Chapter 2 Contents of the Project

2.1 Purpose of the Project

This project based on the Master Plan and Feasibility Study on Groundwater Development in Rural Part of Northern Provinces established in 1999, aims to supply safe drinking water in rural areas where water is insufficiently available. The water source is to be deep groundwater. The project will contribute to increase the development of public water supply systems with pipelines which meet the national program.

2.2 Basic Plan for the Project

The public water supply systems with pipelines were planned in 12 communes in three Provinces of Thai Nguyen, Ninh Binh and Thanh Hoa. The domestic water use is set at 60 liters/capita/day, based on the national program. The water source is proposed to be deep groundwater. However, if the water contains toxic or undesirable substances more than the drinking water standards, construction of a water supply system in the commune is to be excluded from the project, since this project is to be financed by Japanese Grant Aid Scheme.

2.2.1 Project Sites

The project site requested from the Vietnamese Government were originally 15 communes which were selected by the above-mentioned JICA's Study. They are 2 communes in Hanoi, 4 communes in Thai Nguyen, 3 communes in Ninh Binh and 6 communes in Thanh Hoa.

Among the above-requested communes, 2 communes in Hanoi Province were excluded from the project due to the following reasons:

- They are covered by the future master plan for Hanoi City's Water Supply System.
- In the territory of the two communes, Hanoi's future development plans have been established and future water supply system in the two communes is to be planned in cooperation with the Hanoi's integrated programs including water use for business and industries, not only for domestic water use.
- There is a possibility that the water supply systems in the two communes will be managed by the Hanoi Water Supply Company in the future.

The above was agreed between JICA and MARD in June 2001, and the Basic Design Study was made on the 13 communes shown in Table 2.1:

Table 2.1 Communes for Study

Province	Rural District City under Province Town under Province	Commune Town under District
Thai Nguyen Province	Dong Hy Rural District	No.1 : Hoa Thuong Commune
	Dong Hy Rural District	No.2 : Dong Bam Commune
	Thai Nguyen Town	No.3 : Thinh Duc Commune
	Pho Yen Rural District	No.4 : Nam Tien Commune
Ninh Binh Province	Nho Quan Rural District	No.5 : Dong Phong Commune
	Tam Diep Town	No.6 : Quang Son Commune
	Yen Mo Rural District	No.7 : Yen Thang Commune
Thanh Hoa Province	Vinh Loc Rural District	No.8 : Vinh Thanh Commune
	Vinh Loc Rural District	No.9 : Vinh Loc Town
	Yen Dinh Rural District	No.10 : Dinh Tuong Commune
	Thieu Hoa Rural District	No.11 : Van Ha Town (Thieu Hung Commune)
	Thieu Hoa Rural District	No.12 : Thieu Do Commune
	Nong Cong Rural District	No.13 : Van Thang Commune

Note 1: In early 2001, "Thieu Hung Commune (No.11)" was administratively changed to "Van Ha Town" under the District; its administrative territory was not changed.
Note 2: A part of Dinh Tuong Commune (No.10), along the National Road No.45 was transferred to the adjacent Quan Lao Town, in 1998.
Note 3: In this report, unless otherwise, the word of "Commune" includes "Town under District".

2.2.2 Target Year

Target year for the project was decided at the year 2005 according to the following reasons:

- This project is to be implemented by the Japan's Grant Aid Scheme and its policy is that the beneficiaries of the project shall be the present people living there, basically.
- Vietnamese policy of "National Rural Clean Water Supply and Sanitation Strategy up to Year 2020" defines the first target year as 2005.
- This project is scheduled to be completed in year 2005.

2.2.3 Service Area and Service Population

(1) Service Area

The service areas to be covered by the water supply systems were proposed in the project taking density of households, distance between villages, distance from water source and main distribution pipelines, construction methods etc. into consideration.

(2) Future Population and Service Population

Future population was estimated at the target year of 2005 by each commune. Based on present population, the year 2005's population was calculated with use of annual population growth rate was published in April 1999 by the Government of Vietnam The present population of 85,200 persons in the project sites will be increased to 92,300 by the estimation.

The service population will be 75,400 persons in 2005. They are 13,000 - 3,230 by commune, and the rate of service population will be 82% in the commune on average.

Table 2.2 Administrative Population and Service Population

Province	Commune		Present population (Year)	Future Population in Year 2005	Service population in Year 2005
Thai Nguyen	No.1	Hoa Thuong	9,449 (2000)	10,120	7,760 (76.7%)
	No.2	Dong Bam	5,445 (2000)	6,020	6,020 (100%)
	No.3	Thinh Duc	6,236 (1998)	6,900	3,457 (50.1%)
	No.4	Nam Tien	6,339 (2000)	6,948	4,518 (65.0%)
Ninh Binh	No.5	Dong Phong	10,000 (1998)	10,798	9,890 (62.1%)
	No.6	Quang Son	7,500 (1998)	8,192	5,090 (62.1%)
	No.7	Yen Thang	8,350 (1998)	9,296	8,790 (94.6%)
Thanh Hoa	No.8 No.9	Vinh Thanh Vinh Loc	11,900 (2001) (No.8+No.9)	13,000 (No.8+No.9)	13,000 (100%) (No.8+No.9)
	No.10	Dinh Tuong	6,628 (2001)	6,997	6,360 (90.9%)
	No.11	Van Ha (Thieu Hung)	6,780 (2001)	6,785	7,272 (100%)
	No.13	Van Thang	6,536 (2001)	7,272	3,230 (47.6%)
Total : 12 Communes (11 Systems)			85,163	92,329	75,387 (81.7%)

Note 1: Communes No.8 and No.9 will have a common-single water supply system.
Note 2: Commune No.12 is to be excluded from the Project because of bad water quality, excessive ammonia.

2.2.4 Capacity Planned

(1) Per Capita Water Use

Per capita water demand is set at 60 liters/day for domestic use on the daily average basis at the year 2005, based on the "National Rural Clean Water Supply and Sanitation Strategy up to Year 2020". In addition, other uses such as for schools, hospitals, offices, shops and so on are added by 10% of 60 liters, that is 6 liters/day.

(2) Capacity

The daily maximum capacity was decided based on the service population, taking the per capita demand and seasonal peak factor (135%) and leakage loss (10%) into consideration.

Capacity of each commune is given below:

Table 2.3 Capacity of Each Commune (at year 2005)

Commune	Total Population in 2005 (person)	Service Population in 2005 (person)	Service Rate (%)	Daily Average Demand (m3/day)	Daily Average Supply (m3/day)	Daily Maximum Supply (m3/day)
No.1: Hoa Thuong	10,120	7,760	76.7	512	569	770
No.2: Dong Bam	6,0,20	6,020	100	397	441	600
No.3: Thinh Duc	6,900	3,457	50.1	228	253	350
No.4: Nam Tien	6,948	4,518	65.0	298	331	450
No.5: Dong Phong	10,798	9,890	91.6	653	726	980
No.6: Quang Son	8,192	5,090	62.1	336	373	510
No.7: Yen Thang	9,296	8,790	94.6	580	644	870
Nos.8&9: Vinh Thanh &Vinh Loc	13,000	13,000	100	858	953	1,290
No.10: Dinh Tuong	6,997	6,360	90.9	420	467	630
No.11: Van Ha (Thieu Hung)	7,272	7,272	100	480	533	720
No.13: Van Thang	6,786	3,230	47.6	213	237	320
Total	92,329	75,387	81.7	4,976	5,529	7,490

Note: - Water demand : Domestic use and other uses.
- Daily average demand : Water demand plus loss of 10%
- Daily maximum supply : (Daily average demand) x 1.35
- Treatment capacity includes 5% of treatment loss.

2.2.5 Basic Plan of the Project

(1) Service Level

Regarding the service level of water supply, public standpipe system (PS) or house connection system (HC) is considered. As a result of a comparative study (See Appendix-12 for more details), HC (house connection) system is proposed in the project. The comparison of costs of service pipes' facilities and land areas required for the construction of facilities are given in Table 2.4.

Table 2.4 Comparison of HC and PS Systems (Costs and Land areas)

Items			PS (Public Standpipes)	HC (House Connections)
Service facilities			Public standpipe : 583 sites (in 12 communes) Block service pipes : 25,700 m	House connection: 18,000 Nos. Block service pipes: 149,580 m
Land area required			29 sites (16,930 m2) for plants plus 583 sites (29,150 m2) for public standpipes : 46,080 m2 in total	29 sites for plants : 16,930 m2
Construction costs of service pipes			14,967 million VND	28,476 million VND
Vietnamese side's costs			Government : 2,609 mil VND Beneficiaries : 0	Government : 9,782 mil VND Beneficiaries : 5,399 mil VND
Annual O/M costs			2,619 million VND	2,609 million VND
Water production cost (tariff)			1,441 VND/m3	1,435 VND/m3
Evalu-ation	Convenience of water use		Inconvenient, due to water taking distance	Convenient, due to location of water taps
	Needs of people		Not required	Required
	Construction cost of service pipes' facilities		Cheaper (Half of HC system)	Expensive (Two times of PS system)
	Annual O/M costs		No difference	
	Water tariff		No difference	
	Land acquisi-tion	Land cost	Expensive (2.7 times of HC)	Cheaper (1/2.7 times of PS)
		Number of sites	Many as 612 sites (27 times of HC)	Not many as 29 sites (1/27 times of PS)
		Possibility	Unrealistic	Possible

Comparing both the systems, HC system is apparently superior to PS system in the quality of public service and convenience of daily water use. The HC system meets the requirement of people. Although land acquisition is a big issue in Vietnam, lands required for the HC system is 29 sites in 12 communes; the land acquisition is considered feasible.

