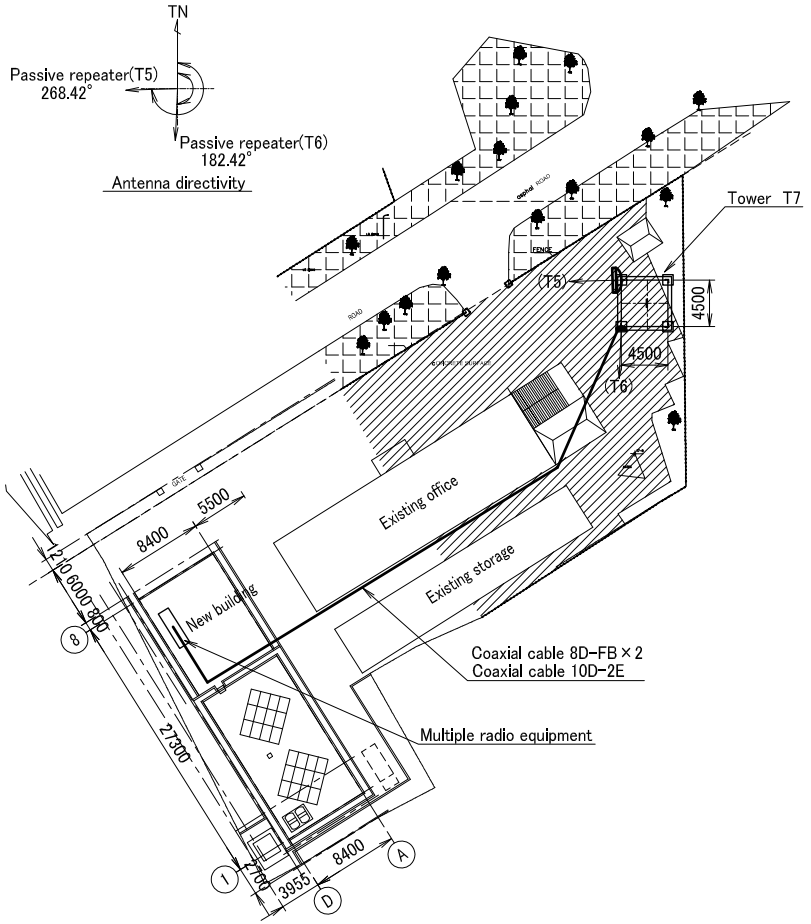
2-95

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Location Map		M-1

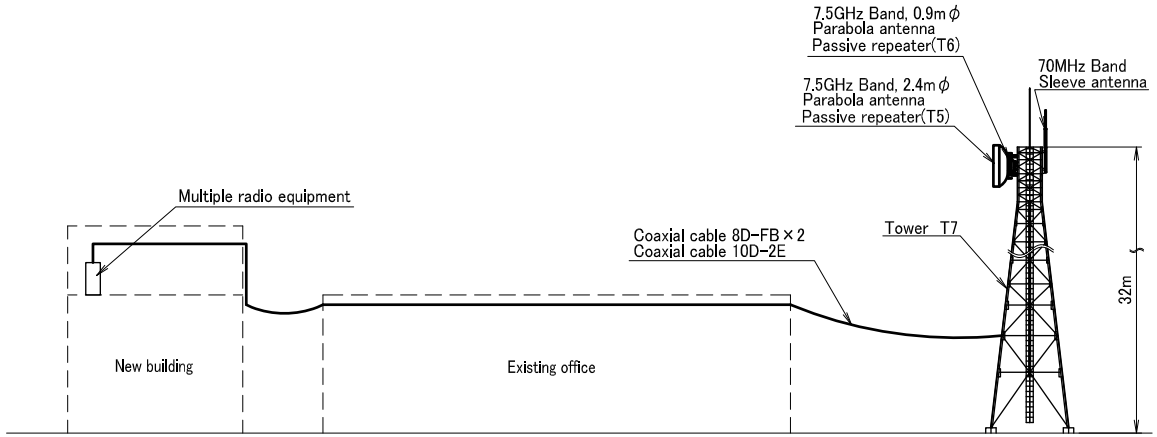


Station location
(S=1/30000)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Station location		M-2

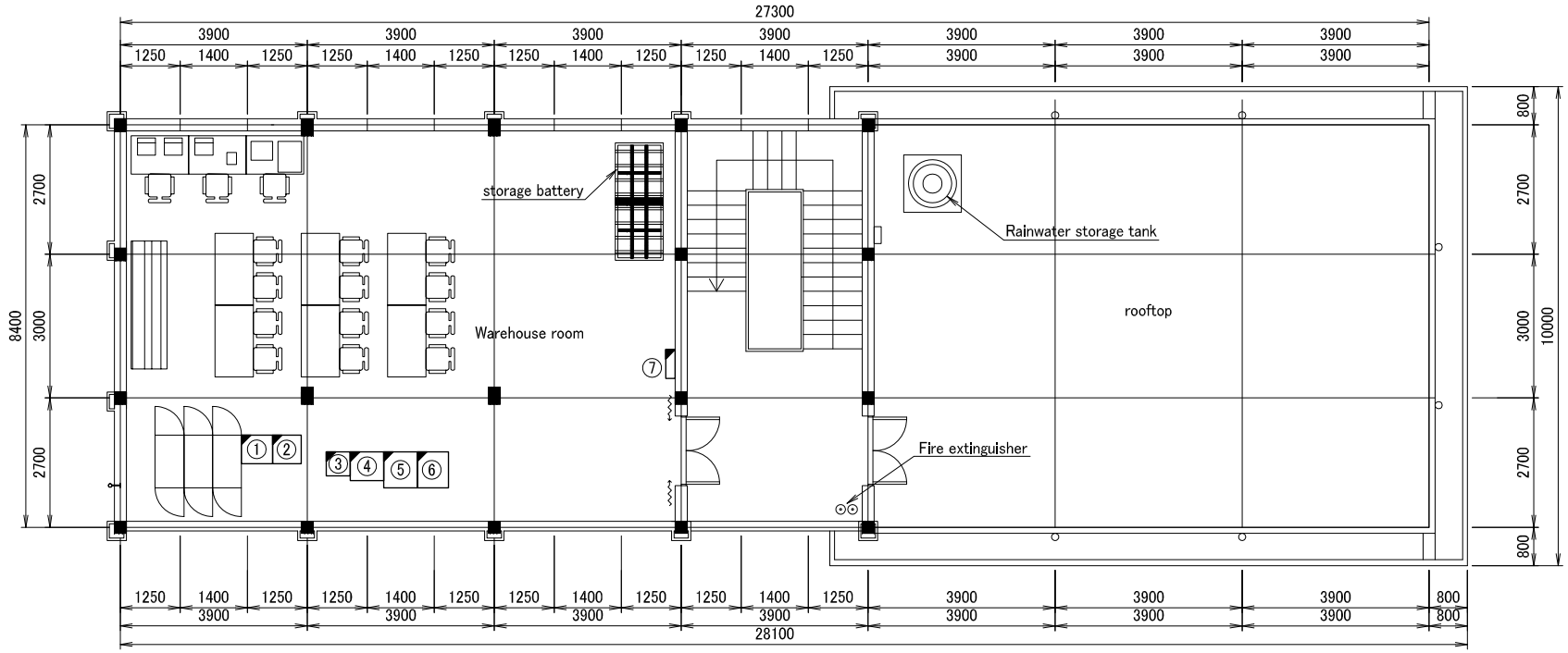


Site layout
(S=1/500)



Elevation
(S=1/300)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	PCC-NDPCSR T7 Site layout and elevation		M-3



Equipment layout
(S=1/50)

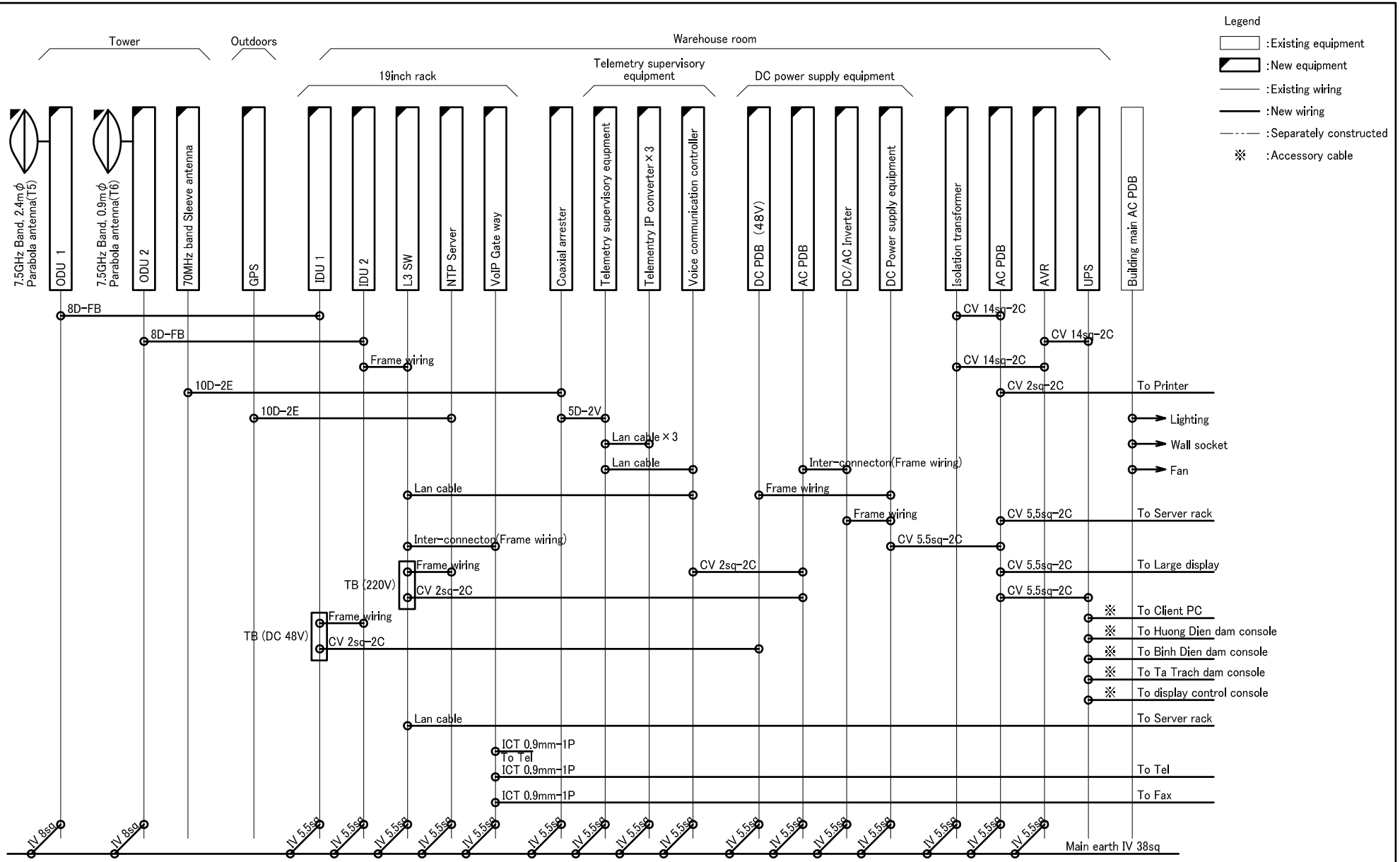
No.	Equipment name	Remarks
1	Telemetry Supervisory Equipment	
2	19inch rack	
3	Isolation transformer	
4	DC Power Supply	
5	UPS	
6	AVR	
7	AC PDB	

Legend

:Existing equipment

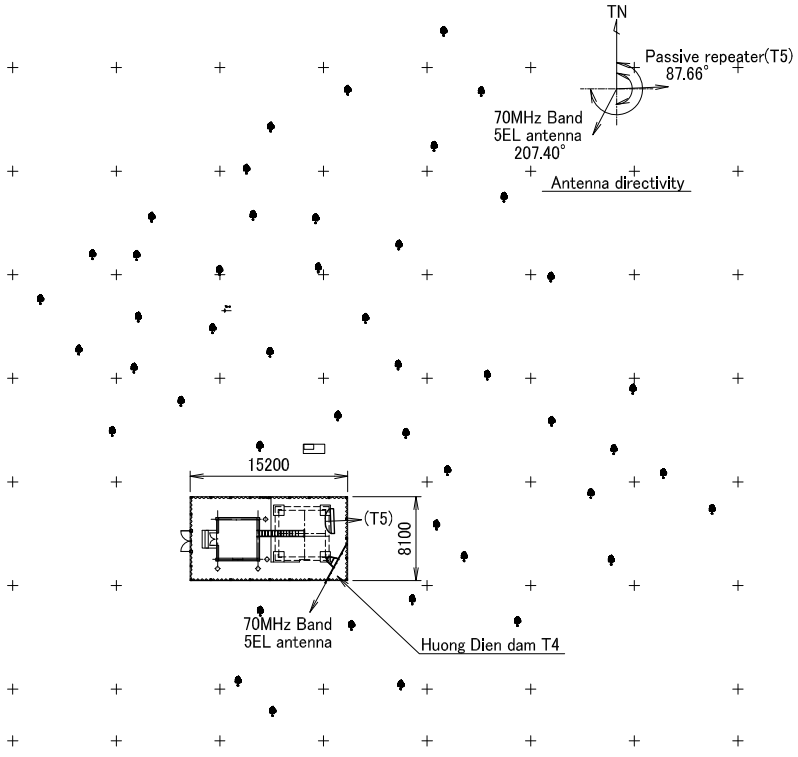
:New equipment

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	PCC-NDPCSR T7 Equipment layout		M-4

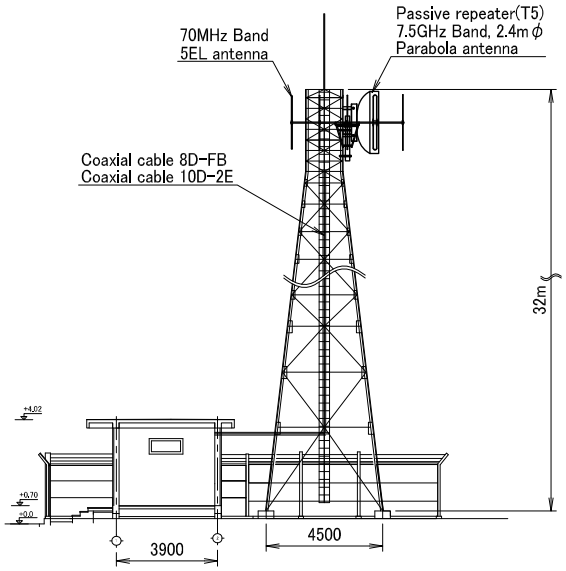


Wiring diagram

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	PCC-NDPCSR T7 Wiring diagram		M-5

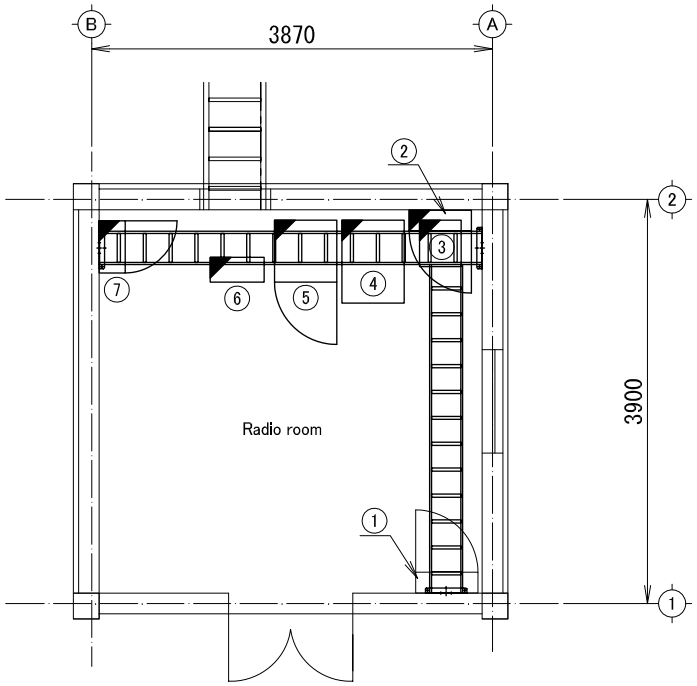


Site layout
(S=1/500)



Elevation
(S=1/200)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Huong Dien dam T4 Site layout and elevation		M-6



Equipment layout
(S=1/50)

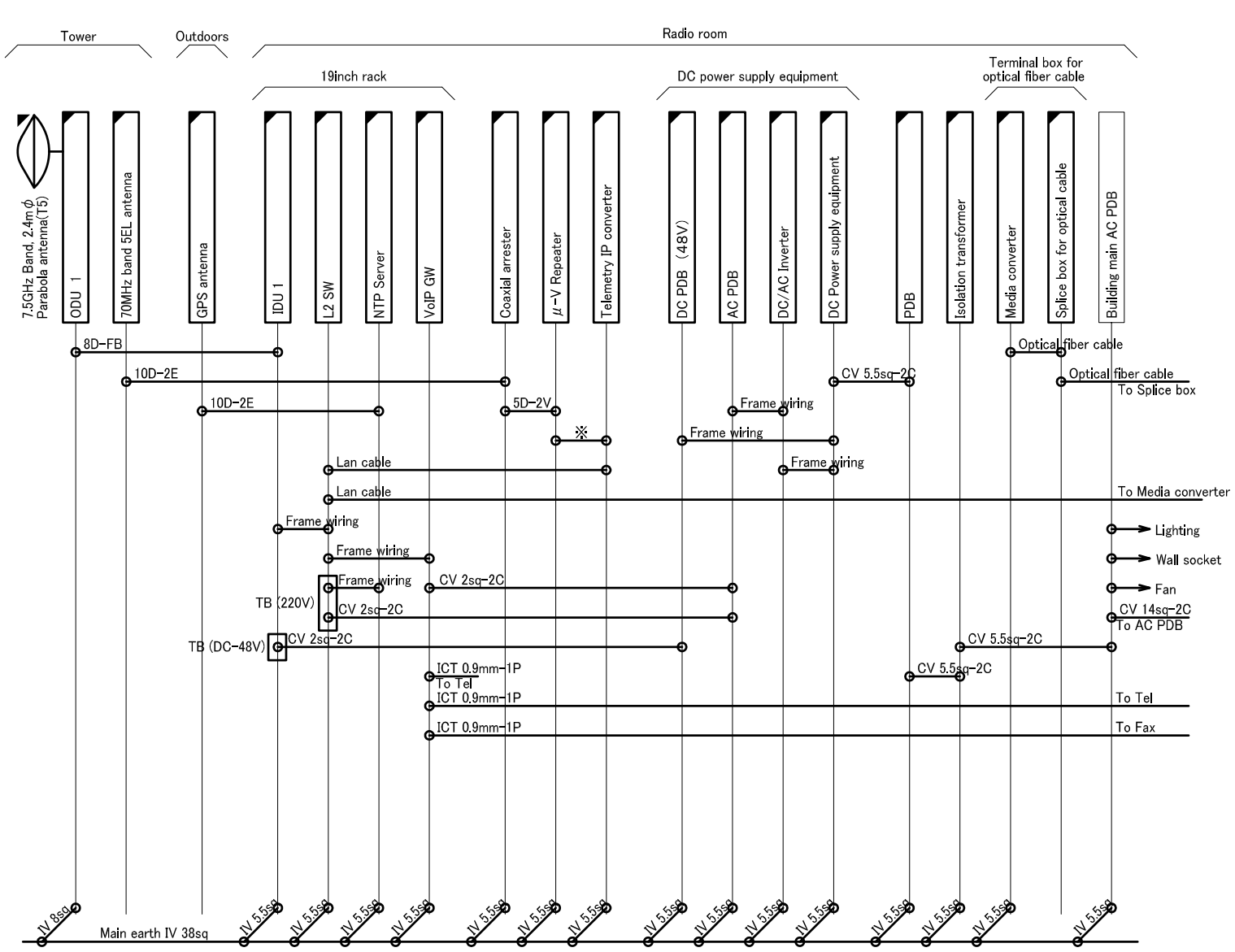
No.	Equipment name	Remarks
1	Building main AC PCB	
2	PCB	
3	Isolation transformer	
4	DC power supply equipment	
5	19inch rack	
6	μ-V Repeater	
7	Terminal box for optical fiber cable	

Legend

: Existing equipment

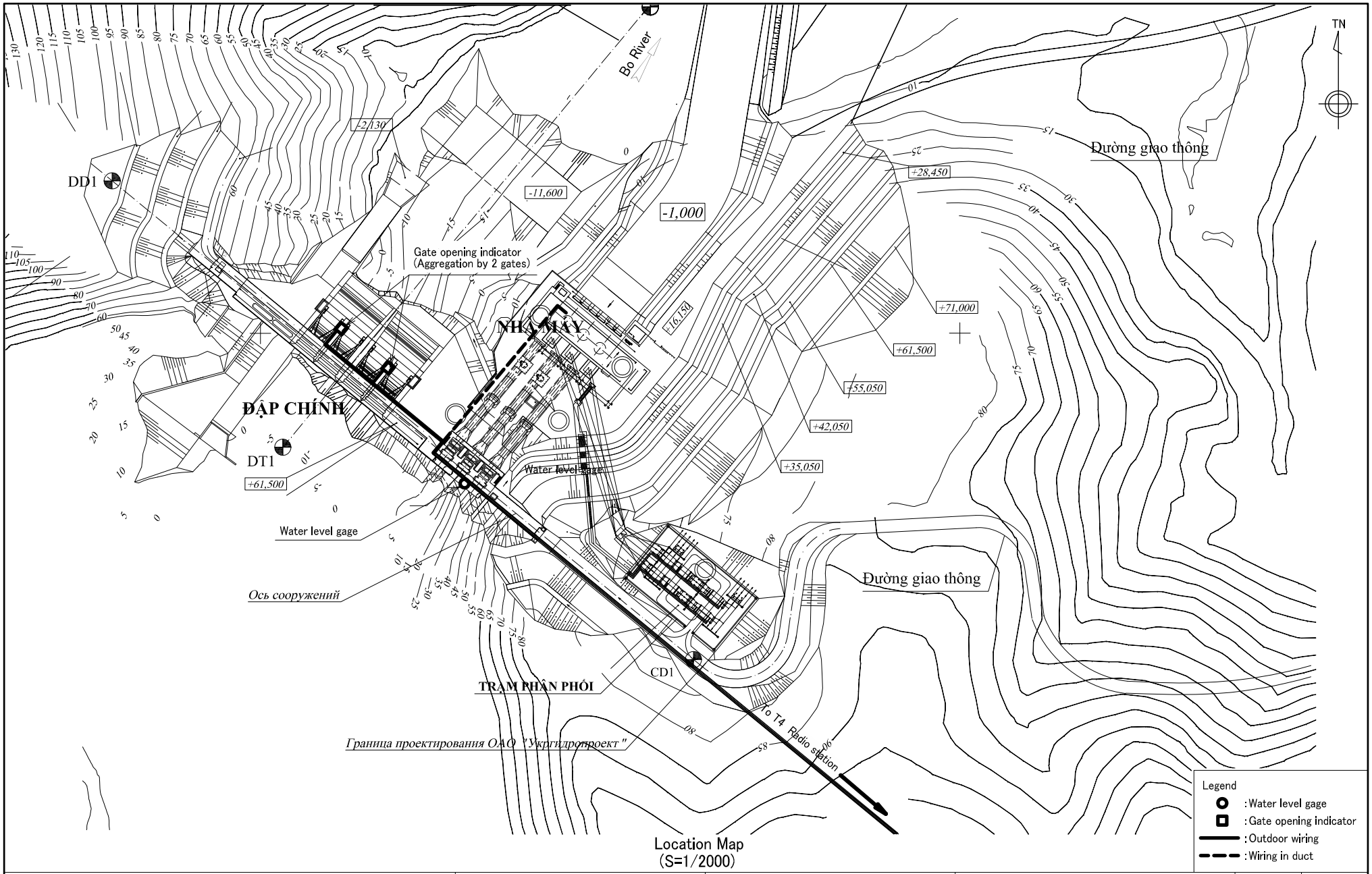
: New equipment

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Huong Dien dam T4 Equipment layout		M-7



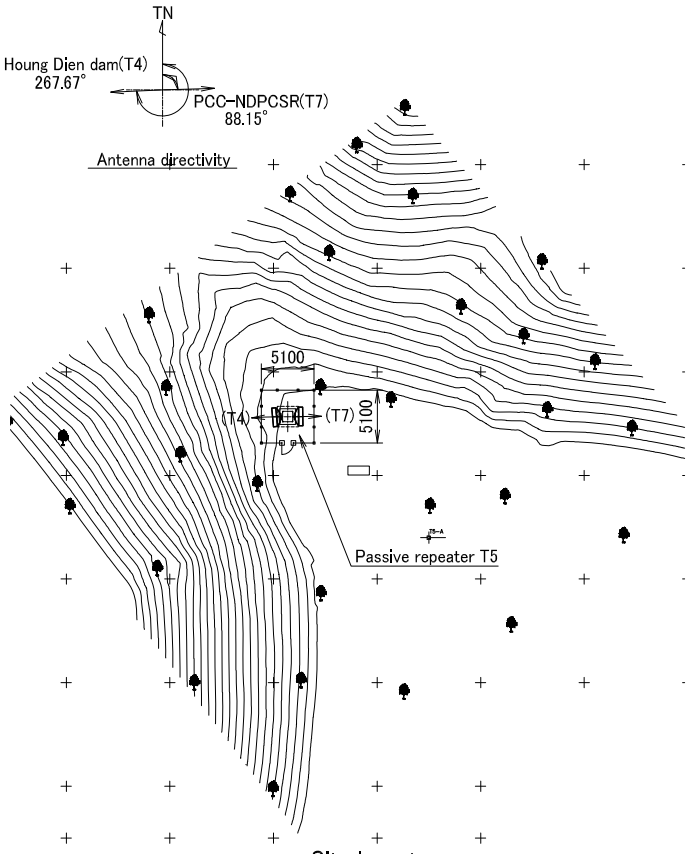
Wiring diagram

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Huong Dien dam T4 Wiring diagram		M-8

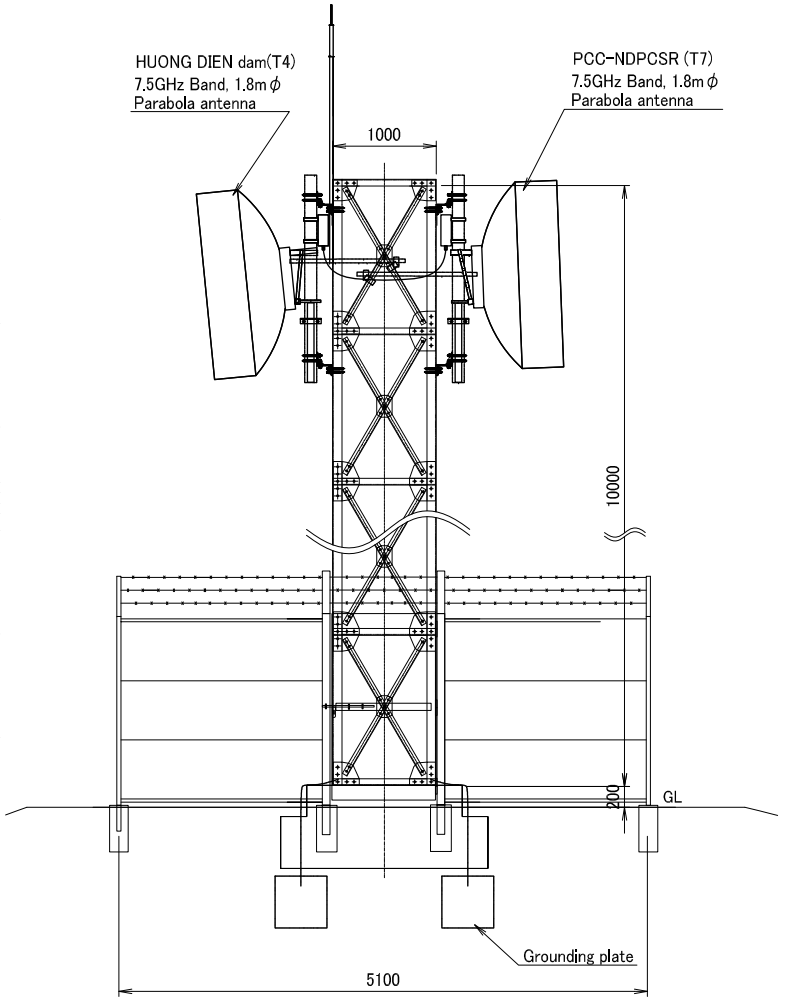


Location Map
(S=1/2000)

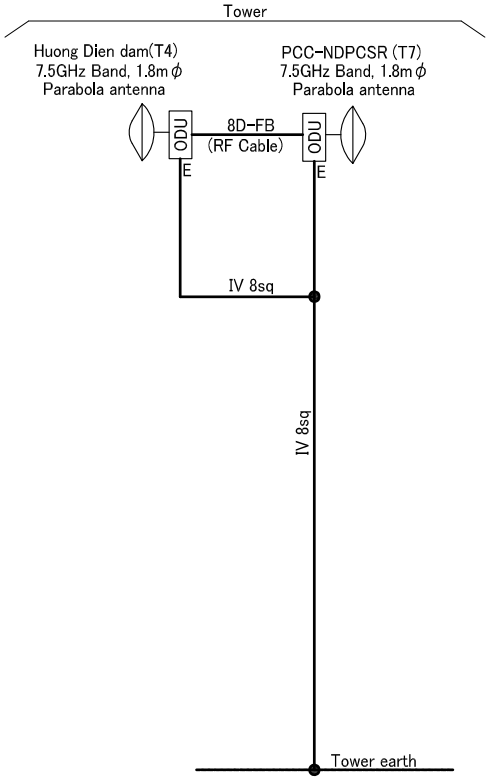
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Huong Dien dam T4 Water level gage and gate opening indicator		M-9



Site layout
(S=1/500)

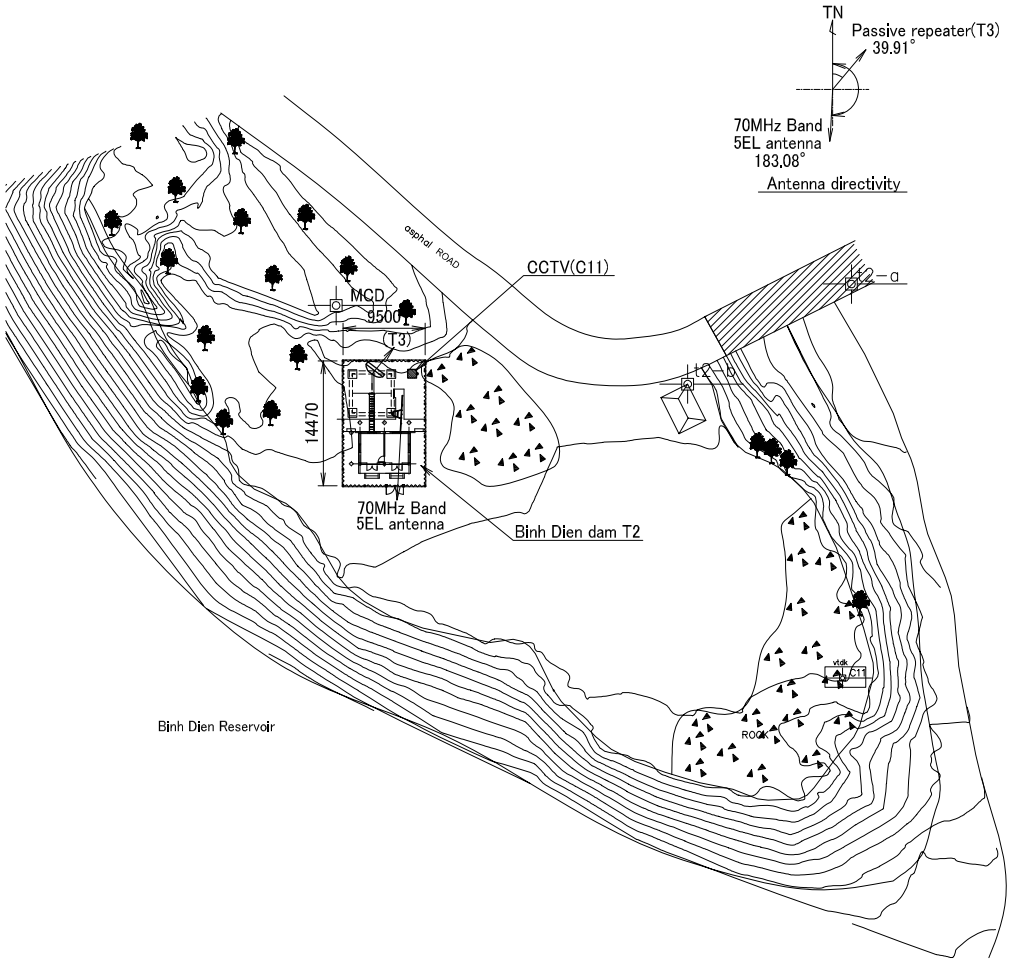


Elevation
(S=1/50)

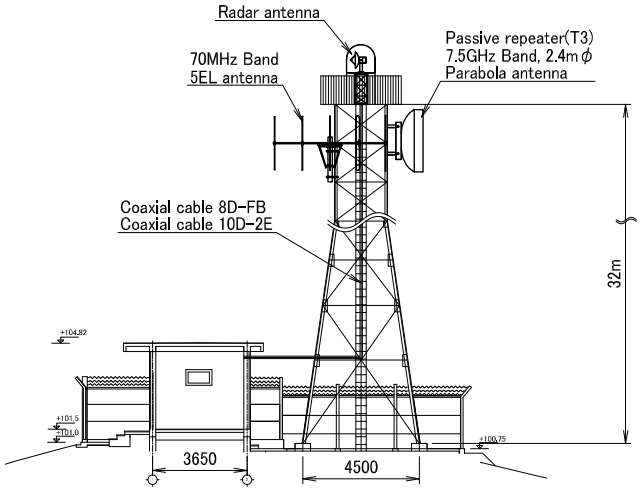


Wiring diagram

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Huong Dien dam Passive repeater station T5 Site layout , elevation and wiring diagram		M-10

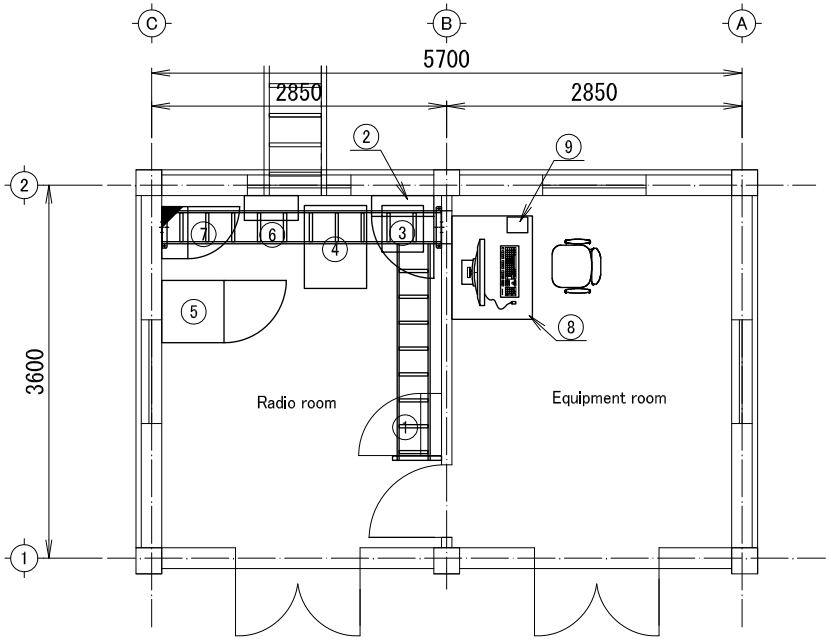


Site layout
(S=1/600)



Elevation
(S=1/200)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Binh Dien dam T2 Site layout and elevation		M-11



No.	Equipment name	Remarks
1	Building main AC PCB	
2	PCB	
3	Isolation transformer	
4	DC power supply	
5	19inch rack	
6	μ-V Repeater	
7	Terminal box for optical fiber cable	
8	Radar console	
9	UPS	

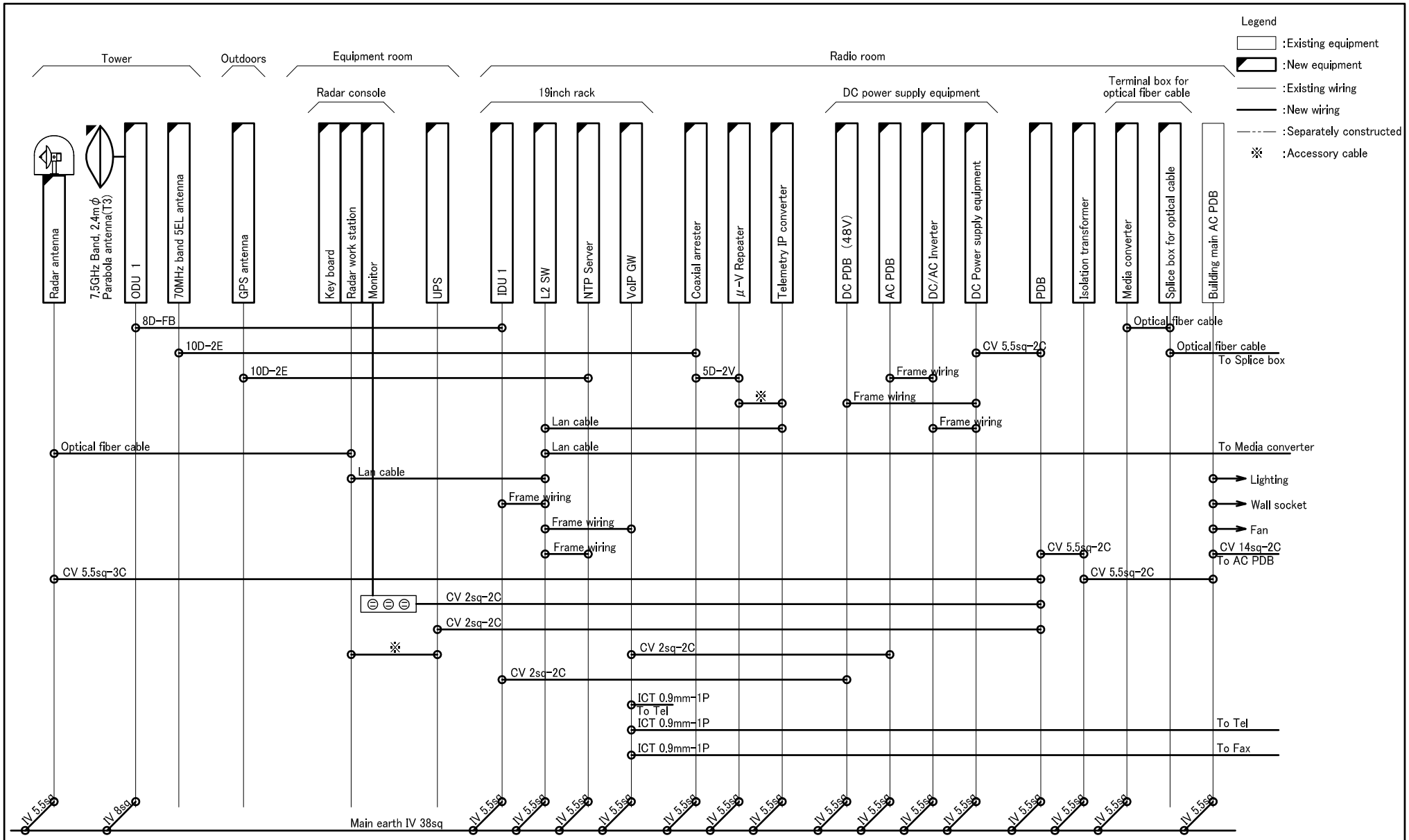
Legend

: Existing equipment

: New equipment

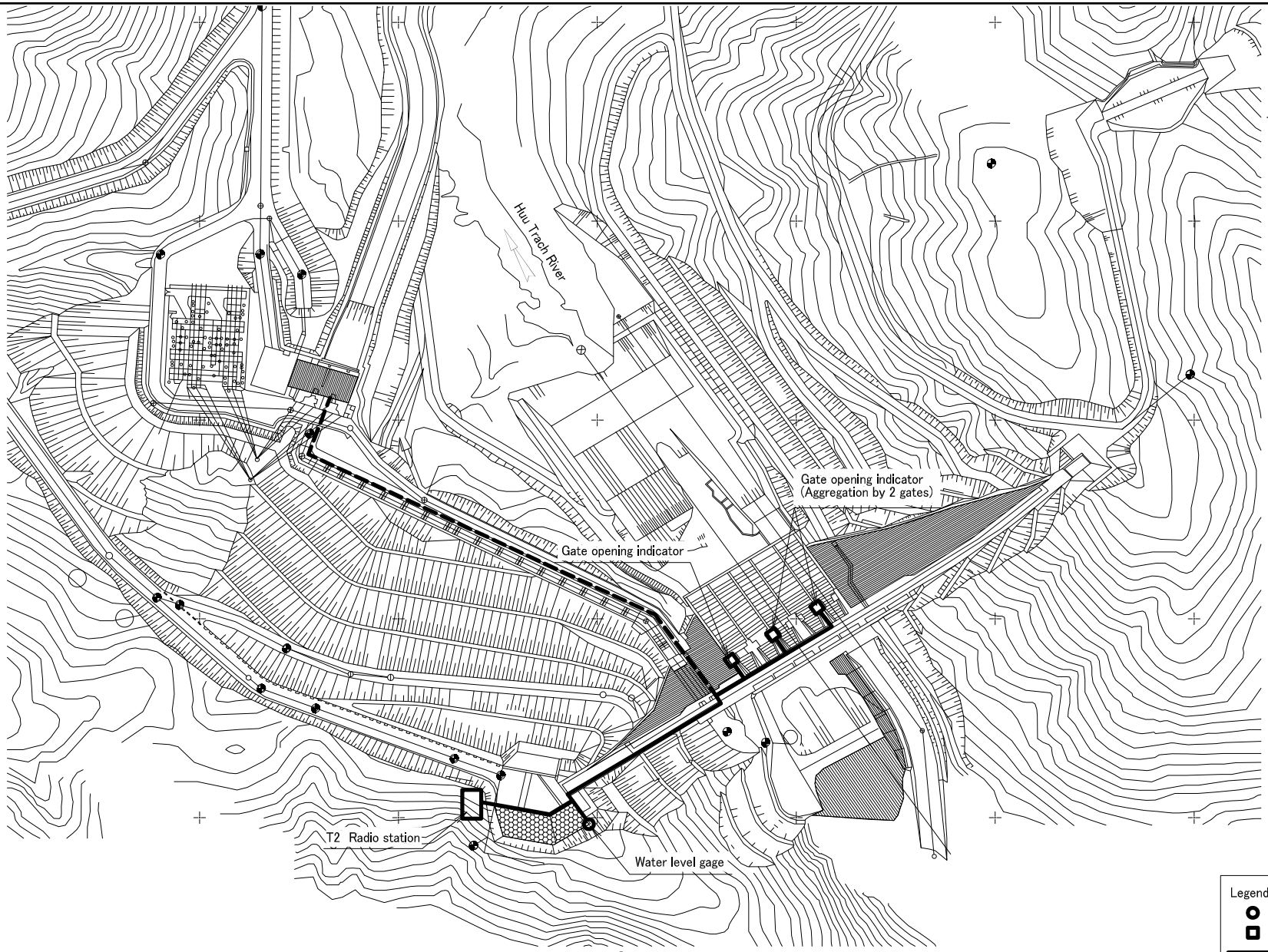
Equipment layout
(S=1/50)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Binh Dien dam T2 Equipment layout		M-12



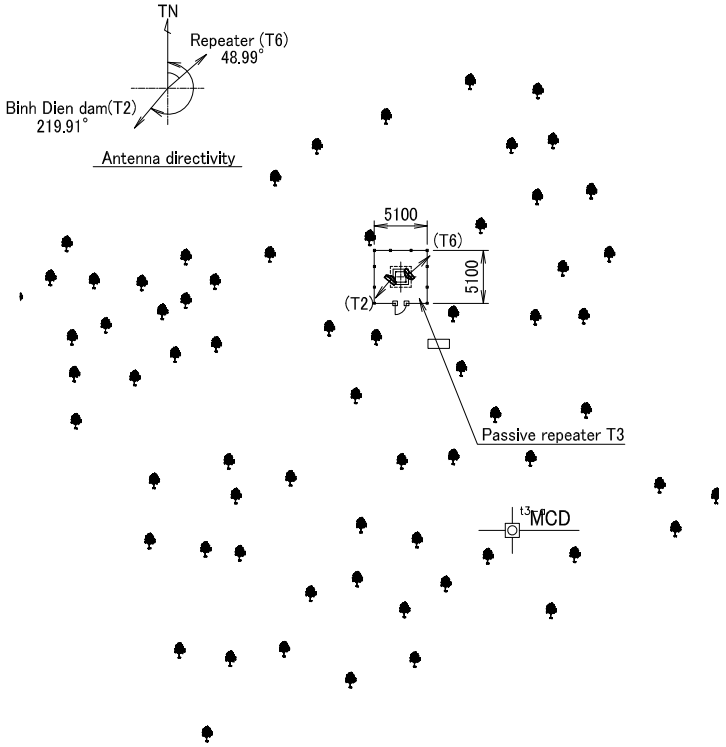
Wiring diagram

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
FRICS / CTI *Foundation of River & Basin Integrated Communications, JAPAN* Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Binh Dien dam T2 Wiring diagram		M-13

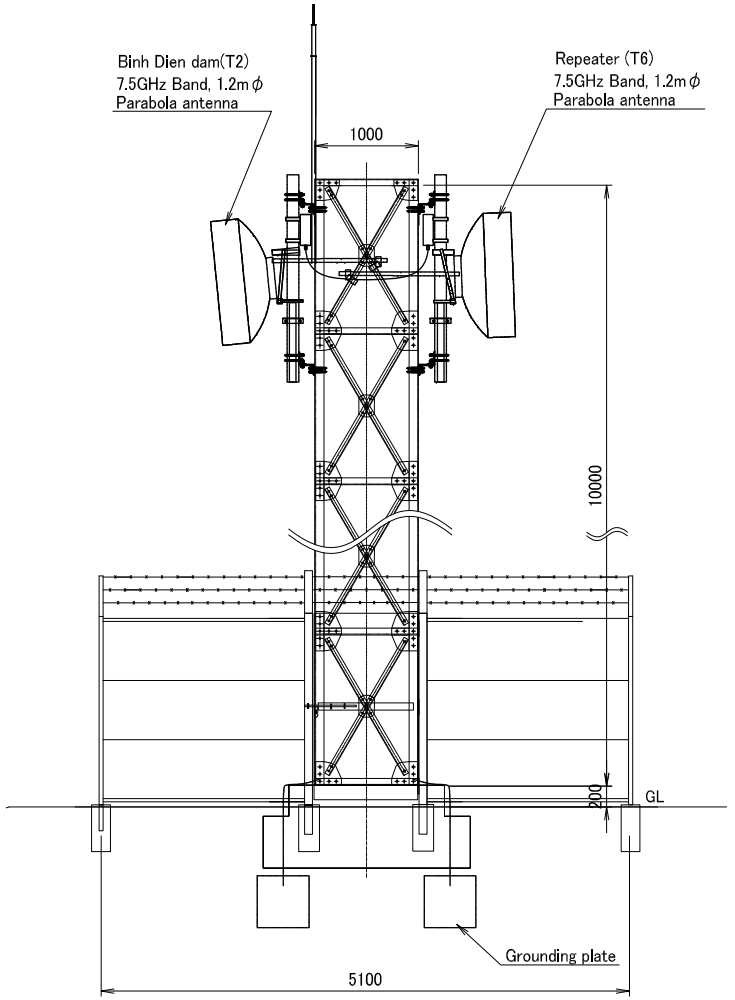


Site layout
(S=1/2000)

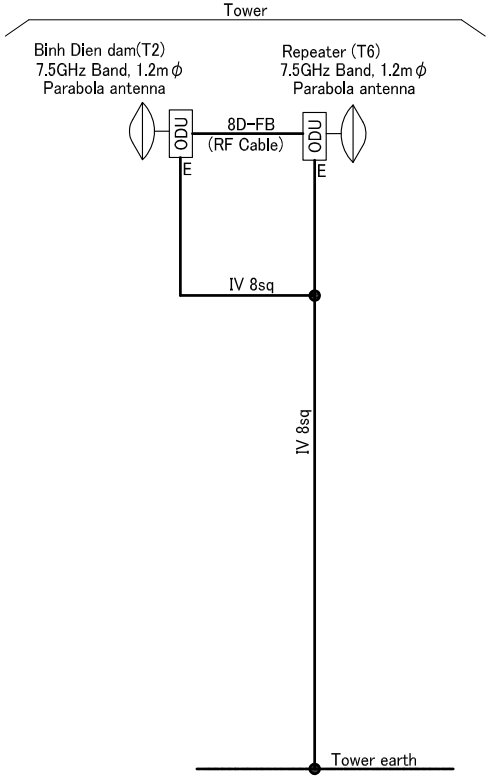
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Binh Dien dam T2 Water level gage and gate opening indicator		M-14



Site layout
(S=1/500)

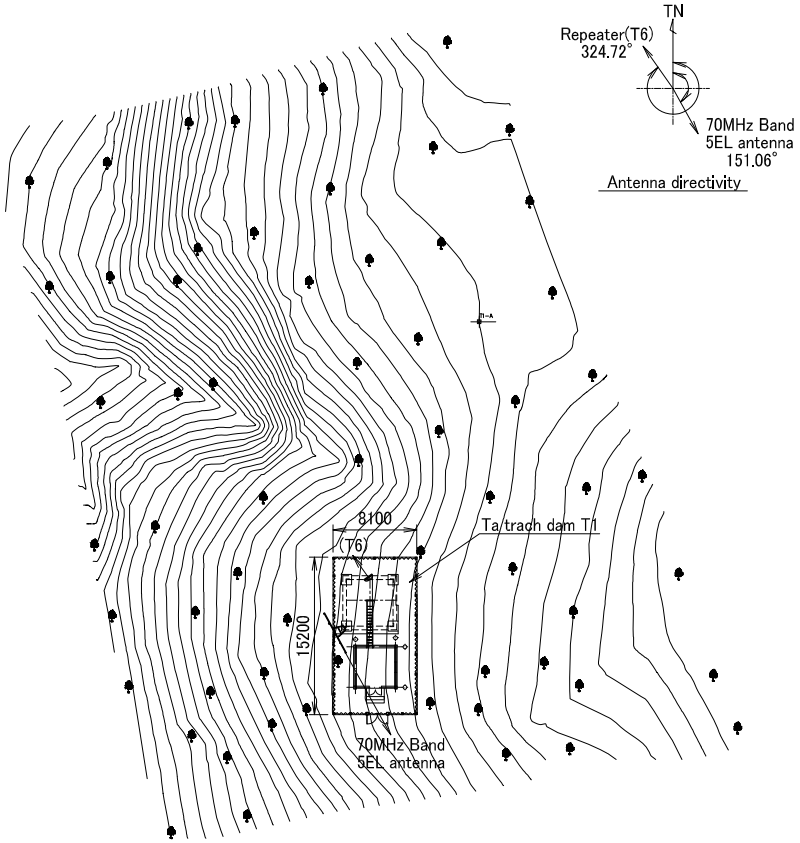


Elevation
(S=1/50)

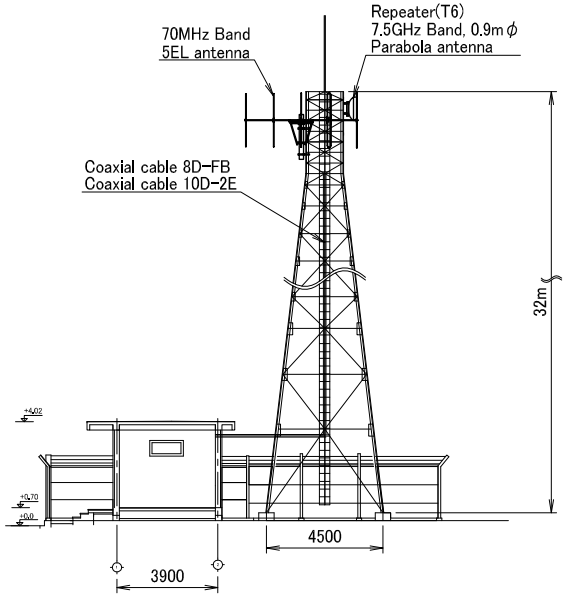


Wiring diagram

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Binh Dien dam Passive repeater station T3 Site layout , elevation and wiring diagram		M-15

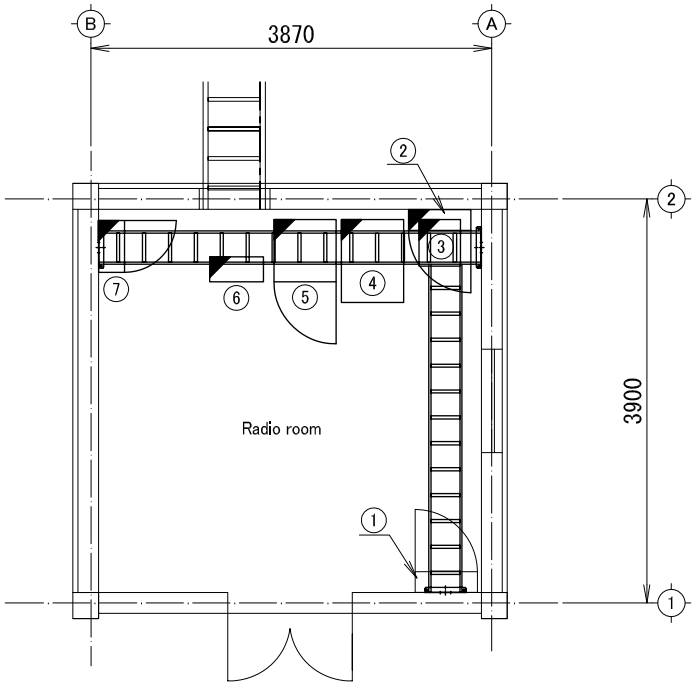


Site layout
(S=1/500)



Elevation
(S=1/200)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Ta Trach dam T1 Site layout and elevation		M-16



No.	Equipment name	Remarks
1	Building main AC PCB	
2	PCB	
3	Isolation transformer	
4	DC power supply equipment	
5	19inch rack	
6	μ-V Repeater	
7	Terminal box for optical fiber cable	

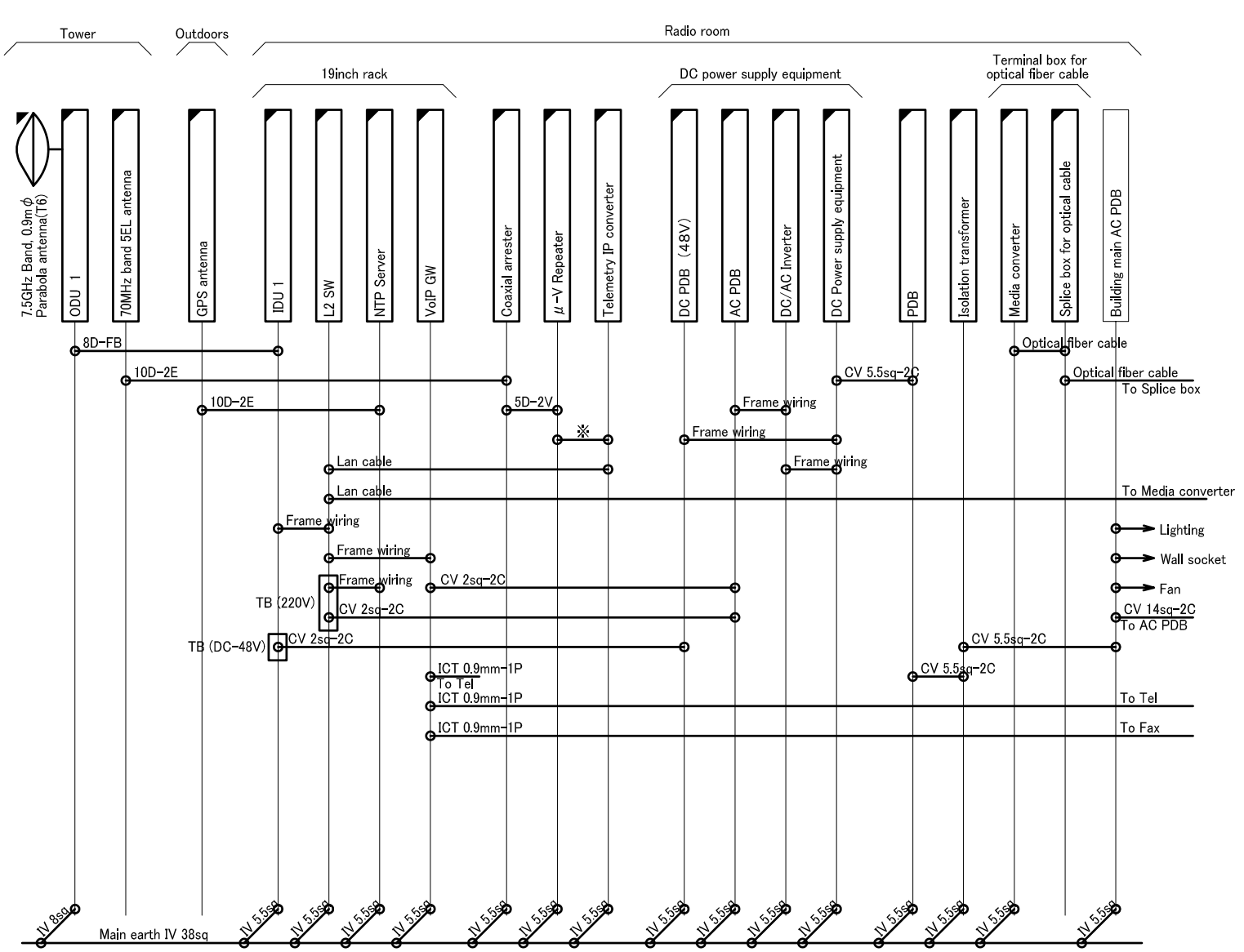
Legend

: Existing equipment

: New equipment

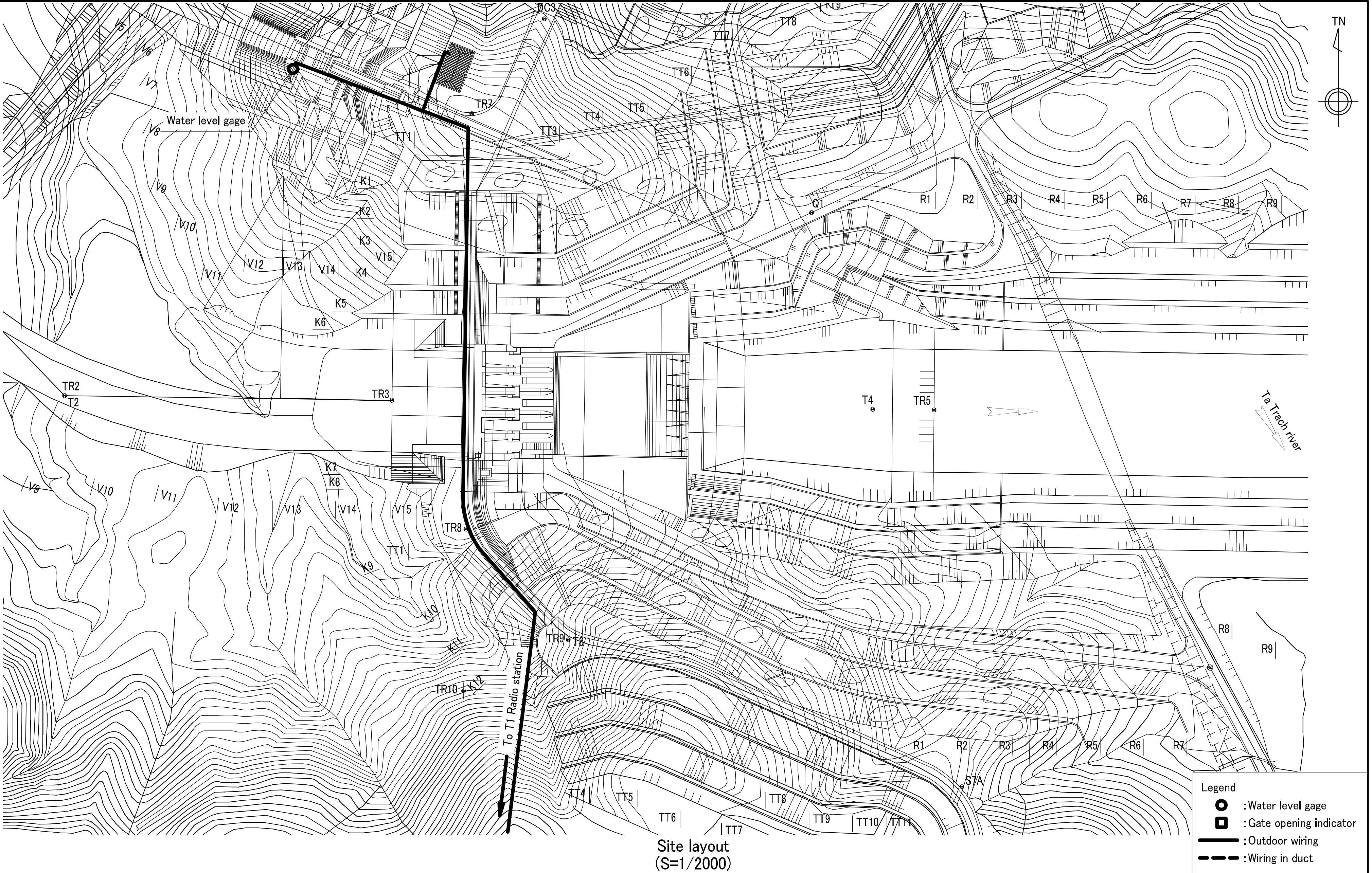
Equipment layout
(S=1/50)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Ta Trach dam T1 Equipment layout		M-17



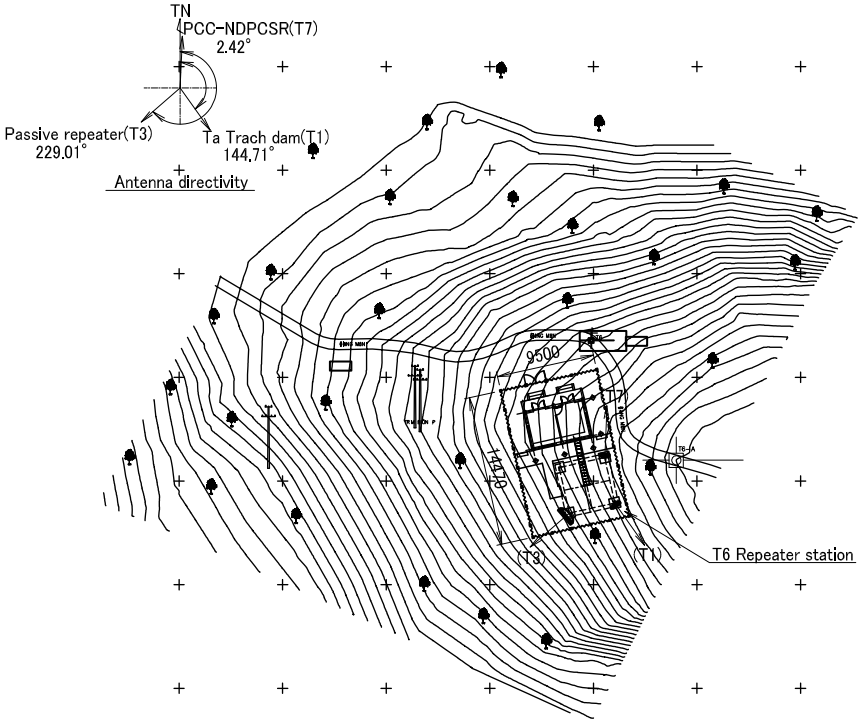
Wiring diagram

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Ta Trach dam T1 Wiring diagram		M-18

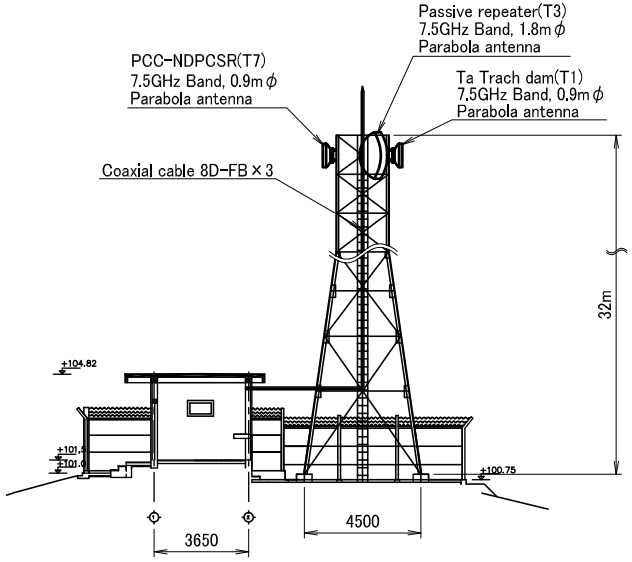


Site layout
(S=1/2000)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Ta Trach dam T1 Water level gage and gate opening indicator		M-19

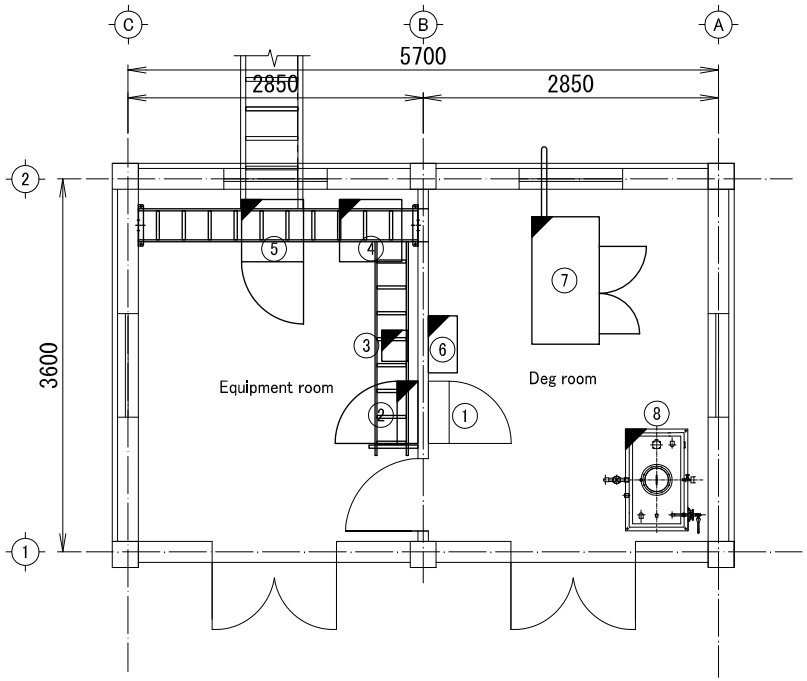


Site layout
(S=1/500)



Elevation
(S=1/200)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Repeater station T6 Site layout and elevation		M-20



Equipment layout
(S=1/50)

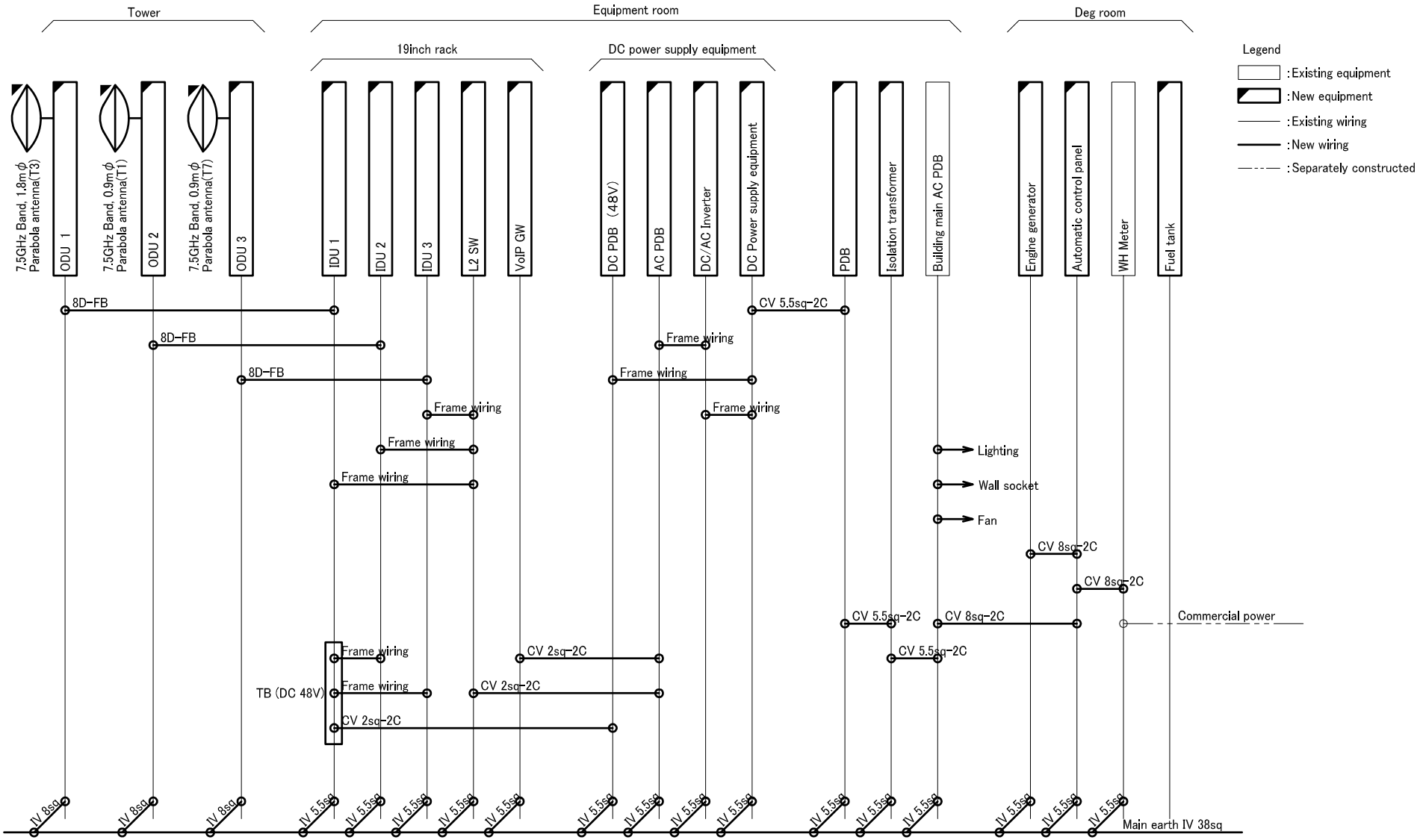
No.	Equipment name	Remarks
1	Building main AC PCB	
2	PCB	
3	Isolation transformer	
4	DC power supply	
5	19inch rack	
6	Automatic control panel	
7	Engine generator	
8	Fuel tank	

Legend

: Existing equipment

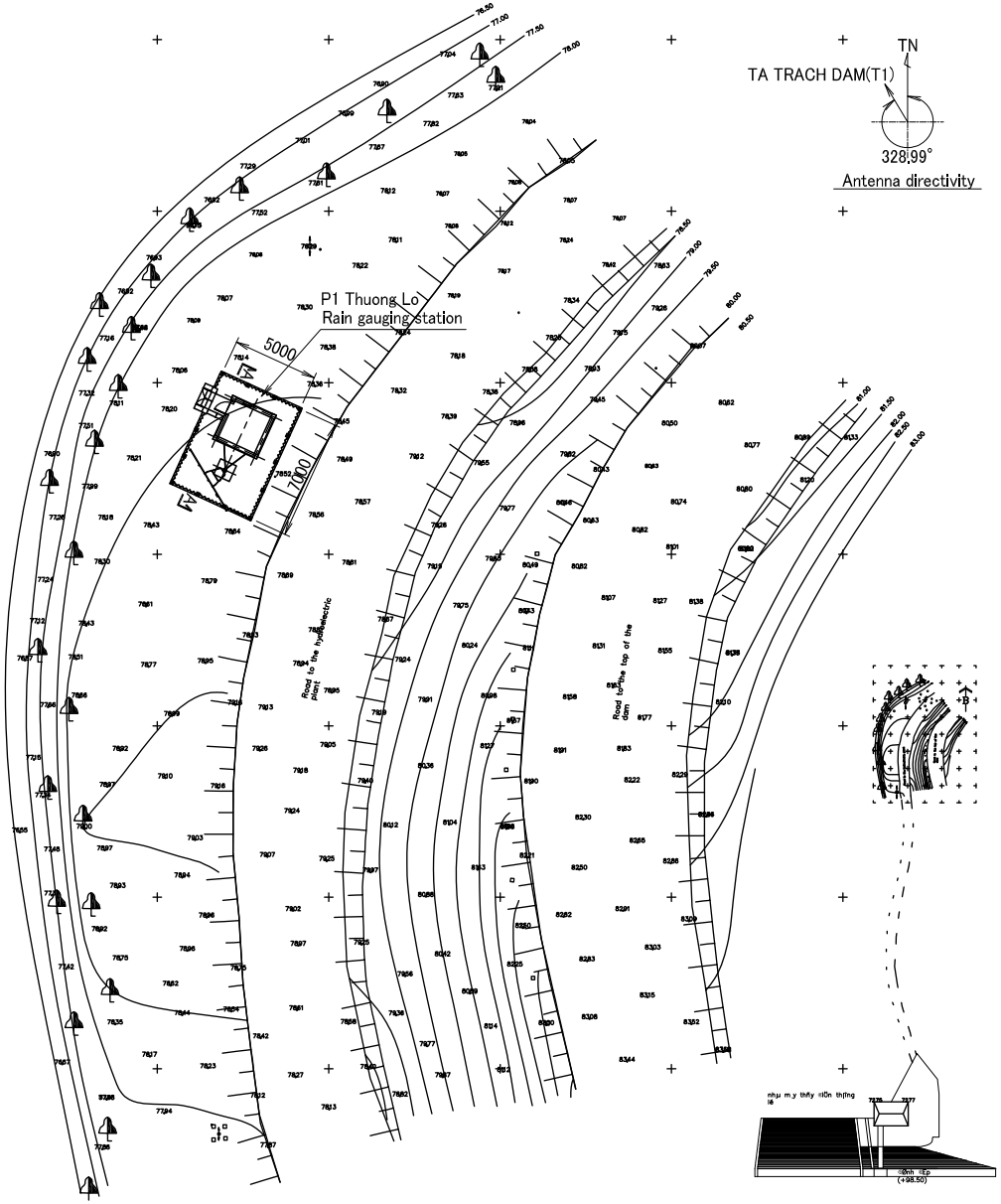
: New equipment

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Repeater station T6 Equipment layout		M-21

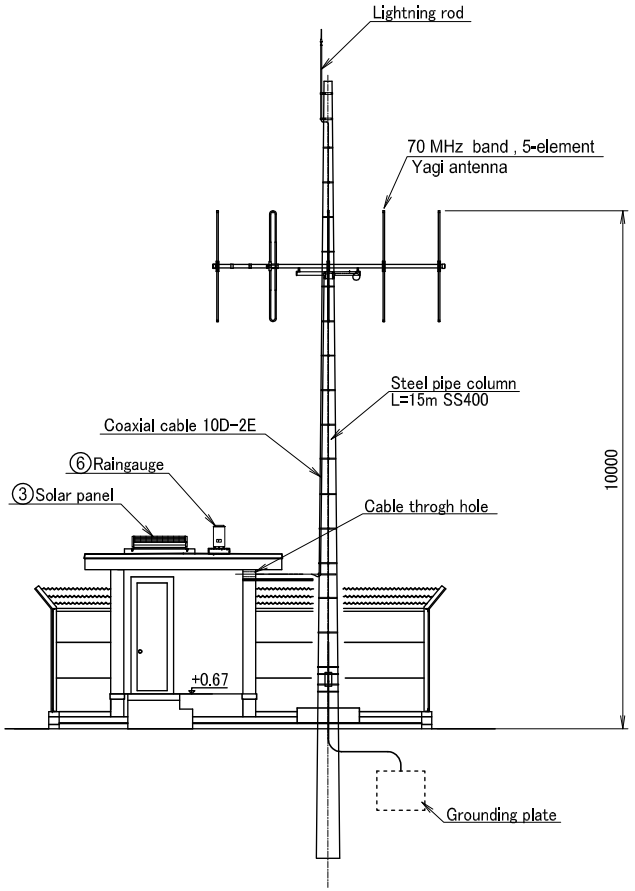


Wiring diagram

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	Repeater station T6 Wiring diagram		M-22

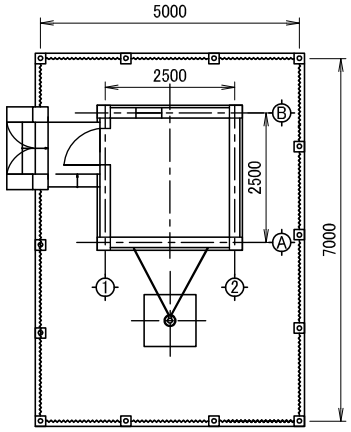


Site layout
(S=1/300)

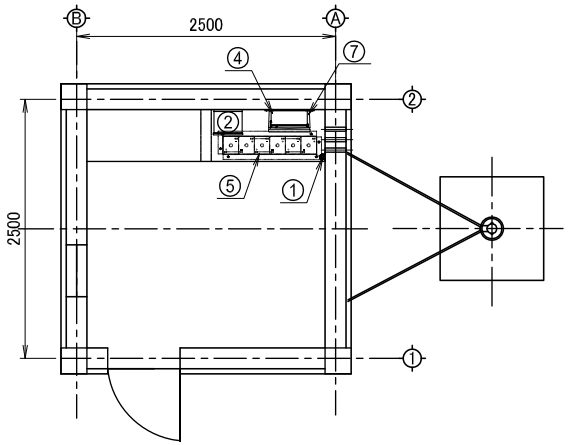


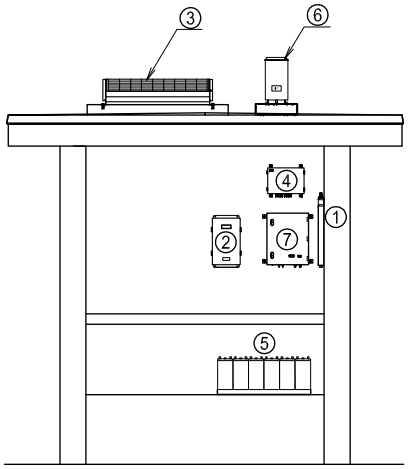
Arrow view A-A
(S=1/100)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P1 Thuong Lo Rain gauging station Site layout and arrow view		M-23



Floor layout
(S=1/100)

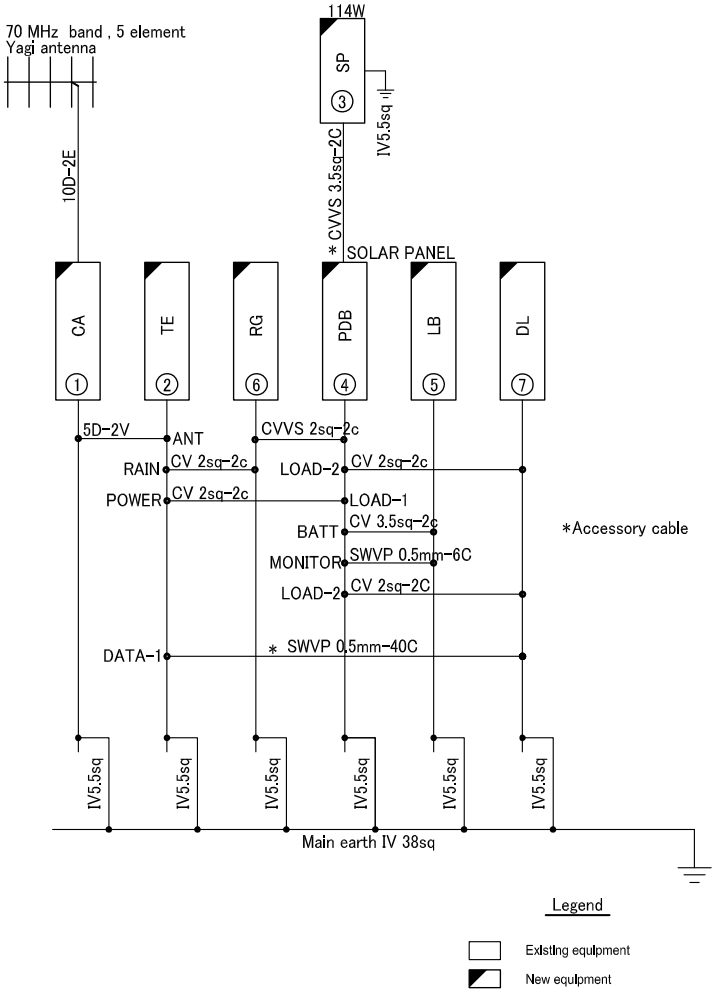




Equipment layout
(S=1/50)

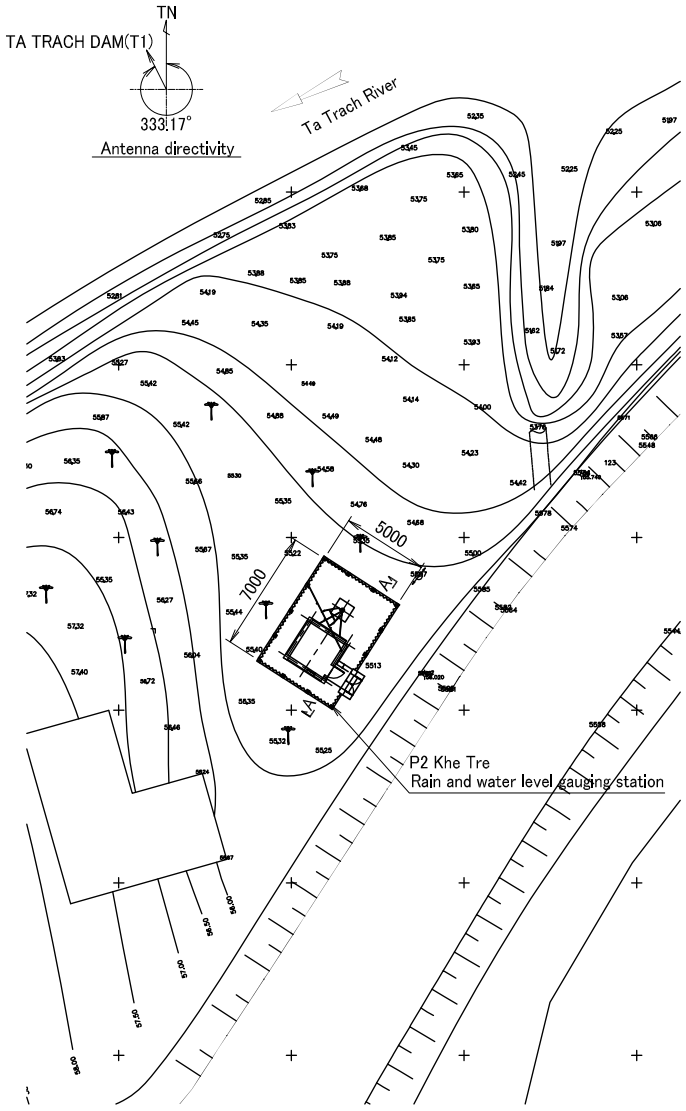
Legend

① CA : Coaxial arrester
② TE : Telemetry equipment
③ SP : Solar panel
④ PDB : Solar power distribution board
⑤ LB : Lead-acid battery
⑥ RG : Rain gauge
⑦ DL : Data logger