The project is proposed with house connection (HC) system. The individual house connection cost is burdened to households in the HC system. In general, house connection fee in Vietnam is about 600,000 VND, almost equivalent to one month's income of a household. The public water supply facility constructed by the project is to be used by commune people, and its maintenance cost shall be borne by the users. Hence, it is very important that the people make sure that they apply for house connections.

One half of the house connection fee is for pipe materials and water meter. From the above point of view, this project plans to supply water meters and pipe materials for house connections. This reduces a house connection fee to about half of the total cost (from 600,000 VND to 300,000 VND). This 50% reduction of the fee will help to promote and reinforce the people to apply to house connection. The result of household survey on all the communes shows that the amount of 300,000 VND is affordable and reasonable for a house connection.

On the other hand, P-CERWASS is requested to manage house connection construction work. The work progress shall be in cooperation with the progress of Japanese side's works.

The PS system has advantage in the construction costs of service pipes' facilities, it requires land acquisition of 612 sites in total which is enormous and unrealistic. Such land acquisition is judged almost impossible within the project period.

Another important issue to be carefully managed in this project is deemed "land acquisition". The application of land acquisition is to be requested by P-CERWASS to the Provincial Peoples Committee (PC); and PC negotiates with right holder of the land. While the acts regarding the land in Vietnam have been established in 1990's (See the Supplemental Note), there has frequently been delayed the land acquisition activities for the facilities of water supply projects, causing remarkable delay of the progress of the project implementation. CERWASS and Provincial PC are required to take necessary procedures without delay.

(Note) Acts for Land and Land Acquisition :

In Vietnam, lands are not occupied by private persons, but by the Government as property of nations. The Government issues certificates for right of land use and rents to the private citizens, companies, social organizations etc. In 1992, issue of the certificates which is valid up to year 2006 started; and by an act in 1993, exchange of the right, transfer, inheritance, rental and mortgage for lands were admitted by the Government. According to acts concerning residential houses, issue of registration to private houses and land-use-right certificate are to be controlled by the Provincial Peoples Committee. The private person is able to transfer the land use right and fixed-assets on the land such as house buildings. For the purpose of public projects, request or application of land acquisition is to be made from the implementing agency to the Peoples Committee who negotiates with person having the land right. The land is compensated by money or substitute of lands.

The following issues are pointed out on public standpipe system:

- Land:

  Places for the public standpipes are either private or public lands. Since a vast land is required, land acquisition activity is difficult and takes long time in the case of private lands.

- Service Facilities:

  Maintenance of public standpipes is rather difficult owing to damages of standpipes due to unsuitable use and shortage of maintenance staff.

- Water Charge System:

  Fair or even distribution of water charge to standpipe users is difficult, and it causes troubles among standpipe users.

From the above, CERWASS does not propose the public standpipe system, excepting the case of such places as 1) Where household income is low, 2) Where house density is low, 3)Where water pressure becomes low due to topographical conditions, etc. After 1995, CERWASS is promoting the house connection systems in rural water supply.

The annual O/M costs and water tariff do not show remarkable difference.

Considering all the pros and cons stated above, the HC (house connection) system is proposed in this project.

(2) Groundwater Development, Water Quality and Treatment

The project aims supply of safe domestic water which meets the drinking water standards in Vietnam. In the case that the groundwater contains some substances more than permissible level and they can be removed with normal and traditional methods in Vietnam, they will be removed by treatment facilities. However, if it contains toxic or undesirable substances, the groundwater will not be developed and be excluded from the project.

Thus, substances to be treated when necessary in the project will be bacteria including coliform groups, iron and manganese.

(3) Contents of the Water Supply System

The proposed systems are the water supply systems having distribution pipelines and their water source is to be groundwater taken through a deep well. The groundwater will be lifted to ground surface from the deep well using a submersible pump sunken in the well casing pipe. The water will be chlorinated for disinfection purpose before distribution. In the case the water contains iron / manganese higher than the permissible level, they will be removed by treatment facilities before chlorination. The chlorinated water will be stored in a supply reservoir / an elevated tank, and then distributed to consumers through distribution pipelines and service pipes by gravity force flow. The facilities will be basically composed of the following:

Deep well → Intake submersible pump → Pump chamber → Transmission pipeline → (Treatment facilities) → Chlorination → Reservoir tank → Distribution pump → Elevated tank → Distribution pipelines → Service pipes → Households

The system and facilities under the project will be planned based on the grade of technology which is common in Vietnam and understandable to operators with level of commune people.

(4) Deep Wells

For the 11 water supply systems, the number of deep wells required will be 22 in total. The existing JICA wells are proposed to be fully utilized as much as possible. They will be converted to the actual production wells in the project. Among the existing JICA wells, nine (9) wells will be used in the project. Accordingly, thirteen (13) wells will be additionally constructed by the project.

Production of wells and number of wells by commune are given in the following table.

Table 2.5 Deep Wells for the Project

Province	Commune		Possible production of one well (m3/day)	Plan (Target year :2005)			
				Water Demand (m3/day)	Required number of well (Nos.)	Existing JICA well To be used (Nos.)	Additional well required (Nos.)
Thai Nguyen	No.1	Hoa Thuong	1,000	810	1	1	0
	No.2	Dong Bam	800	630	1	0	1
	No.3	Thinh Duc	150	350	3	1	2
	No.4	Nam Tien	100	475	5	1	4
Ninh Binh	No.5	Dong Phong	1,500	980	1	1	0
	No.6	Quang Son	250	510	3	1	2
	No.7	Yen Thang	300	870	3	0	3
Thanh Hoa	Nos. 8&9	Vinh Thanh & Vinh Loc	1,500	1,350	1	1	0
	No.10	Dinh Tuong	1,700	660	1	1	0
	No.11	Van Ha (Thieu Hung)	1,400	760	1	1	0
	No.13	Van Thang	300	320	2	1	1
Total : 11 systems (12 communes)				7,715	22	9	13

(5) Water Treatment Plant

If the groundwater contains iron / manganese more than permissible level of the drinking water standards, they will be removed by treatment facilities. Among 11 systems in the project sites, 6 systems will have treatment facilities to remove iron / manganese. (The remaining 5 systems will not have treatment facilities.) The proposed treatment plant sites are listed below:

Table 2.6 Treatment Plant

Province	Commune		Treatment Plant (Target year : 2005)	
			Treatment capacity (m3/day)	Substances to be removed
Thai Nguyen	No.1	Hoa Thuong	810	Iron and Manganese
	No.2	Dong Bam	630	Iron and Manganese
	No.4	Nam Tien	475	Manganese
Thanh Hoa	Nos.8 & 9	Vinh Thanh & Vinh Loc	1,350	Manganese
	No.10	Dinh Tuong	660	Iron and Manganese
	No.11	Van Ha (Thieu Hung)	760	Manganese
Total (6 sites in 7 communes)			4,685	

(6) Distribution

Safe water, after treatment, will be distributed to consumers through the pressured distribution pipelines in all the 11 systems. The distribution plan by commune is listed in the following table.

Table 2.7 Distribution Plan

Province	Commune		Distribution Plan (Target year : 2005)				
			Daily Maximum Distribution Capacity (m3/day)	Service Population (person)	Houses Served (house)	Distribution Pipelines	
						Diameter (mm)	Distance (m)
Thai Nguyen	No.1	Hoa Thuong	770	7,760	1,850	250 – 50	17,910
	No.2	Dong Bam	600	6,020	1,440	200 – 50	14,180
	No.3	Thinh Duc	350	3,457	830	100 – 50	6,650
	No.4	Nam Tien	450	4,518	1,080	200 – 50	13,490
Ninh Binh	No.5	Dong Phong	980	9,890	2,360	200 – 50	11,070
	No.6	Quang Son	510	5,090	1,220	150 – 50	9,310
	No.7	Yen Thang	870	8,790	2,100	200 – 50	12,120
Thanh Hoa	Nos. 8&9	Vinh Thanh & Vinh Loc	1,290 (Nos.8&9)	13,000 (Nos.8&9)	3,100 (Nos.8&9)	300 – 50	13,520 (Nos.8&9)
	No.10	Dinh Tuong	630	6,360	1,520	200 – 50	6,960
	No.11	Van Ha (Thieu Hung)	720	7,272	1,730	200 – 50	10,910
	No.13	Van Thang	320	3,230	770	150 – 50	6,330
Total：11 systems (12 Communes)			M3/day 7,490	Persons 75,387	Houses 18,000	mm 300 - 50	m 122,450

2.3 Basic Design

2.3.1 Design Policy of Facilities

(1) To Natural Conditions

The project sites belong to sub-tropical climate zone and have rather much rainfall. It shall be noted that intensive heavy rainfall sometimes makes localized flood happenings; hence, the land for intake and treatment facilities shall be carefully selected and designed in order not to be flooded. Facilities for rain water drainage shall also be taken into consideration.

The project sites belong to a tropical typhoon zone. As wind is generally strong; tall structures such as elevated tanks shall be carefully designed against wind strength.

As for earthquake, Vietnam belongs to semi-seismic zone, attention for earthquake shall be paid to structures to some extent, particularly to elevated tanks.

(2) To Social Conditions

Almost all of the project sites belongs agricultural rural areas, cultivating mainly rice fields. Struggle among minority people or discord on religions among people is seldom found in the areas.

As for water use, it shall be taken into consideration that time in a day for water use is concentrated into particular certain time period, since farmers, majority of commune people, take similar patterns of activities for agricultural works within a commune, and water tends to be used during almost same time in a day.

Land acquisition is always big issue everywhere in Vietnam. In the case of private land in particular, procedure for the land acquisition is very complicated and it takes in general long time. Accordingly, land required for construction of facilities is recommended to be selected among public land.