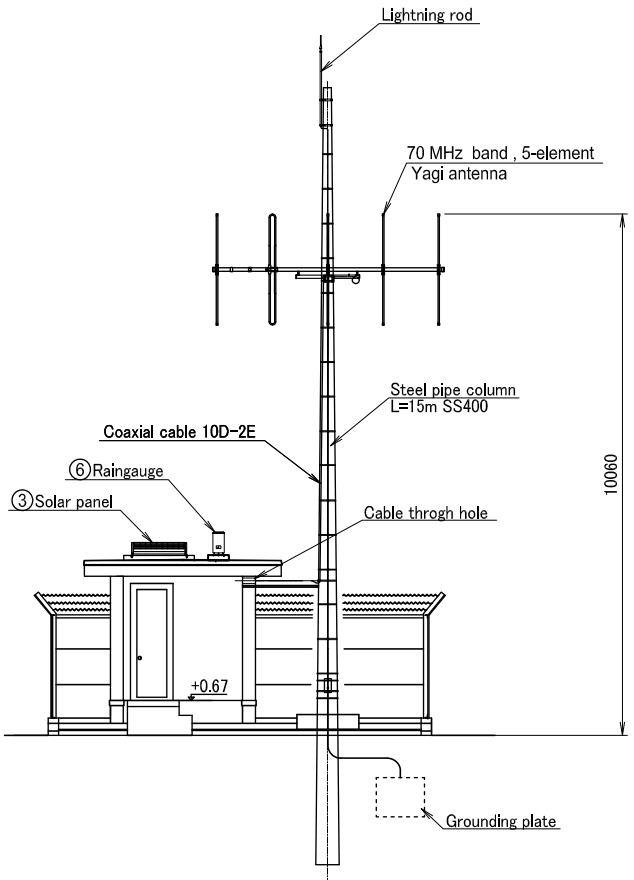


Wiring diagram

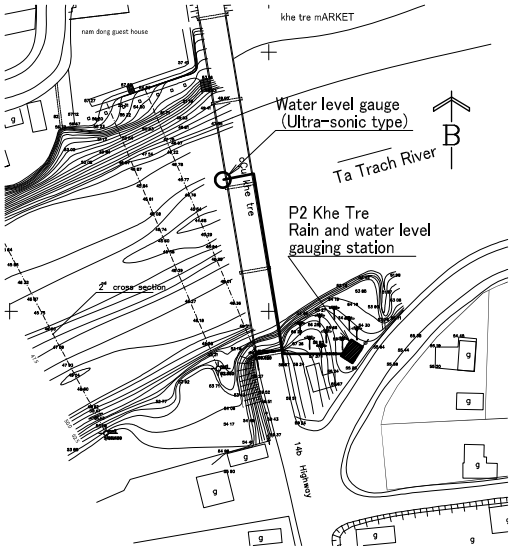
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P1 Thuong Lo Rain gauging station Equipment layout and wiring diagram		M-24



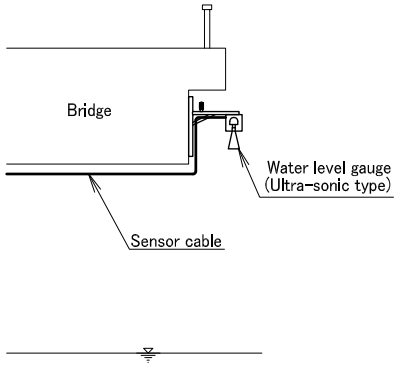
Site layout
(S=1/300)



Arrow view A-A
(S=1/100)

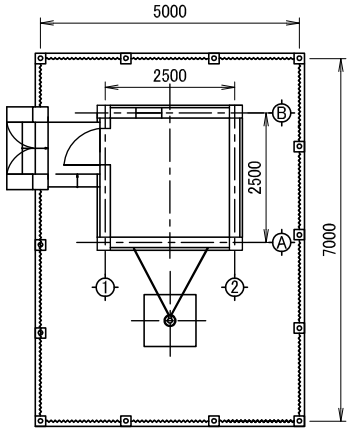


Site Map
(S=1/2000)

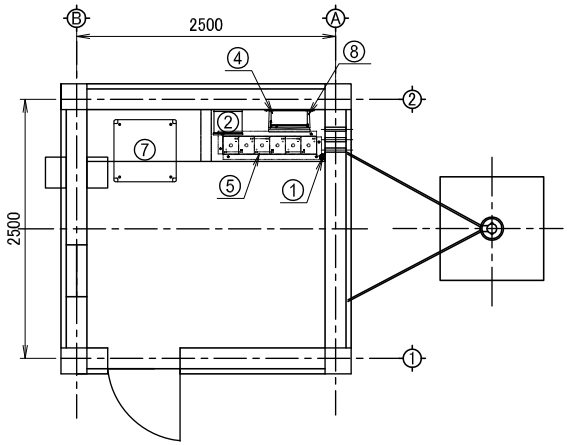


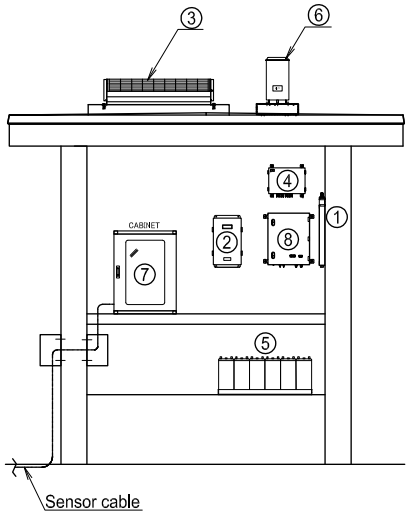
Water level gauge image
(Ultra-sonic type)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P2 Khe Tre Rain and water level gauging station Site layout and arrow view		M-25



Floor layout
(S=1/100)

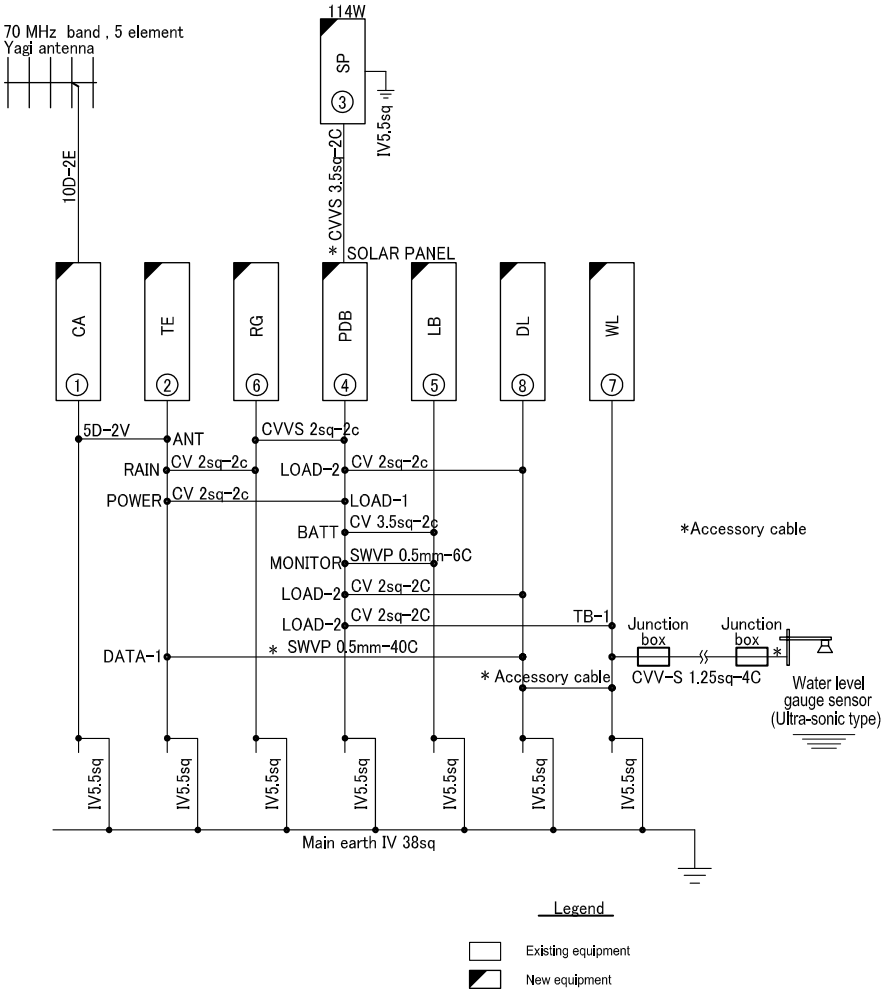




Equipment layout
(S=1/50)

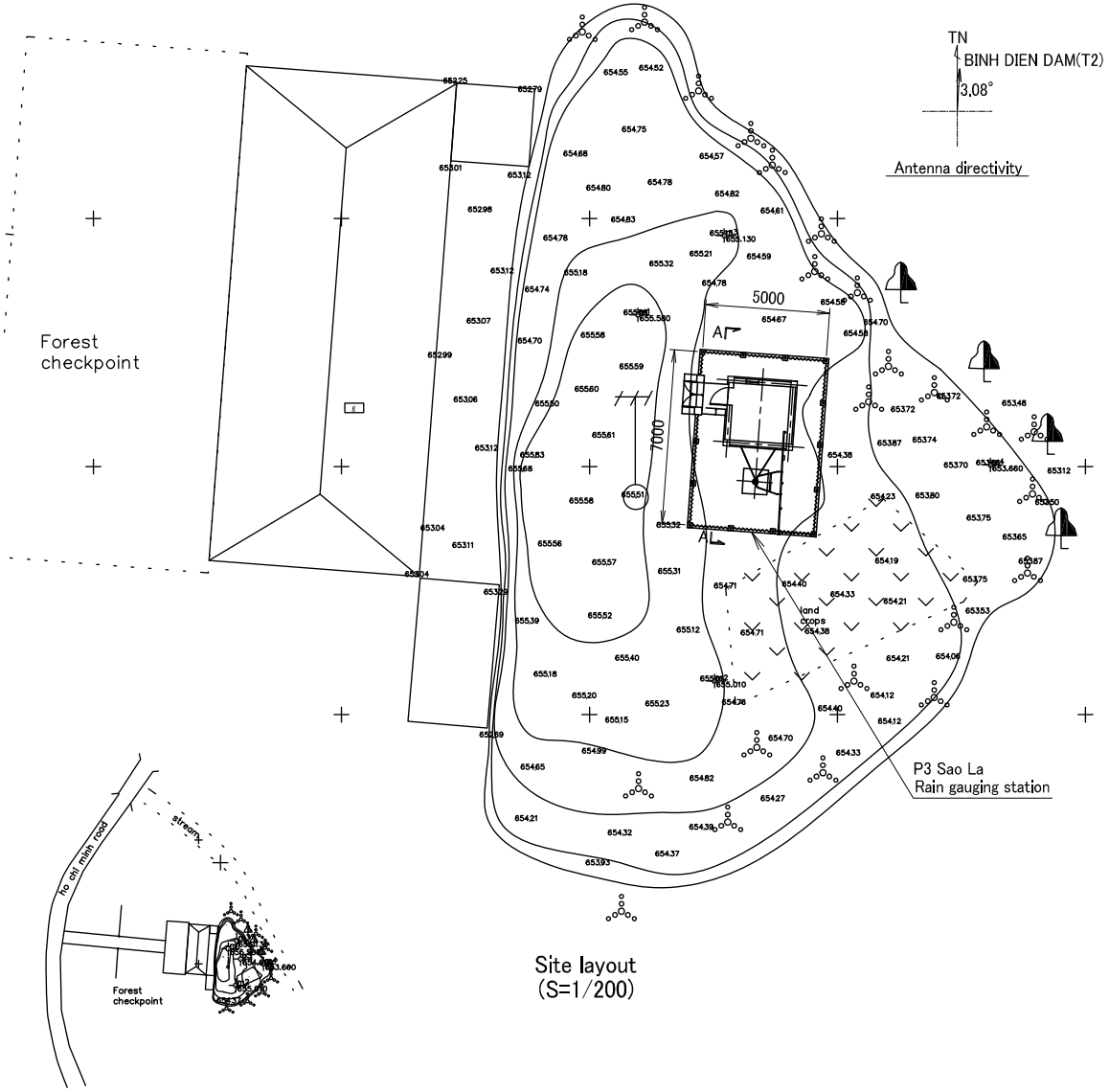
Legend

① CA : Coaxial arrester
② TE : Telemetry equipment
③ SP : Solar panel
④ PDB : Solar power distribution board
⑤ LB : Lead-acid battery
⑥ RG : Rain gauge
⑦ WL : Water level gauge
⑧ DL : Data logger

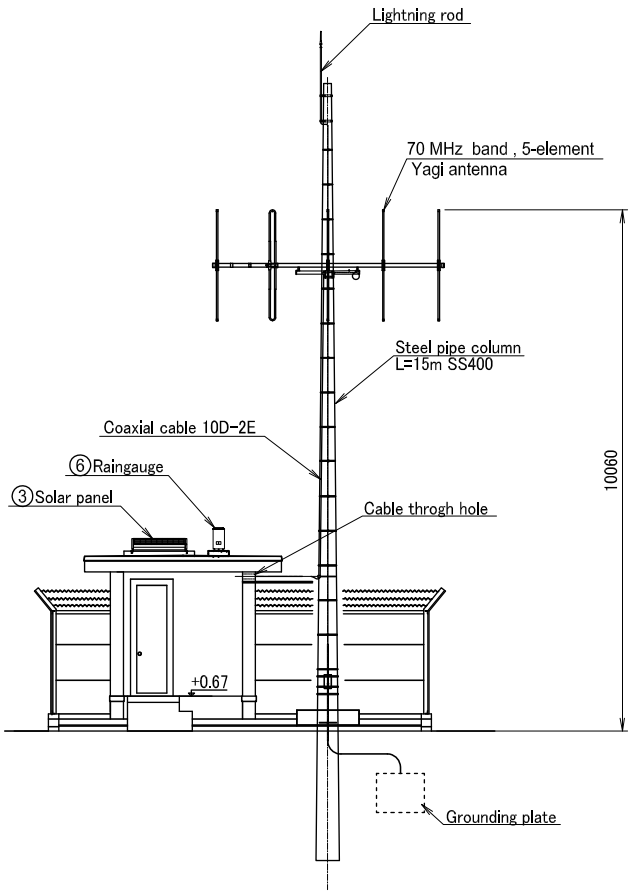


Wiring diagram

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P2 Khe Tre Rain and water level gauging station Equipment layout and wiring diagram		M-26



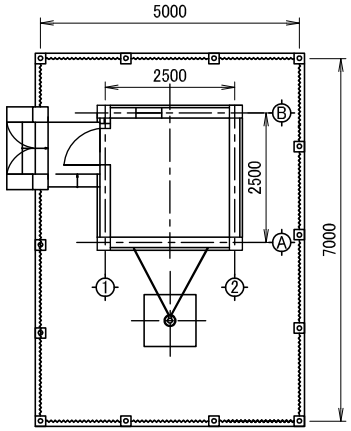
Site layout
(S=1/200)



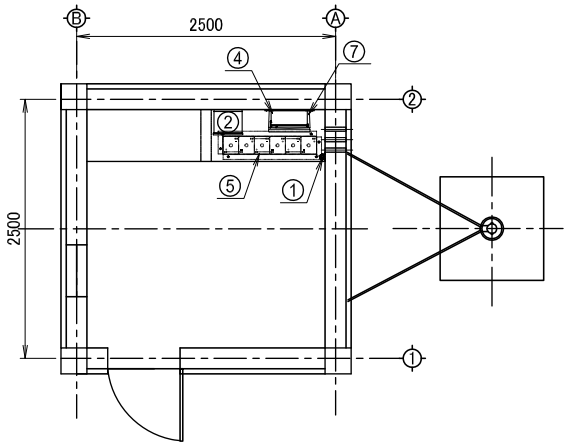
Arrow view A-A
(S=1/100)

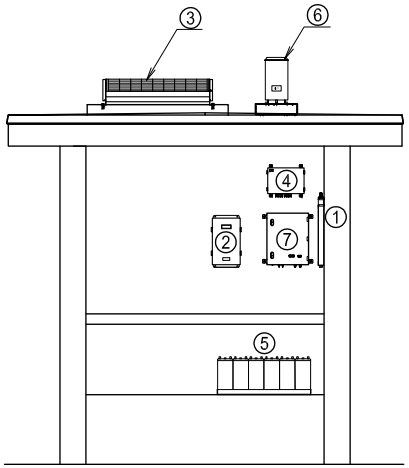
2-121

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P3 Sao La Rain gauging station Site layout and arrow view		M-27



Floor layout
(S=1/100)

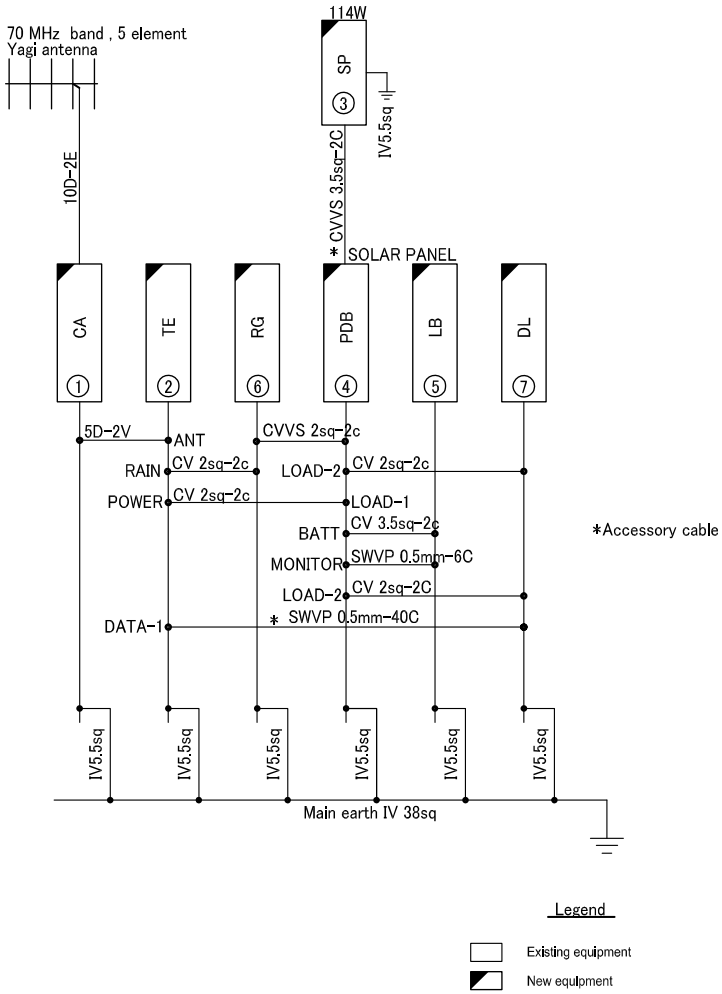




Equipment layout
(S=1/50)

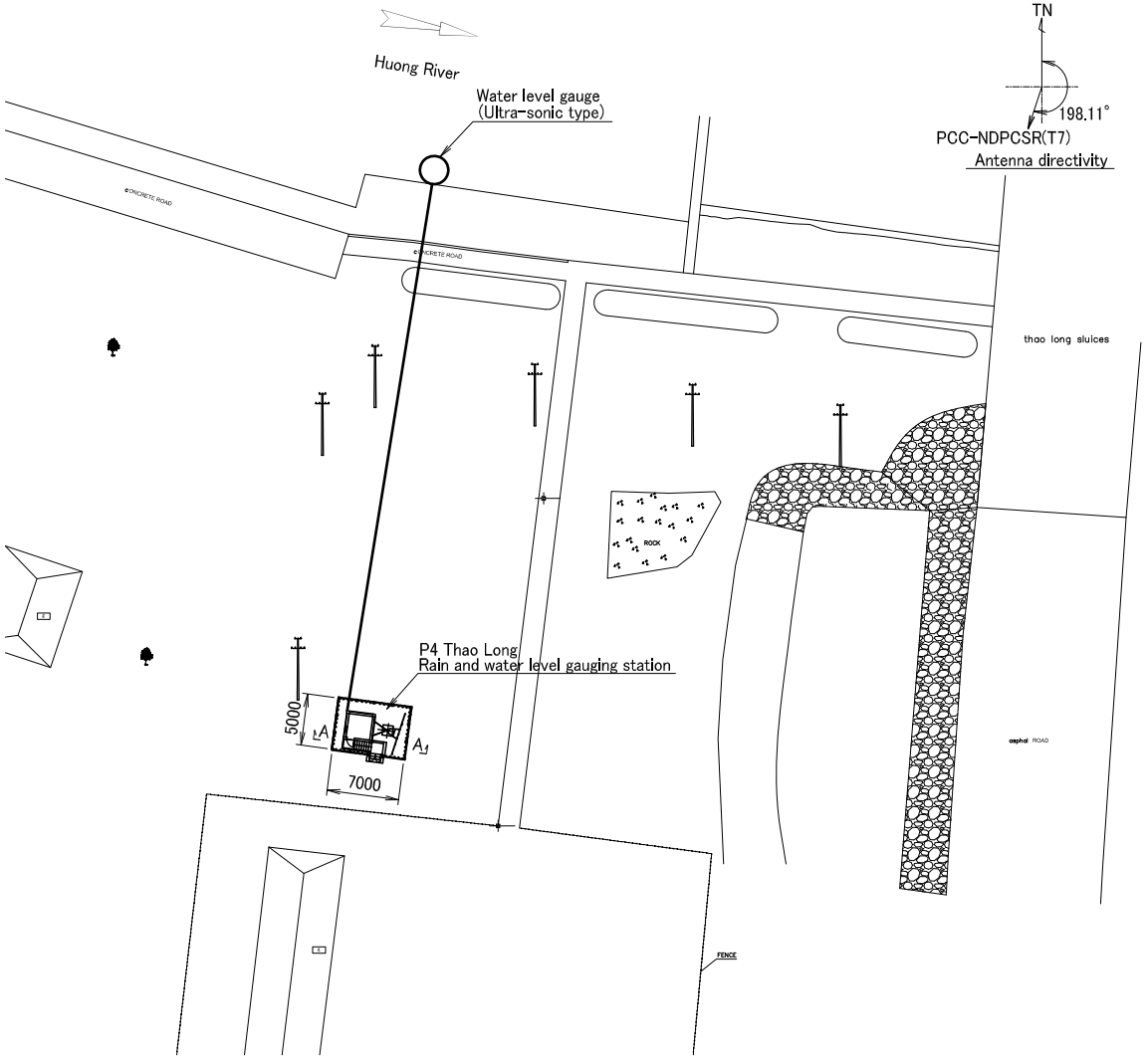
Legend

① CA : Coaxial arrester
② TE : Telemetry equipment
③ SP : Solar panel
④ PDB : Solar power distribution board
⑤ LB : Lead-acid battery
⑥ RG : Rain gauge
⑦ DL : Data logger

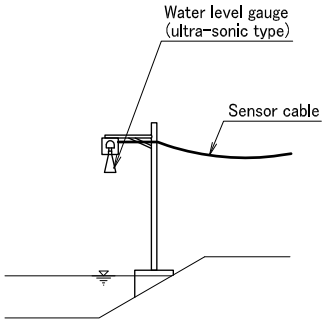


Wiring diagram

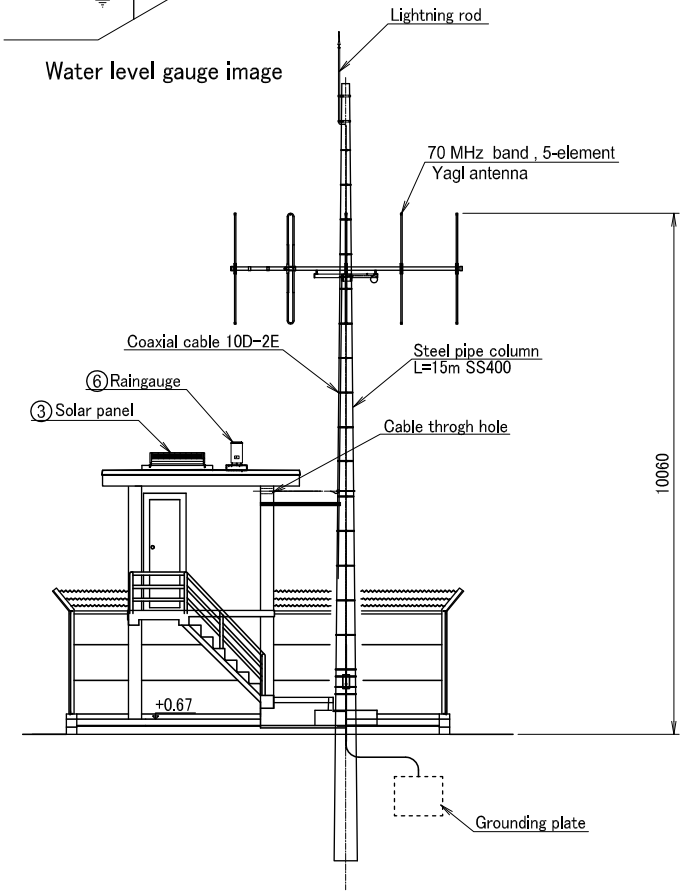
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P3 Sao La Rain gauging station Equipment layout and wiring diagram		M-28



Site layout
(S=1/500)

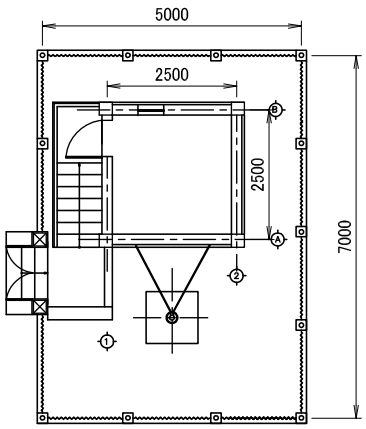


Water level gauge image

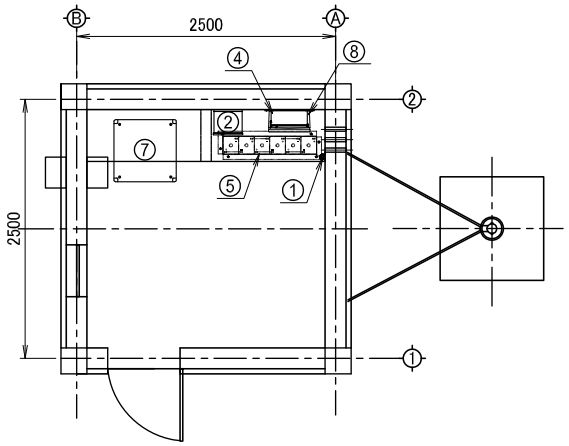


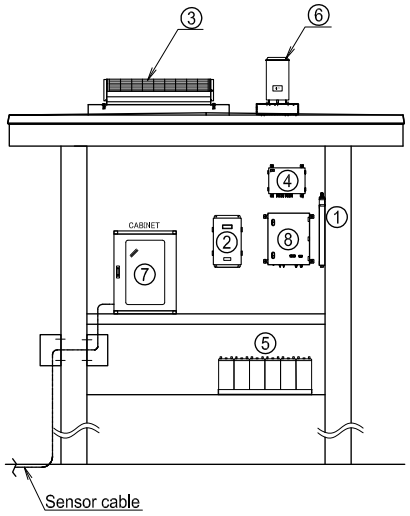
Arrow view A-A
(S=1/100)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P4 Thao Long Rain and water level gauging station Site layout and arrow view		M-29



Floor layout
(S=1/100)

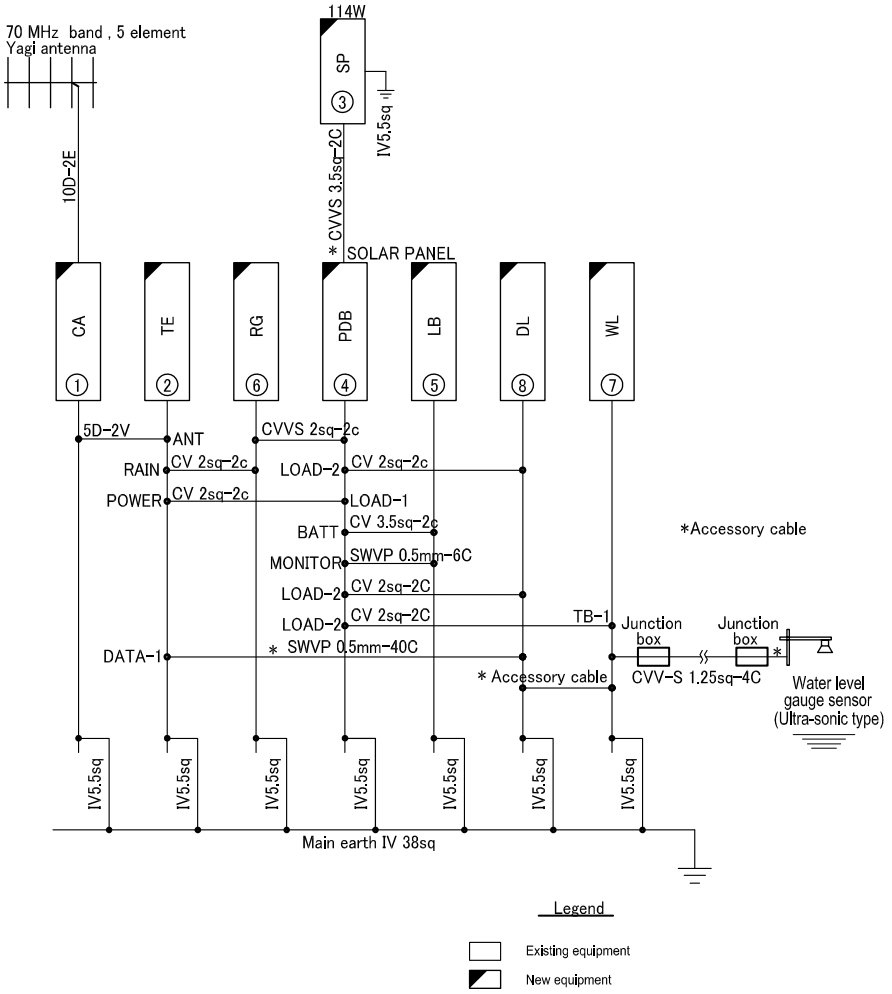




Equipment layout
(S=1/50)

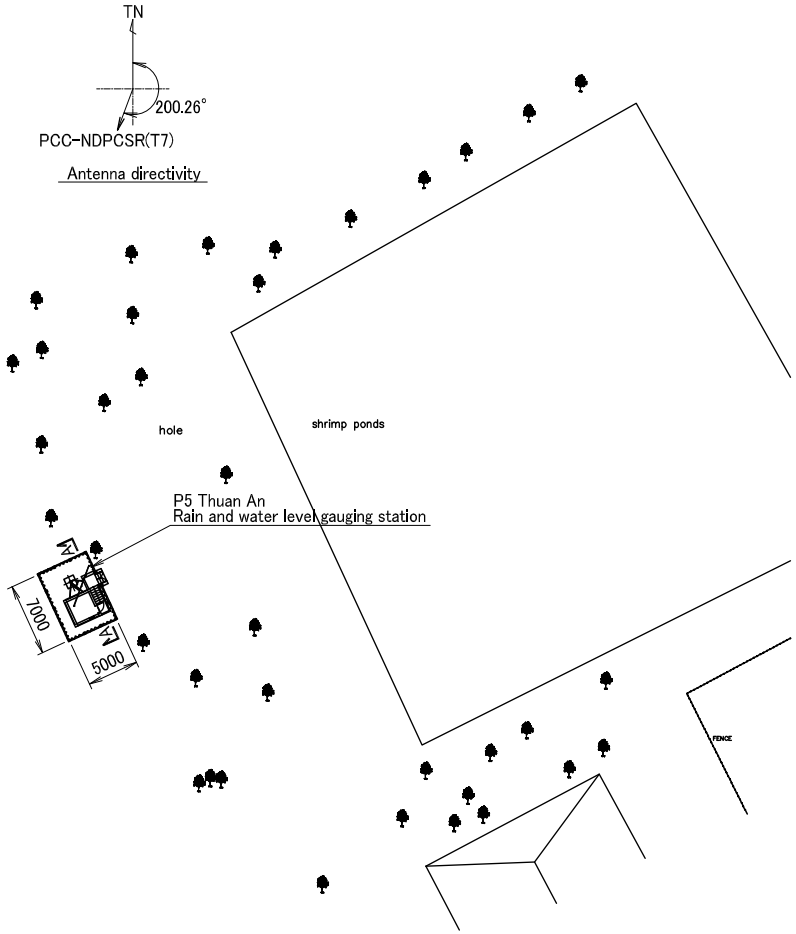
Legend

① CA : Coaxial arrester
② TE : Telemetry equipment
③ SP : Solar panel
④ PDB : Solar power distribution board
⑤ LB : Lead-acid battery
⑥ RG : Rain gauge
⑦ WL : Water level gauge
⑧ DL : Data logger

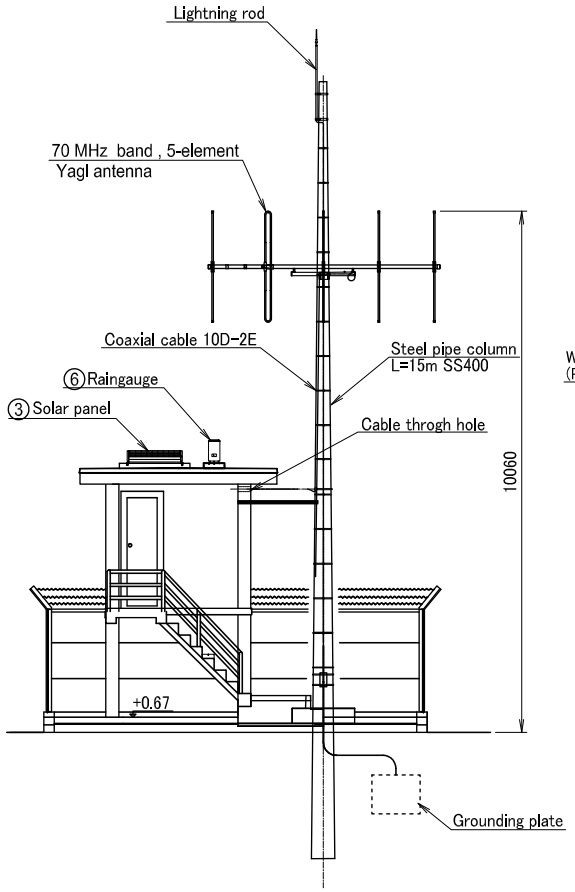


Wiring diagram

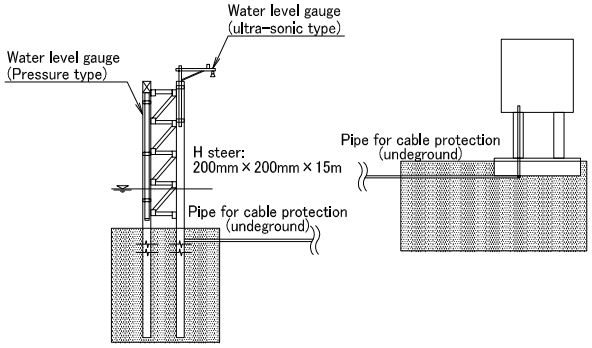
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P4 Thao Long Rain and water level gauging station Equipment layout and wiring diagram		M-30



Site layout
(S=1/500)

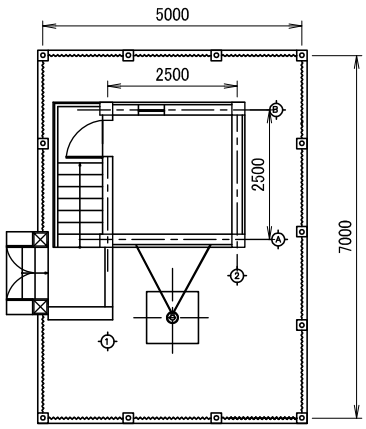


Arrow view A-A
(S=1/100)

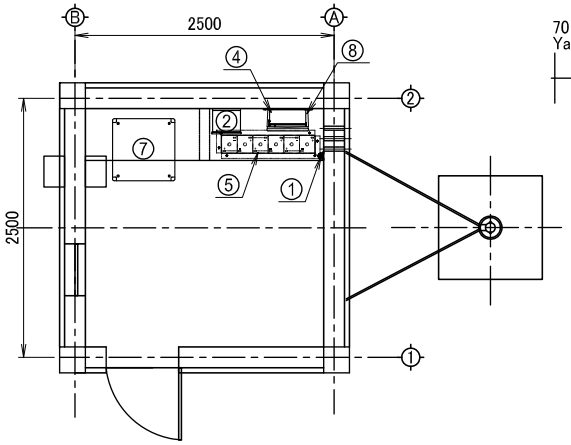


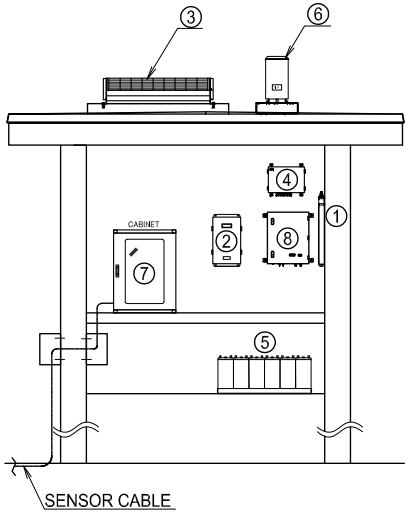
Water level gauge image

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P5 Thuan An Rain and water level gauging station Site layout and arrow view		M-31



Floor layout
(S=1/100)

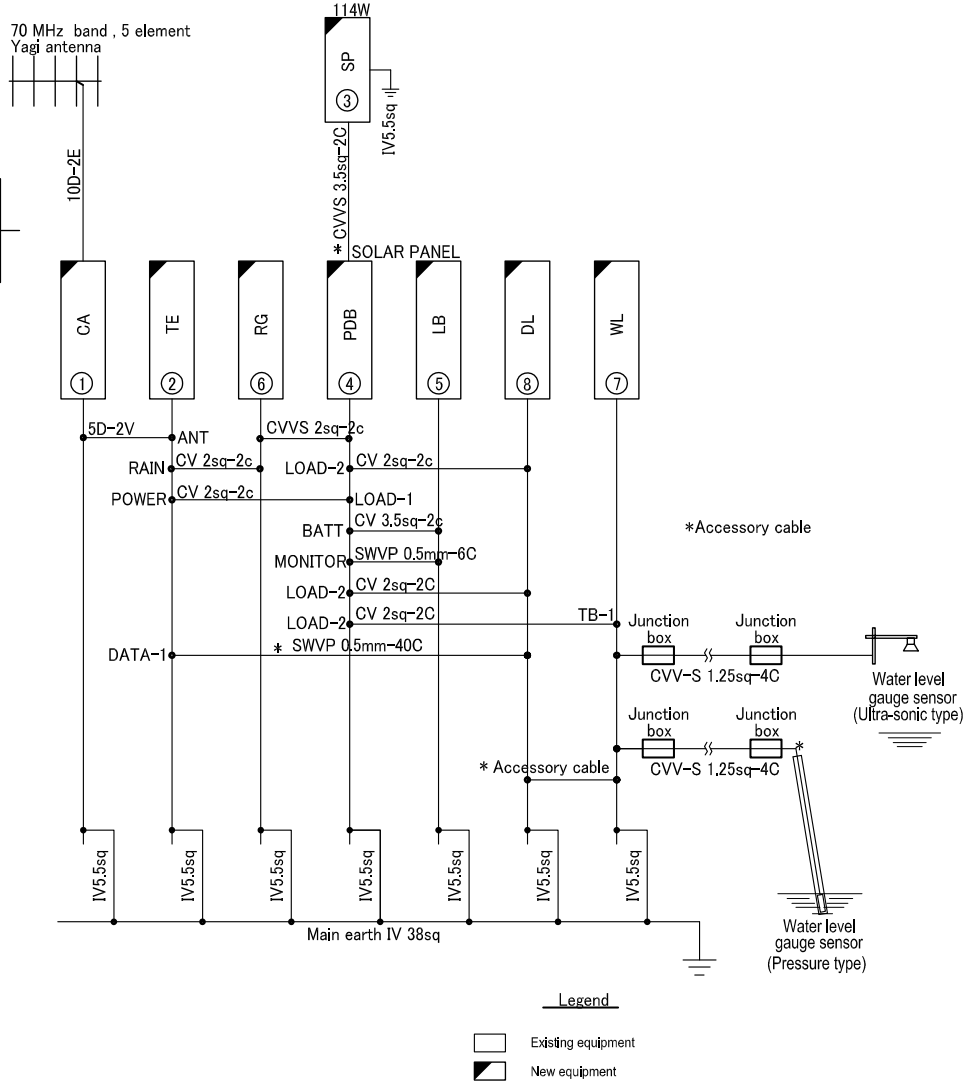




Equipment layout
(S=1/50)