Prior to construction work, investigation and treatment of unexploded bombs shall be carried out on construction sites for facilities and on roads or places for pipelines under the responsibility of the Vietnamese Government.

(3) To Construction Conditions and Use of Local Contractors

Facilities to be constructed under the project are not particular, but common in urban areas; therefore, there will be little difficulties in both capability of local contractors and availability of skilled workers. Although the construction sites are located in local rural areas, accessibility to the sites is comparatively satisfactory, and transportation of materials and others will not meet much difficulties.

As for construction materials, almost all of them are available in Vietnam. However, some equipment such as submersible pumps, bulk water meters and others which are not manufactured in Vietnam will be imported from Japan or other countries.

In the case pipelines proposed will cross the important existing line-facilities such as national highways, rivers, irrigation canals, flood-protection dykes, etc., considerable procedure will be necessary. Therefore, particular attention shall be placed on the progress of such crossing-works.

There exist many construction companies in Hanoi. As several companies are able to construct large-scaled water supply facilities, there will not be difficulties in capability and availability of local contractors. Accordingly, the prime Japanese contractor will be able to employ local contractors in Vietnam as sub-contractors.

Note: The prime contractor is limited to the Japanese national one, according to the regulation of the Japanese Grant Aid Scheme.

(4) To Operation and Maintenance Organization

For the communes of the project site, the water supply facilities to be constructed under the project are new subjects; and new organization for the system shall be required. The systems are to be managed by the Provincial CERWASS after the completion of construction works and branch offices will be established in each commune for operation and maintenance including work of water charge collection. The staff of the branch offices will be employed among the commune people. The water supply business is to be executed on the self-finance basis.

(5) To Quality of Facilities and Materials

The system under the project will be planned by Vietnamese conventional one and consist of popular materials in Vietnam as much as possible.

(6) To Construction Period

As the total distance of pipelines under the project is comparatively large, and in addition the project sites are scattered in 12 communes in 3 Provinces; construction period will take three (3) years.

The number of land acquisition for facilities construction will be 29 places in total. As the land acquisition to be covered by the Vietnamese authorities will take long period of time, it shall be executed without delay.

Most of the project sites are in agricultural rural areas, mainly rice fields. There will be possibility to use temporarily the rice fields during construction period. Such temporary works shall be carefully planned in order to avoid inconvenience of agricultural works.

The scope of work of the Japanese side is up to the installation of distribution pipelines and the construction work

of the house-connection service pipes is under the responsibility of Vietnamese side. Between these works, time and places shall be adjusted and cooperation is necessary for both parties.

2.3.2 Basic Plan and Condition

(1) Water Quality and Treatment

Main items of the groundwater quality and treatment methods, by each commune, are given in the following table. (See Appendix-4 for more detailed result of water quality analysis.)

In the project, groundwater is proposed to be treated in the following manners:

- In the case that the groundwater quality satisfies the drinking water quality standards, the water will be just chlorinated for disinfection before distribution.
  (Intake → Transmission → Chlorination → Distribution → Consumers)
- In the case that concentration of iron / manganese does not meet the drinking water standards, the water will be treated by removal of iron / manganese, and chlorinated.
  (Intake → Transmission → Treatment → Chlorination → Distribution → Consumers)

Table 2.8 Groundwater Quality and Treatment

Commune	Groundwater Quality		
	Iron (mg/l)	Manganese (mg/l)	Treatment
Vietnamese drinking water standards	0.5	0.1	
No.1: Hoa Thuong	1.1 (*)	0.15 (*)	Removal of manganese and iron; and chlorination
No.2: Dong Bam	1.1 (*)	0.15 (*)	Removal of manganese and iron; and chlorination
No.3: Thinh Duc	0.09	0.10	Chlorination only
No.4: Nam Tien	0.38	0.16 (*)	Removal of manganese; and chlorination
No.5: Dong Phong	0.38	0.04	Chlorination only
No.6: Quang Son	0.50	0.02	Chlorination only
No.7: Yen Thang	0.10	<0.01	Chlorination only
No.8&9: Vinh Thanh &Vinh Loc	0.20	0.25 (*)	Removal of manganese; and chlorination
No.10: Dinh Tuong	2.7 (*)	0.34 (*)	Removal of manganese and much iron; and chlorination
No.11: Van Ha (Thieu Hung)	0.13	1.6 (*)	Removal of manganese; and chlorination
No.13: Van Thang	0.18	0.10	Chlorination only

Note: Items attached with the mark (*) do not meet the drinking water standards.

(2) Water Supply System

Water supply system from groundwater intakes to house connections will be categorized into three types due to geographical and topographical conditions.

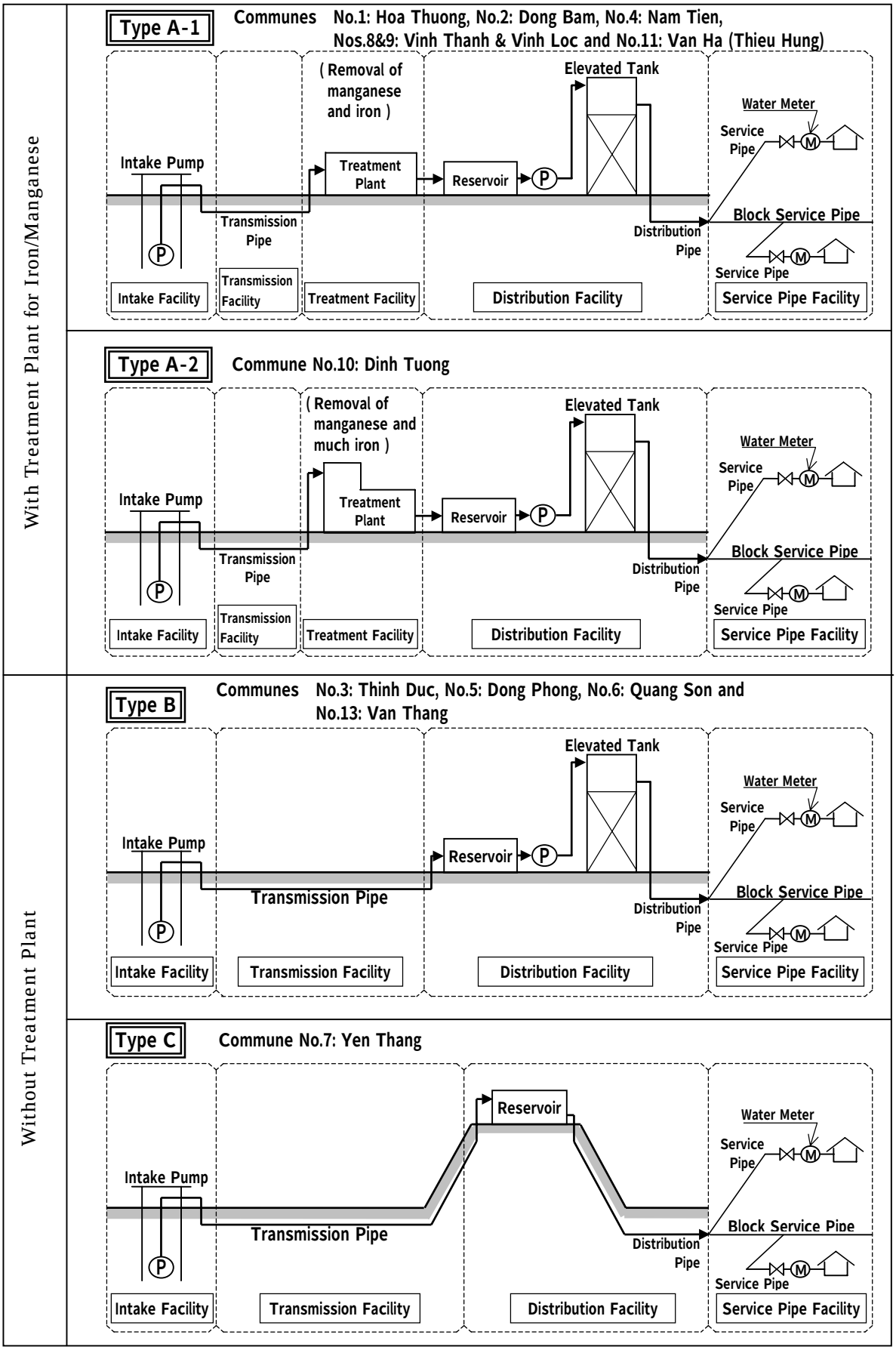


Fig.2.1 Treatment Plant System

Types of water supply system will be applied to each commune as follows.

Table 2.9 Application of Each System to Communes

Type of System	Gravity flow from reservoir	Treatment Plant	Substances to be removed by treatment	Commune
Type A-1	No	Yes	Manganese	No.4: Nam Tien Nos.8&9: Vinh Thanh & Vinh Loc No.11: Van Ha (Thieu Hung)
			Manganese and iron	No.1: Hoa Thuong No.2: Dong Bam
Type A-2	No	Yes	Manganese and much iron	No.10: Dinh Tuong
Type B	No	No	Chlorination (only)	No.3: Thinh Duc No.5: Dong Phong No.6: Quang Son No.13: Van Thang
Type C	Yes	No	Chlorination (only)	No.7: Yen Thang

Outline of each facility involved in the water supply systems is mentioned below:

i) Intake Facility

Intake facility will be composed of deep wells, intake submersible pumps, rising pipes, and appurtenances, pump houses and electrical equipment.

ii) Transmission Facility

Transmission facility is a transmission pipeline transmitting the groundwater from a deep well to water treatment facilities or distribution facilities.

iii) Treatment Facility

Treatment facilities to remove iron / manganese will be composed of aeration tanks, sedimentation basins, sand filters, sludge pits, chemical dosing equipment, administration buildings, pump housings, and electrical equipment.

iv) Distribution Facility

Distribution facility will be composed of reservoirs, distribution pumps, elevated tanks and distribution pipelines.

v) Service Pipe Facility

Service pipe facility will be composed of block service pipes and service pipes for house connections. Block service pipe will be blanched from distribution pipelines and connected to house connection service pipes. Outside diameter (OD) of the block service pipes will be 40 mm. Service pipes for house connection will be blanched from the block service pipes and connected to each house. Service pipes will have 20 mm OD in size and water meter of 13 mm nominal diameter.