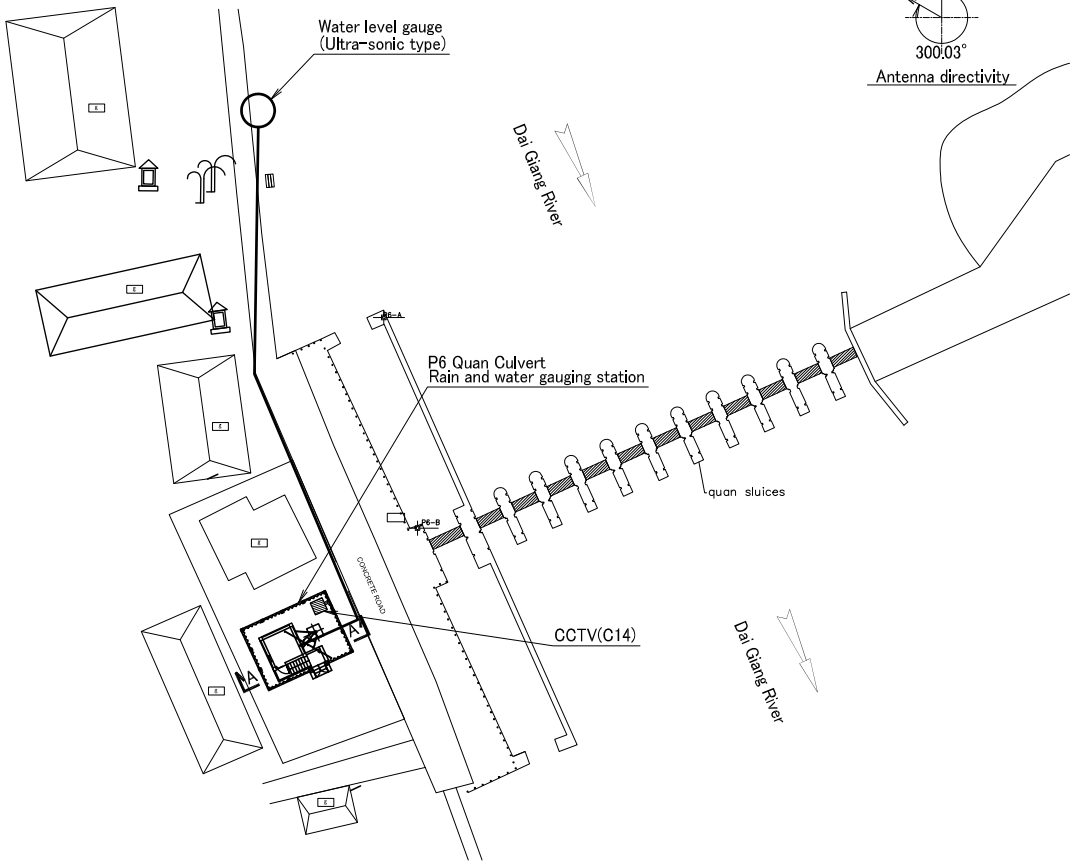
Legend

① CA : Coaxial arrester
② TE : Telemetry equipment
③ SP : Solar panel
④ PDB : Solar power distribution board
⑤ LB : Lead-acid battery
⑥ RG : Rain gauge
⑦ WL : Water level gauge
⑧ DL : Data logger

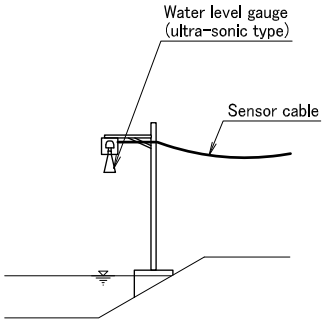


Wiring diagram

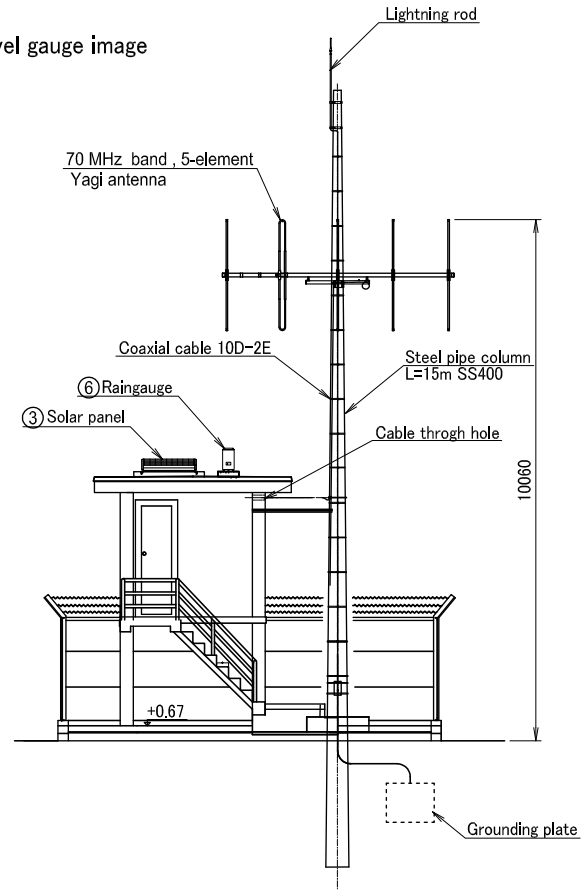
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P5 Thuan An Rain and water level gauging station Equipment layout and wiring diagram		M-32



Site layout
(S=1/400)

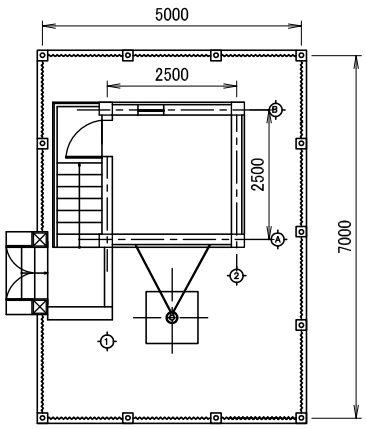


Water level gauge image

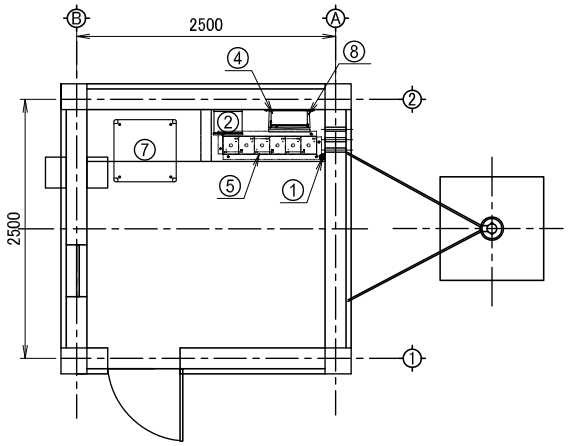


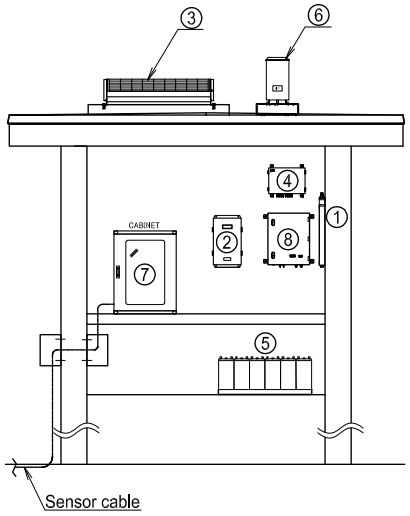
Arrow view A-A
(S=1/100)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P6 Quan Culvert Rain and water gauging station Site layout and arrow view		M-33



Floor layout
(S=1/100)

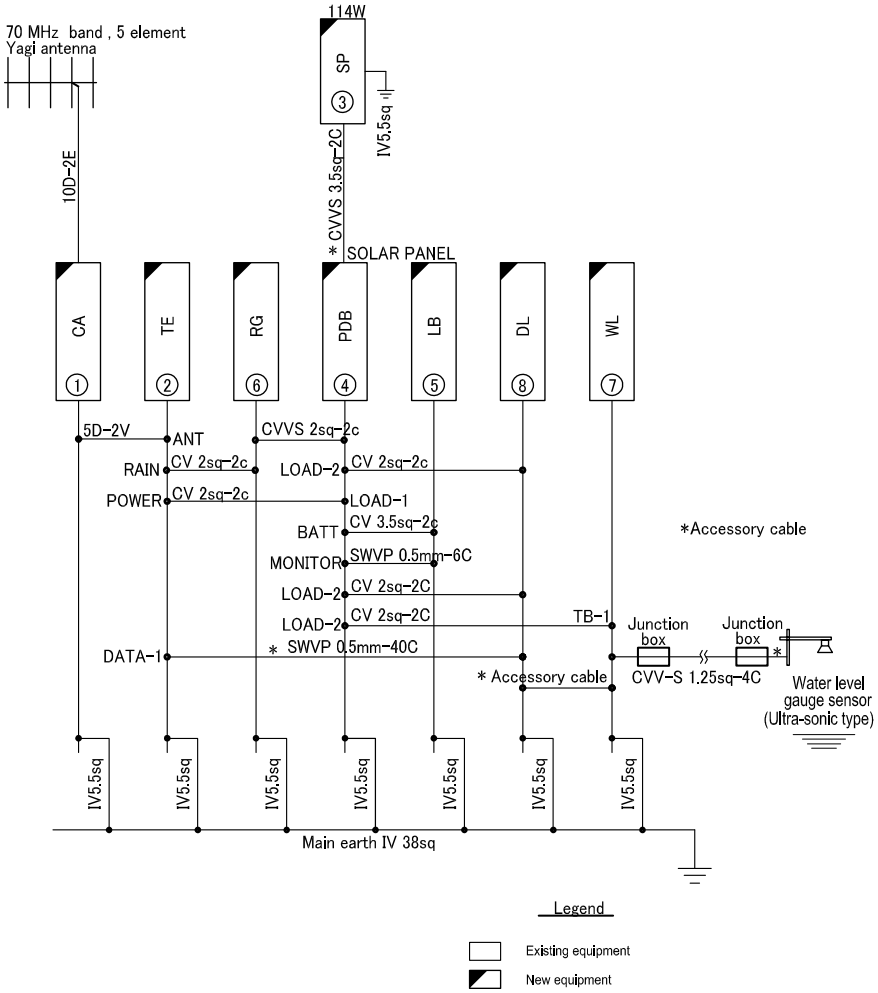




Equipment layout
(S=1/50)

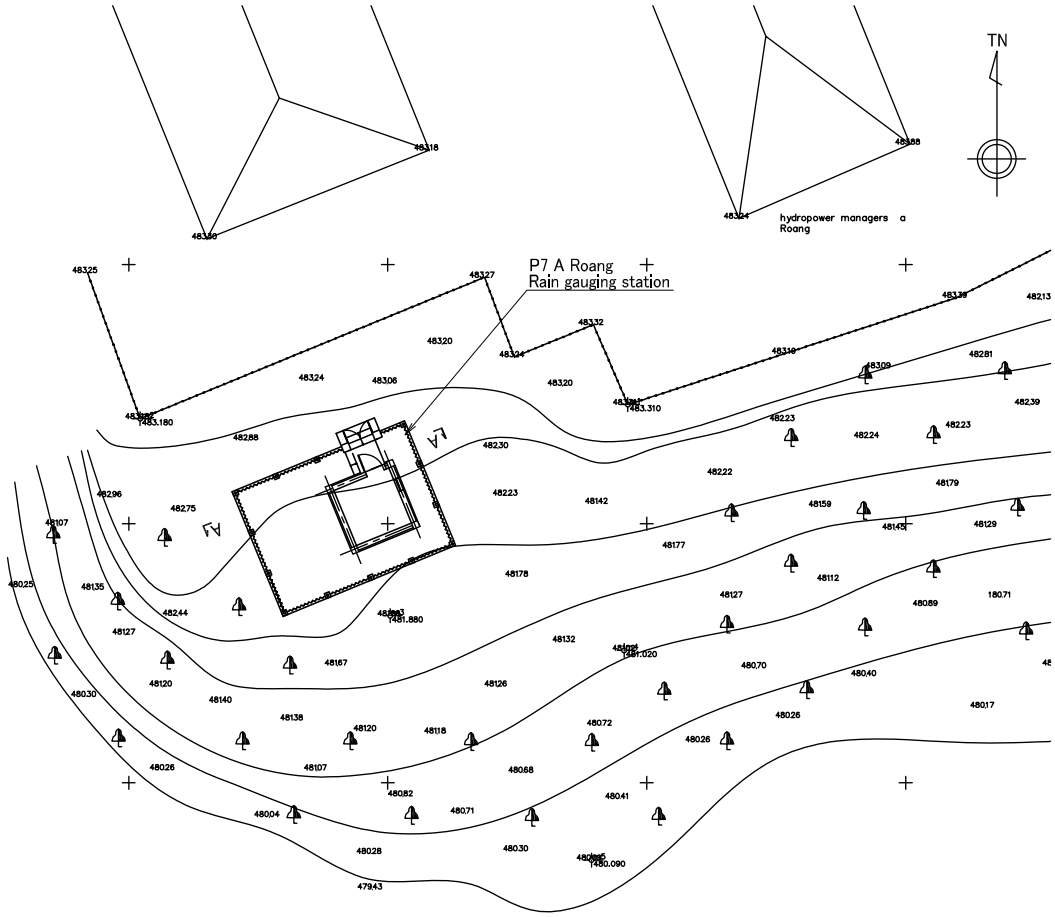
Legend

① CA : Coaxial arrester
② TE : Telemetry equipment
③ SP : Solar panel
④ PDB : Solar power distribution board
⑤ LB : Lead-acid battery
⑥ RG : Rain gauge
⑦ WL : Water level gauge
⑧ DL : Data logger

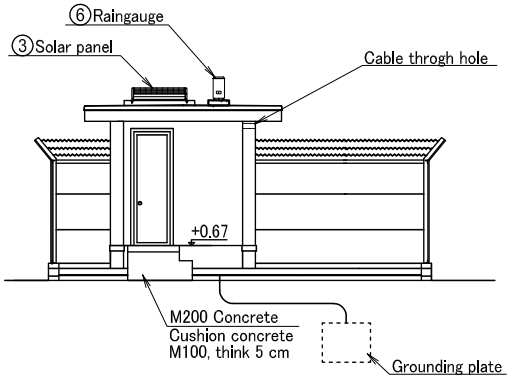


Wiring diagram

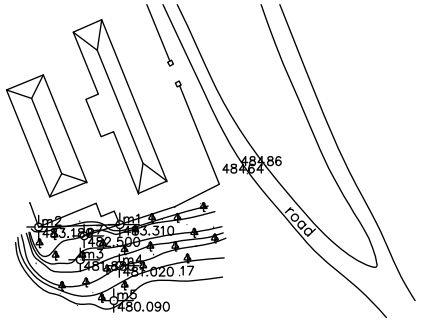
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P6 Quan Culvert Rain and water level gauging station Equipment layout and wiring diagram		M-34



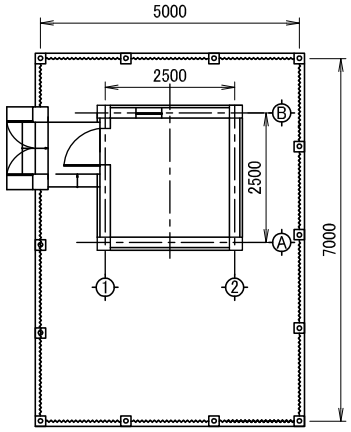
Site layout
(S=1/200)



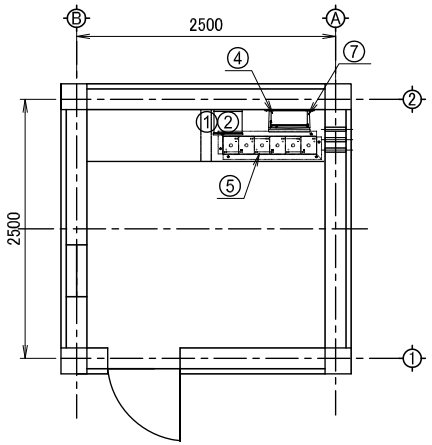
Arrow view A-A
(S=1/100)

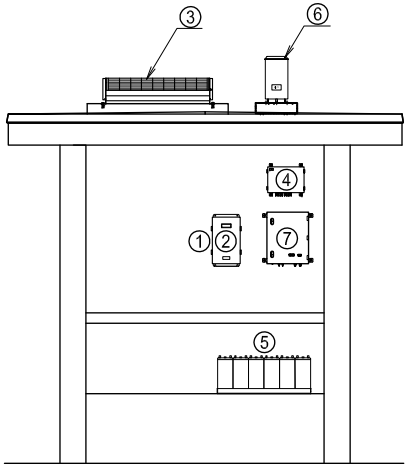


CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P7 A Roang Rain gauging station Site layout and arrow view		M-35



Floor layout
(S=1/100)

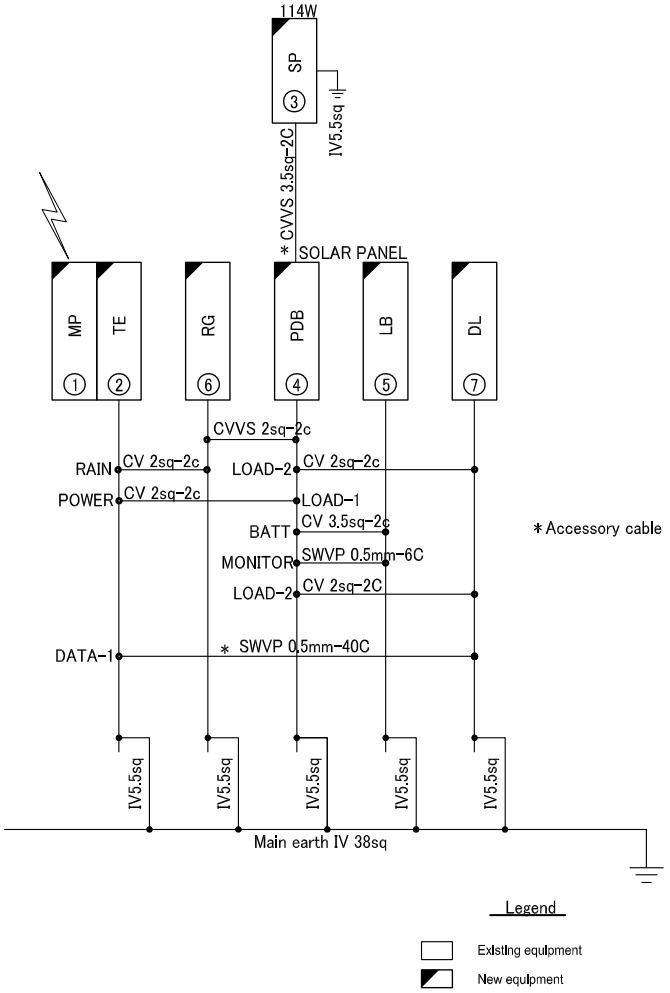




Equipment layout
(S=1/50)

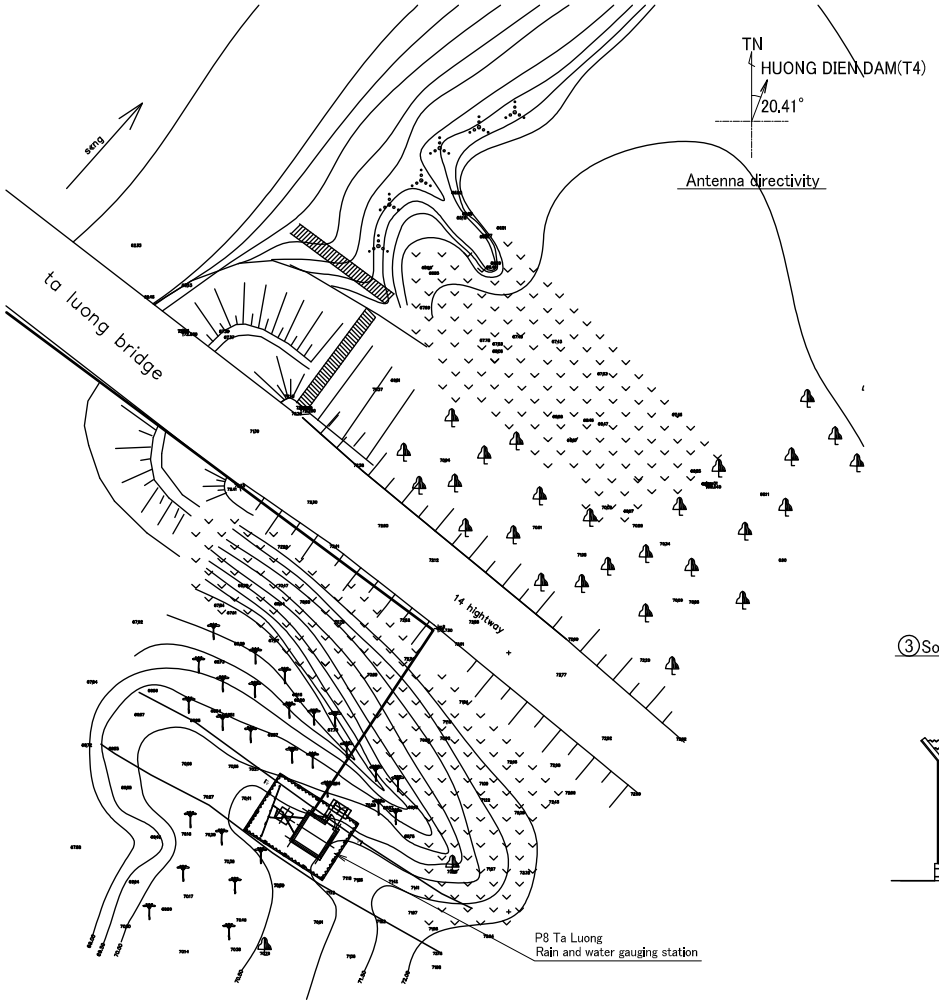
Legend

① MP : Mobile phone
② TE : Telemetry equipment
③ SP : Solar panel
④ PDB : Solar power distribution board
⑤ LB : Lead-acid battery
⑥ RG : Rain gauge
⑦ DL : Data logger

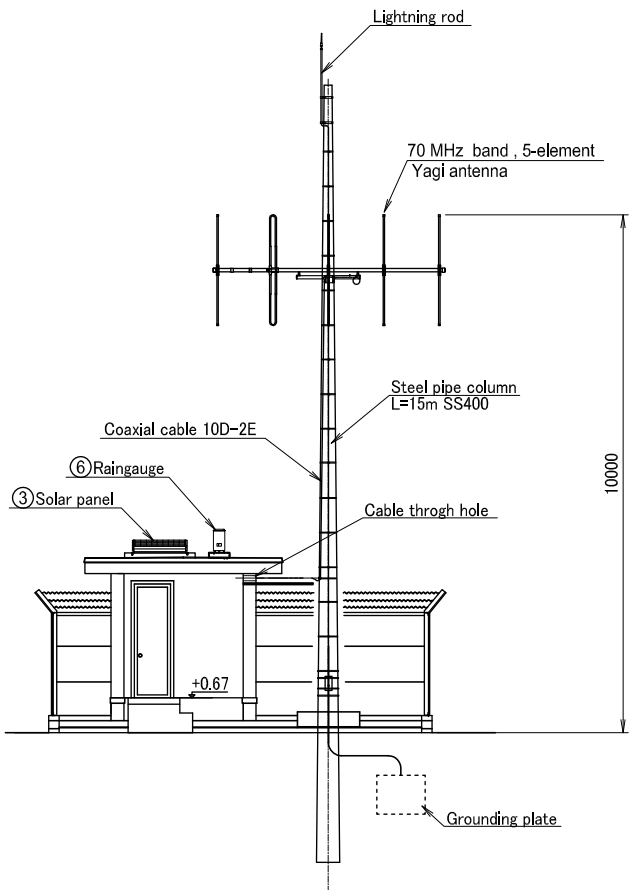


Wiring diagram

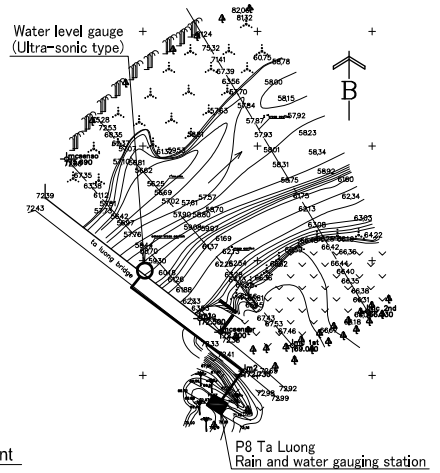
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P7 A Roang Rain gauging station Equipment layout and wiring diagram		M-36



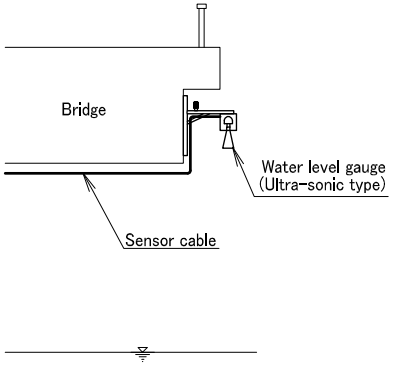
Site layout
(S=1/400)



Arrow view A-A
(S=1/100)

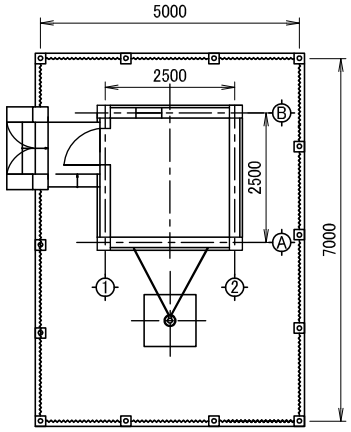


Site Map

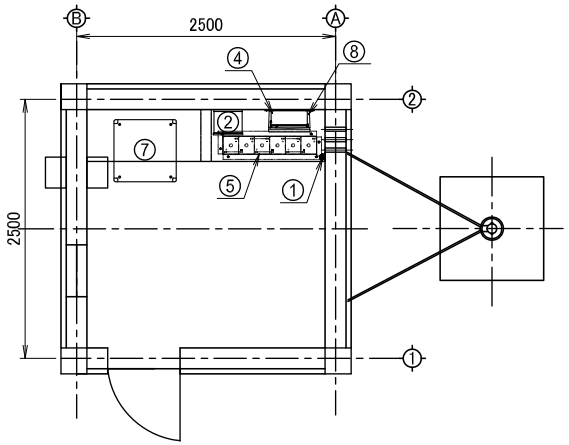


Water level gauge image
(Ultra-sonic type)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P8 Ta Luong Rain and water gauging station Site layout and arrow view		M-37

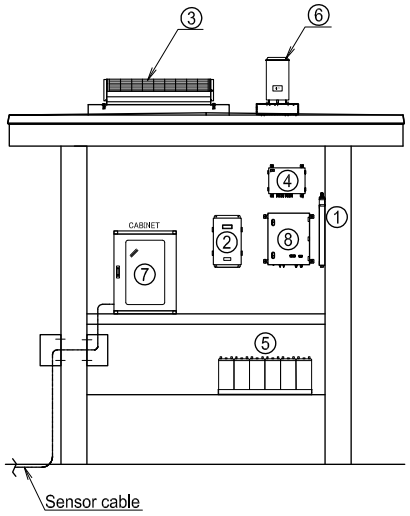


Floor layout
(S=1/100)

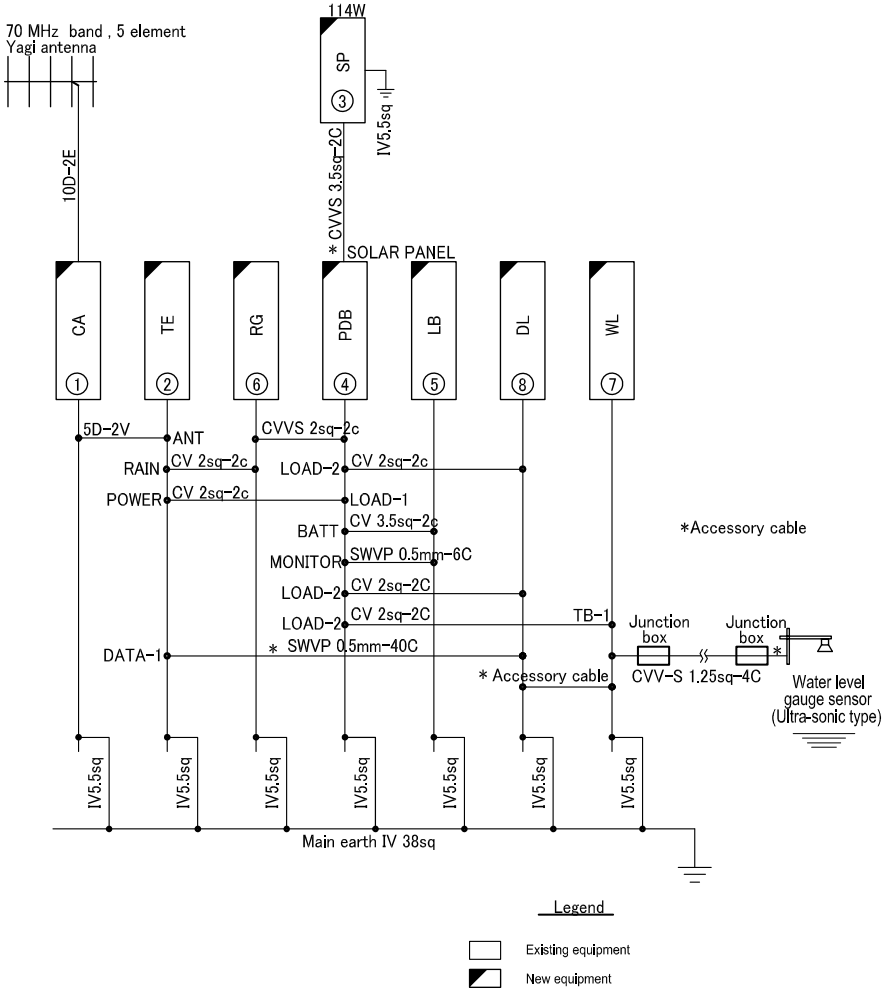


Legend

① CA : Coaxial arrester
② TE : Telemetry equipment
③ SP : Solar panel
④ PDB : Solar power distribution board
⑤ LB : Lead-acid battery
⑥ RG : Rain gauge
⑦ WL : Water level gauge
⑧ DL : Data logger

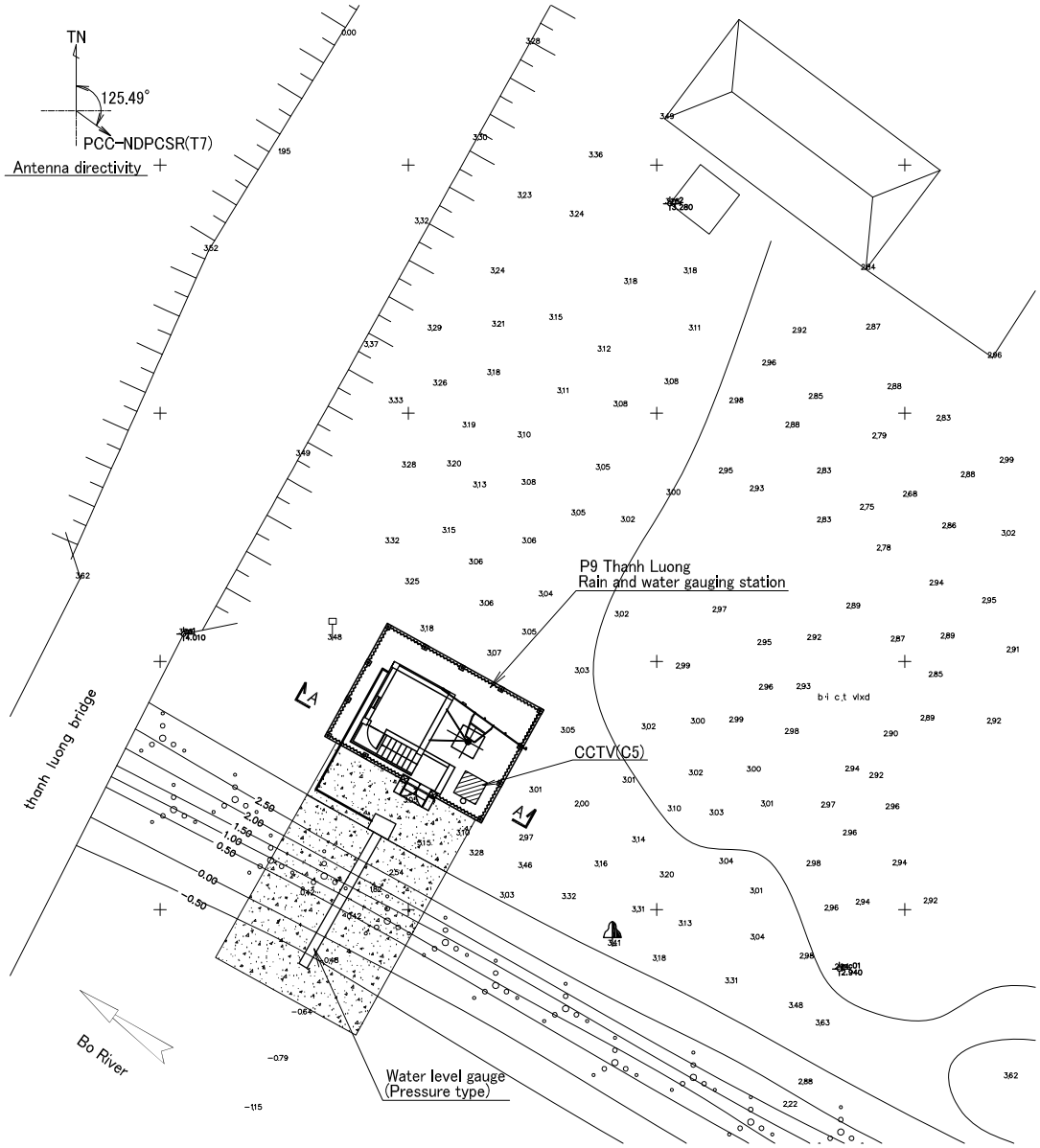


Equipment layout
(S=1/50)

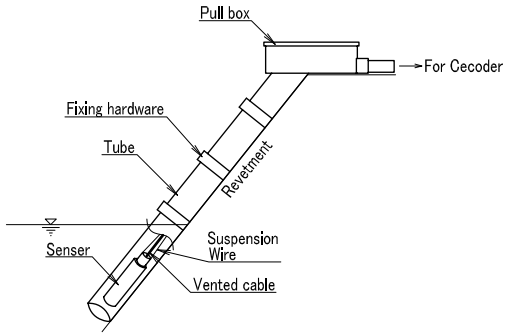


Wiring diagram

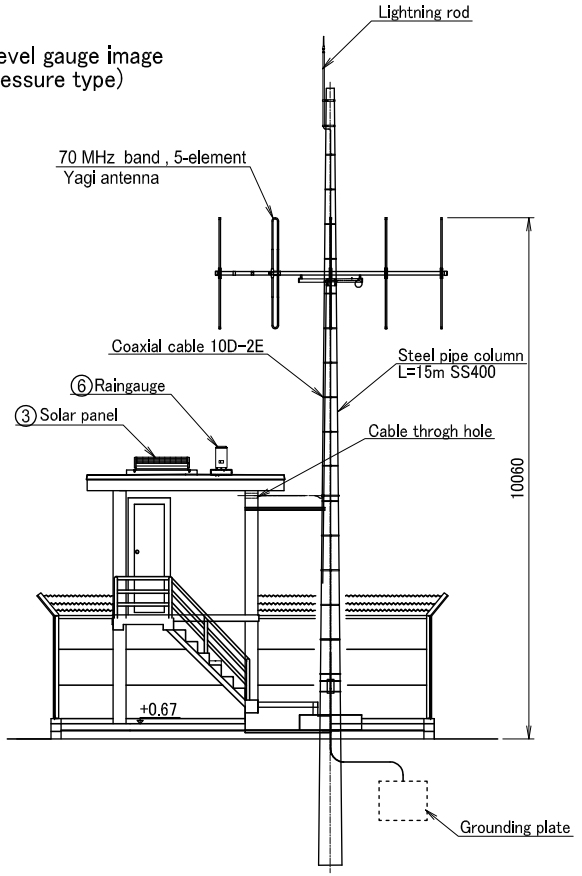
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P8 Ta Luong Rain and water level gauging station Equipment layout and wiring diagram		M-38



Site layout
(S=1/200)

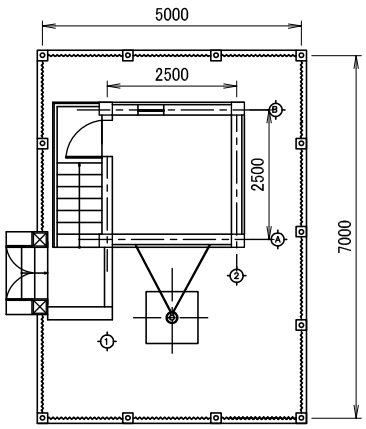


Water level gauge image
(Pressure type)

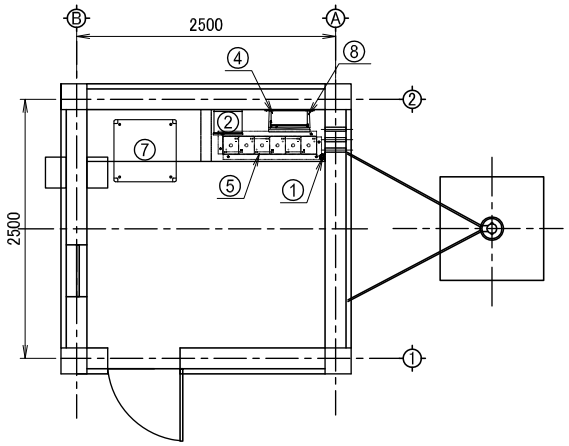


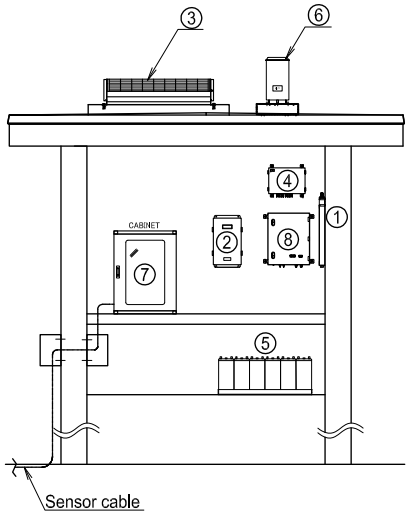
Arrow view A-A
(S=1/100)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P9 Thanh Luong Rain and water gauging station Site layout and arrow view		M-39



Floor layout
(S=1/100)

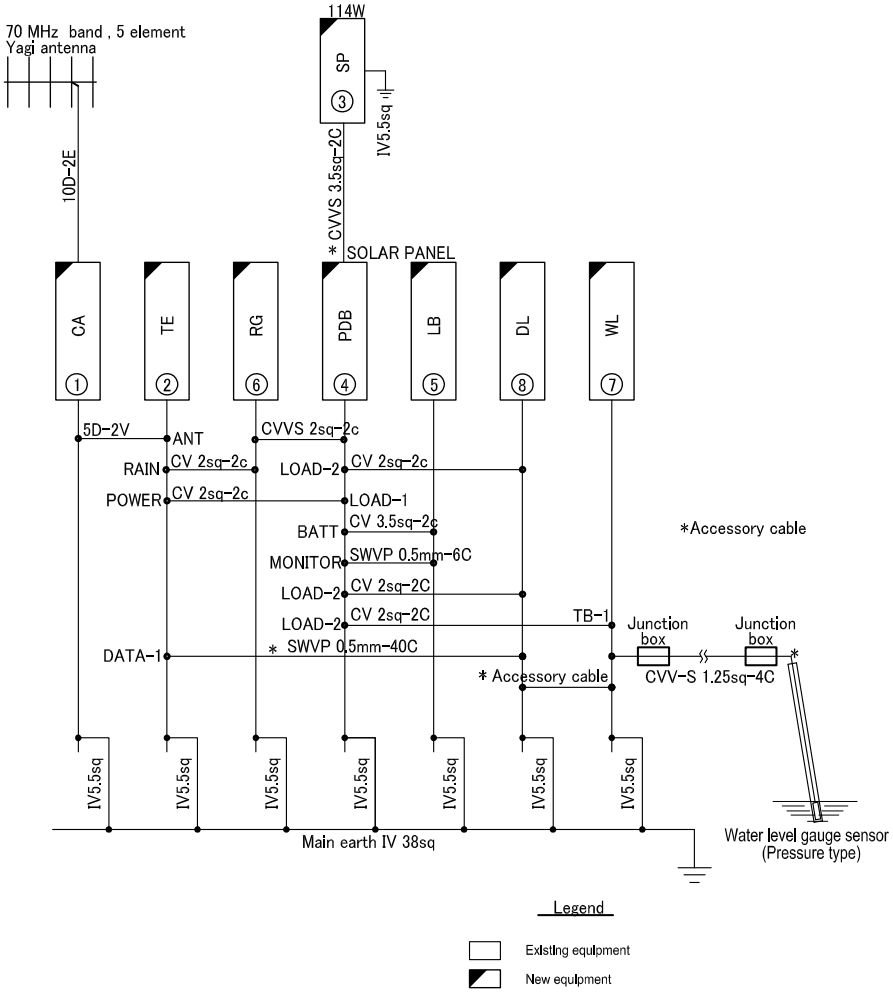




Equipment layout
(S=1/50)