(3) Design Capacity of Facilities

Design capacity has been determined based on i) the daily average water demand, ii) loss of 5% volume in treatment facilities, iii) leakage loss of 10% in pipelines and iv) 2.0 of hourly maximum factor for distribution facilities. The following table shows design capacity of facilities by each commune.

Table 2.10 Design Capacity of Facilities

Commune	System Type	Intake & Transmission Facility (m3/day)	Treatment Facility (m3/day)	Distribution Facility (m3/day)	Service Pipe Facility (m3/day)
No.1:Hoa Thuong	A	810	810	1,540	1,540
No.2:Dong Bam	A	630	630	1.200	1,200
No.3: Thinh Duc North Area	B	150	150	300	300
South Area	B	200	200	400	400
No.4: Nam Tien	A	475	475	900	900
No.5: Dong Phong	B	980	980	1,960	1,960
No.6: Quang Son	B	510	540	1,020	1,020
No.7: Yen Thang	C	870	870	1,740	1,740
Nos.8&9:Vinh Thang & Vinh Loc	A	1,350	1,350	2,580	2,580
No.10: Dinh Tuong	A	660	660	1,260	1,260
No.11: Van Ha (Thieu Hung)	A	760	760	1,440	1,440
No.13: Van Thang	B	320	340	640	640

2.3.3 Design of Facilities

(1) Intake Facility

1) Number of Wells and Construction Sites

a) Number of Wells

Potential yield of each well in the commune and number of wells required for the project were determined based on the pumping test results conducted by the Basic Design Survey and/or the Master Plan Study.

The existing JICA test wells constructed at the Master Plan Study stage were studied whether they could be converted to production wells. It was found that the wells in No.2 Dong Bam and No.7 Yen Thang could not be used as production wells anymore because of construction failure (Dong Bam) and of salty water (Yen Thang).

Intake capacity of each well and required number of wells are listed below:

Table 2.11 Potential Yield and Number of Wells Required

Commune	Intake Capacity Required (m3/day)	Potential Yield of Deep Well (m3/day)	Required Number of Wells (No.)	Use of Existing JICA Wells (No.)	Additional Wells Required (No.)
No.1: Hoa Thuong	810	1,000	1	1	0
No.2: Dong Bam	630	800	1	0	1
No.3: Thinh Duc North Area	150	150	1	0	1
South Area	200	150	2	1	1
No.4: Nam Tien	475	100	5	1	4
No.5: Dong Phong	980	1,500	1	1	0
No.6: Quang Son	510	250	3	1	2
No.7: Yen Thang	870	300	3	0	3
Nos.8 & 9: Vinh Thanh & Vinh Loc	1,350	1,500	1	1	0
No.10: Dinh Tuong	660	1,700	1	1	0
No.11: Van Ha (Thieu Hung)	760	1,400	1	1	0
No.13: Van Thang	320	300	2	1	1
Total	7,715		22	9	13

b) Well Construction Sites

Construction sites of additional deep wells required for the project were selected and determined

according to the following considerations.

First, construction sites for wells were selected by the following criteria.

- Site where abundant groundwater is expected by the hydrogeological study maps prepared in Master Plan study.
- Site where availability of groundwater is expected according to the data on existing wells and electric-hydrogeological survey results.
- Site being adjacent to water service areas and to water supply facilities proposed.
- In the case ground elevation of service area is much higher than that of the intake site, both of construction cost and maintenance cost are not economical; therefore, areas ground elevation of which are not 10 m higher than intake site will be selected for service area.

Second, the sites were determined according to the following criteria with field reconnaissance.

- Sites where geological faults are supposed to exist from topographical view points
- Sites where well construction machine is accessible for well construction work
- Site where land acquisition seems not so difficult
- Site where public electrical supply is available

Based on the above criteria and field survey, well construction sites were determined.

2) Well Structure

Structure of the deep wells is based on the following:

- Digging depth of well is determined according to the existing boring data and electric- hydrogeological survey results conducted by the Basic Design Study.
- Length of screen is determined by depth and thickness of groundwater aquifer predicted by the electric-hydrogeological survey results.

Materials of casing pipes and screen will be of FRP, and opening rate of the screens will be big as 20 % in order not to clog easily.

Table 2.12 Structure of Deep Wells Proposed

Commune	Well Number	Diameter of Bore Hole (mm)	Well Depth (m)	Diameter of Screen (mm)	Length of Screen (m)
No.1: Hoa Thuong	J-2	-	150	150	28
No.2: Dong Bam	W1	200	75	150	24
No.3: Thing Duc North Area	W2	200	75	150	24
South Area	J-4	-	100	150	32
	W3	200	75	150	24
No.4: Nam Tien	J-3	-	100	150	12
	W1	200	60	150	24
	W2	200	60	150	24
	W3	200	60	150	24
	W4	200	60	150	24
No.5: Dong Phong	J-7	-	150	150	34
No.6: Quang Son	J-5	-	150	150	44
	W1	200	100	150	36
	W2	200	100	150	36
No.7: Yen Thang	W1	200	90	150	28
	W2	200	90	150	28
	W3	200	90	150	28
Nos.8 & 9: Vinh Thanh & Vinh Loc	J-11	-	148	150	32
No.10: Dinh Tuong	J-10	-	92	150	32
No.11: Van Ha (Thieu Hung)	J-9	-	80	150	16
No.13: Van Thang	J-8	-	150	150	40
	W1	200	120	150	28

a) Specification of Well Pumps

For planning of well pumps (submersible pumps for intake), the following technical conditions were taken into consideration.

i) A suitable pumping capacity is to be determined based on the pumping test results carried out during the Basic Design Study period, data of existing JICA wells, and data of existing wells located adjacent to the well proposed.

ii) Static/dynamic water level in the wells is determined based on the pumping test results and data of

existing wells.

iii) Position of the pump installation is to be determined considering seasonal fluctuations and dynamic water levels.

Table 2.13 List of Wells and Intake Pumps

Commune	Well Number	Level of Well Site (EL+m)	Required Intake Capacity (m3/day)	Well Pump Dia. x Capacity x Head x Output (mm)x(m3/d)x(m)x(kw)	No. of Unit (No.)	Standby Unit (No.)
No.1: Hoa Thuong	J-2	+ 35.0	810	80 x 810 x 48 x 7.5	1	1
No.2: Dong Bam	W1	+ 28.0	630	80 x 630 x 77 x 11.0	1	1
No.3: Thinh Duc North area	W2	+ 34.0	150	50 x 150 x 53 x 2.2	1	1
South area	J-4	+ 25.0	100	40 x 100 x 36 x 1.5	1	-
	W3	+ 24.0	100	40 x 100 x 53 x 1.5	1	-
No.4: Nam Tien	J-3	+ 12.0	95	40 x 95 x 30 x 1.5	1	-
	W1	+ 14.0	95	40 x 95 x 60 x 2.2	1	-
	W2	+ 13.0	95	40 x 95 x 60 x 2.2	1	-
	W3	+ 12.5	95	40 x 95 x 73 x 2.2	1	-
	W4	+ 12.0	95	40 x 95 x 60 x 2.2	1	-
No.5: Dong Phong	J-7	+ 4.5	980	100 x 980 x 30 x 5.5	1	1
No.6: Quang Son	J-5	+ 51.5	170	50 x 170 x 58 x 3.7	1	-
	W2	+ 55.0	170	50 x 170 x 62 x 3.7	1	-
	W3	+ 55.0	170	50 x 170 x 64 x 3.7	1	-
No.7: Yen Thang	W1	+ 12.0	290	50 x 290 x 57 x 3.7	1	-
	W2	+ 10.0	290	50 x 290 x 57 x 3.7	1	-
	W3	+ 8.0	290	50 x 290 x 60 x 3.7	1	-
Nos.8 & 9: Vinh Thanh & Vinh Loc	J-11	+ 13.1	1,350	100 x 1,350 x 54 x 18.5	1	1
No.10: Dinh Tuong	J-10	+ 10.0	660	80 x 660 x 39 x 5.5	1	1
No.11: Van Ha (Thieu Hung)	J-9	+ 6.0	760	80 x 760 x 35 x 5.5	1	1
No.13: Van Thang	J-8	+ 7.3	160	50 x 160 x 60 x 3.7	1	-
	W1	+ 6.2	160	50 x 160 x 62 x 3.7	1	-

(2) Transmission Facility

A transmission facility is composed of transmission pipes.

a) Pipeline Route

Transmission pipe route will be planned between a deep well and a treatment /distribution facility

alongside public roads, considering minimized distances. In the case that routes of the transmission pipes and distribution pipes are proposed to be on same roads, these pipes will be installed together in a single pipe trench in order to save pipe installation costs. In the case that a pipeline crosses farmlands, particular attentions such as temporary structures and pipe laying method will be employed to minimize disturbances/troubles to the farming works.

b) Pipe Materials and Diameters

PVC pipes will be employed from the following advantages:

- Available in Vietnam
- Suitable to transmission purpose for water
- Suitable in durability, anti-corrosion against water and soil, easy installation works and economy

In the case that a pipeline runs across water canals or on the ground, steel materials will be employed, in place of PVC pipes, where required. Pipe diameters will be determined considering economical velocity and intake well pump head required on the pipeline.

(3) Treatment Facility

The purpose of treatment facilities in the project is to remove iron / manganese excessively contained in the groundwater.

1) Treatment Process

Treatment process will be as shown in the following chart. The process was determined based on site survey results on existing treatment plants for groundwater treatment in Vietnam having conventional method, and also on treatment process adapted in Japan.

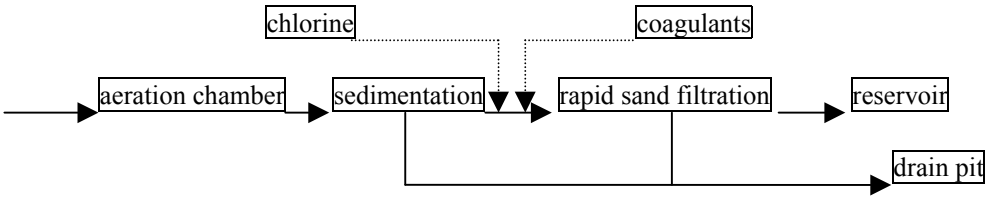


Fig.2.2 Process of Treatment

2) Treatment Facilities

a) Aeration Chamber

In the case iron contents is high, the aeration chamber will be installed. Groundwater pumped at deep wells will be scattered in the air to be oxidized-dissolved iron. The dissolved iron oxidized will be

removed at succeeding process of sedimentation and filtration.

b) Sedimentation

Sedimentation, being upflow-sedimentation type, is used for removal by sedimentation of flocculated particles, i.e. oxidized iron, prior to filtration. The settled water is collected by decanting troughs and flows to filtration.

c) Filtration

Filtration is a physical/chemical process for separating and catching suspended particles such as fine iron and dissolved manganese, by way of filtration media. The filtration bed is of dual-media type, consisting of upper layer with 200 mm thickness of anthracites and bottom layer with 500 mm thickness of manganese sands. Water containing suspended matters flows into the filter. The upper layer in the filter catches suspended fine iron; and the bottom layer of manganese sand catches manganese by contact-oxidation. Backwashing of the filter media will be made by using clean water stored in an elevated tank.

d) Drain Pit

Drain pit is to temporarily store drainage extracted from sedimentation and from filters. Drain pumps will be installed in the drain pits for discharge.

e) Chemical Dosage

For oxidation of manganese at inlet of filters, chlorine is to be dosed. For stability of the treatment, a coagulant will be added. Chemical for chlorination including disinfection purpose will be hypo-chlorite natrium (NaOCl : sodium hypochlorite) in liquid type (8% concentration), since it has advantages of safety, availability, low and popularity.

3) Components of Treatment Facilities

a) Aeration Chamber

Table 2.14 – 1 Aeration Chamber

Commune	Treatment Capacity and Dimensions
No.10: Dinh Tuong	660 m3/d : (6.65 m x 5.5 m x 3.0 m) x 1 unit

b) Sedimentation

Table 2.14 – 2 Sedimentation

Commune	Detention Period (min) and Volume (surface area x effective depth) x units
No.10: Dinh Tuong	120-150 min : 54 m3 (27 m x 2.5 m) x 2 units

c) Filtration

Table 2.14 – 3 Filtration

Commune	Filtration Rate, Filter Area, Number of Filter (and Volume of Backwash Water)
No.1: Hoa Thuong	120 m/d : 3.45 m2 x 2 units x (23.3 m3/one time)
No.2: Dong Bam	120 m/d : 2.7 m2 x 2 units x (18.2 m3/one time)
No.4: Nam Tien	120 m/d : 1.95 m2 x 2 units x (13.7 m3/one time)
Nos.8 & 9:Vinh Thanh & Vinh Loc	120 m/d : 5.52 m2 x 2 units x (37.3 m3/one time)
No.10: Dinh Tuong	120 m/d : 2.75 m2 x 2 units x (18.2 m3/one time)
No.11: Van Ha (Thieu Hung)	120 m/d : 3.17 m2 x 2 units x (21.3 m3/one time)

d) Drain Pit

Table 2.14 – 4 Drain Pit

Commune	Capacity and Dimensions (in meters)	Drain pump Dia x Q x H x kW x units (mm)(m3/min)(m)(kW) (No)
No.1: Hoa Thuong	38 m3 : (3.1 x 6.2 x 2.5) x 1	50 x 0.1 x 20 x 1.5 x 2
No.2: Dong Bam	30 m3 : (2.8 x 5.6 x 2.5) x 1	50 x 0.1 x 20 x 1.5 x 2
No.4: Nam Tien	24 m3 : (2.5 x 4.4 x 2.5) x 1	50 x 0.1 x 20 x 1.5 x 2
Nos.8 & 9: Vinh Thanh & Vinh Loc	64 m3 : (4.8 x 8.0 x 2.5) x 1	50 x 0.1 x 20 x 1.5 x 2
No.10: Dinh Tuong	30 m3 : (2.5 x 5.6 x 2.5) x 1	50 x 0.1 x 20 x 1.5 x 2
No.11: Van Ha (Thieu Hung)	35 m3 : (3.1 x 5.8 x 2.5) x 1	50 x 0.1 x 20 x 1.5 x 2

e) Chemical Dosage Equipment

Table 2.14 – 5 Chemical Dosage Equipment

Commune	Chlorination Dosage (sodium hypochlorite dosage quantity)	Coagulation Dosage (alum dosage quantity)
No.1: Hoa Thuong	2.25 kg/h	3.4 kg/h
No.2: Dong Bam	1.76 kg/h	2.6 kg/h
No.3: Thinh Duc	0.24 kg/h	-
No.4: Nam Tien	1.00 kg/h	1.9 kg/h
No.5: Dong Phong	2.58 kg/h	-
No.6: Quang Son	1.42 kg/h	-
No.7: Yen Thang	0.60 kg/h	-
Nos.8 & 9: Vinh Thanh & Vinh Loc	2.80 kg/h	5.6 kg/h
No.10: Dinh Tuong	10.10 kg/h	2.8 kg/h
No.11: Van Ha (Thieu Hung)	6.40 kg/h	3.2 kg/h
No.13: Van Thang	1.17 kg/h	-

(4) Distribution Facility

Distribution facility is composed of reservoirs, distribution pumps, elevated tanks and distribution pipelines.

1) Reservoir

Reservoirs provide regulation of hourly fluctuations on water demand and retain minimum volume of water during stoppage of operation of intake and treatment facilities. The reservoir capacity will be planned of 8 hours' capacity of daily maximum water demand

2) Distribution Pump

Distribution pumps will be installed to transmit treated water to elevated tanks having enough height for distribution by gravity force flow.

The pumps will be capable to distribute hourly maximum demand water. To determine hourly maximum demand water, the following are considered:

a) Most of communes for the project have around 5,000 to 10,000 population each and live on agricultures, particularly rice. Therefore the living pattern of inhabitants is considered almost similar to each other.
b) Considering the above, water-use hours will be concentrated into a certain time period in a day.

Taking the above and also considering the design guidelines in Japan for water supply engineering, hourly maximum demand factor was set at 2.0 in the project.

As for distribution pumps, one unit of standby purpose will be installed in addition to a normal operation pump. The pumps will be installed in a pump room to ensure pump operation and maintenance. The pump room will contain electrical equipment for pump operation.

3) Elevated Tank

Elevated tanks are to distribute treated water to consumers in the service area by gravity flow. Capacity of elevated tanks will be 1 hour's capacity of daily maximum demand.

4) Distribution Pipelines

a) Pipeline Routes

Distribution pipeline routes will be planned basically alongside public roads. At the end of distribution pipelines, water pressure in the pipes will be designed to keep enough pressure for tap water in households.

For selection of pipeline routes, whole area of the communes were surveyed to confirm present conditions of roads, housings, water courses, water canals, and other obstacles. Based on the above field survey results, service area and pipeline routes were selected and determined.

In the case of a pipelines' installation in farmlands, particular attention such as temporary structures and pipe laying work methods will be employed to minimize troubles to the farming activities.

At crossing points of national roads and dykes, pipes will be protected with concrete, where required.

b) Pipe Materials and Diameters

In this project, PVC pipe will be employed from the following viewpoints:

- Available in Vietnam
- Suitable to distribution purpose for water
- Suitable in durability, anti-corrosion against water and soil
- Easy installation works
- Economical

In the case that a pipeline runs across water canals or on the ground, steel materials will be employed, in place of PVC pipes, where required.

Pipe diameters will be determined based on hydraulic calculation by using the Hazen-Williams' Formula. For the calculations, the residual pressure of 1.0 kgf/cm2 (equivalent to 10 m in water head) at roads is adopted.