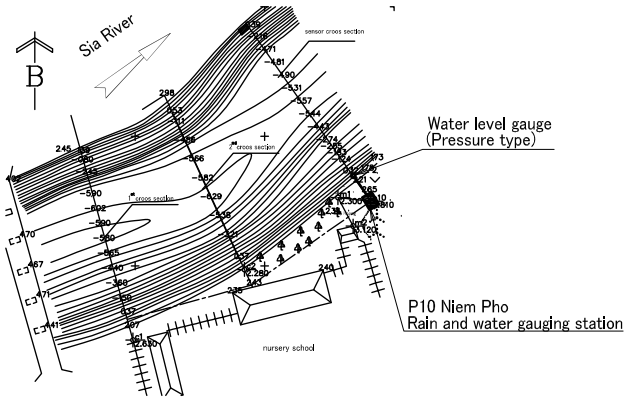
Legend

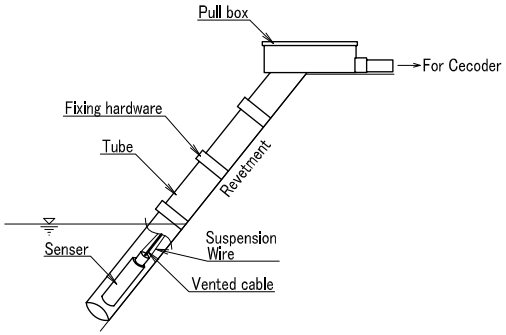
① CA : Coaxial arrester
② TE : Telemetry equipment
③ SP : Solar panel
④ PDB : Solar power distribution board
⑤ LB : Lead-acid battery
⑥ RG : Rain gauge
⑦ WL : Water level gauge
⑧ DL : Data logger



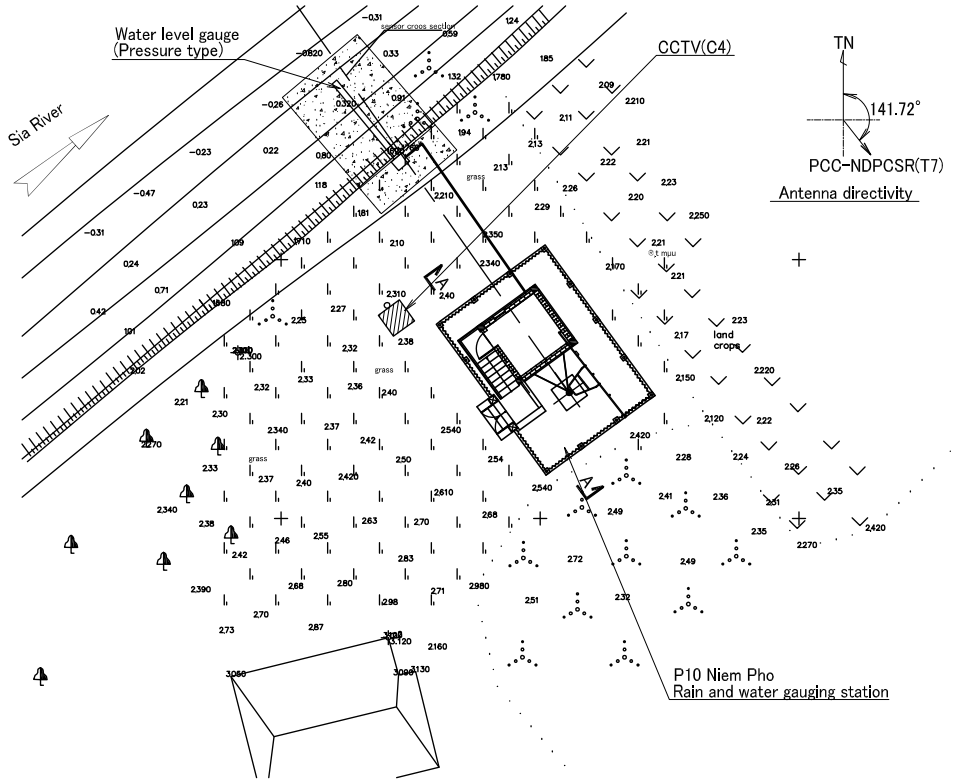
Wiring diagram

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P9 Thanh Luong Rain and water gauging station Equipment layout and wiring diagram		M-40



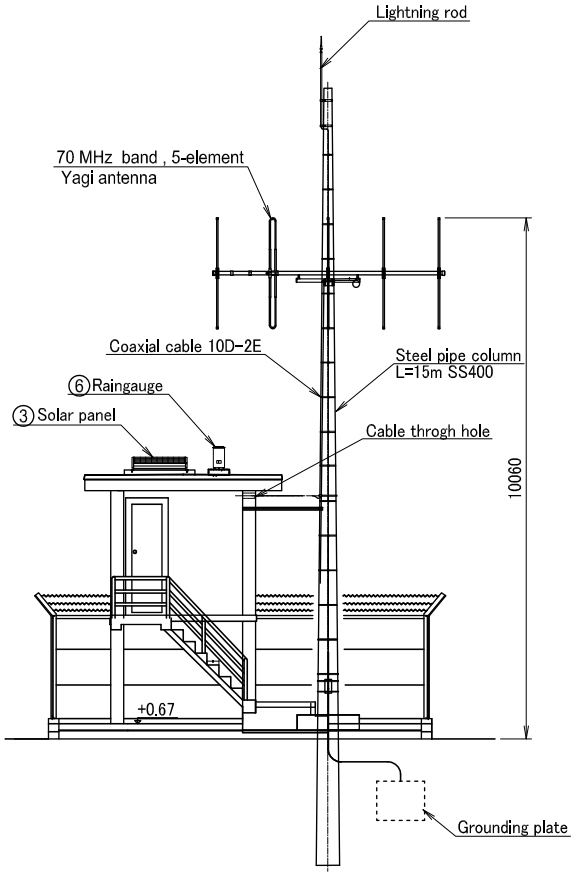


Water level gauge image
(Pressure type)



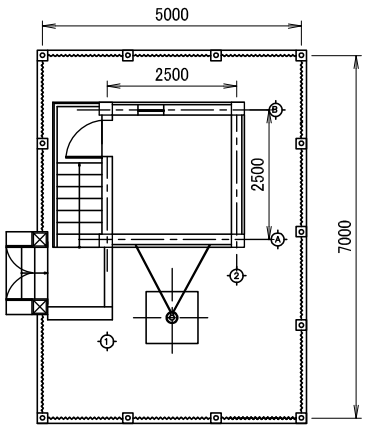
Antenna directivity

Site layout
(S=1/200)

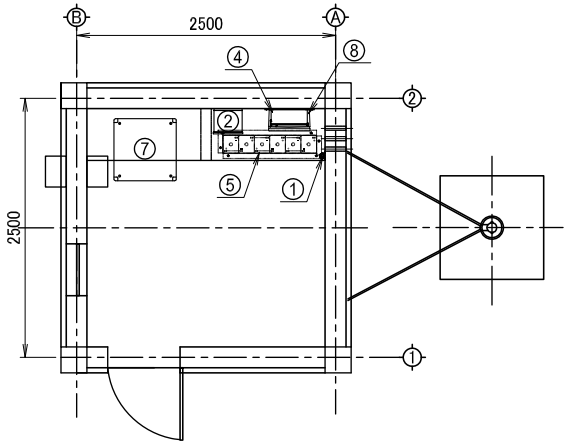


Arrow view A-A
(S=1/100)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P10 Niem Pho Rain and water gauging station Site layout and arrow view		M-41

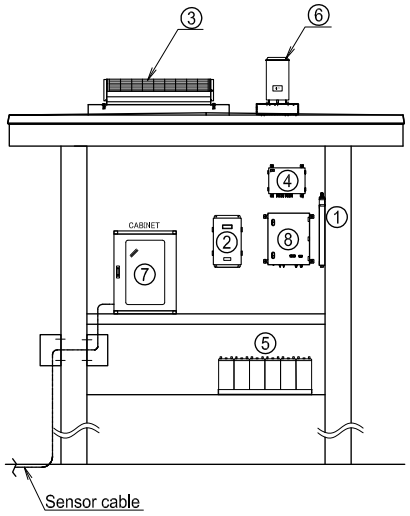


Floor layout
(S=1/100)

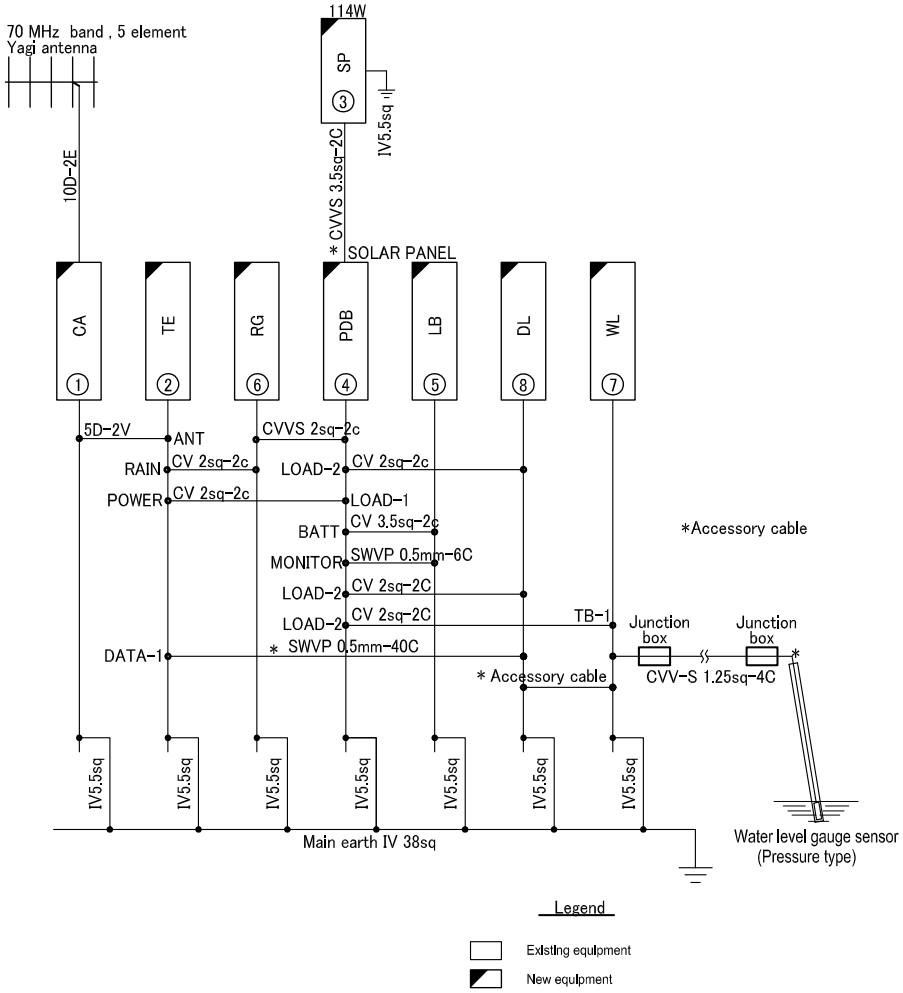


Legend

① CA : Coaxial arrester
② TE : Telemetry equipment
③ SP : Solar panel
④ PDB : Solar power distribution board
⑤ LB : Lead-acid battery
⑥ RG : Rain gauge
⑦ WL : Water level gauge
⑧ DL : Data logger

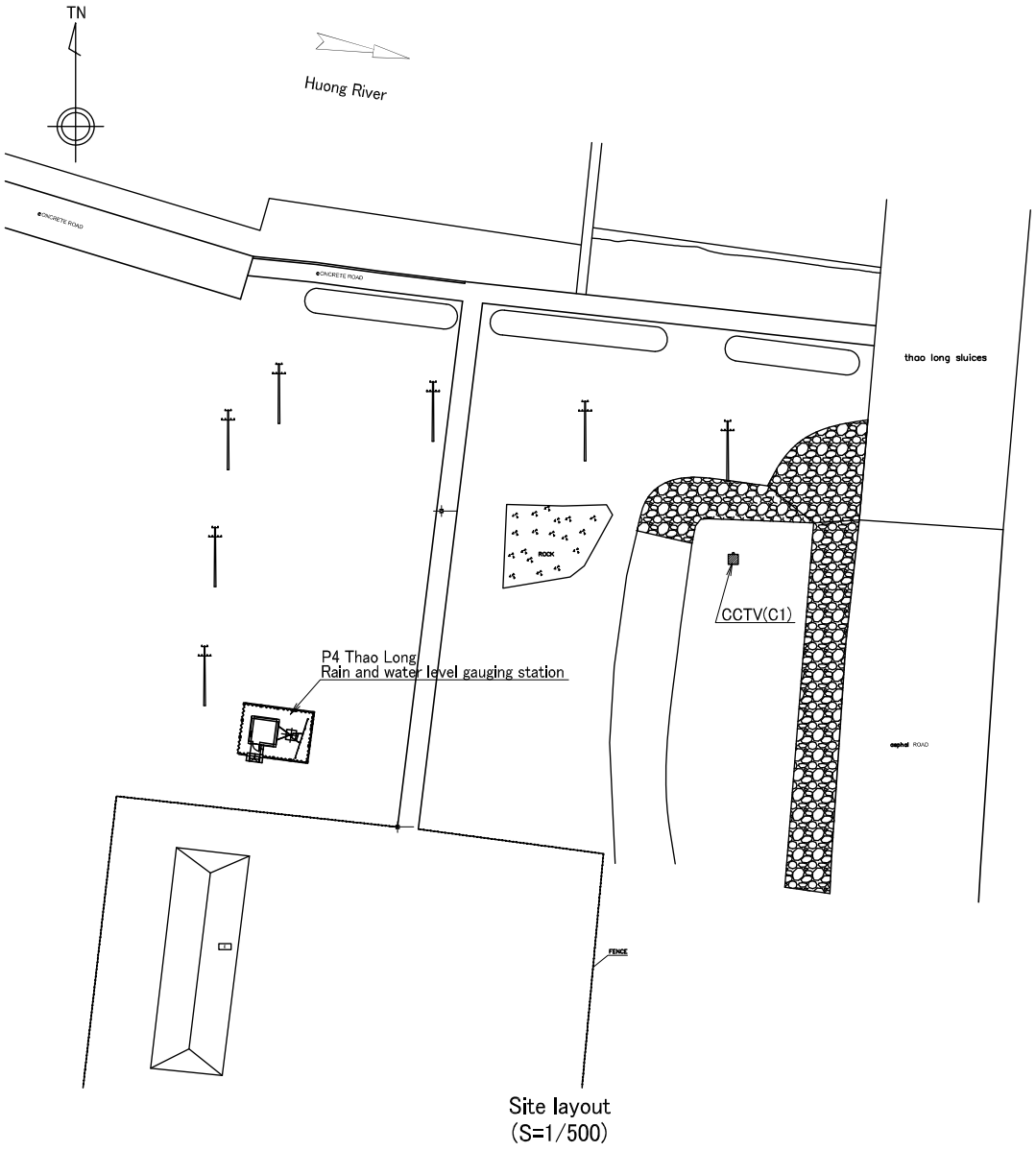


Equipment layout
(S=1/50)

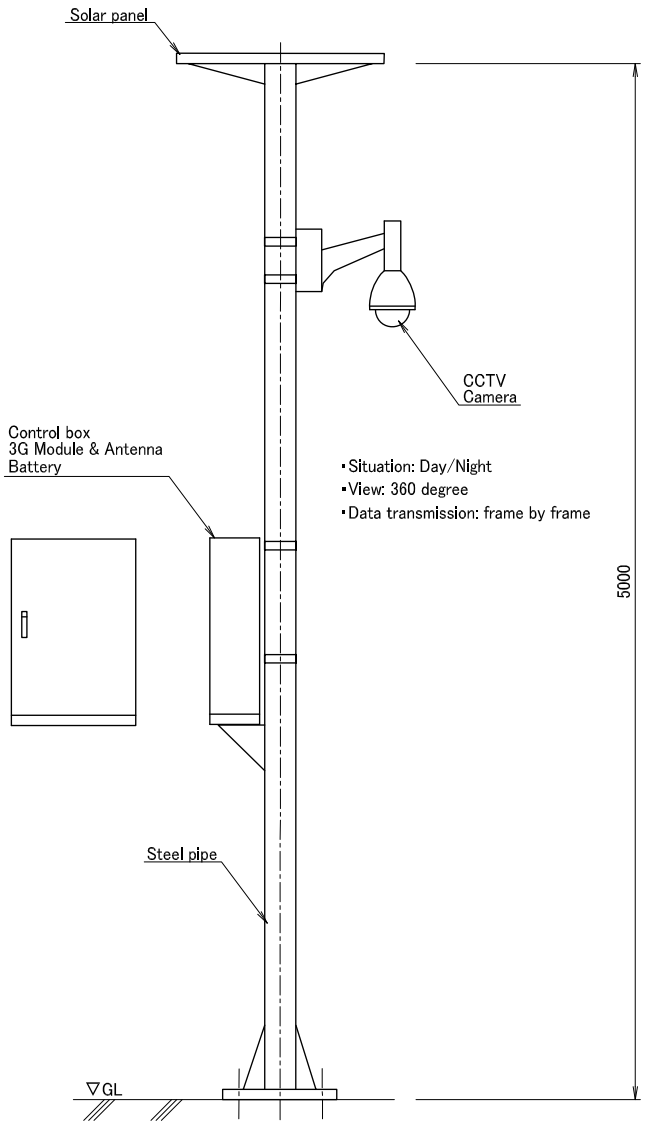


Wiring diagram

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	P10 Niem Pho Rain and water gauging station Equipment layout and wiring diagram		M-42

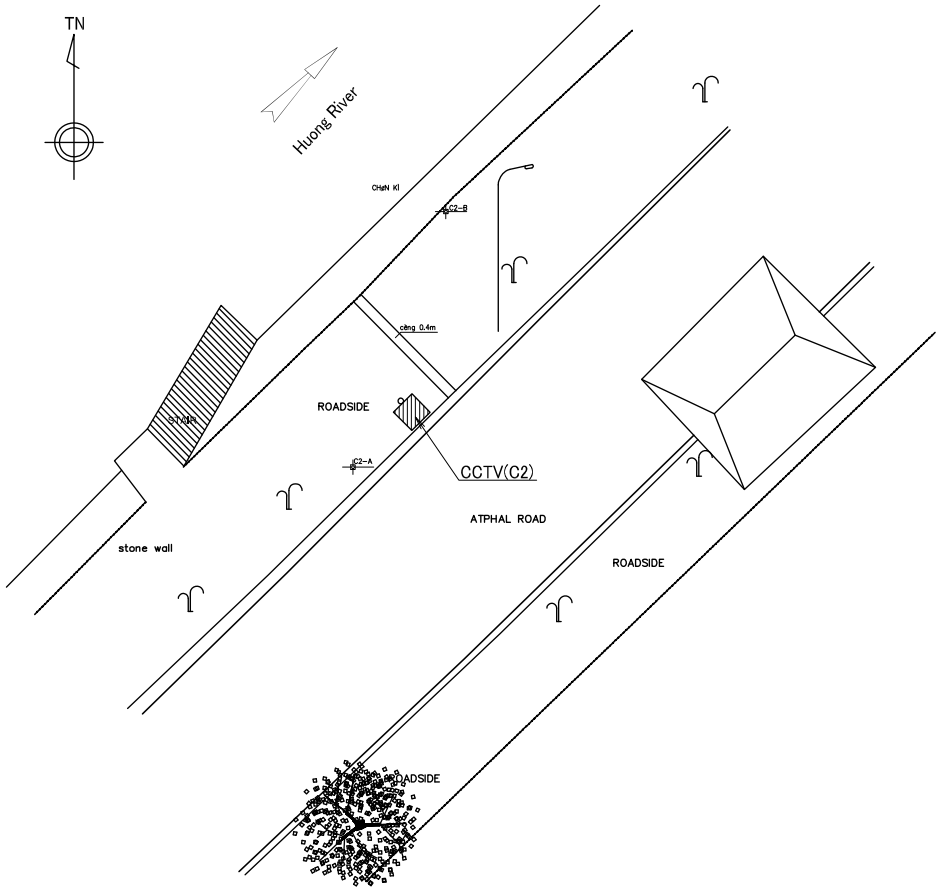


Site layout
(S=1/500)

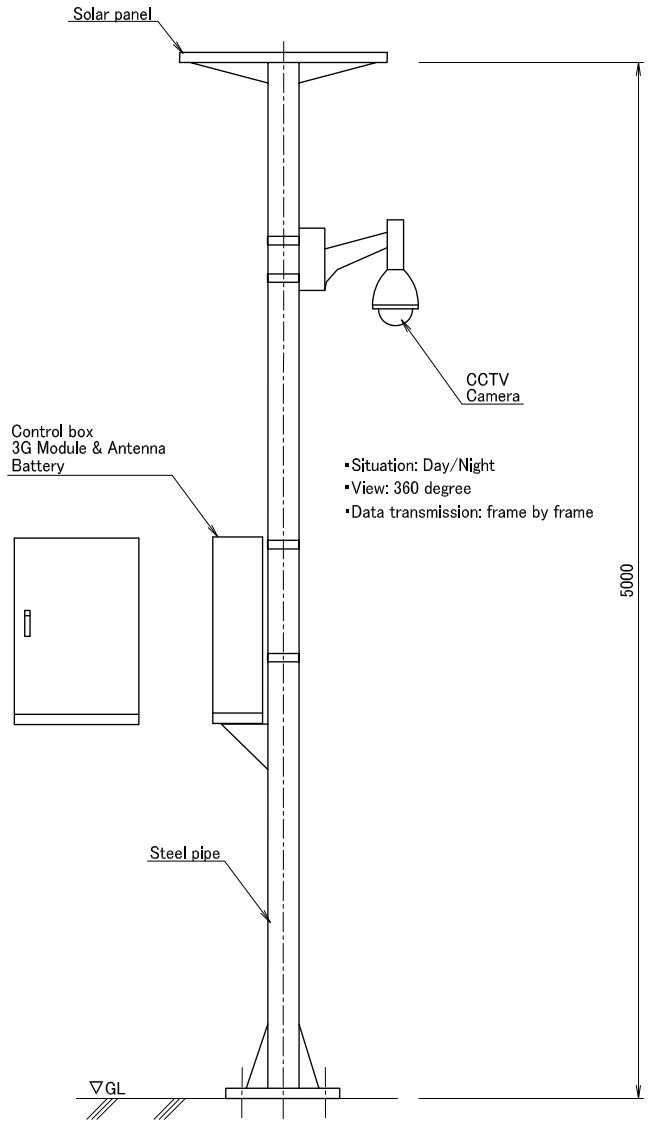


installation plan
(S=1/25)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C1 Location map and installation plan		M-43

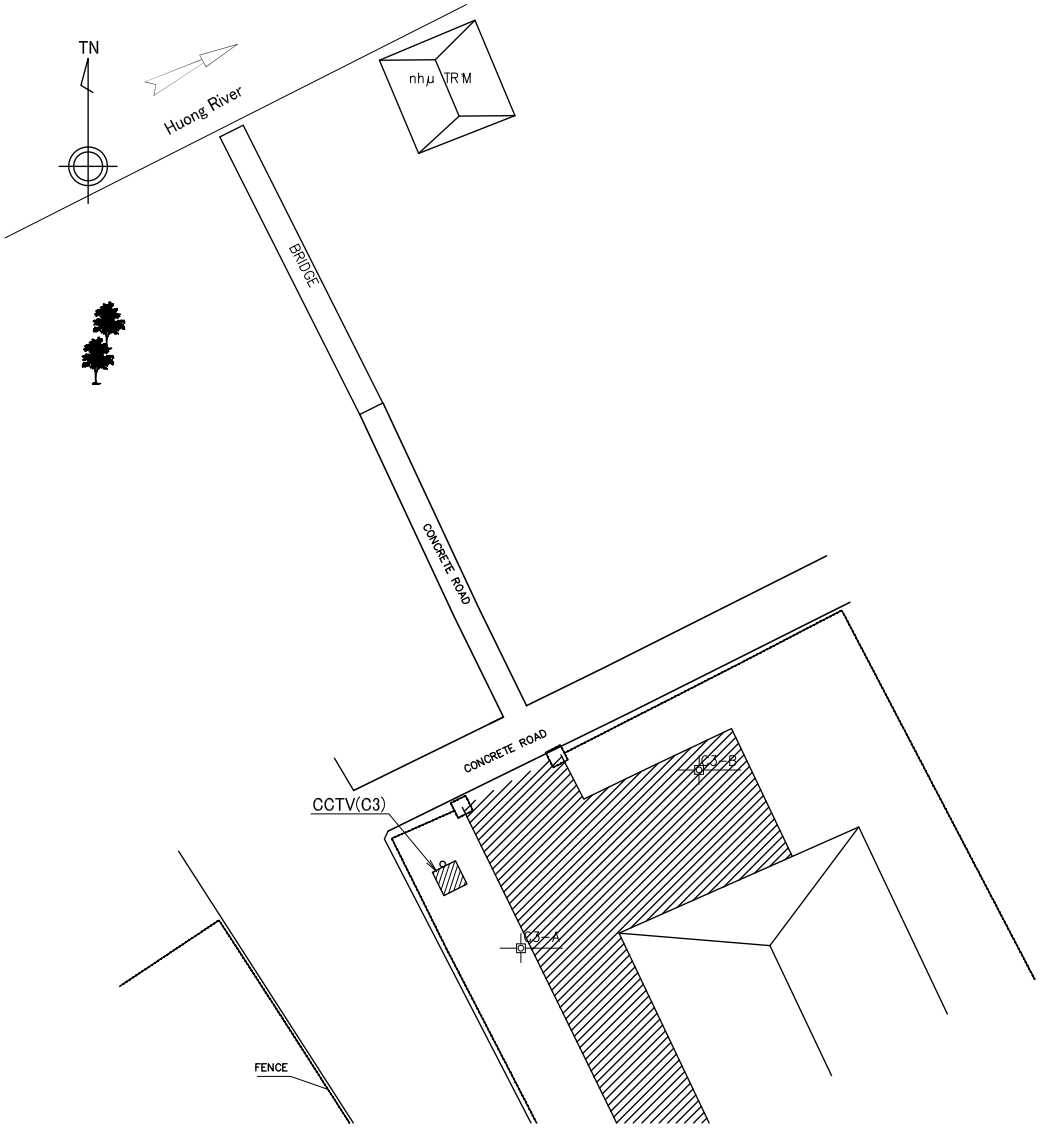


Site layout
(S=1/200)

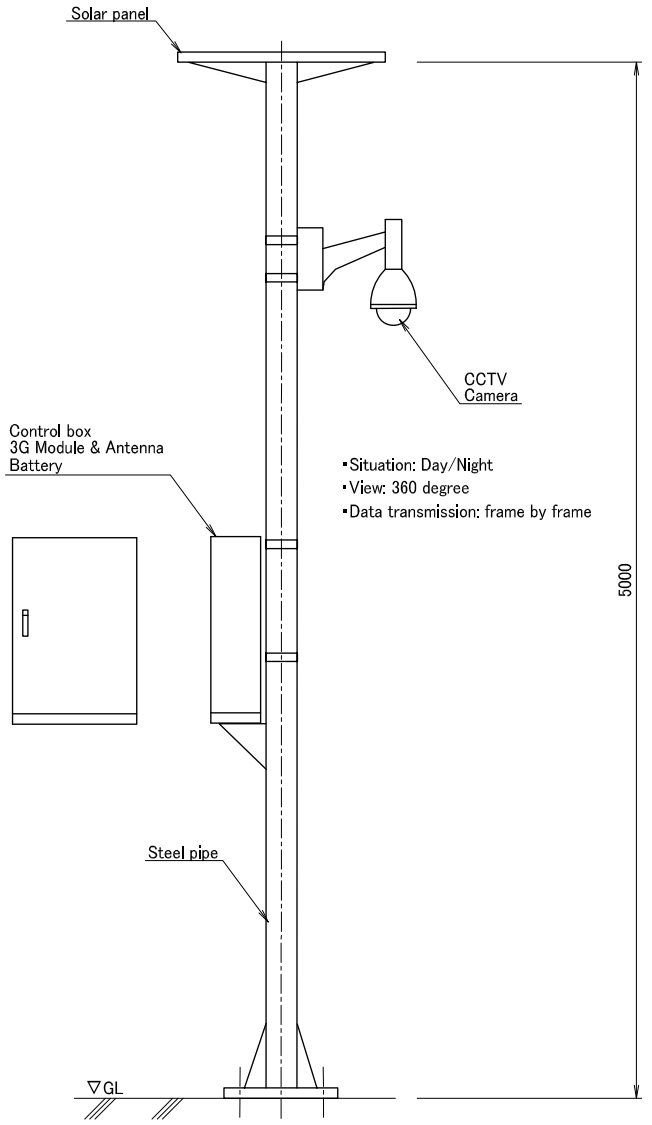


installation plan
(S=1/25)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C2 Site layout and installation plan		M-44

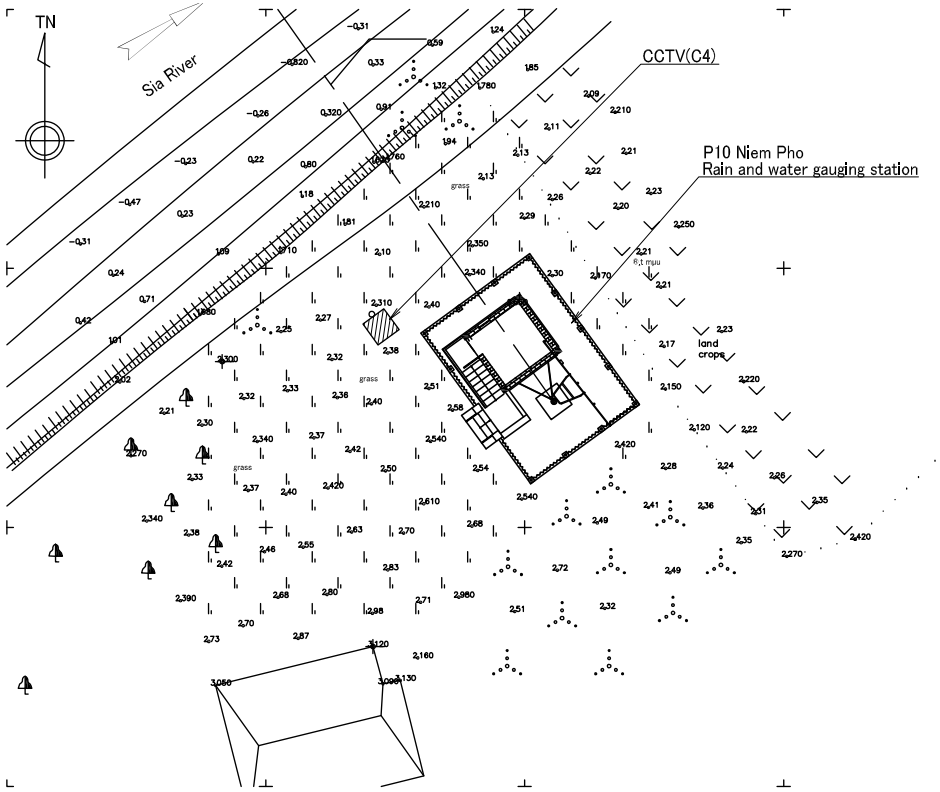


Site layout
(S=1/200)

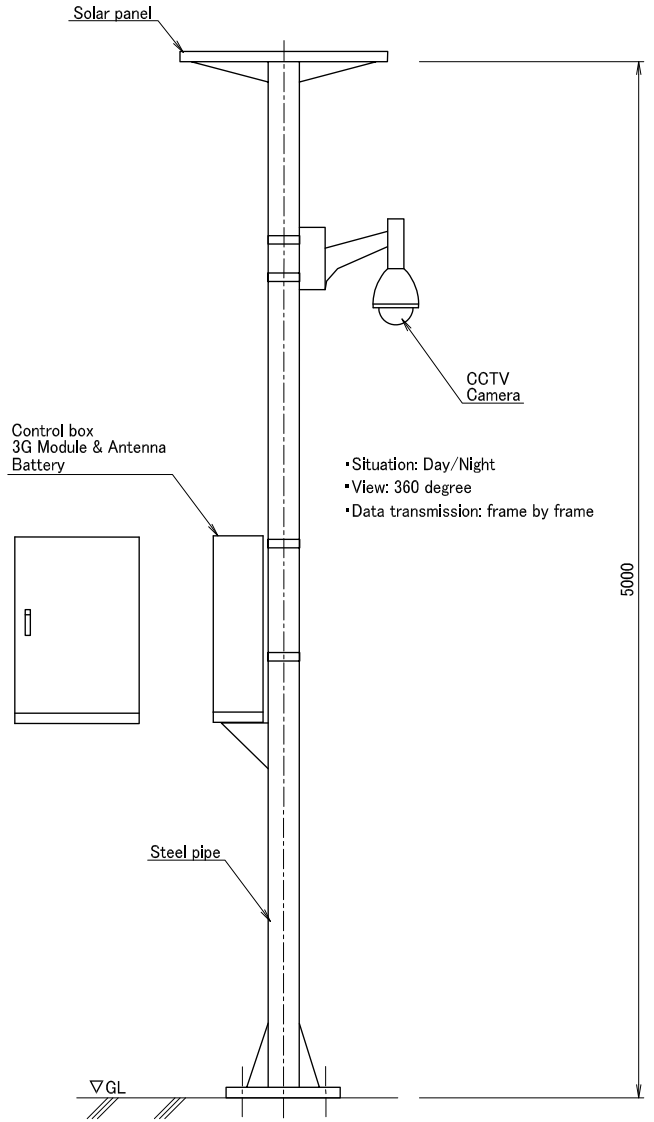


installation plan
(S=1/25)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C3 Site layout and installation plan		M-45

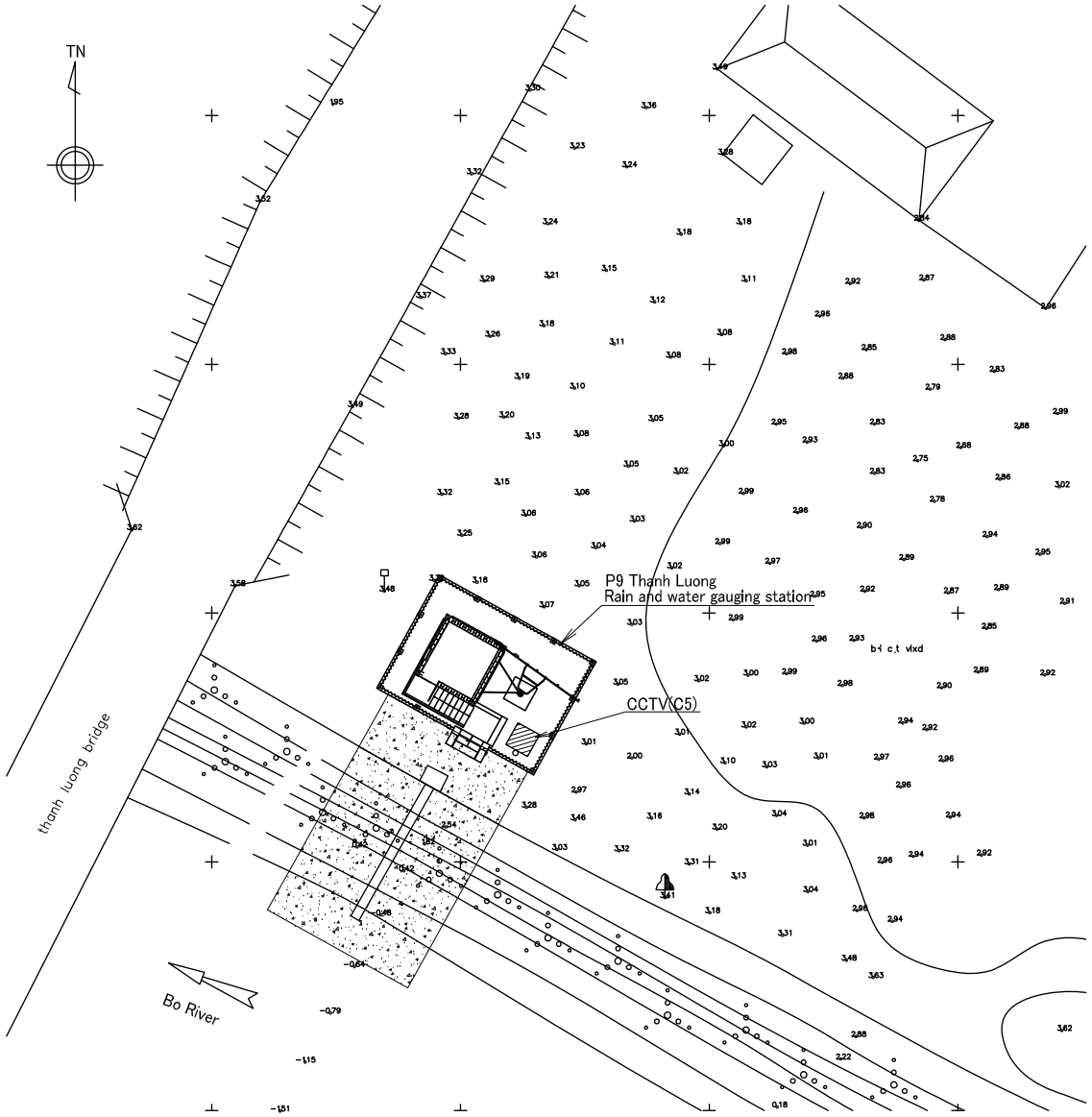


Site layout
(S=1/200)

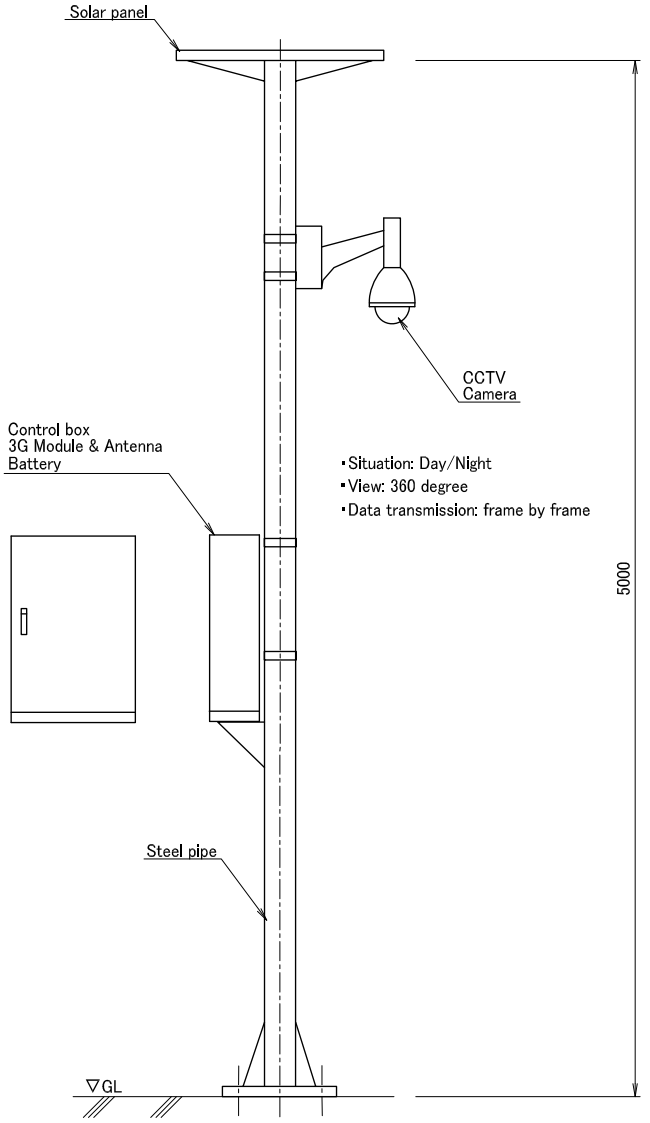


Installation plan
(S=1/25)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C4 Site layout and installation plan		M-46

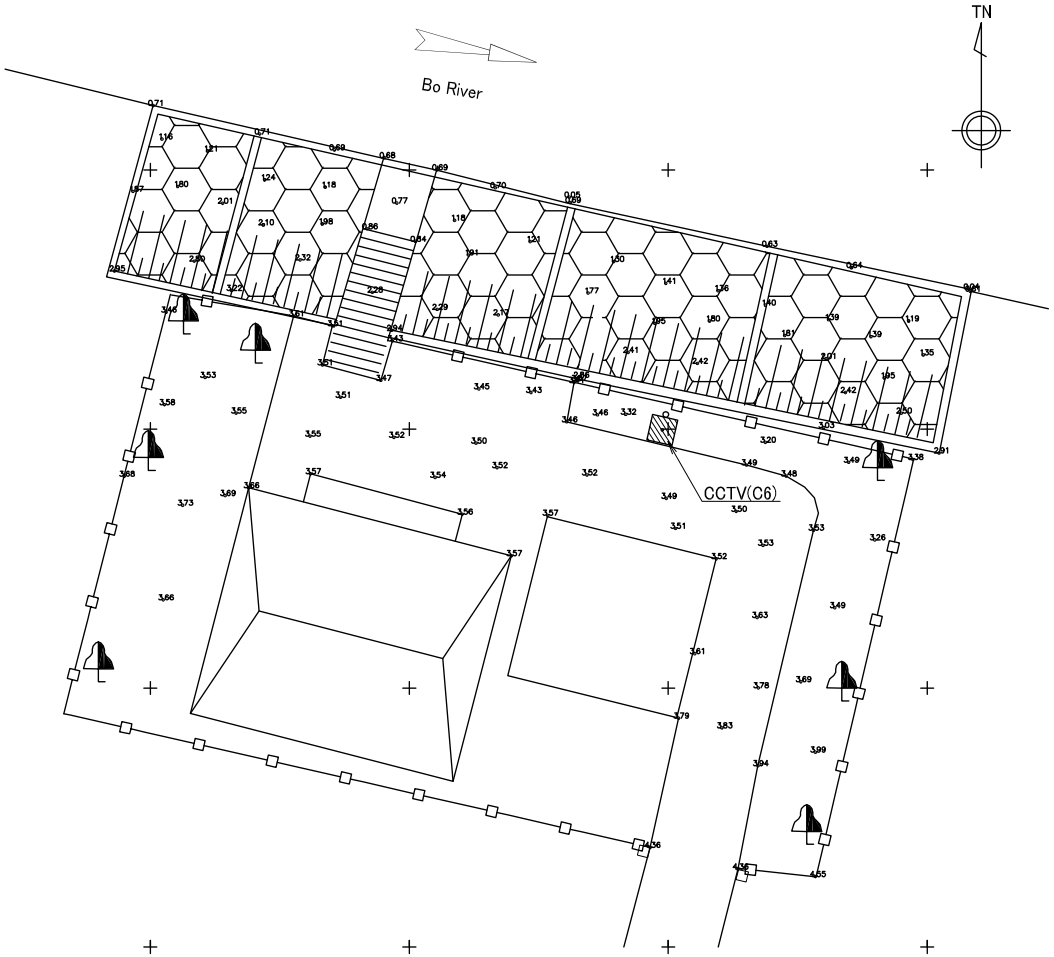


Site layout
(S=1/200)

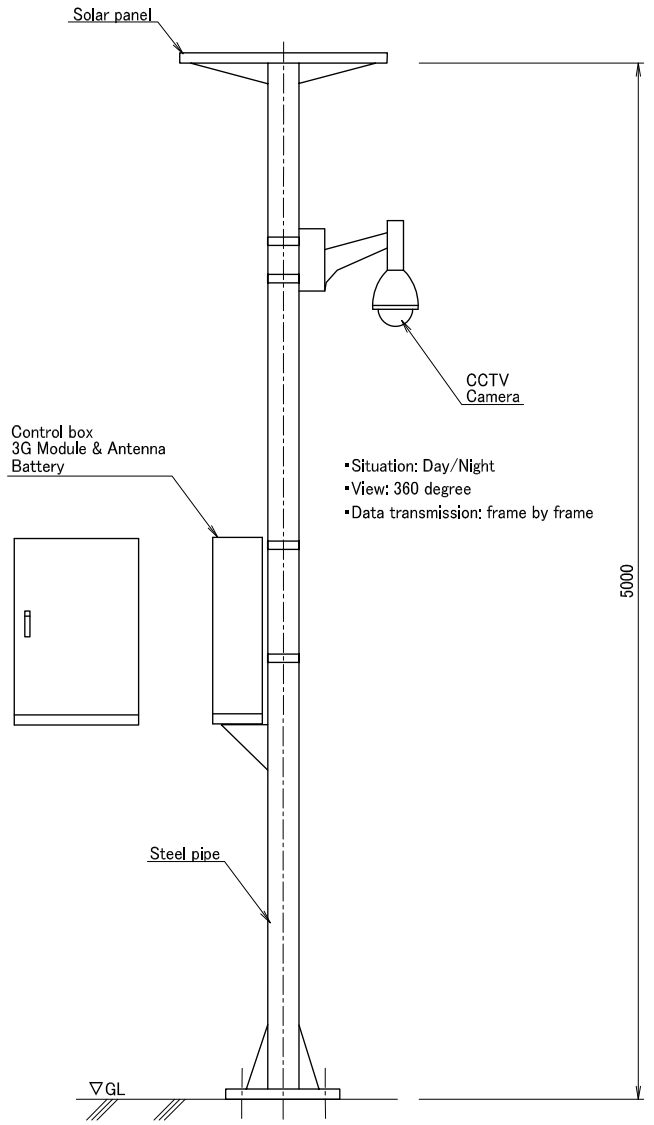


Installation plan
(S=1/25)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C5 Site layout and installation plan		M-47

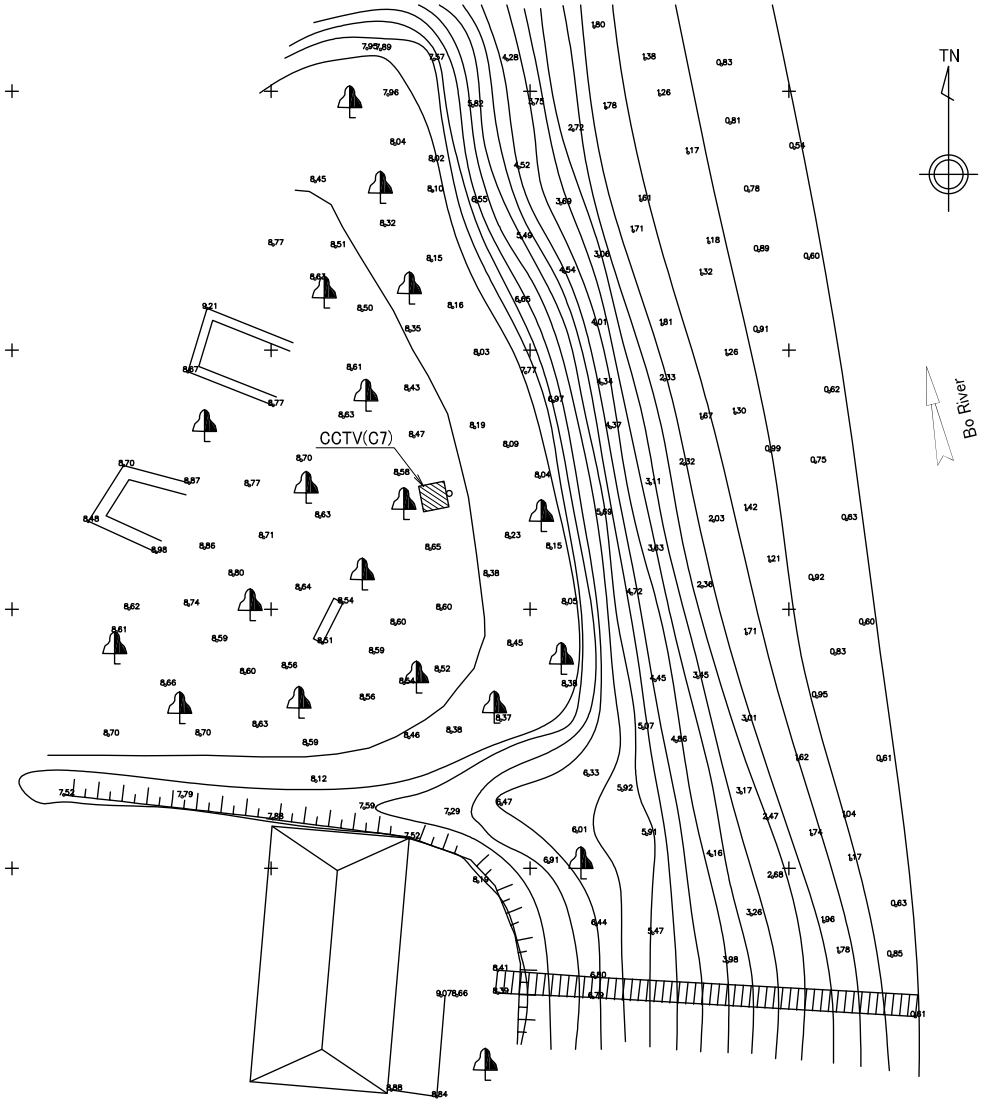


Site layout
(S=1/200)

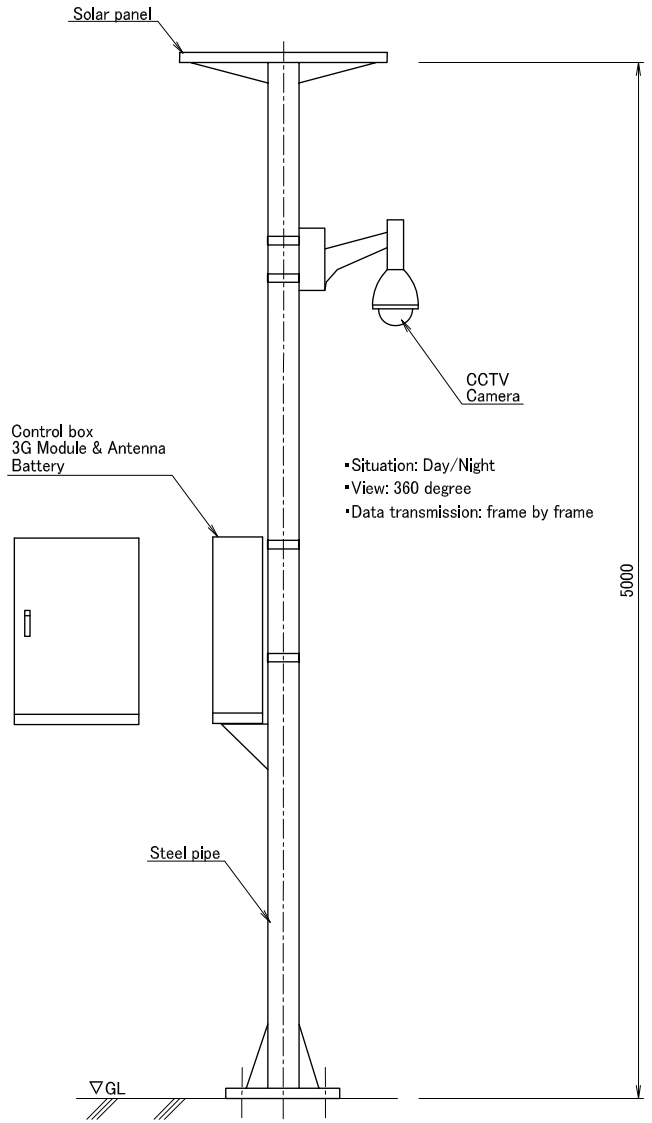


Installation plan
(S=1/25)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C6 Site layout and installation plan		M-48

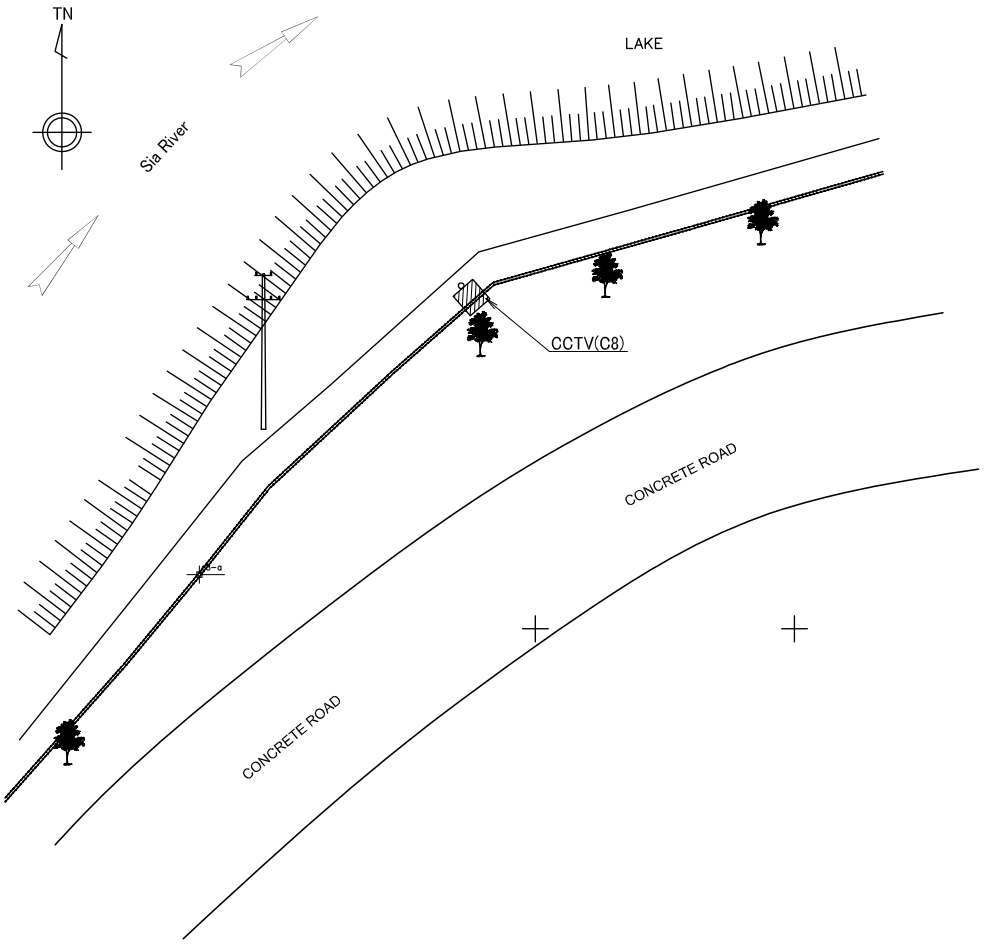


Site layout
(S=1/200)

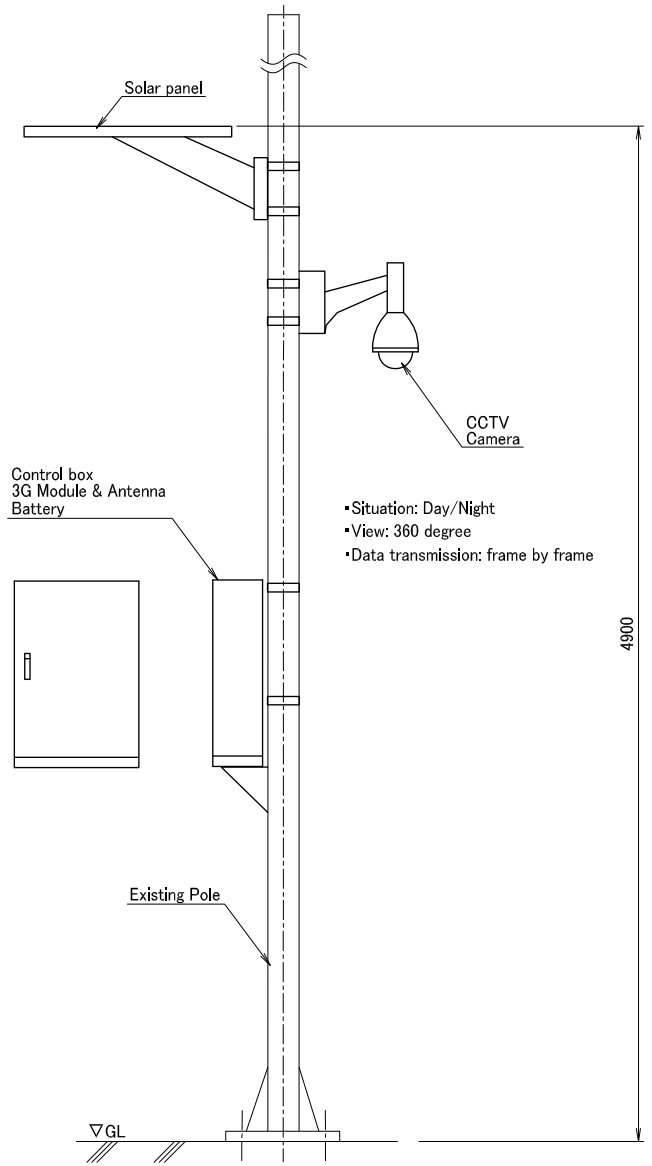


Installation plan
(S=1/25)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C7 Site layout and installation plan		M-49

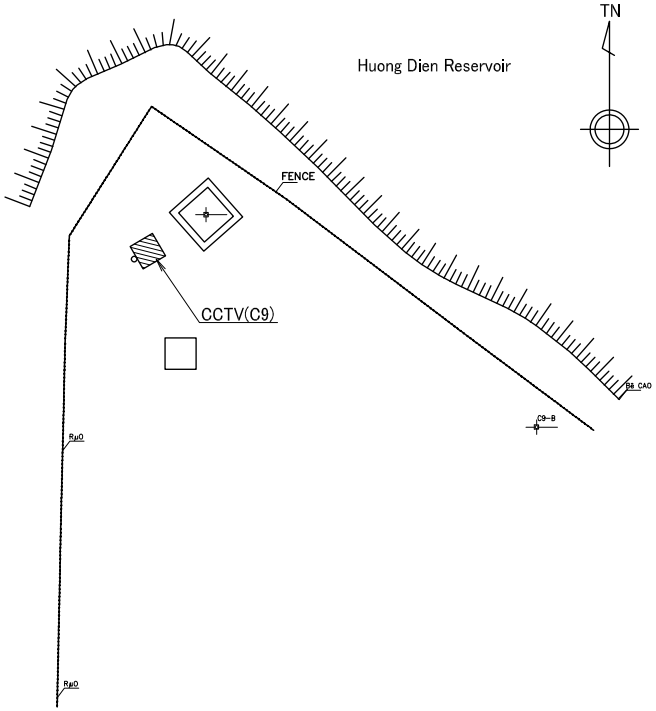


Site layout
(S=1/200)

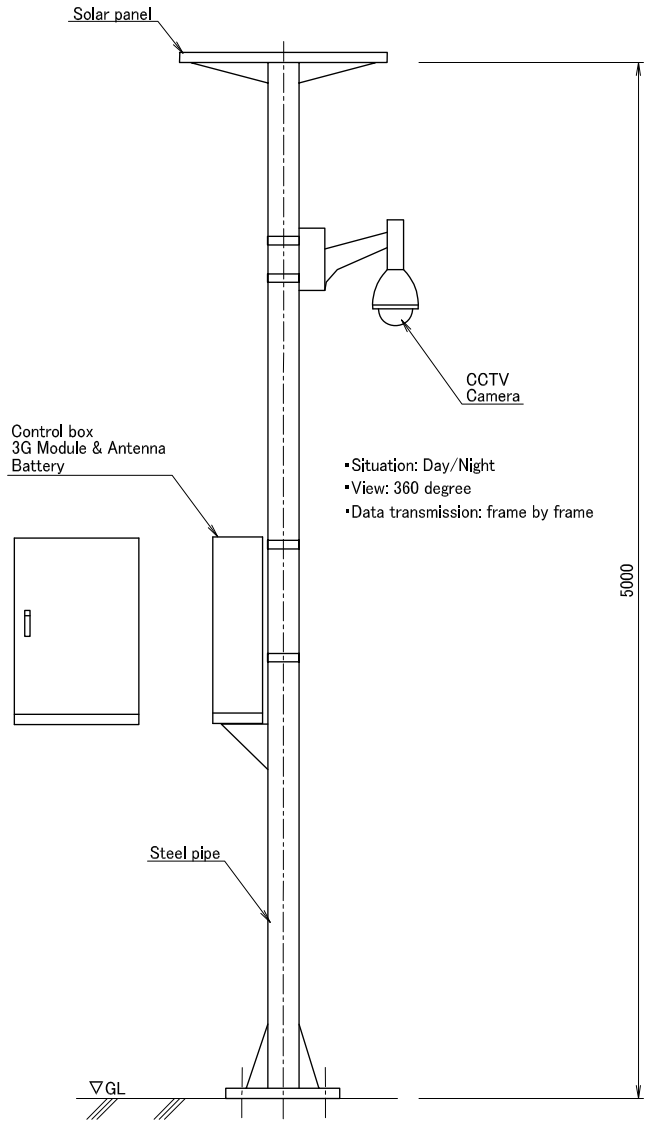


Installation plan
(S=1/25)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C8 Site layout and installation plan		M-50

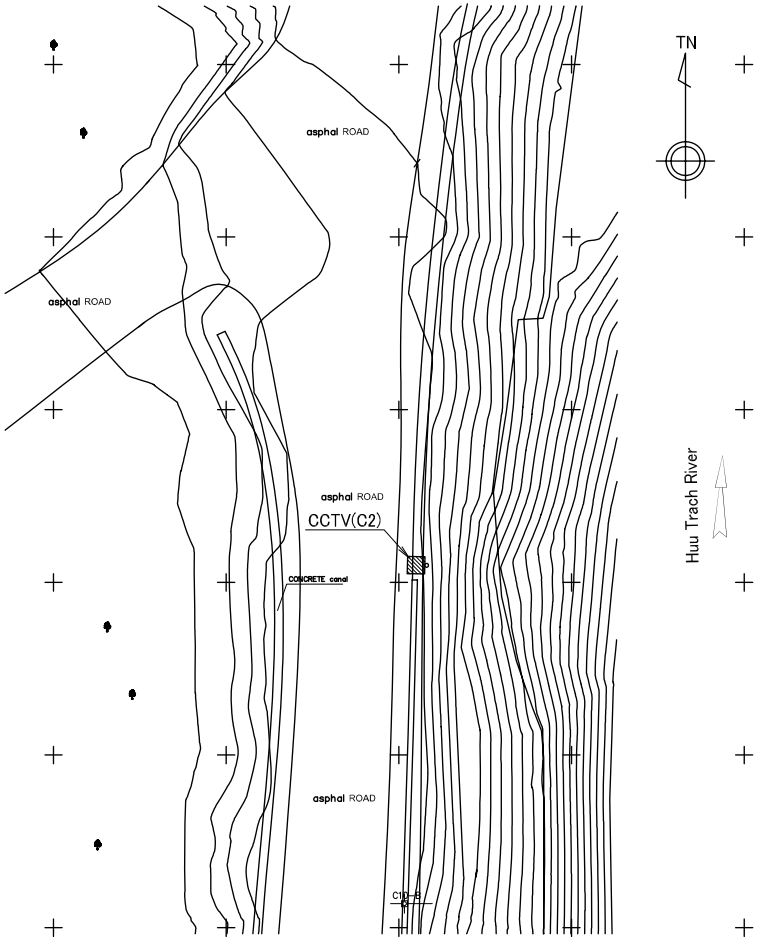


Site layout
(S=1/200)

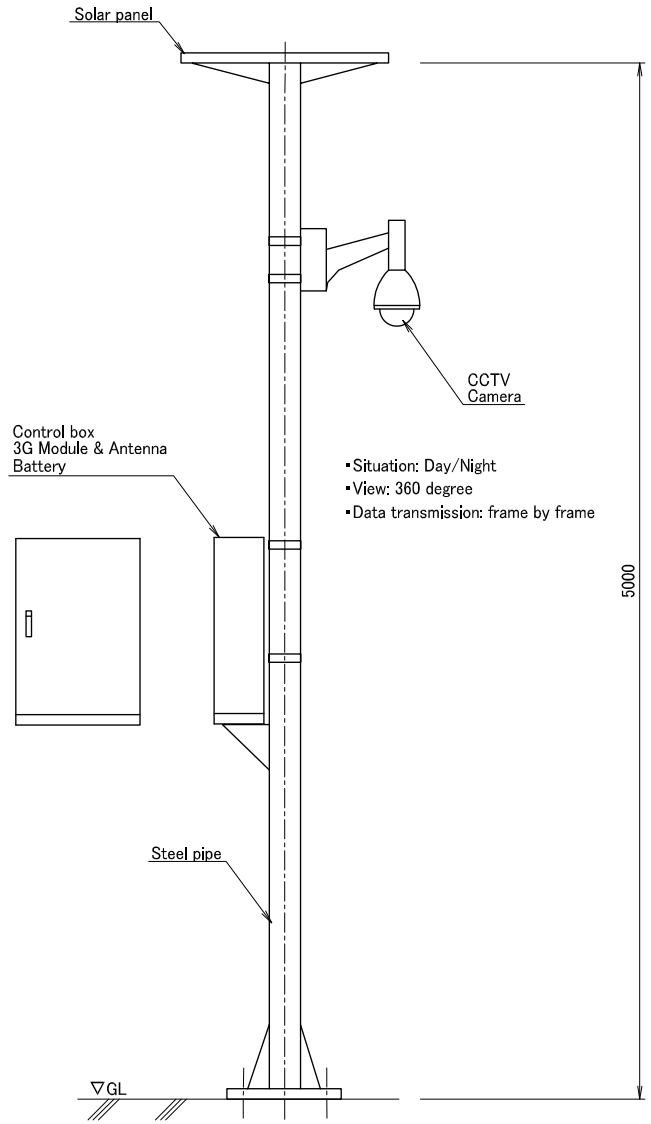


Installation plan
(S=1/25)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C9 Site layout and installation plan		M-51

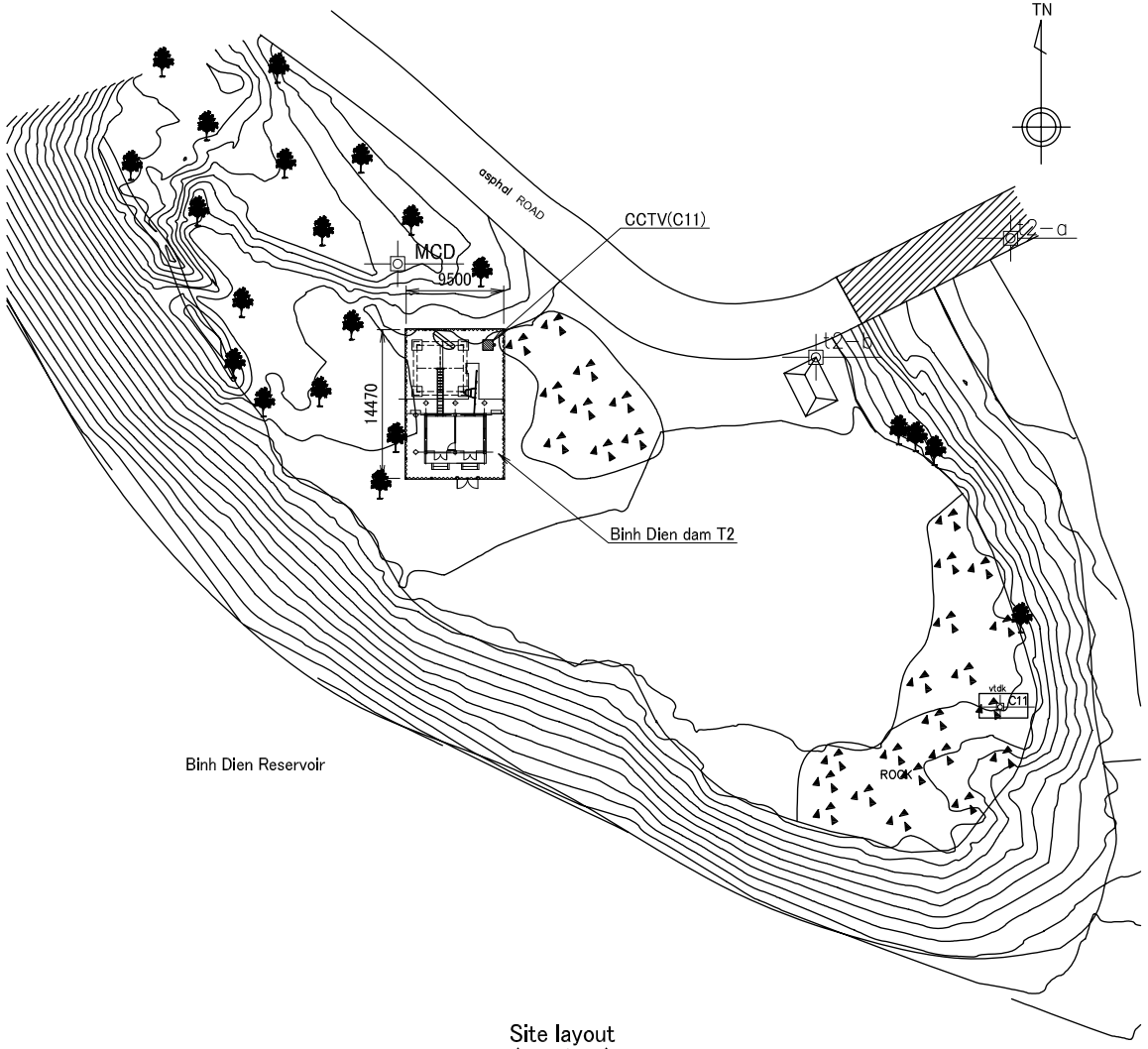


Site layout
(S=1/300)

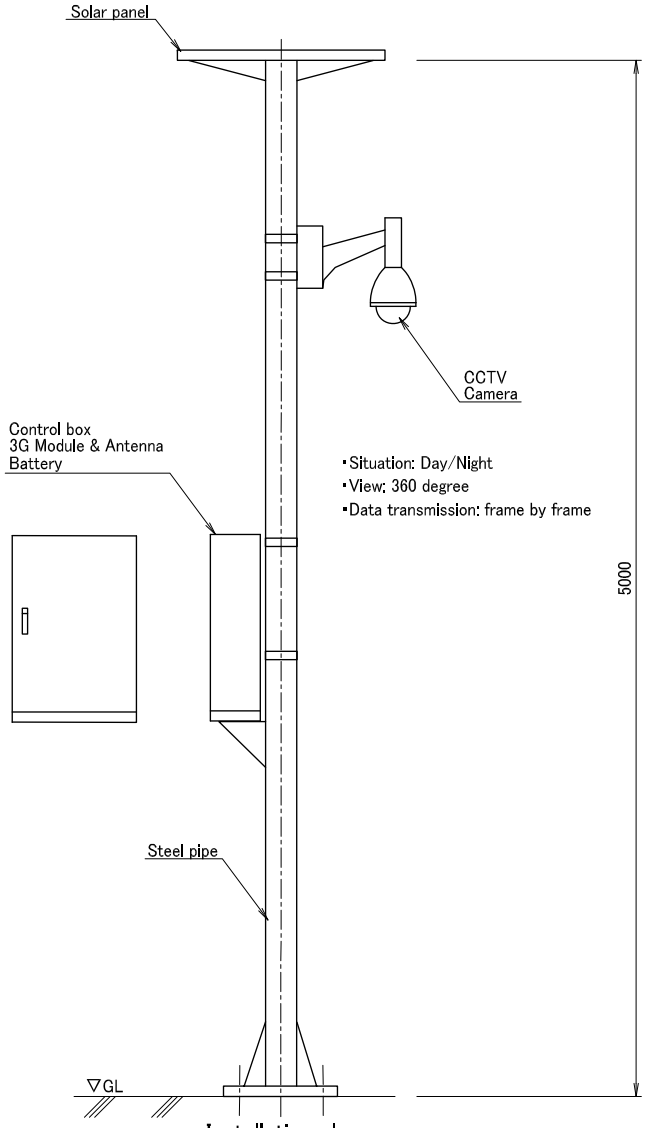


Installation plan
(S=1/25)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C10 Site layout and installation plan		M-52

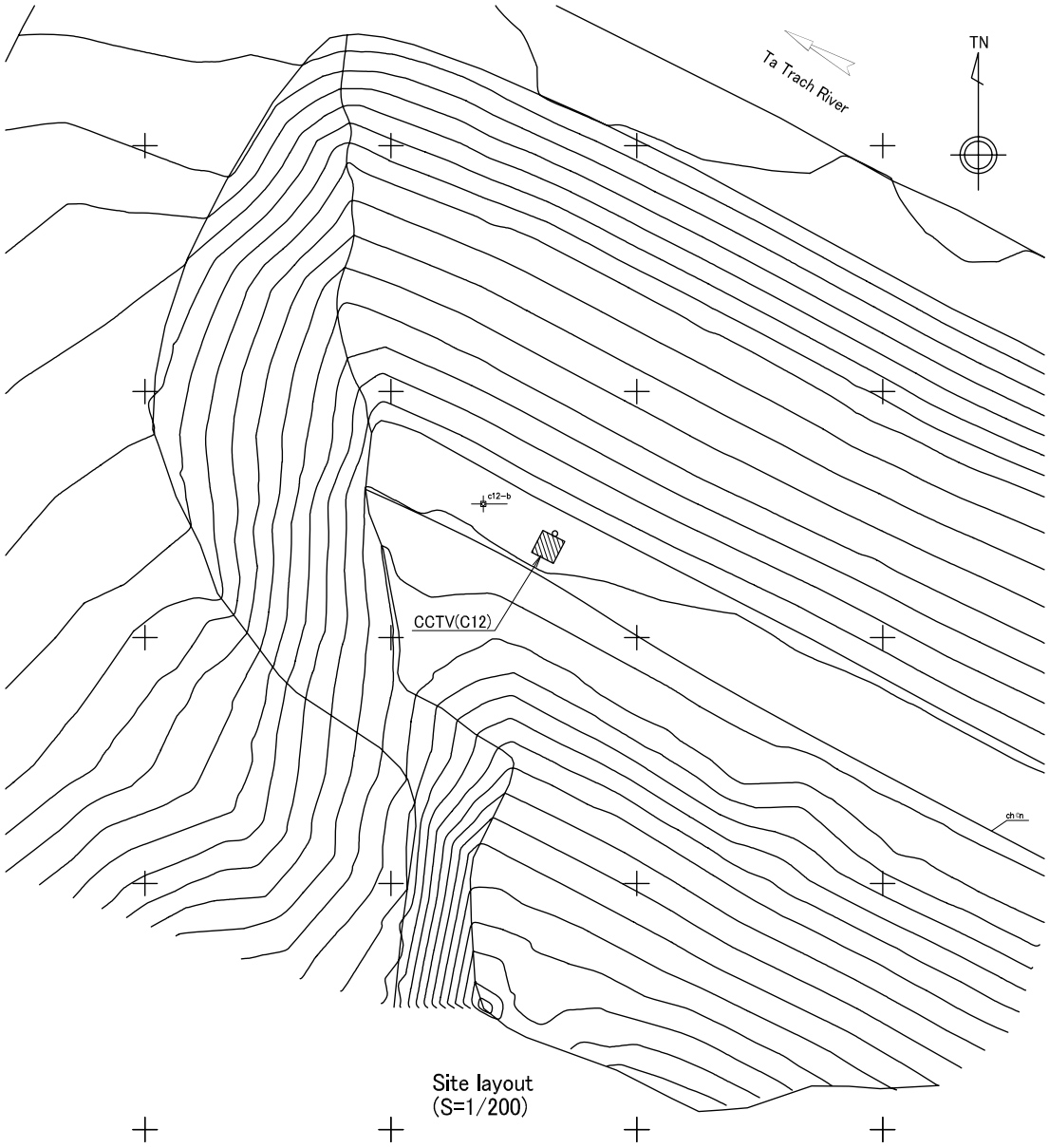


Site layout
(S=1/500)

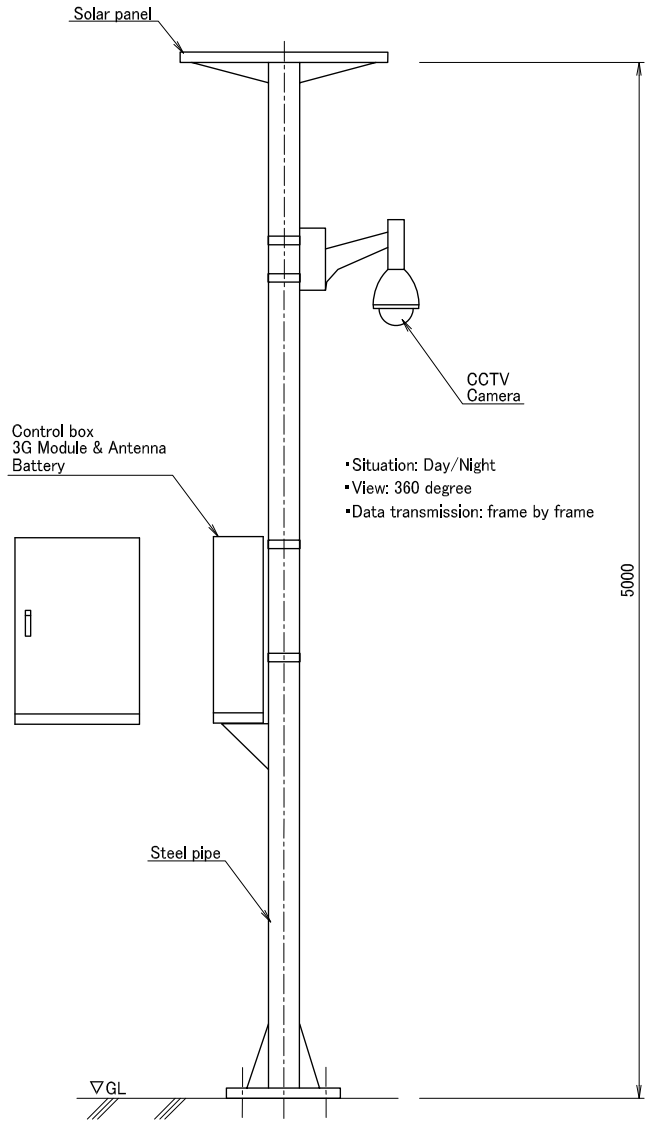


Installation plan
(S=1/25)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C11 Site layout and installation plan		M-53

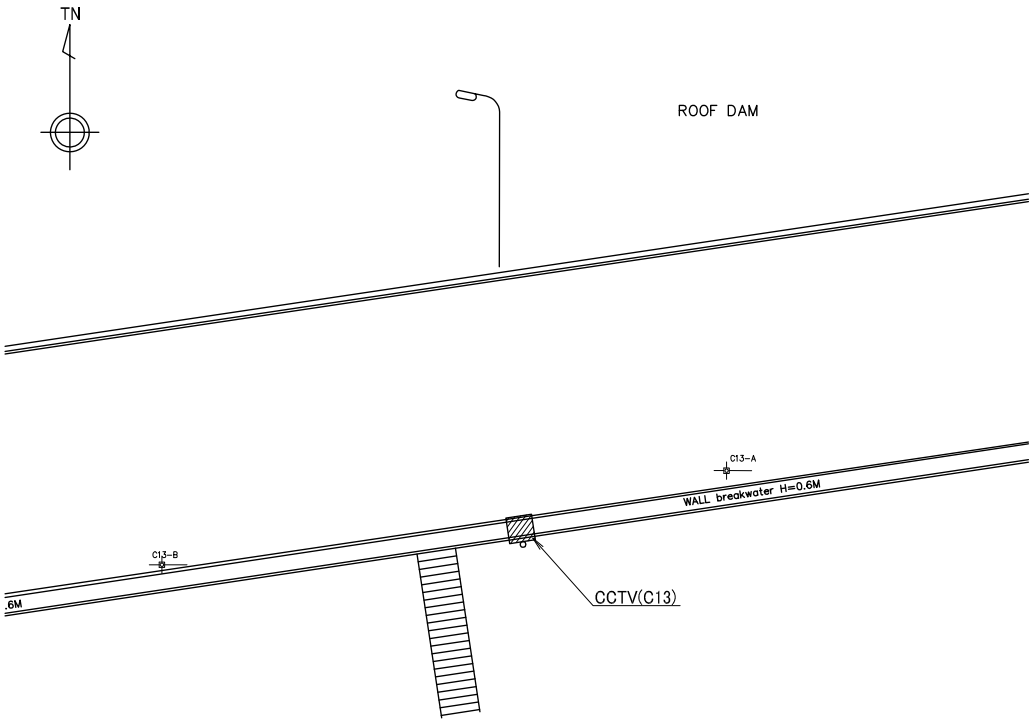


Site layout
(S=1/200)



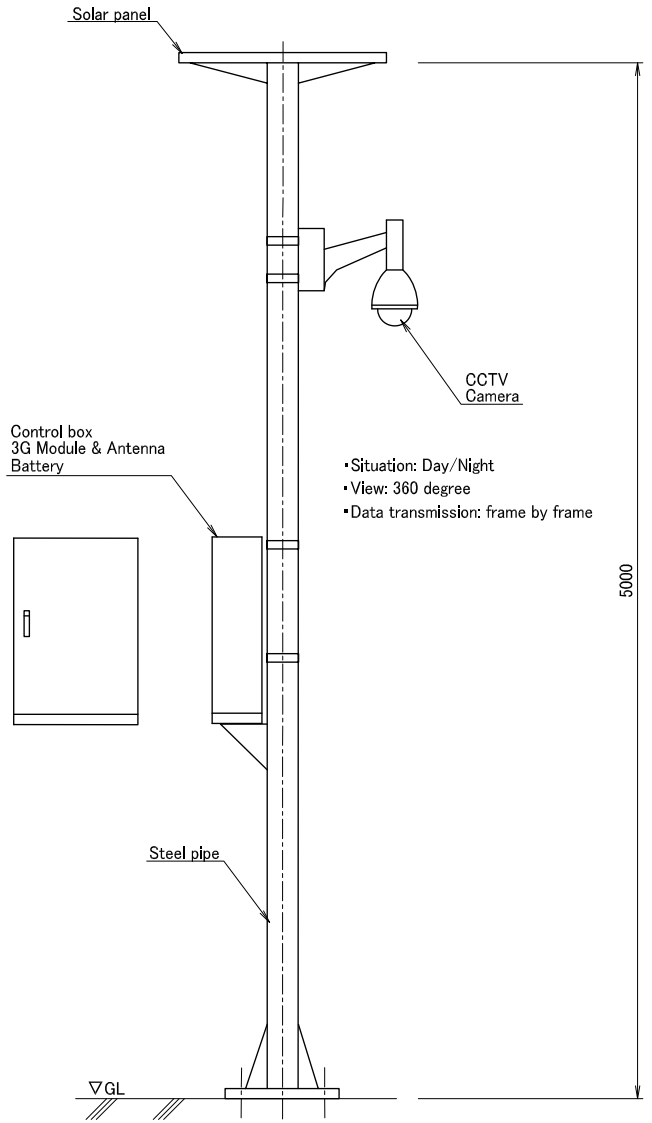
Installation plan
(S=1/25)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C12 Site layout and installation plan		M-54