5) Components of Distribution Facilities

a) Reservoir

Table 2.15 – 1 Reservoir

Commune	Capacity (m3)	Dimensions
No.1: Hoa Thuong	260	(12.3 m x 5.7 m x 2.5 m) x 2 units
No.2: Dong Bam	200	(10.9 m x 5.0 m x 2.5 m) x 2 units
No.3: Thinh Duc North Area	50	(5.0 m x 2.5 m x 2.5 m) x 2 units
South Area	70	(6.3 m x 3.0 m x 2.5 m) x 2 units
No.4: Nam Tien	150	(4.5 m x 8.4 m x 2.5 m) x 2 units
No.5: Dong Phong	330	(13.7 m x 6.5 m x 2.5 m) x 2 units
No.6: Quang Son	170	(10.5 m x 4.5 m x 2.5 m) x 2 units
No.7: Yen Thang	290	(12.9 m x 6.1 m x 2.5 m) x 2 units
Nos.8 & 9: Vinh Thanh & Vinh Loc	430	(15.3 m x 7.5 m x 2.5 m) x 2 units
No.10: Dinh Tuong	210	(10.9 m x 5.3 m x 2.5 m) x 2 units
No.11: Van Ha (Thieu Hung)	240	(11.5 m x 5.7 m x 2.5 m) x 2 units
No.13: Van Thang	110	(8.1 m x 3.9 m x 2.5 m) x 2 units

Note: The reservoirs will be made of reinforced concrete.

b) Distribution Pumps

Table 2.15 – 2 Distribution Pumps

Commune	Pump Specifications Diameter (mm) x Capacity (m3/d) x Head (m) x Motor output (kw)
No.1: Hoa Thuong	80 mm x 1,700 m3/d x 26 m x 7.5 kw x 2 units
No.2: Dong Bam	80 mm x 1,320 m3/d x 27 m x 7.5 kw x 2 units
No.3: Thinh Duc North Area	50 mm x 330 m3/d x 39 m x 3.7 kw x 2 units
South Area	50 mm x 440 m3/d x 35 m x 3.7 kw x 2 units
No.4: Nam Tien	80 mm x 990 m3/d x 27 m x 5.5 kw x 2 units
No.5: Dong Phong	100 mm x 2,160 m3/d x 31 m x 15.0 kw x 2 units
No.6: Quang Son	80 mm x 1,130 m3/d x 30 m x 7.5 kw x 2 units
No.7: Yen Thang	(Not installed)
Nos.8 & 9: Vinh Thang &Vinh Loc	100 mm x 2,840 m3/d x 31 m x 15.0 kw x 2 units
No.10 : Dinh Tuong	80 mm x 1,390 m3/d x 29 m x 7.5 kw x 2 units
No.11: Van Ha (Thieu Hung)	80 mm x 1,590 m3/d x 27 m x 11 kw x 2 units
No.13: Van Thang	65 mm x 710 m3/d x 29 m x 5.5 kw x 2 units

Note: Two units of pumps include one unit for standby.

c) Elevated Tanks

Table 2.15 – 3 Elevated Tanks

Commune	Capacity (m3)	Elevation at Tank Bottom (Above sea level)
No.1: Hoa Thuong	35.0	+ 56.0 m
No.2: Dong Bam	25.0	+ 53.5 m
No.3: Thinh Duc North Area	6.3	+ 64.6 m
South Area	8.5	+ 48.5 m
No.4: Nam Tien	20.0	+ 29.0 m
No.5: Dong Phong	40.0	+ 25.6 m
No.6: Quang Son	22.0	+70.7 m
No.7: Yen Thang	-	-
Nos.8 & 9: Vinh Thanh & Vinh Loc	55.0	+ 34.9 m
No.10: Dinh Tuong	26.0	+ 29.0 m
No.11: Van Ha (Thieu Hung)	30.0	+ 22.8 m
No.13: Van Thang	13.0	+ 25.3 m

Note: The elevated tanks will be made of reinforced concrete.

d) Distribution Pipelines

Table 2.15 – 4 Distribution Pipelines

Commune	Pipe Diameters	Total Distance
No.1: Hoa Thuong	250 mm – 50 mm	17,910 m
No.2: Dong Bam	200 mm – 50 mm	14,180 m
No.3: Thinh Duc	100 mm – 50 mm	6,650 m
No.4: Nam Tien	200 mm – 50 mm	13,490 m
No.5: Dong Phong	200 mm – 50 mm	11,070 m
No.6: Quang Son	150 mm – 50 mm	9,310 m
No.7: Yen Thang	200 mm – 50 mm	12,120 m
Nos.8 & 9: Vinh Thanh & Vinh Loc	300 mm – 50 mm	13,520 m
No.10: Dinh Tuong	200 mm – 50 mm	6,960 m
No.11: Van Ha (Thieu Hung)	200 mm – 50 mm	10,910 m
No.13: Van Thang	150 mm – 50 mm	6,330 m
Total	300 mm – 50 mm	122,450 m

(5) Service Pipe Facility

Service pipe facility to supply treated water to consumers in the service areas is composed of block service pipes, house connection pipes, individual water meters and appurtenances.

A typical sketch of the service pipe facility is illustrated in the following figure.

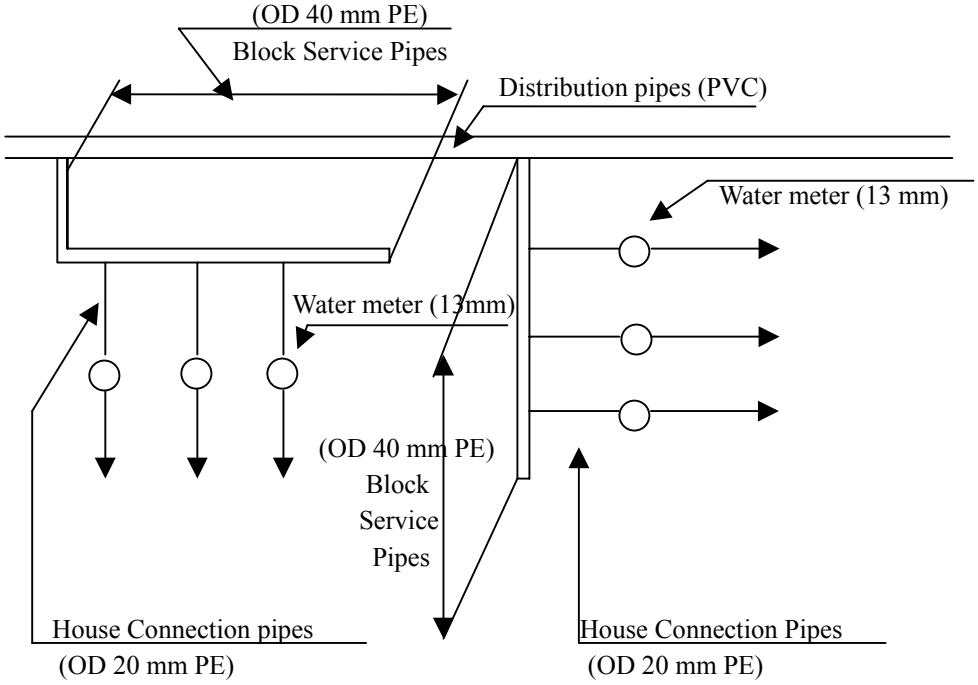


Fig.2.3 Service Pipe Facility

The following list shows block service pipes and house connection pipes of each commune.

Table 2.16 List of Service Pipes Facilities

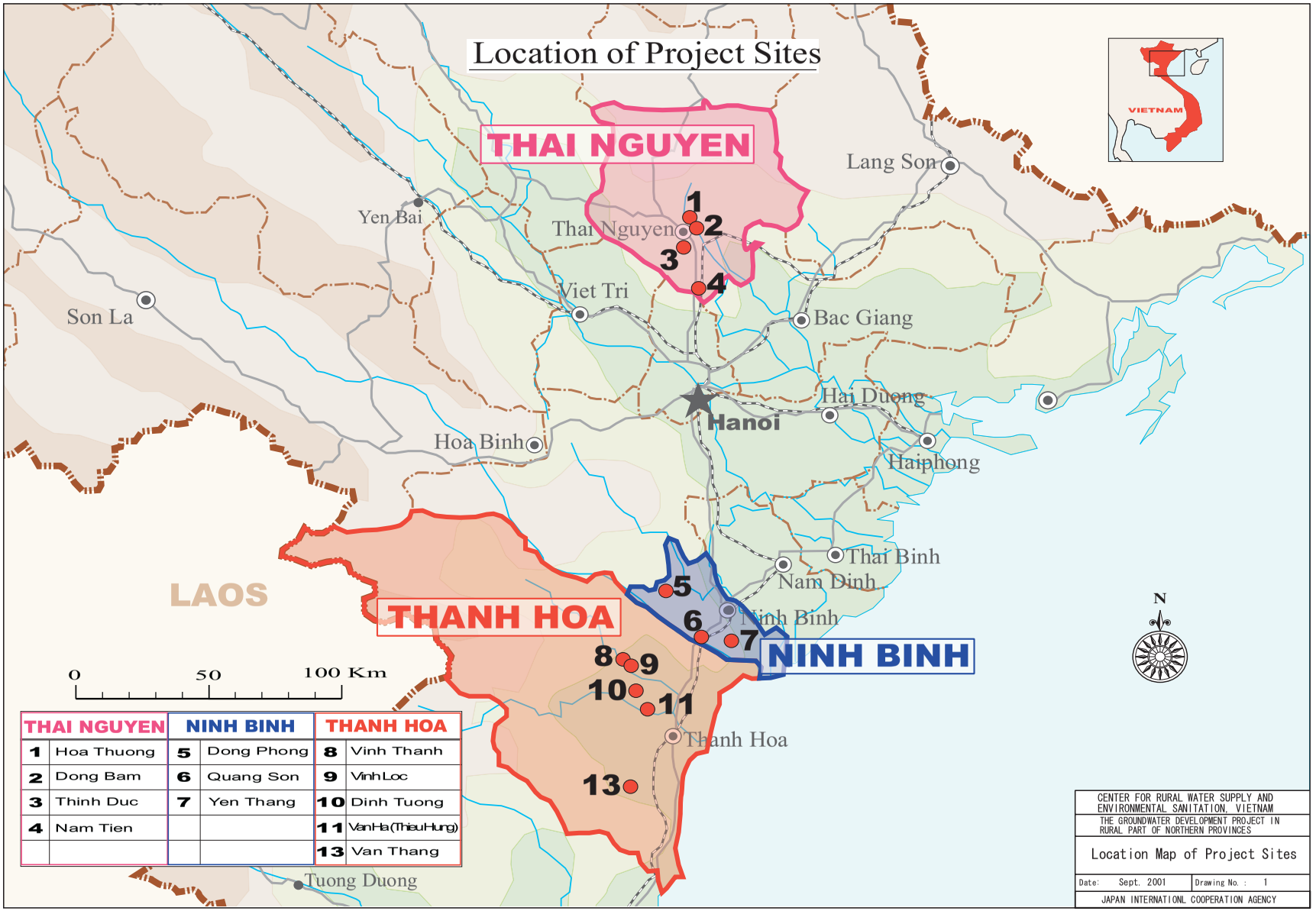
Commune	Total Length of Block Service Pipes (Dia.= 40 mm OD) (m)	Total Length of House Connection Pipes (Dia.= 20 mm OD) (m)	Number of Water Meters (Dia.= 13 mm ND) (numbers)
No.1: Hoa Thoung	22,760	37,000	1,850
No.2: Dong Bam	16,280	28,800	1,440
No.3: Thinh Duc	8,100	16,600	830
No.4: Nam Tien	15,340	21,600	1,080
No.5: Dong Phong	16,770	47,200	2,360
No.6: Quang Son	11,260	24,400	1,220
No.7: Yen Thang	12,020	42,000	2,100
Nos.8 & 9: Vinh Thanh & Vinh Loc	15,970	62,000	3,100
No.10: Dinh Tuong	11,860	30,400	1,520
No.11: Van Ha (Thieu Hung)	13,200	34,600	1,730
No.13: Van Thang	6,030	15,400	770
Total	149,590	360,000	18,000

Note: The length of house-connection pipes was assumed to be 20 m for each household.

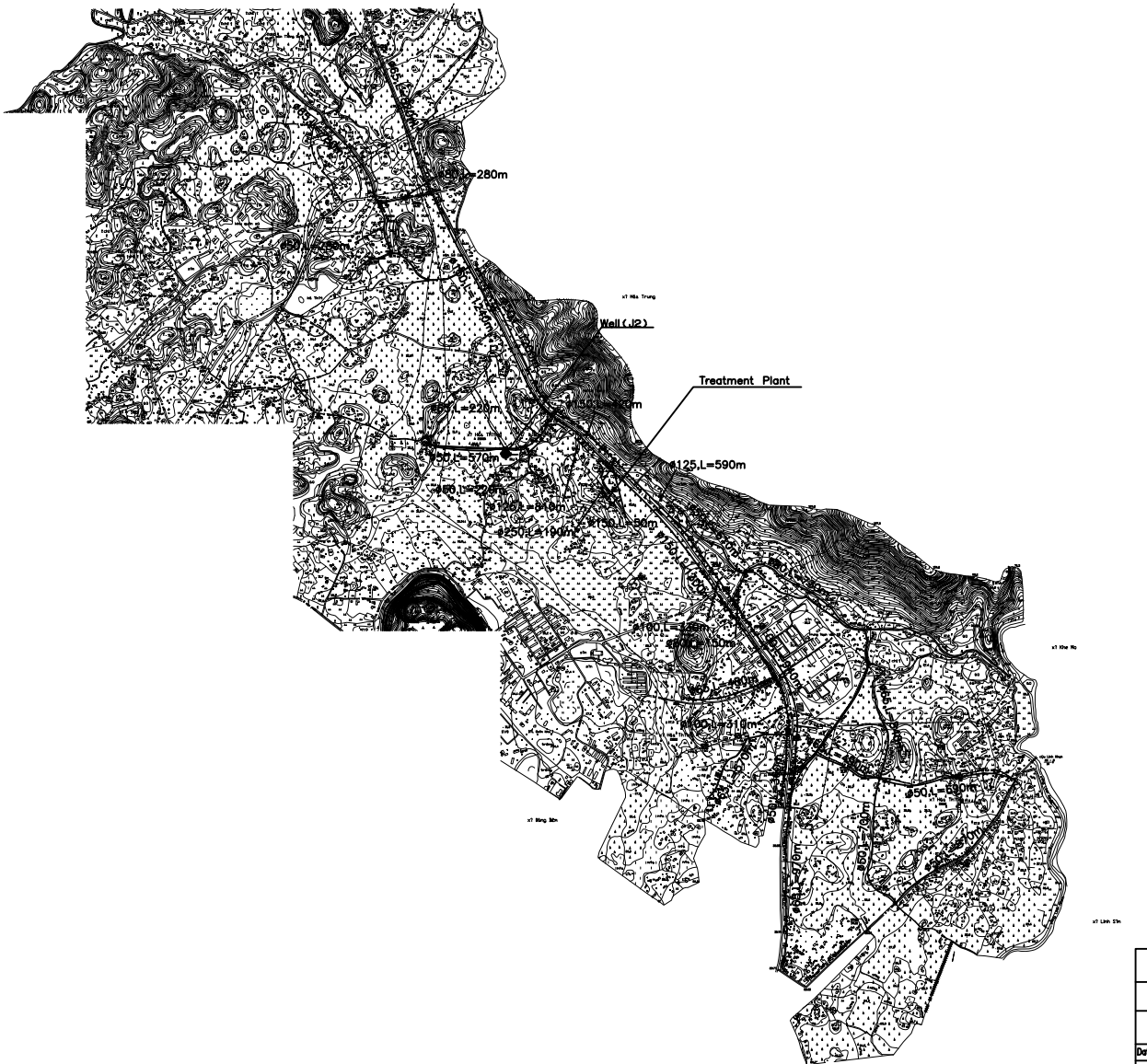
2.3.4 Basic Design Drawings

Table 2.17 List of Drawings

Drawing No.	Content
1	Location Map of Project Sites
2	General Plan of Water Supply Facilities in Hoa Thuong (No.1)
3	" " " Dong Bam (No.2)
4	" " " Thinh Duc (No.3)
5	" " " Nam Tien (No.4)
6	" " " Dong Phong (No.5)
7	" " " Quang Son (No.6)
8	" " " Yen Thang (No.7)
9	" " " Vinh Thanh & Vinh Loc (Nos.8 & 9)
10	" " " Dinh Tuong (No.10)
11	" " " Van Ha (Thieu Hung: No.11)
12	" " " Van Thang (No.13)
13	Flow Sheet of Type A-1
14	" " Type A-2
15	" " Type B
16	" " Type C
17	Layout of Facilities for Hoa Thuong (No.1)
18	" " Dong Bam (No.2)
19	" " Thinh Duc North (No.3 – North)
20	" " Thinh Duc South (No.3－South)
21	" " Nam Tien (No.4)
22	" " Dong Phong (No.5)
23	" " Quang Son (No.6)
24	" " Yen Thang (No.7)
25	" " Vinh Thanh and Vinh Loc (Nos. 8 & 9)
26	" " Dinh Tuong (No.10)
27	" " Van Ha (Thieu Hung: No.11)
28	" " Van Thang (No.13)
29	Intake Facilities
30	Treatment Facilities
31	Drain Pit
32	Reservoirs
33	Elevated Tanks
34	Trench for Pipe Works
35	Intake Pump Chamber
36	Administration House



THAI NGUYEN		NINH BINH		THANH HOA	
1	Hoa Thuong	5	Dong Phong	8	Vinh Thanh
2	Dong Bam	6	Quang Son	9	VinhLoc
3	Thinh Duc	7	Yen Thang	10	Dinh Tuong
4	Nam Tien			11	VanHa(ThieuHung)
				13	Van Thang



Dia(mm)	Length(m)
50	5,400
65	5,170
80	1,160
100	1,580
125	1,400
150	3,010
200	–
250	190
300	–
Total	17,910

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM

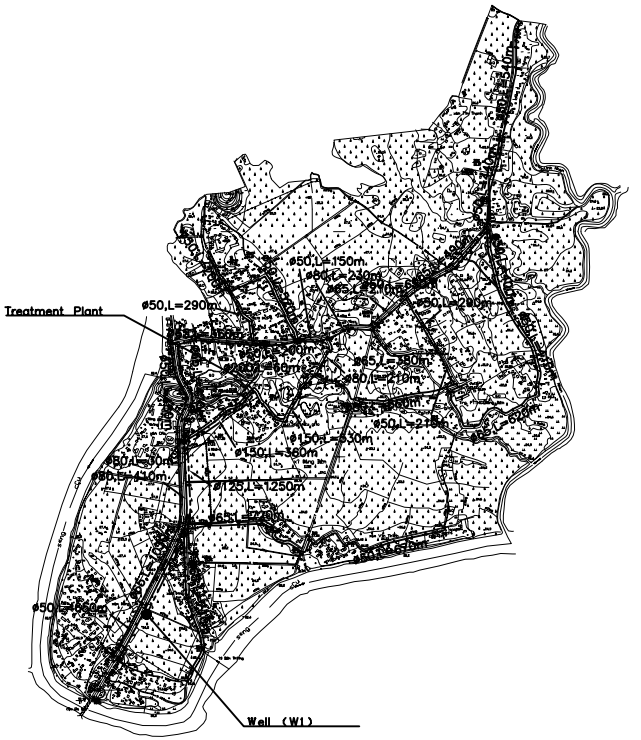
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES

General Plan of Water Supply Facilities Hoa Thuong (No.1)

Date : Drawing No. 2

JAPAN INTERNATIONAL COOPERATION AGENCY

Dia(mm)	Length(m)
50	5,450
65	4,990
80	1,540
100	–
125	1,250
150	890
200	60
250	–
300	–
Total	14,180