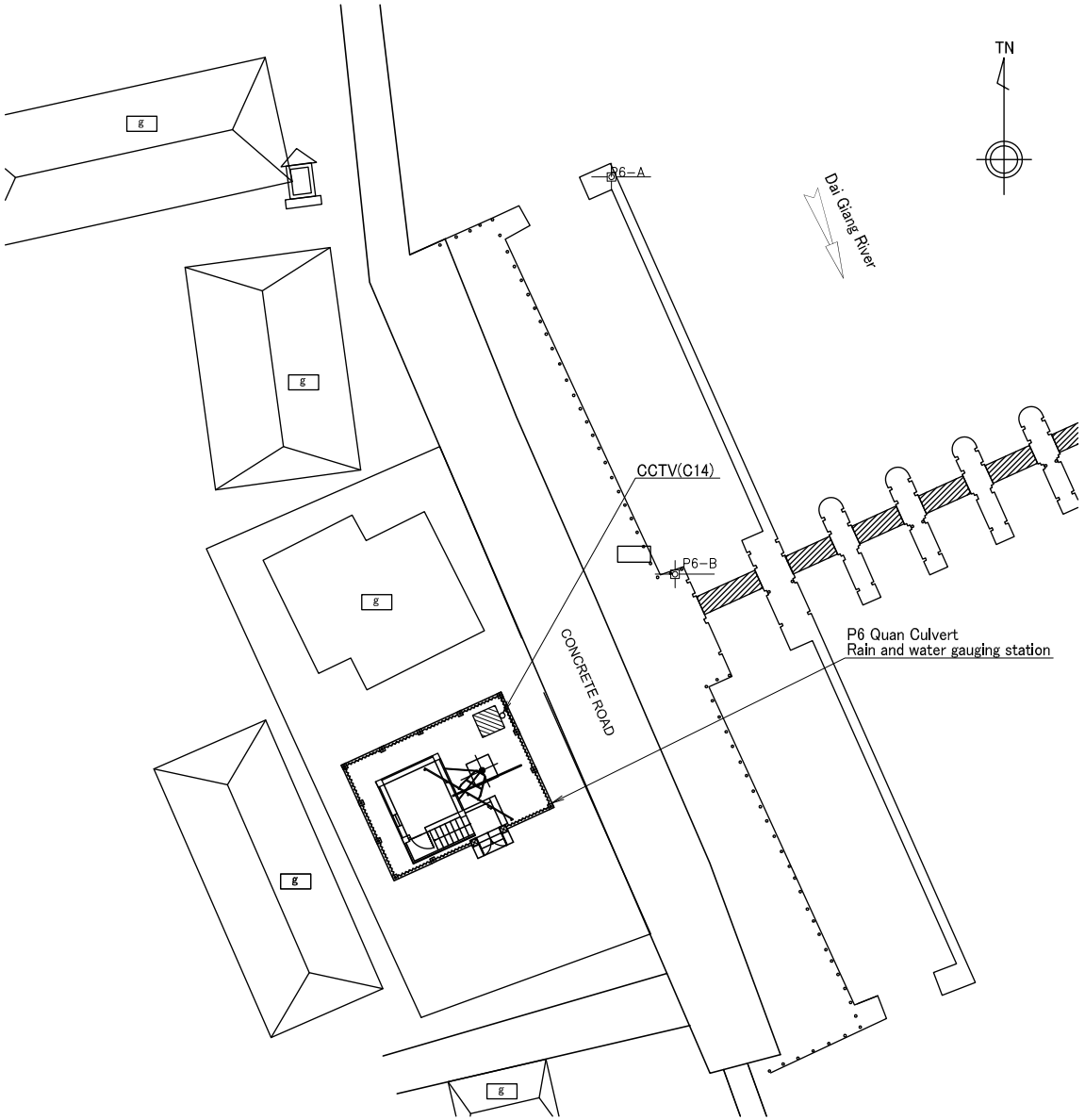
Ta Track Reservoir

Site layout
(S=1/200)

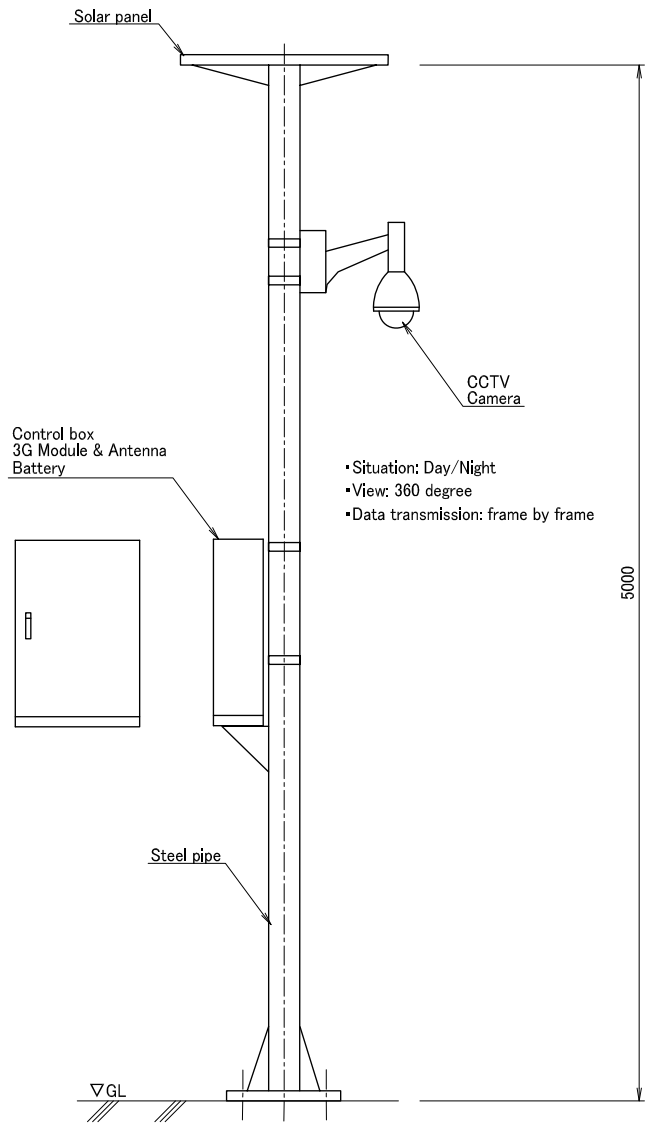


Installation plan
(S=1/25)

CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C13 Site layout and installation plan		M-55

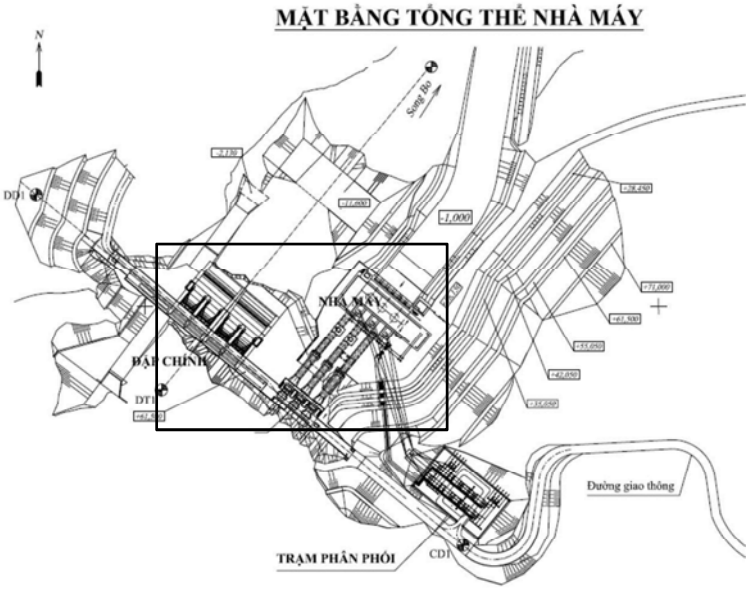


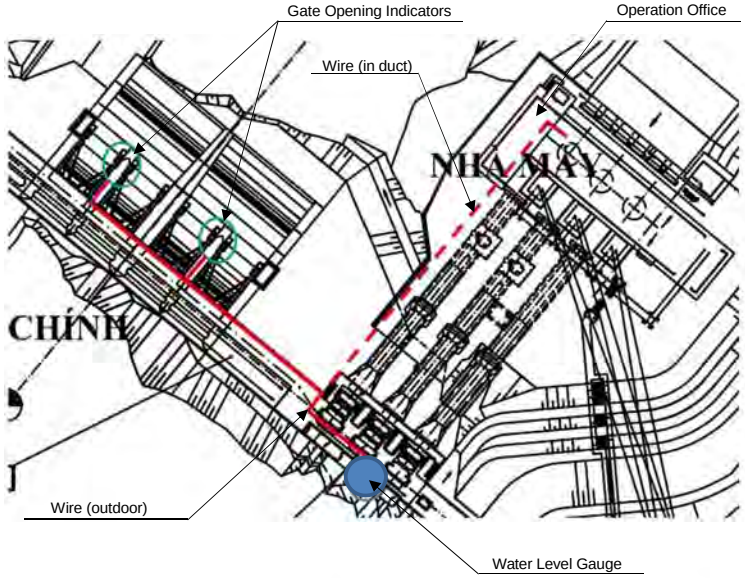
Site layout
(S=1/200)

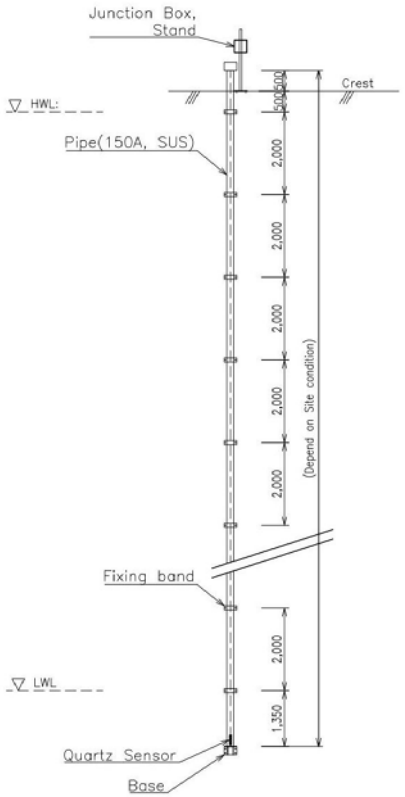


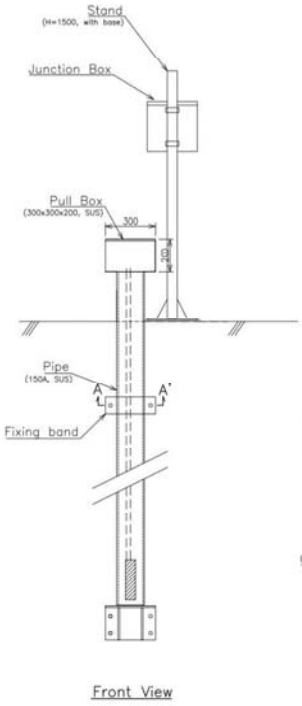
Installation plan
(S=1/25)

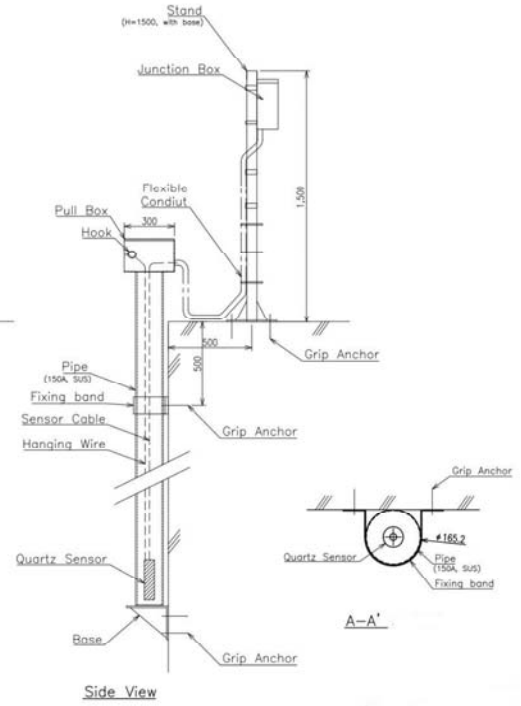
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	CCTV C14 Site layout and installation plan		M-56











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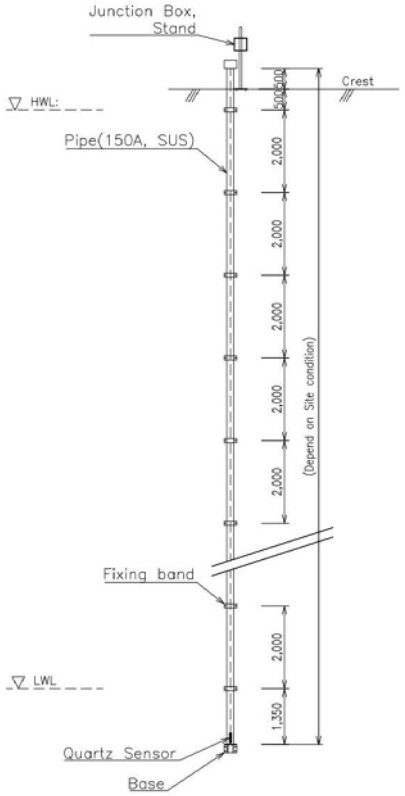
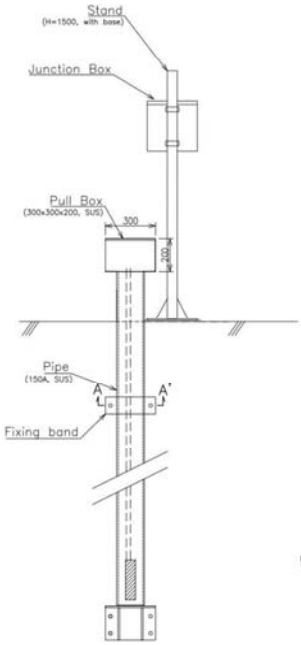
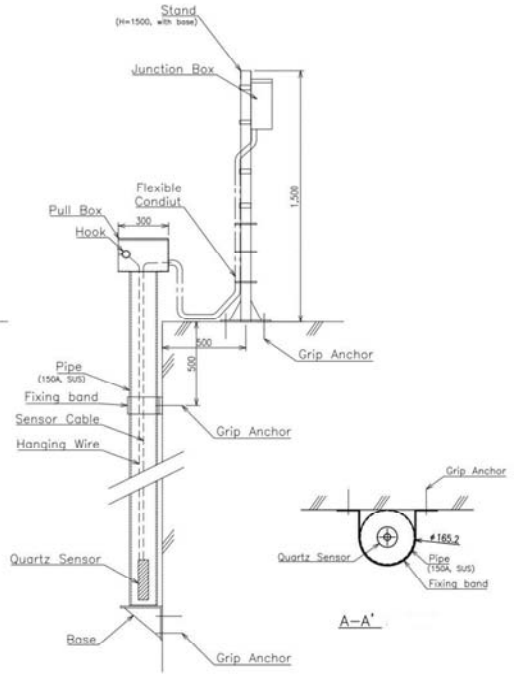
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	**Water Level Gauge at Dam** **Huong Dien Dam**		**M-57**

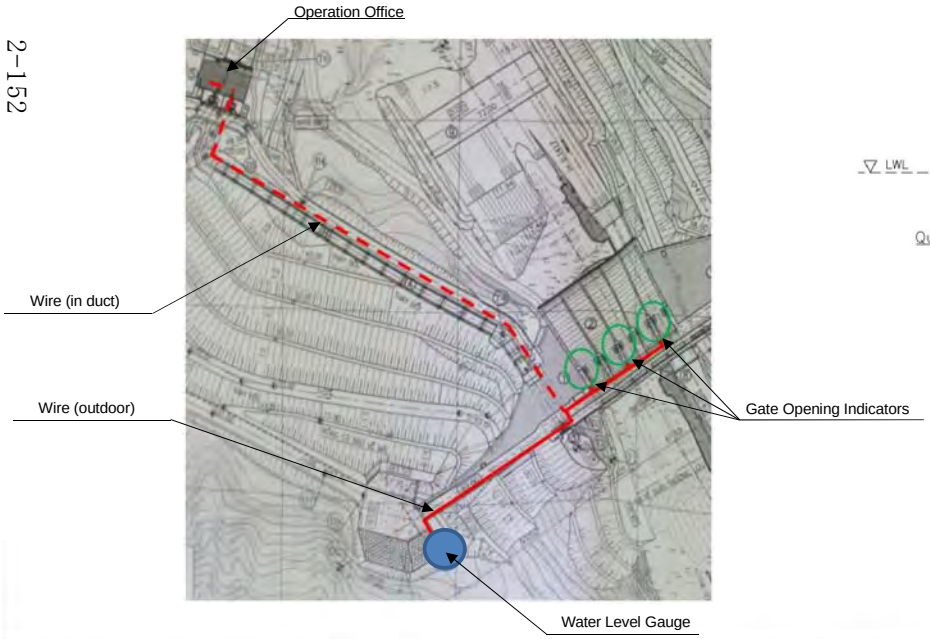




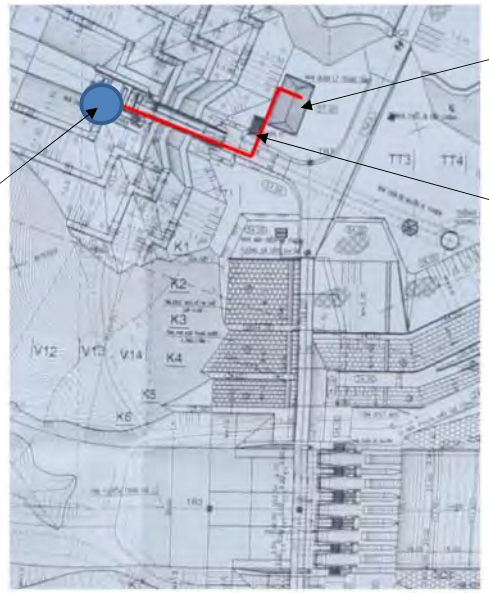
Front View

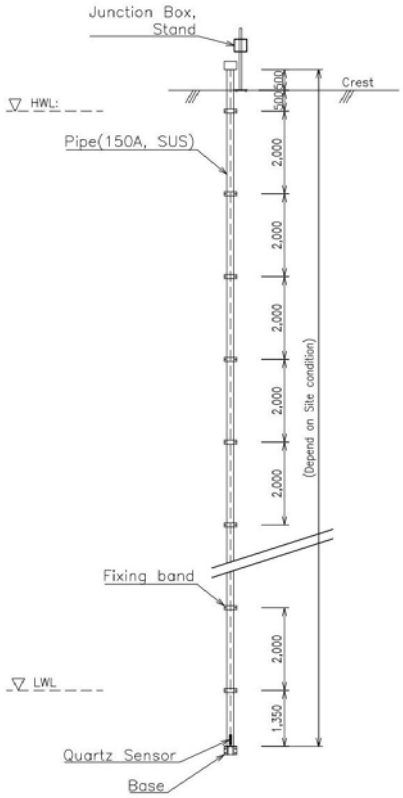


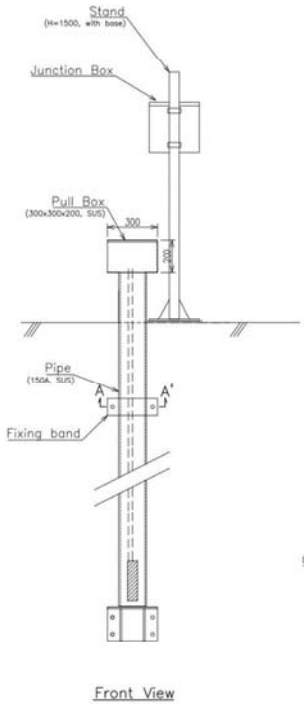
Side View

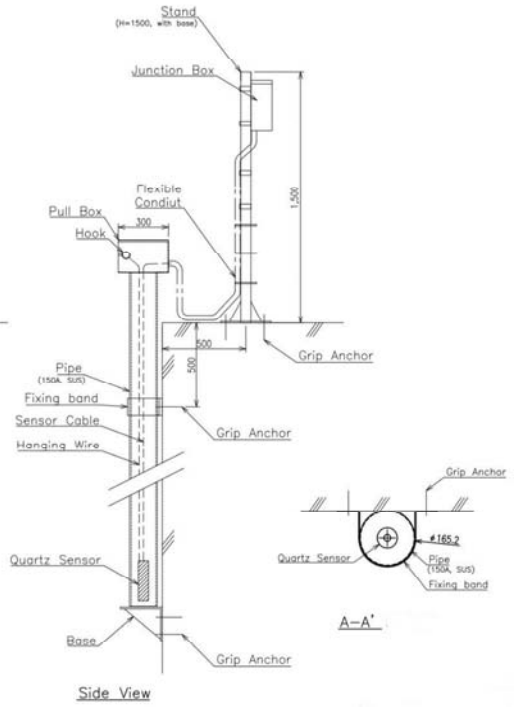


CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	**Water Level Gauge at Dam** **Binh Dien Dam**		**M-58**

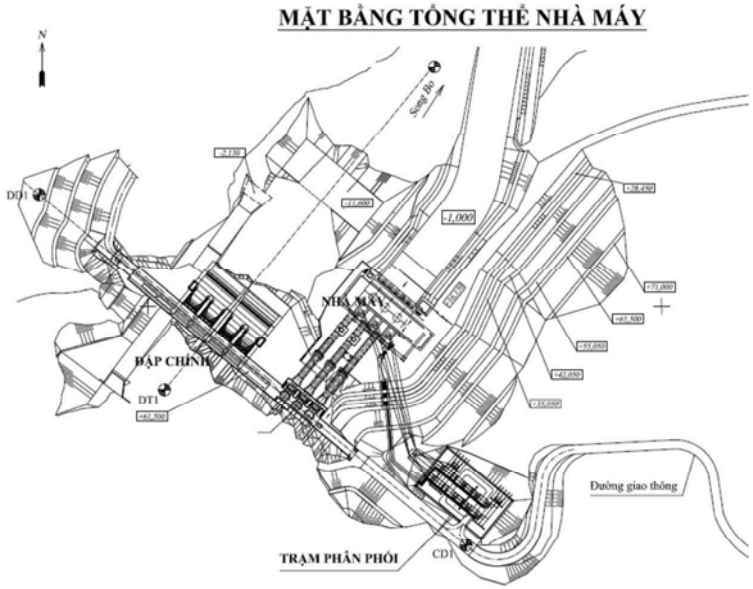


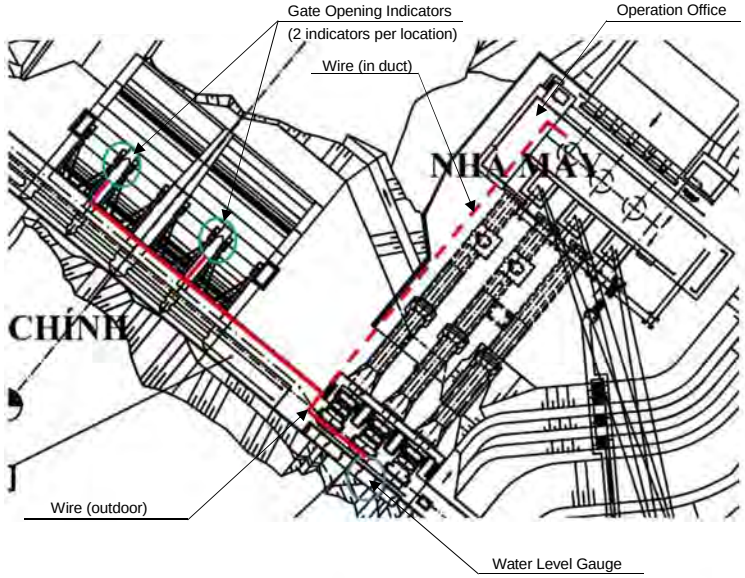


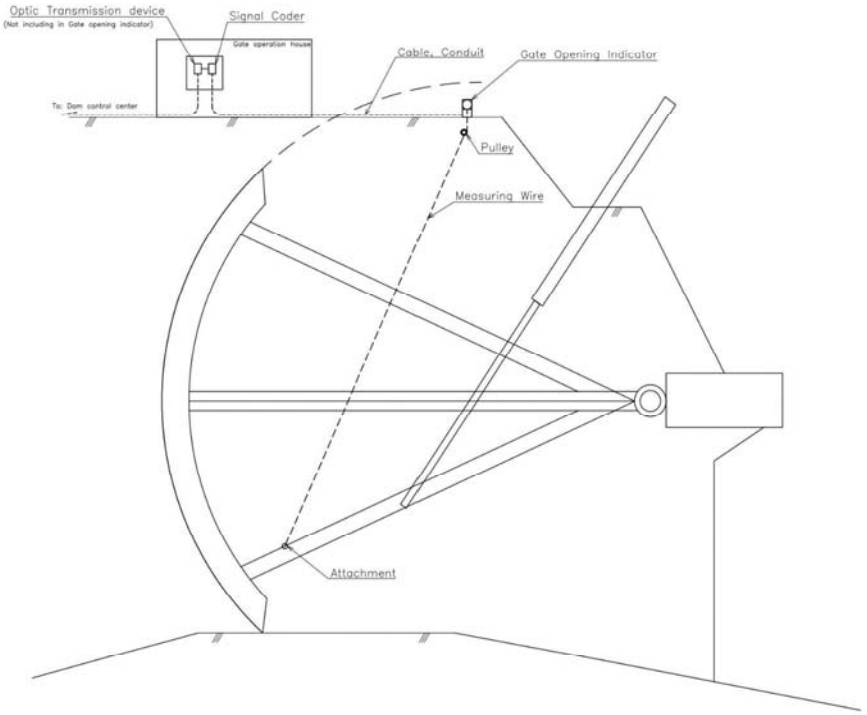




CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	**Water Level Gauge at Dam** **Ta Track Dam**		M-59







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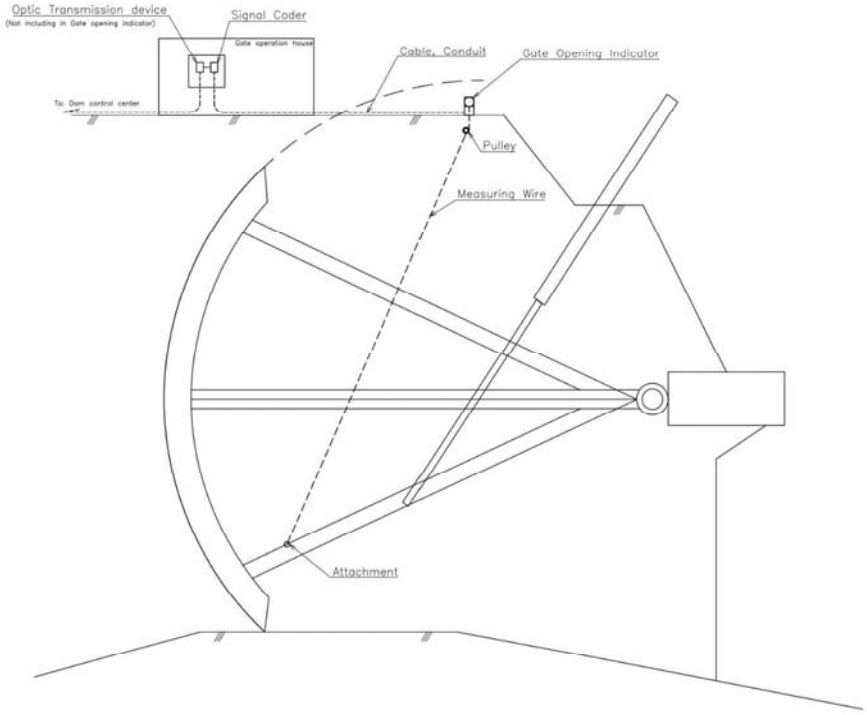
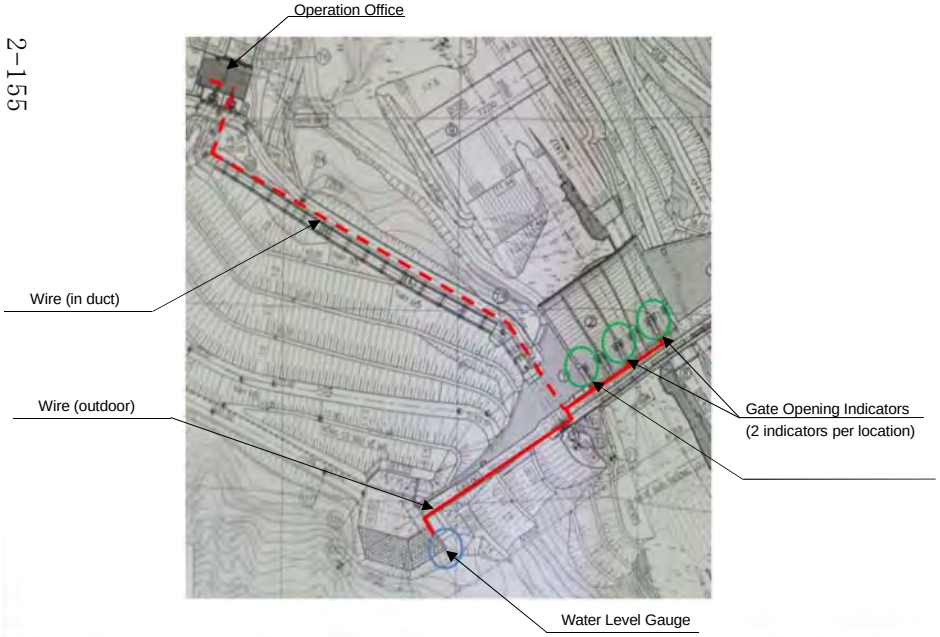
CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	**Gate Opening Indicators** **Huong Dien Dam**		**M-60**





CONSULTANT				Ministry of Agriculture and Rural Development		PROJECT NAME	SHEET CONTENTS	SET No.	SHT No.
FRICS Foundation of River & Basin Integrated Communications, JAPAN Japan Water Agency CTI CTI Engineering CO.,LTD	Designed by	Checked by	Approved by	Directorate of Water Resources		Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System	**Gate Opening Indicatosr** **Binh Dien Dam**		**M-61**

2-2-4 Construction Plan / Procurement Plan (To be revised in accordance with itemized statement)

Although this project relates to the procurement of equipment, it does not end when the equipment is delivered to the other party; its scope also covers the installation of the procured equipment. This involves the construction of station buildings; the installation, wiring, adjustment and test-running of the pieces of equipment that make up the water related disaster management information system, such as measurement instruments, communication equipment and control devices; and providing training on the initial operation of the system before the final handover. As such, the project requires end-to-end quality and process control to be applied to the entire process from system design to the selection of equipment for, and the production and installation of the system, with the suppliers providing quality assurance throughout the process all the way up to post-installation operation checks. So, the Japanese subsidiary with the results and the trust in Japan is considered appropriate to be in charge. It is critical that plans are in place to ensure that a successful delivery can be achieved within the limited timescale under this arrangement.

2-2-4-1 Construction Policy / Procurement Policy

This project comprises hydrological observation stations, CCTV facilities, radar systems, multiplex wireless equipment, telemetry systems, information processing and display systems, dam water level metering systems and dam gate opening indicators and involves the procurement, installation and adjustment of the equipment as well as the construction of the buildings, and it is important to ensure consistency throughout these different elements of the project. Given the time it takes to build the necessary equipment and the fact that heavy rainfalls and typhoons during the monsoon season from September to December will affect the work, schedule control requires particular care.

(1) Project implementation bodies

The implementation bodies of this project is the Directorate of Water Resource (DWR) of the Ministry of Agriculture and Rural Development (MARD) ,which is the orderer of the consultant and contractor contract.

(2) Consultant

It is essential that a Consulting Service contract concerning this project is entered into as soon as the Exchange of Notes between the Vietnamese and Japanese governments and the Grant Aid Agreement (G/A) between Vietnam and JICA are signed. The Consulting Service Agreement is to be entered into between the DWR and a consultant company established under the laws of Japan that has its principle office in Japan and that has been recommended by JICA.

Once the Consulting Service Agreement is entered into, the consultant

company assumes the role of the consultant for this project. The Consultant creates detailed designs and provides tender documentation including technical specifications, drawings and diagrams. Additionally, the Consultant supports the DWR in the holding of the tender and continues with the supervision of the construction and procurement processes to ensure the successful completion of the project.

(3) Contractors

The contractors of this project (materials and equipment procurement agents, construction companies and LiDAR surveyors) will be selected through public tenders open to qualifying Japanese companies. Due to the different nature of the work, the order lot for the LiDAR surveys will be kept separate from the procurement and installation of equipment. The winning contractors undertake the construction of the facilities, the production, procurement and installation of equipment, LiDAR surveying and other contracted work under the agreements entered with DWR.

LiDAR survey data includes Vietnamese national secret, so the data handling work from surveying to delivery of DEM data shall be carried out in Vietnam.

Table 2-17. Separation of work lots

Work lot	Description	Breakdown
1	Procurement and installation of equipment for water related disaster management information system	Water level meters and rain gauges, CCTV facilities, radar systems, multiplex wireless equipment, telemetry systems, information processing and display systems, dam water level metering systems, dam gate opening indicators
2	LiDAR surveying	Aerial laser measurement, 3D measurement data processing, aerial laser data preparation, river crossing data preparation

2-2-4-2 Notes on Construction / Procurement

(1) Measures against natural disasters

The locations where the facilities are to be built and the equipment is to be installed are spread across Hue Province, and some of them are only accessible via unpaved or poorly surfaced roads that are likely to become impassable after rain. Strong winds may also disrupt the construction work to build steel towers. The potential impact of typhoons and heavy rains should be taken into account when planning the work schedule.

(2) Notes concerning equipment installation

As part of the water related disaster management information system, X-band radar rain gauges, wireless communication units, data servers and other pieces of equipment that contain complex electrical and electronic circuits will have to be

installed in multiple locations. It is therefore necessary to send electrical engineers to adjust and connect the equipment over the course of the project time frame. Additionally, during the installation, adjustment and test-running of these X-band radar rain gauges, wireless communication units and data servers, it is also necessary to send engineers specializing in radar systems, wireless communications, computer networks and software to ensure that optimal accuracy and functionality can be gained from the entire system. High levels of accuracy and functionality are critical for the stable operation of the water related disaster management system.

Furthermore, in order to ensure that the equipment is operated and maintained properly and effectively by the DWR, Huế PCC-NDPCSR and the dams, technology transfer to the local engineers working for these organizations will be conducted during and after the installation work in the form of on-site, on-the-job training by the seconded engineers.

(3) Notes on procurement

The equipment procured in Japan will be shipped to Đà Nẵng Port, Vietnam, and transported to Huế Province on trailers after customs clearance. For convenience, 20-ft containers will be used for transportation, which will be transferred onto trailers upon landing and transported over land to a holding location in Huế city approx. 80 km away. Thereafter, the equipment will be sorted and sent to the 31 hydrological observation stations, station buildings and radio base stations for installation. As the installation work, will be carried out sequentially, a roofed warehouse will need to be provided in Huế city to store the expensive precision equipment, which require water protection.

The stored equipment will be transported to individual sites on 4-ton trucks according to the installation schedule. Some of the radio base stations are located in areas that have no access roads passable by heavy vehicles; for these locations, the cargo would need to be hauled manually over part of the route.

2-2-4-3 Construction Classification / Procurement and Installation Classification

The table below shows the allocation of costs between Japan and Vietnam, based on the JICA guideline for the Grant Aid.

Table 2-18 Allocation between Japan and Vietnam

Cost item		Japan	Vietnam
Procurement and installation	Sea transportation (of equipment procurement)	○	
	Expenses of counterpart staff involved in works supervision and inspection		○
	Land procurement, land use permits, etc.		○
	Equipment procurement	○	
	Equipment delivery, installation, test-running and adjustment	○	
	Training on initial operations and running of system	○	
	Expenses of counterpart staff involved in operation testing		○
	Application for power grid connection / receiving power (primary side)		○
	Soft components (sending engineers, preparing documentation)	○	
	Expenses of counterpart staff related to soft components		○
	Application for / obtaining permits to enter restricted areas		○
	Application for / obtaining permits under radio law		○
	Software licensing cost for system installation phase (OS, basic office applications, antivirus software, etc.)	○	
	Software license express necessary for operating the system after the delivery (OS, basic office applications, antivirus software, etc.)		○
LiDAR surveying	Measurement plan	○	
	Application for / obtaining flight permits	○	
	Application for / obtaining permits for aerial surveys		○
	Application for / obtaining permits for bringing in sensor equipment to relevant countries		○
	Site selection / observation of GPS ground reference stations	○	
	Site selection / observation of control points	○	
	Aerial laser measurement (including aerial photography)	○	
	Processing of measurement data (in Vietnam) (3D measurement data processing, original data preparation)	○	
	Inspection of intermediate data		○
	Application for / obtaining permits for taking inspected measurement data abroad		○
	Processing of measurement data (in Japan) (preparation of ground data, orthophotos, DEM and river cross-section data)	○	
	Preparation of data for delivery	○	
	Inspection of delivered data		○
	Expenses of counterpart staff involved in supervision and inspection		○
Duty exemption	Exemption of import duty and inland tax ※1		○
Payments	BA/AP handling fees etc. ※2		○

※1: According to Japanese grant aid regulation, the grant amount shall not cover any taxes, duties or fiscal levies. To ensure that customs duties, internal taxes and other fiscal levies which may be imposed in the country of the Recipient with respect to the purchase of the Products and/or the Services be exempted or be borne by its designated authority and shall not be covered by the Grant;
Such customs duties, internal taxes and other fiscal levies mentioned above include VAT, commercial tax, income tax and corporate tax of Japanese nationals, resident tax, fuel tax, but not limited, which may be imposed in the recipient country with respect to the supply of the products and services under the verified contract
※2: B/A: Banking Arrangement, A/P: Authorization to pay

2-2-4-4 Construction Supervision Plan/Procurement Supervision Plan

(1) Consultant's Procurement Supervision Plan

1) Content of work

The consultant will supervise the supplier procuring/constructing the equipment, so as to ensure the quality and proper process control, and confirm that the equipment delivered to the site is properly installed and adjusted. The following are major operations conducted by the consultant regarding procurement supervision.

1. Discussions with supplier over design, main components, process and quality control plan
2. Witness and control of pre-shipment inspection at the plant
3. Discussions and briefing with DWR, Huế PCC-NDPCSR and relevant organizations
4. Confirmation of equipment procurement
5. Confirmation and follow up of customs clearance of equipment
6. Supervision of installation and associated engineering work (process control, quality control, yield control)
7. Witness of equipment inspection and installation inspection
8. Issuance of completion certificate etc.
9. Submission of report etc.

2) Implementation design system

A) In detail design period, equipment specification is reviewed to make a necessary adjustment to the plan. The operation chief and the operator will generate and approve tender documents, bid and evaluate the bidding.

B) Confirmation and adjustment of the design of the building and poles

Building and pole design regarding the following equipment will be confirmed.

・hydrometric observation station
・CCTV facility
・radar system
・multiplex wireless equipment
・telemeter system

Concerning the sites to install building and poles for 10 telemeter facilities (P1-P10), 4 multiplex wireless facilities (T1, T2, T4 and T6) and 14 CCTV facilities (C1-C14), the local situation, restrictions and other conditions at

placing an order will be investigated on site, final installation site will be confirmed and necessary adjustment will be made to the drawings based on the result of survey at project implementation.

C) Confirmation and adjustment of steel tower design

Regarding the steel tower of radar system and multiplex wireless equipment, the local situation, restrictions and other conditions at placing an order will be investigated on site, confirmed, and adjusted.

Configuration, structure and dimensions will be confirmed by considering the following. Regarding the conditions of basic, entire data and design, the steel tower structure will be finalized, and the drawing will be generated.

- Installation location, direction, kind and quantity of the antenna;
- Accessory structures (ring, platform, feeder rack, lifting unit, fall prevention device etc.);
- Associated unit (lightning protection equipment, aircraft warning light etc.);
- Natural landscape;
- Conditions for the plot;
- Requested performance conditions;
- Economic efficiency

D) Discussions on confirmation of software design and method to confirm the functions and performance (detail will be explained in Section 2.5)

At the stage of implementation design, through adjustment with various staff including dam controllers from State of Vietnam, the detail of necessary functions, user interface, and data format will be finalized.

The confirmation of software functions and performance at development stage will be discussed to generate materials for confirmation such as checklist. In the same manner, the method of final confirmation of software functions and performance in simulation by the State of Vietnam will be discussed to generate materials for confirmation such as checklist.

3) Procurement supervision system

A) Confirmation of equipment production drawing

In order to confirm equipment production drawing and equipment specification.

B) Witness of product inspection/pre-shipment inspection

Equipment procured from Japan will be inspected at a manufacturer’s plant. The motion of the entire water related disaster management information system and individual equipment will be confirmed. The name of manufacturer, style, make-up, product appearance, and presence/absence of manual will also be confirmed.

C) Witness of pre-shipment inspection

Pre-shipment equipment verification will be inspected by a third-party organization that has signed a contract with the consultant. The inspection includes verification of the list of contracted equipment with shipping documents, and verification of shipping documents with quantity, weight and size of equipment.

D) Station supervisor (including acceptance inspection and transfer)

For 14 months from the start of procurement supervision to completion inspection and completion of transfer, a full-time supervisor is to be dispatched.

E) Completion inspection, inspection prior to the end of manufacturer guarantee period (including defect inspection)

For completion inspection, inspection personnel (4) is to be dispatched once for 0.5 month＊. For inspection prior to the end of manufacturer guarantee period one year after the completion of operation (including defect inspection).

F) Progress control and technical support for equipment procurement

For telemeter system, multiplex wireless equipment and CCTV facility, the motion of single unit as well as the motion of the entire system must be properly confirmed through close coordination and adjustment of the whole process that comprises different equipment. For proper process control, after the submission of process plan, the supplier must periodically report the work progress, and ensure thorough process control to prevent any delay in the progress. During the equipment production period and the installation adjustment period, report is to be submitted every 2 months for necessary inspection. Inspection personnel in charge of progress control is to be dispatched for 0.1 month* 6 times, a total of 0.6M/M.

The entire system is made up of various equipment (10 telemeter facilities (P1-P10), 4 multiplex wireless facilities (T1, T2, T4 and T6) and 14 CCTV facilities (C1-C14)) under various geographic conditions and surrounding environment. In order to ensure the functions of individual facilities, knowledge, experience, extremely high expertise and technologies are required in order to meet the conditions below.

[1] To ensure proper technical support for the environment where different kinds of equipment are simultaneously produced in various factories in the country.

[2] To provide technical support for unitization during domestic production period to ensure the functions of equipment overseas.

[3] To provide technical support to adjust equipment setting that allows extra time so as to prevent possible risks expected in the use overseas

[4] To provide technical support of motion test for not only testing a single equipment, but also testing fully connected equipment and comprehensive

testing

[5] To provide technical support for motion test by inputting various test patterns expected in Japan

[6] To provide technical support for on-site installation adjustment to ensure smooth motion of multiple equipment at multiple work sites

[7] To make final adjustment with Vietnamese staff regarding the data used for operational test plan and operational test, and to witness operational test and provide technical support

[8] To provide technical support for Vietnamese staff to generate data used for operational test

As explained above, technical support will be provided for the supplier during equipment production period and installation adjustment period.

G) Progress control for software development

Various software functions defined as requirement which are developed during the procurement period will fulfill their purpose after all the functions are confirmed. When the operation starts, the developer must generate and submit an appropriate process plan. After the confirmation, development must be conducted according to the process plan. To ensure software development process control, the developer must report the work progress periodically, and ensure proper progress process control to prevent any delay. During the development period, report is to be submitted every 2 months for necessary inspection.

H) Technical support during development, adjustment to operational test plan, and generation of operational test data (See Section 2.5 for detail.)

The most important function to be developed this time for the software is proper operation of the dam in case of flood and drought based on the estimation, and to provide proper information for relevant organizations. In order to develop the function, knowledge, experience, extremely high expertise and technologies are required for actual dam control at the site. The software should also provide functions that fit the Vietnamese dam control system and the actual control. During development period, technical support including the coordination with State of Vietnam will be provided for the developer.

Furthermore, for trial run/ adjustment of the entire system, and initial operation instruction/use instruction, JICA staff will witness the site, make the final confirmation of performance of the developed software, and provide technical support to promote the understanding of the users. In order to ensure proper operational test by the State of Vietnam, the staff will make final coordination with Vietnamese staff on data to be used for operational test plan and operational test, and witness the operational test to provide technical instruction.

Operational test prior to acceptance inspection/transfer will be conducted by the State of Vietnam. An operational test requires a large amount of data in various kinds. It is difficult for the State of Vietnam to prepare data for operational test in a designated format. The data will be prepared by the consultant, and provided for the State of Vietnam. To prepare the data, the consultant will make a coordination with relevant organizations from the State of Vietnam, obtain necessary information from the organizations, process the information properly into and a format that can be used by the system.

I) LiDAR survey

At the following time points, supervision, inspection by the State of Vietnam, and support for documentation of application for approval will be provided.

[1] During measurement planning

[2] Interim data inspection

[3] Delivered data inspection

[1] Supervision of measurement planning

[1st time]

・Supervision of measurement planning

・Explanation of measurement plan for relevant organizations

[2nd time]

・Generation of, and support for application document for permission of aerial survey

[2] Interim data inspection

・Interim data (original data) inspection

[3] Delivered data inspection

・Delivered data (DEM data) inspection

・Explanation of delivered data for relevant organizations

J) Other procurement supervision

To assist station supervisor engineer, a local employee procurement supervisor engineer (10 years of experience) and a 4WD vehicle (with a driver) are to be provided during the term of station supervisor.

An on-site employee procurement supervisor engineer will assist the station supervisor engineer, and engage in witness inspection by sharing the work with the station supervisor engineer because witness and inspection are required simultaneously in the vast installation area.

To witness and support operation test by the State of Vietnam.

(2) Japanese staff plan regarding procurement control by the supplier

[1] Confirmation of equipment production drawing

To confirm equipment production drawing and equipment specification, inspection personnel.

[2] Witness of product inspection/pre-shipment inspection

Equipment procured from Japan will be inspected at the manufacturer's plant, and motion of equipment will be confirmed. Furthermore, the name of manufacturer, style, make-up, product appearance, and presence/absence of manual will also be confirmed.

[3] Witness of pre-shipment inspection

Pre-shipment equipment verification will be inspected by a third-party organization that has signed a contract with the consultant. The inspection will include verification of the list of contracted equipment with shipping documents, and verification of shipping documents with quantity, weight and size of equipment.

[4] On-site procurement management

The on-site procurement management is to manage local works

which include : construction of steel tower, prop and sheds ; installation of equipment ; calibration and trial run of the system.

2-2-4-5 Quality management Plan

(1) Quality of equipment

The following inspection will be conducted to ensure consistent quality of equipment from procurement to the completion of installation.

1) Inspection

The following inspection will be conducted for materials and equipment delivered from Japan in order to confirm the quantity, performance and delivery term as indicated in the certificate of approval referred to in the inspection.

1)-1 Witness inspection in plant

When the contractor completes the production and inspection of the equipment, and purchase of material/equipment, confirms the comprehensive motion of the system, and is satisfied with the performance/quantity of the specification, witness inspection will be conducted at the contractor's plant to verify the performance and quantity.

1)-2 Package inspection

When the plant inspection is completed, and the contractor packaged all the materials and equipment, and is ready for shipping, the package will be inspected, quantity of packaged materials and equipment, packing style, and case mark will be inspected with the packing list in order to make sure that the package is durable enough for marine transport and land transport in the State of Vietnam. The following are the method to package for export.

- Main equipment: vacuum package in a wooden box reinforced so that the equipment is protected from oscillation during the transport.
- Antenna pillars: package in a wooden frame reinforced to protect from

oscillation during the transport.

1)-3 Shipment inspection by a third-party organization

After the package inspection is completed, a third-party organization will inspect the shipment to confirm proper shipment.

1)-4 On-site quantity inspection

Quantity of materials and equipment delivered from Japan, and locally procured material and equipment will be inspected to confirm the quantity.

1)-5 Completion transfer inspection

When the contractor completed the adjustment and inspection of the installation of entire system, the quantity and performance will be confirmed, and inspection completion report will be submitted to the Vietnamese government to certify the completion.

1)-6 Gratuitous guarantee period

The contractor will guarantee the quality of materials and equipment for 1 year after the completion of transfer inspection, and try its best for restoration from defect, if any, for free of charge without delay.

2) Marine and land transport, and storage

Materials and equipment procured in Japan will be shipped from the Tokyo or Yokohama port by sea to the Da Nang port. Equipment will be transported by land from the Da Nang port to Hue Province, and stored there. Then, individual equipment will be transported to the sites of installation according to the construction plan.

Vietnam will clear the customs for equipment shipped from Japan at the Da Nang port. After the customs clearance, the contractor receives the materials and equipment, and transports them by land. The contractor will be responsible for storage thereafter and individual transport to the sites. For the land transport from Da Nang to the storage warehouse in Hue, domestic laws and regulations will be carefully investigated for a transport plan in order to prevent any delay in transport.

3) Process control

All the equipment manufacturing period and materials procurement period will be surveyed to shorten the manufacturing period. In order to finish the installation in a short period, such measures as unpacking and assembling necessary equipment at warehouse should be taken.

(2) Quality of construction

The quality of construction of telecommunication equipment will be inspected at the completion inspection on individual facility to confirm the quality is the same as indicated by the specification. The method of wiring and fixing will also be confirmed to see the work has been done as specified.

The quality of construction work is inspected mainly by checking the concrete used for the building and the foundation of water level gauge. The following table shows the quality control items, test method, and test frequency.

Table 2-19 Concrete control items

Quality control item	Test method	Test frequency
Slump	Slump test	Twice/day per one kind of concrete
Compression strength (material age 28 days)	Compression strength test	3 samples from each inspection lot, once for every placing area, and every placing day

The result of control test will be judged by statistical method (histogram and control chart) to confirm whether it meets quality control standard, and the quality is stable.

2-2-4-6 Procurement Plan for Equipment, Materials, etc.

(1) Procurement location

For equipment and materials procured in this project that are necessary for the water related disaster management information system and ancillary construction, the procurement location will be selected appropriately according to surveys conducted on local records of use and quality, price, after-sales service structure, etc.

The following shows procurement locations and methods for major equipment and materials.

1) Water related disaster management information system and equipment the system is composed of

There is no record of use of water related disaster management information systems in Vietnam.

There are many instances of similar systems being used as dam control systems in Japan, with communication equipment and the like used being almost the same and stable operation achieved 24 hours a day, 365 days a year.

For telemeter data collection systems, which make up part of a water related disaster management information system, those made in Italy are available and have been installed with assistance from Italy.

In this project, wireless equipment is to be in the 70 MHz band to enable stable use in the severe communication conditions of mountainous areas. The Italian systems, however, are 400 MHz band wireless equipment with a different frequency band, so conditions differ from those for this project.

Moreover, response to problems is not taken until after concluding a contract

for annual maintenance, and such a contract has not been concluded at the time of the survey. Therefore, a problem where maintenance cannot be done and observation data is missing for a long period of time has been seen.

As a result of studying these records of use, it is deemed that it would be appropriate to introduce Japanese systems due to their quality and track record.

Many of the hydrological observation stations and wireless radio base stations expected to be installed in this project are in unpopulated locations with no nearby paved roads, and maintenance is expected to be very difficult. Those conditions need to be taken into account, so a highly reliable system that suffers few failures is needed.

In terms of reliability, the track record in stable operation of unmanned hydrological observation stations and wireless radio base stations in Japan demonstrates that they have sufficient reliability.

Water related disaster management information systems are composed of hydrological observation stations, CCTV systems, radar systems, multiplex wireless equipment, telemetry systems, information processing and display systems, dam water level metering systems, and dam gate opening indicators, and high reliability is needed for the each equipment. Therefore, Japanese devices shall be adopted due to their track records of use in Japan.

The servers and other general-purpose equipment to be included in the system can be procured in Vietnam at similar performance levels as those produced in Japan, but taking into consideration shipping of system components that include those high-performance general-purpose equipment, they will be procured in Japan. This is because in production of the water related disaster management information system, modules composed of those components will be put together in Japan, necessary wiring and software added, and overall system adjustment and operation tests conducted before shipping.

For water level gauges, efforts will be taken to actively incorporate products made in Vietnam taking into consideration factors such as maintenance and prompt response to failures.

For pressure-type water level gauges, there are Vietnamese products with sufficient accuracy, so specifications that Vietnamese products meet shall be set.

For ultrasonic water level gauges, there are no products made in Vietnam having sufficient accuracy, so specifications that Japanese products meet shall be set.

Table 2-20 Procurement location

Equipment name	Procurement location
Water level gauges/rain gauges	Japan/Vietnam
CCTV systems	Japan
Radar systems	Japan
Multiplex wireless equipment	Japan
Telemetry systems	Japan
Information processing and display systems	Japan
Dam gate opening indicators	Japan

2) Cables, wiring materials, etc.

The main cables used in this project are mostly cables to connect measuring equipment and control devices installed in hydrological observation stations and small-diameter communication and control cables connecting antennas and telemeters, and the number of cables to be used is small.

Connecting cables and the like for telemeters and control devices are needed at test operation and adjustment in Japan, and completing work such as attaching terminals and terminal numbers in Japan will make cable connection work locally easier, so multi-core measuring cables and the like shall be procured in Japan.

Towers and poles for wireless radio base stations and others designed to comply with local standards shall be procured locally.

3) Building materials

Major building materials can be procured locally, so mainly local procurement shall be done.

Materials that can be procured locally should be actively employed as it would be advantageous to do so in terms of maintenance after the facilities are completed.

3)-1 Ready-mixed concrete, cement, concrete secondary products

Buildings and the like to be constructed using ready-mixed concrete in this project will be located mainly in mountainous areas without vehicle roads, far from plants, and very small amounts will be used. Therefore, the plan shall be for sieves and small-scale pot mixers (0.08 m^3 class) to be transported to the site and aggregate sieved from soil around the building site, with that used to produce concrete in pot mixers. However, just the cement will be transported to the site, with that cement being procured in Vietnam.

3)-2 Sand and aggregate

The volume of aggregate to be used at each site is small and transport would be difficult at some locations. So, except for sites with favorable conditions such as being near a plant and a transport road, the plan shall be for sieves to be brought to the site and surrounding soil and the like sieved to produce the necessary aggregate.

3)-3 Reinforcing bar/steel material

Thin reinforcing bar of about D10 size is needed for buildings in this project, and that shall be procured in Vietnam.

3)-4 Other construction-related materials

The number of types of construction materials to be used in this project is not very large, with materials other than those above being limited for the most part to paint and doors and windows used in buildings, and those can be acquired in Vietnam.

3)-5 Construction machinery (leased)

Most construction in this project will be done manually due to factors such as scale of construction and transport route issues, so construction machinery used will be limited to pot mixers (0.08 m^3 class) for concrete mixing, compressors, pick hammers, welding machines, and other small machinery, and the period in which they are used will be very short.

That machinery as well shall be leased from construction companies and lease companies (including individuals owning machinery) in Vietnam.

3)-6 Labor-related topics

Construction work can be sufficiently handled by Vietnamese laborers.

However, installation of electrical and communication equipment, wiring work, and the like shall be done by electrical and commutation engineers dispatched from Japan. Equipment test operation, adjustment, and the like as well shall be performed by Japanese engineers.

Table 2-21 Procurement locations of construction materials

Material name	Procurement location
Cement	Vietnam
Ready-mixed concrete	Vietnam
Concrete secondary products	Vietnam
Sand and aggregate	Vietnam
Reinforcing bar, steel products	Vietnam
Paint	Vietnam
Other construction materials	Vietnam

Table 2-22 Procurement locations of Major construction equipment (leased)

Machinery name	Specification	Procurement location
Backhoes	0.45 m^3	Vietnam
Truck cranes	4.9 t	Vietnam
Trucks	4 t	Vietnam
Dump trucks	4 t	Vietnam
Concrete mixers	0.08 m^3	Vietnam
Welding machines	300 A engine-powered	Vietnam
Compressors	3.5 m^3/min class	Vietnam
Pick hammers		Vietnam
Generators	30 kVA class	Vietnam

4) Transport plan

4)-1 Transport route

Equipment and materials used in this project shall be procured locally and in Japan.

The transport route for items procured in Japan is by sea transport to Vietnam's Da Nang port and then, after customs clearance, by land transport from Da Nang port to Hue Province where items will be transported to construction sites. There are very many construction sites, and timing of start of construction varies, so equipment and materials will be temporarily stored in warehouses in Hue City and transported individually to installation sites according to the construction plan.

4)-2 Transport time

Transport time is about 45 days, with total transport volume of 668 freight tons being transported in 27 20-foot containers.

Number of days required for each process is as shown in the following table.

Table 2-23 Transport route/duration

Country procured in	Planned loading location	Sea transport	Planned unloading port	Customs clearance	Inland transport
Japan	Tokyo and Yokohama ports	About 30 days	Da Nang port	14 days	1 day to Hue

4)-3 Transport packaging method

Precision equipment such as communication equipment and computers procured are generally sold packaged, so packaging expenses shall not be budgeted.

Most of the equipment is precision equipment and will be shipped to Tokyo or Yokohama port in boxes or other stable packaging.

Taking into consideration convenience of ground transport in Vietnam, 20-

foot containers shall be used with those being unloaded at Da Nang port in Vietnam, transferred to trailers, and transported by land approximately 80 km to the holding space in Hue City.

4)-4 Transport to individual sites

Transport from warehouse to individual site shall be 4-ton truck.

2-2-4-7 Plan for Initial Operation Instruction and Management Instruction, etc.

(1) Initial operation instruction

Parties using water related disaster management information systems procured within the scope of this project consist of 8 organizations (Hue PCC-NDPCSR, Hanoi CSC-NDPC, 3 dams, NHMS [Hanoi, Hue and Da Nang). Thus, initial instrument operation instruction will be conducted at 8 locations. Ahead of the handover of the facilities and equipment, a total period of approximately 1 month will be set up for technical staff and so on operating the systems, during which explanations on the functions of delivered equipment, operational instruction and maintenance inspection instruction conducted by delivering vendor technicians, will be performed in the form of practical on-site training.

Instruments for which initial operational instruction is to be conducted are as follows.

- Hydrological observation station instruments
- CCTV equipment
- Radar systems
- Multiplex wireless systems
- Telemetry systems
- Information processing and display systems
- Dam water level metering system
- Dam gate opening indicators

(2) Management instruction

Operators at each of the institutions will be able to conduct basic management of the various apparatuses through initial operation instruction. However, this kind of short-term technical instruction is not sufficient for the effective utilization needed in order to manage the system in a comprehensive manner. The soft component in the below will be implemented to make up for this. Parties involved with water related disaster management information systems in Vietnam will learn the comprehensive management of systems.

2-2-4-8 Soft Components Plan

During this project, a soft component will be implemented with the goal of conducting the necessary transferal of expertise, so as to assist in the prevention and mitigation of water-related disasters within the basin areas via continuous long-term utilization of processed instruments and systems in the project.

(1) Background of soft component

The central coastal areas of Vietnam are typhoon-prone zones. As such, they see yearly wind and water caused damage as well as damage from landslides. Disaster prevention and emergency measures are an urgent challenge from the perspective of prevention of both loss of human life and social/economic capital. At irrigation dams set up in major river and basin zones (which are mostly earth dams), flood damage occurs frequently in down-stream regions due to dam washouts during torrential downpours. Causes of flood damage other than issues having to do with dam facilities (design/construction), include the following. Information collection regarding precipitation, waterway water levels and flow rate, dam water levels and so on, flood risk information, and flood forecasting and warning transmission frameworks are underdeveloped. Also, the storing and discharging of water at dams is not taking place with appropriate timing and with the appropriate amounts of water.

The Vietnamese government has put forth the appropriate administration and management of dams as an important challenge within the Disaster Prevention and Mitigation Act instituted in 2013 which focuses on disaster prevention. At the same time, the Prime Minister has instructed the Ministry of Agriculture and Rural Development (MARD) to enhance appropriate management and safety measures for dams on the Huong River after the frequent flood damage occurring in recent years within downstream regions. Moreover, integrated management rules during times of flooding have been set out in accordance with the decision of the Prime Minister for three major dams (the Binh Dien Dam, the Huong Dien Dam and the Ta Trach Dam) located in the Huong River basins in 2014; while drought countermeasures were also added in 2015, information systems required for the realization of these are still not developed.

Given the above, in order to improve safety at dams and basins through conducting appropriate decisions and control with respect to the timing of the storing and discharging of water at dams along with discharging amounts, thereby going about accurate ascertaining and conveyance of flood disaster risk information in downstream regions, the observation and sharing of highly precise hydrological data in real-time and flooding forecasts are absolutely necessary. The streamlining of systems providing information for prevention which conduct such processes requires urgent attention.

Based on this background, the Project for Emergency Reservoir Operation and Effective Flood Management using Water related Disaster Management Information System (Vietnam), aims to contribute to the prevention and mitigation of water-related disasters in the basin areas via transmittal and conveyance of timely and precise disaster management information and appropriate management and operation of dams as a result of the installation of observational equipment for precipitation, river water levels and flow rate, dam water levels and so on in the Huong River (located in T. T. Hue Province), as well as the building of an Integrated Disaster Management Information System utilizing observed data obtained through such means.

Hydrological observation network has still not been arranged in the river basin regions in Vietnam, meaning that there is a lack of experience when it comes to dam operation and river management based on real-time observed data and so on. Therefore, there is a need to go about improving the abilities of the organization's staffs in-charge in Vietnam through the implementation of a soft component in order to sufficiently achieve the purpose of the Project via appropriate operation, use and application of the instruments and systems to be procured in the project.

(2) Soft component goal

The goal of the soft component is to transfer the expertise required in building necessary technology and knowledge foundations so as to continuously achieve the below objectives over the long-term.

1) Conduct responses and inspection/maintenance when trouble has occurred in order to have observational data from new and existing hydrological observation station facilities appropriately observed and transmitted, and have such data displayed in real-time on display screens for water related disaster management information systems
2) Have the organizations involved locally precisely operate and utilize water related disaster management information systems, and have them assist in the alleviation of flood disasters and the appropriate use of water in the Huong River basin areas

(3) Soft component accomplishments

The following table shows the achievements anticipated through the implementation of the soft component.

(4) Method of confirmation of level of achievement of results

For the goals of each achievement of the soft components, the level of achievement thereof will be assessed through tests on whether or not staff in Vietnam are able to conduct the items by themselves. The right-side column of

the following table shows the methods for assessing the level of achievement for each achievement.

Table 2-24 Results expected from soft components

Achievement item	Description	Method of confirmation of level of achievement
Achievement 1 Handling when trouble occurs in equipment and systems	Acquisition of inspection and maintenance of each of the equipment and systems and identification of defective areas, investigation into the causes thereof and handling methods	Confirmation of the level of proficiency in terms of responding to trouble during utilization in practical operations
Achievement 2 Inspection and maintenance of equipment and systems	Acquisition of handling methods during occurrences of trouble with respect to observational equipment such as radars, CCTVs, communications equipment, information processing and display equipment, data accumulation equipment and the systems for that equipment	Confirmation of proficiency levels through practical inspection and maintenance in line with manuals
Achievement 3 Acquisition of monitoring method of indicative data	Acquisition of methods for screening and detection of abnormalities in display data and investigation of the causes thereof and handling	Confirmation of proficiency levels for screening and detection of abnormalities in display data and investigation of the causes thereof and handling during utilization in practical operations
Achievement 4 Management of water related disaster management information system	Acquisition of dam operation methods for alleviating flood damage and drought countermeasures (in line with the instructions of the Prime Minister) utilizing water related disaster management information systems	Confirmation of proficiency levels through operational training in line with manuals
Achievement 5 Transmission of flood risk information	Acquisition of precise conveyance methods to residents and so on for flood damage risk information (information for basins and flood forecast warnings)	Confirmation of proficiency levels through information conveyance training in line with manuals
Achievement 6 Acquisition of parameter identification method of radar rain gauge	Acquisition of methods for precision assessments and identification of constants utilizing surface precipitation observation figures and quality calculations for radar rain gauges using rainy season observational data	Confirmation of processes and results of practical work
Achievement 7 Acquisition of parameter identification method of runoff analysis model	Acquisition of parameter identification method of runoff analysis models based on precipitation observation figures (surface and radar), water level and flow amount observation figures, surveys concerning overflow and submergence situations and so on	Confirmation of processes and results of practical work
Achievement 8 Acquisition of preparation and utilization methods for HQ curves	Acquisition of methods for observation of flow amount (via float measurement methods, radio anemometers and so on) and HQ curve preparation methods for converting water level observation figures at waterways into flow amounts	Confirmation of processes and results of practical work

(5) Soft component activities (necessary input)

The soft components will constitute direct support conducted by persons in-charge of instrument operation, management, water related disaster management information systems and radar rain gauges. It will take place over the course of 17 months from October 2018 to February 2020. (Total 8.0M/M) Persons in-charge of instrument operation and management handle “Achievement 1:

Handling method when trouble occurs in equipment and systems" and "Achievement 2: Inspections and maintenance of equipment and systems". Persons in-charge of the water related disaster management information system handle "Achievement 3: Acquisition of monitoring method of indicative data", "Achievement 4: Management of water related disaster management information system", "Achievement 5: Transmission of flood risk information", "Achievement 7: Acquisition of constant identification method of runoff analysis model" and "Achievement 8: Acquisition of creation and utilization methods for HQ-curve". The persons in-charge of radar rain gauges handle "Achievement 6: Acquisition of constant identification method of radar rain gauge".

The following table shows achievement items and the method of procurement for implementation resources along with the activity plan for the soft component. With respect to practical operational instruction for handling during the occurrence of trouble and monitoring of display data abnormalities, instruction on investigating causes and handling methods will be conducted by artificially inducing generating system shutdowns due to power outages, abnormalities in parts of observation data and missing data together with the handling of actual trouble.

Table 2-25 Soft Component Activity Plan

Achievement item	Subject	Implementation method	Item achieved	Resource
Achievement 1 Handling method when trouble occurs in equipment and systems	Staff in-charge of equipment operation such as those at MARD, DARD and the administrative stations at the 3 dams (about 20 people)	・On-the-job instruction for practical operations ・Instruction for methods of handling for artificial trouble occurrences	Training materials Summaries of results for practical operation instruction	Consultant in-charge of equipment operation and management 5 days (direct support-type)
Achievement 2 Inspection and maintenance of equipment and systems	Staff in-charge of equipment maintenance management, such as those at MARD, DARD and the administrative stations at the 3 dams (about 20 people)	・Confirmation of performance for equipment at each of the equipment installation sites and implementation of training for practical maintenance operations ・Preparation of Maintenance Management Manuals ・On-the-job instruction (TOR preparation) for work management of external maintenance crews	Inspection and maintenance manuals Maintenance contract TOR Summaries of results for practical operation instruction	Consultant in-charge of equipment operation and management 5 days (direct support-type)
Achievement 3 Acquisition of monitoring method of indicative data	Staff in-charge of display data monitoring, such as those at MARD, DARD and the administrative stations at the 3 dams (about 10 people)	・Training implementation and on-the-job instruction for detection of display data abnormalities, investigations of causes and methods for handling (breakdowns of observation facilities, mistakes in data entry, information conveyance and processing instrument trouble, program bugs, power source abnormalities and so on)	Training materials Summaries of results for practical operation instruction	Consultant in charge of the water related disaster management information system 5 days (direct support-type)

		・instruction for methods of handling for artificial abnormality displays		
Achievement 4 Management of water related disaster management information system	Staff in-charge of water related disaster management information system operations, such as those at MARD, DARD and the administrative stations at the 3 dams (about 20 people)	Implementation of training for dam operation utilizing the water related disaster management information system ・instruction for practical system operation	Dam Operations Manual using Water related disaster management Information System Summaries of results for practical operation instruction	Consultant in charge of the water related disaster management information system 10 days (direct support-type)
Achievement 5 Transmission of flood risk information	Staff in-charge of disaster prevention, such as those at MARD, DARD and the administrative stations at the 3 dams (about 20 people)	Implementation of training for effective conveyance to residents .etc of flood damage risk information (information for basins and flood forecast warnings) ・ Implementation of training for the conveyance of information on flood damage risks ・instruction for practical operations for conveyance of information on flood damage risks	Summary of instruction results for information conveyance training	Consultant in charge of the water related disaster management information system 5 days (direct support-type)
Achievement 6 Acquisition of parameter identification method of radar rain gauge	Radar rain gauge operation management representative staff at MARD, DARD and NHMS (about 10 people)	・ Implementation of training concerning radar rain gauge observations ・Instruction for practical operations for quality calculation procedures at the initial commencement stage of radar operation ・Instruction for practice operations for the verification of observation precision using flood season data (Sept-Dec), for identification of constants and for configuration on the system	Training materials Summaries of results for practical operation instruction	Consultant in charge of radar rain gauges 70 days (direct support-type)
Achievement 7 Acquisition of parameter identification method of runoff analysis model	Staff in-charge of water related disaster management information system operations, such as those at MARD and DARD etc. (about 10 people)	・ Implementation of training for overviews of runoff analysis models (built into the water related disaster management information system) and parameter identification procedures ・Instruction for practical operations for verification/identification of constants for runoff analysis models using flood season hydrological observation data (Sept-Dec) and configuration on the system	Training materials Summaries of results for practical operation instruction	Consultant in charge of the water related disaster management system 40 days (direct support-type)
Achievement 8 Acquisition of preparation and utilization methods for HQ curves	Staff in-charge of hydrological observation stations at DARD etc. (about 10 people)	・Instruction for practical operations for sequences of work used in the preparation of HQ curves based on flow amount observations at spots where water levels are observed on the main part of the Huong River and branch streams during the flood season (Sept-Dec), as well as configuration of that on the system	Training materials Summaries of results for practical operation instruction	Consultant in charge of the water related disaster management information system 20 days (direct support-type)

In river basins in Vietnam, experience is lacking for dam operation and river management that utilizes water management systems based on real-time observed data and so on, meaning that expertise levels are low. Through the implementation of the soft component, the goal is to raise the level of expertise to that where instruments and systems are smoothly operated, where they are effectively utilized in the actual operation of dams and in operation and risk information transmission, and where (depending on the need) radar rain gauge parameters and model constants and so on are updated and can be configured on the system. Following figure (Fig. 2-25) shows organizations in Vietnam involved in this project and the soft component will apply to their staffs in charge.

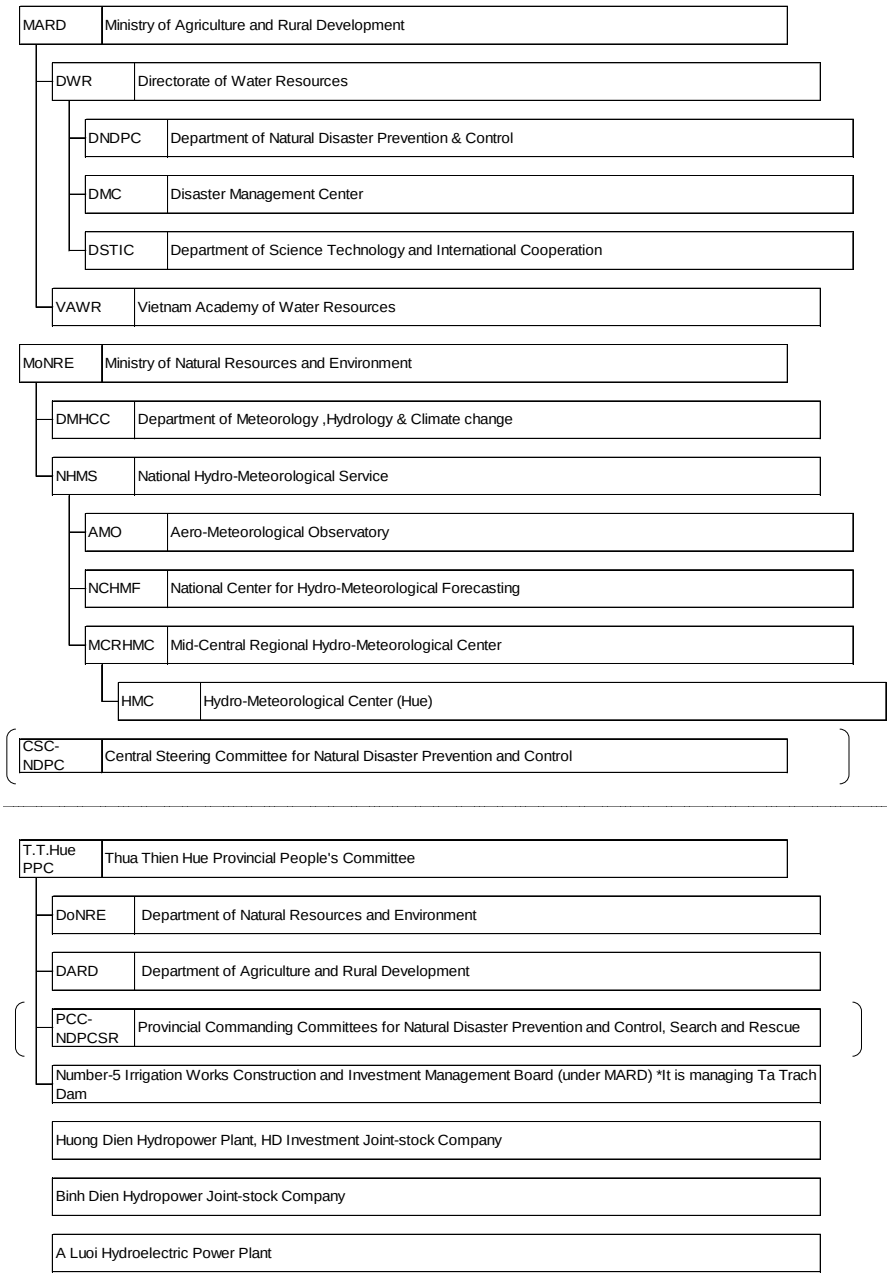


Fig. 2-25 Vietnamese organizations related to the project
(Staff of the colored departments are assumed to be subject to the soft component)

The following figure shows an arrangement of items for the initial stage operation instruction conducted by instrument manufacturers for operation and maintenance management of instruments and systems contrasted with the content implemented in the soft component.

Table 2-26 Initial operation instruction by manufacturers and arrangement of the content implemented in the soft component

Initial operation instruction by instrument manufacturers	Content implemented during the soft component
○ Operation methods for main function buttons (including for turning the power on and off) with respect to each instrument and system ○ Methods for restart when a system is downed due to a power-outage etc. ○ Configuration (update) methods for various constants on systems ○ Exchange methods for consumables etc.	○ Instruction on practical operations for handling methods when trouble occurs in equipment and systems ○ Instruction on practical operations for periodic inspections and maintenance based on manuals ○ Instruction on practical operation for abnormality detection through monitoring of display screens and handling methods ○ Practical operational instruction for various procedures for the updating of constants

(6) Procurement method for implementation resources for the soft component

In terms of content to be implemented in the soft component, it would be difficult to find appropriate people to serve as local resources on-site, given that specialized technical know-how is required with respect to the operational management of similar systems, radar rain gauge precision assessments/parameter identification, as well as parameter identification for runoff analysis models and so on. Thus, it would be appropriate to have the relevant items directly implemented by the experienced consultants. The consultants are to get necessary cooperation of the Vietnamese organizations related to the Project on the present status of hydrological observation and analysis.

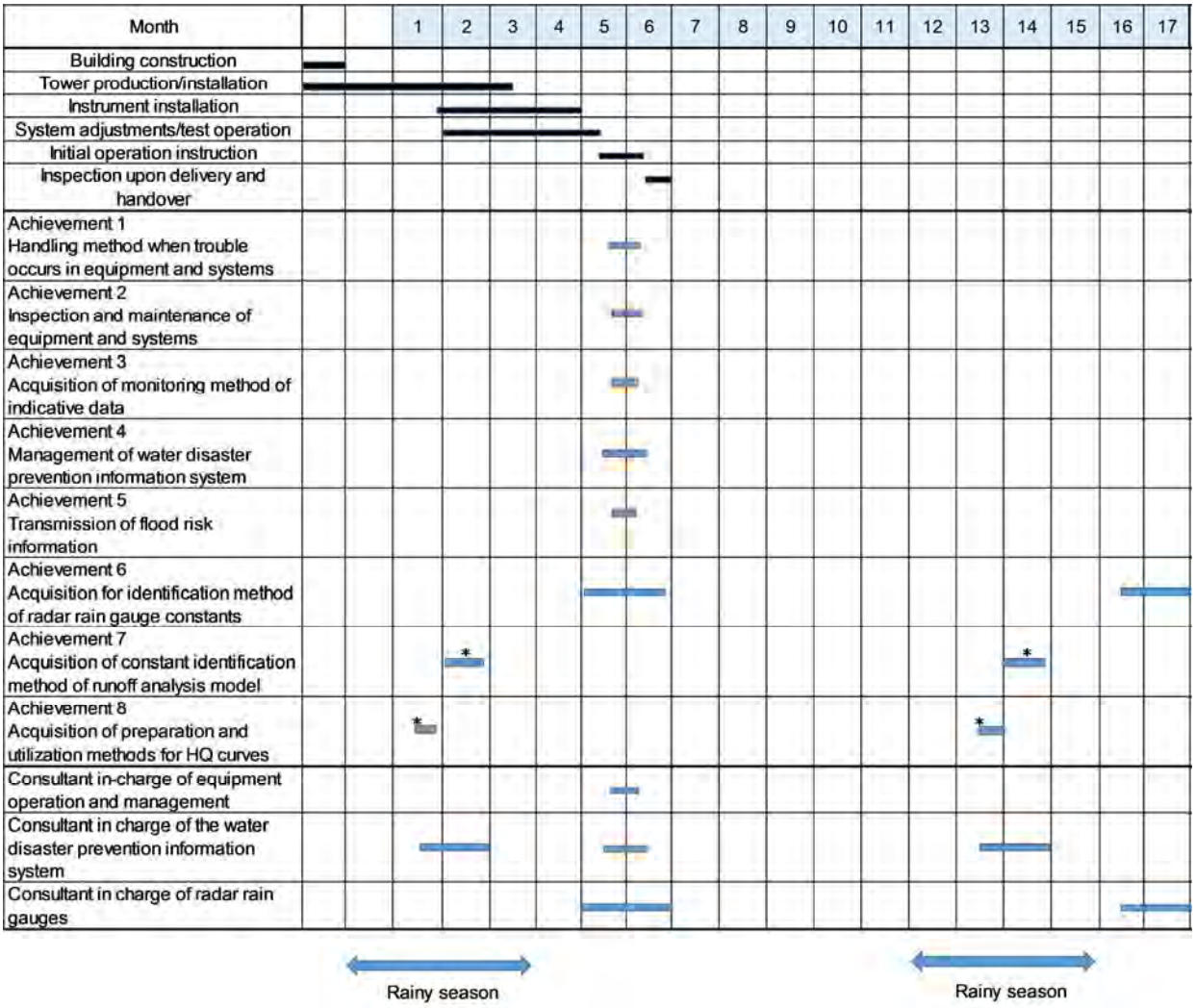
During the period of activities conducted locally by consultants in-charge of the soft components, a technician will be employed (who has over 10 years of experience as an on-site employee) in order to provide support for the coordination of contact with relevant institutions and the arrangement and collection of materials. The local technician handle a lot of support work alone and almost all the time of such technician will be allocated to such work. Therefore, an interpreter will be employed to help the consultant communicate smoothly with concerned persons in relevant institutions and in day-to-day activities.

(7) Soft Component Implementation Schedule

The soft component to be implemented before the handover of instruments will be conducted from October through November with respect to HQ curve preparation and the configuration for initial constant values for runoff analysis models based those HQ curves. All other items (items which will not be carried out until the full completion of installation for observational facilities and system building) will be conducted when the equipments are installed and test operation start. Moreover, on-the-job-type technical instruction for identification of radar rain gauge parameters and identification of constants for runoff analysis models will be implemented based on observed data obtained via observational networks built within this project during the rainy season (Sep-Dec) after handover of the instruments. The schedule of soft component activities will be flexibly planned.

Table 2-27 Entire schedule for the soft component

(17 month before and after installing the eqipments)



*: Soft component activities for 7 and 8 are to be executed when heavy rainfall event occurs during rainy season.

(8) Soft components achievements

Prepare and submit the following documents as soft components achievements at the completetion of the transfer of expertise.

Table 2-28 Soft components achievements

Achievement Item	Item Achieved
1. Handling when trouble occurs in equipment and systems	Training materials with respect to the handling method when trouble occurs in equipment and systems and a practical operation instruction results summary
2. Inspection and maintenance of equipment and systems	Manuals for inspection and maintenance of equipment and systems maintenance, contract TOR and a practical operation instruction results summary
3. Acquisition of monitoring method of displayed data	Training materials for detection of display abnormalities and handling methods and a practical operation instruction results summary
4. Management of water related disaster management information system	Summary of the Dam Operations Manual using Water related disaster management Information System and instruction for practical operations
5. Transmission of flood risk information	Summary of instruction results for information conveyance training
6. Acquisition of parameter identification method of radar rain gauge	Training materials for radar rain gauge precision assessments and parameter identification procedures and a practical operation instruction results summary
7. Acquisition of parameter identification method of runoff analysis model	Training materials for identification of constants for runoff analysis models and a practical operation instruction results summary
8. Acquisition of preparation and utilization methods for HQ curves	Training materials for HQ curve preparation procedures and a practical operation instruction results summary

(9) Responsibility of the Vietnamese side

After the completion of this project, continuous implementation of the below items should take place in order to realize effective utilization of instruments and systems in Vietnam for the long-term.

1) Periodic inspection and maintenance of equipment and systems

2) Updates for HQ formulas and reflection within the system based on flow amount observations during flood seasons at water level observation sites

3) Verification of runoff analysis models using hydrological observed data during flood season and updates (depending on the need) to model parameters

4) Verification of observation precision levels for radar rain gauges using

precipitation observed on the ground and updates (depending on the need) to observation parameters

With respect to these items, the transfer of expertise can be carried out through the instruction on practical operations implemented during the soft component. On the Vietnamese side, there is a need to continuously improve the skills of individuals in-charge by building the required organization frameworks together with securing human resources during that time and utilizing them in practical operations.

Furthermore, to operate the dam reservoirs in the Huong River basin during the flood season as well as dry seasons in accordance with the Prime Minister's decision, while effectively using the water related disaster management information system, each relevant institution must adequately understand its roles and responsibilities and fulfill such role properly. For this purpose, it is necessary to continuously strive for proficiency in correct operation of the system and smooth information transmission through regular information transmission trainings etc.

2-2-4-9 Implementation Schedule

After an Exchange of Notes is concluded between the governments of Japan and Vietnam for this project, the project will be conducted using Japanese grant aid based on the Grant Aid Agreement concluded between JICA and the Vietnamese government. Total project term is about 35 months including 6 months for contract process and detailed design and 29 months for procurement and installation of equipments and soft component (technical assistance). It takes about 24 months from the contract to the delivery of equipments as a completion of the project. Details are as shown in the below implementation schedule chart.

Table 2-29 Implementation Schedule Chart