LEGEND

: Distribution pipe

: Raw Water Transmission

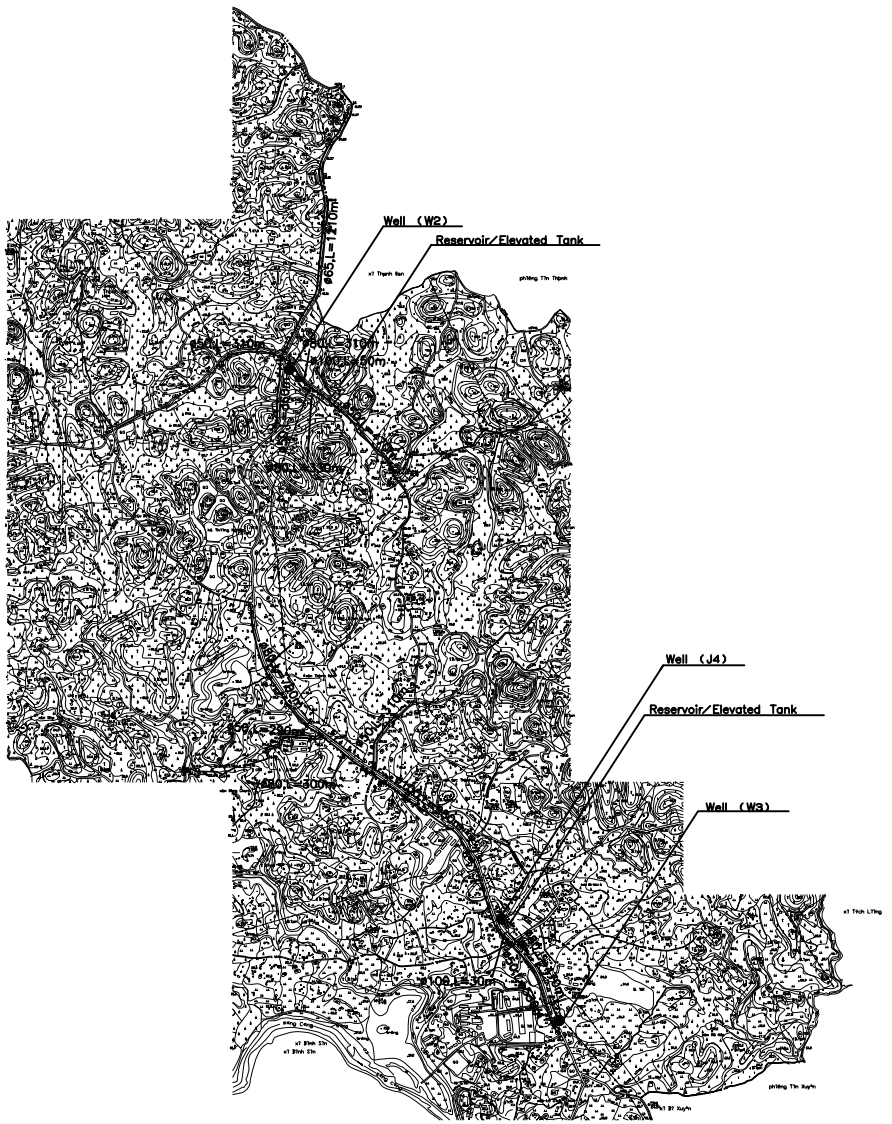
: Well

: Treatment Plant

: Sluice Valve

100 0 100 200 300 400 500
(Length:m)

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES
General Plan of Water Supply Facilities Dong Bam (No. 2)
Date : / Drawing No. 3
JAPAN INTERNATIONAL COOPERATION AGENCY



Dia(mm)	Length(m)
50	2,270
65	1,210
80	2,110
100	1,060
125	–
150	–
200	–
250	–
300	–
Total	6,650

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM

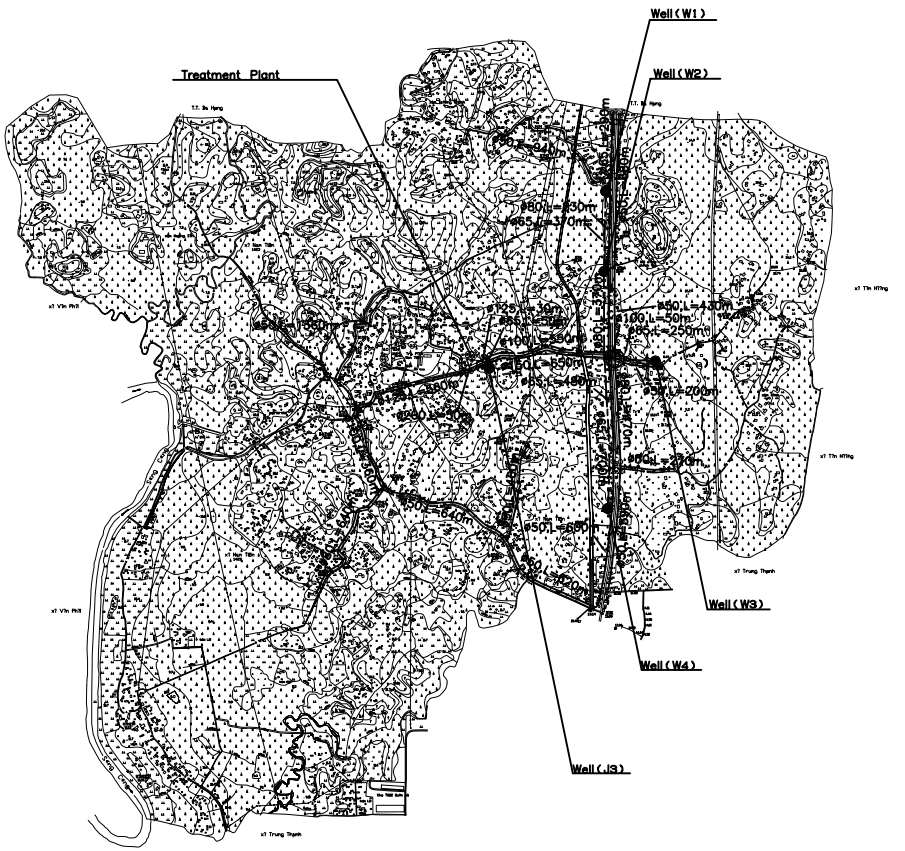
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES

General Plan of Water Supply Facilities Thinh Duc (No. 3)

Date : Drawing No. 4

JAPAN INTERNATIONAL COOPERATION AGENCY

Dia(mm)	Length(m)
50	6,790
65	2,140
80	2,310
100	960
125	590
150	650
200	50
250	–
300	–
Total	13,490



LEGEND

——— : Distribution pipe

—·—·— : Raw Water Transmission

● : Well

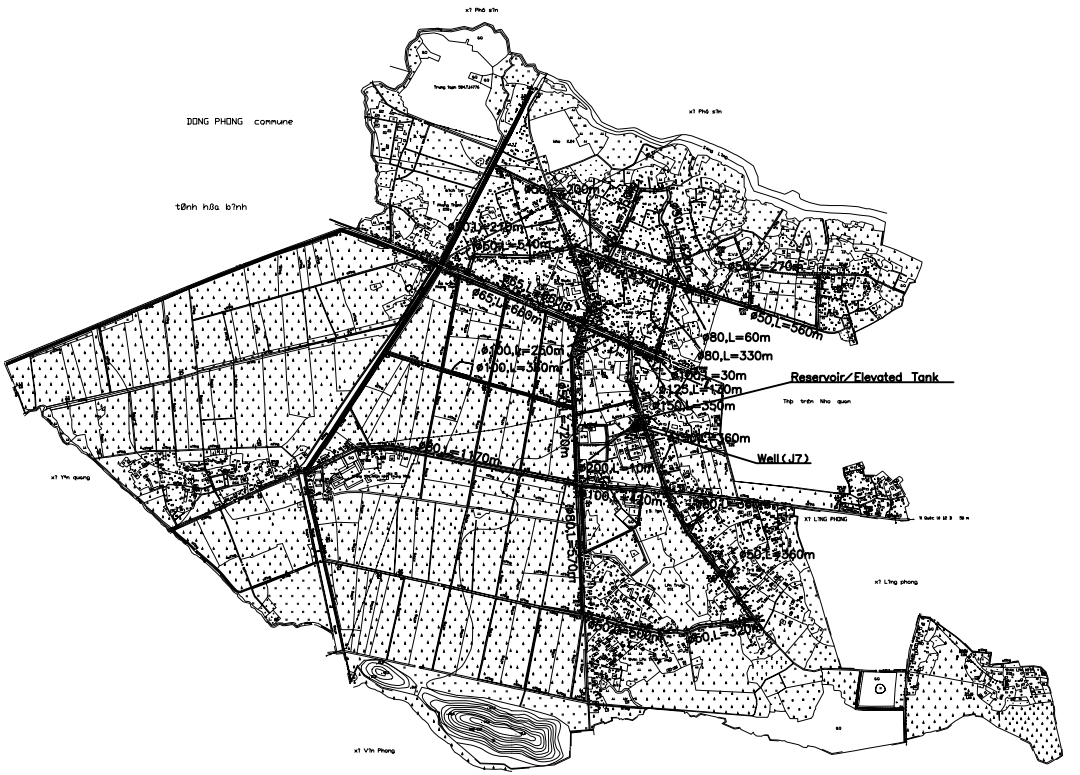
⊠ : Treatment Plant

⋈ : Sluice Valve

100 0 100 200 300 400 500

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES
General Plan of Water Supply Facilities Nam Tien (No. 4)
Date : / Drawing No. 5
JAPAN INTERNATIONAL COOPERATION AGENCY

Dia(mm)	Length(m)
50	4,990
65	1,320
80	2,850
100	1,060
125	130
150	710
200	10
250	–
300	–
Total	11,070



CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM

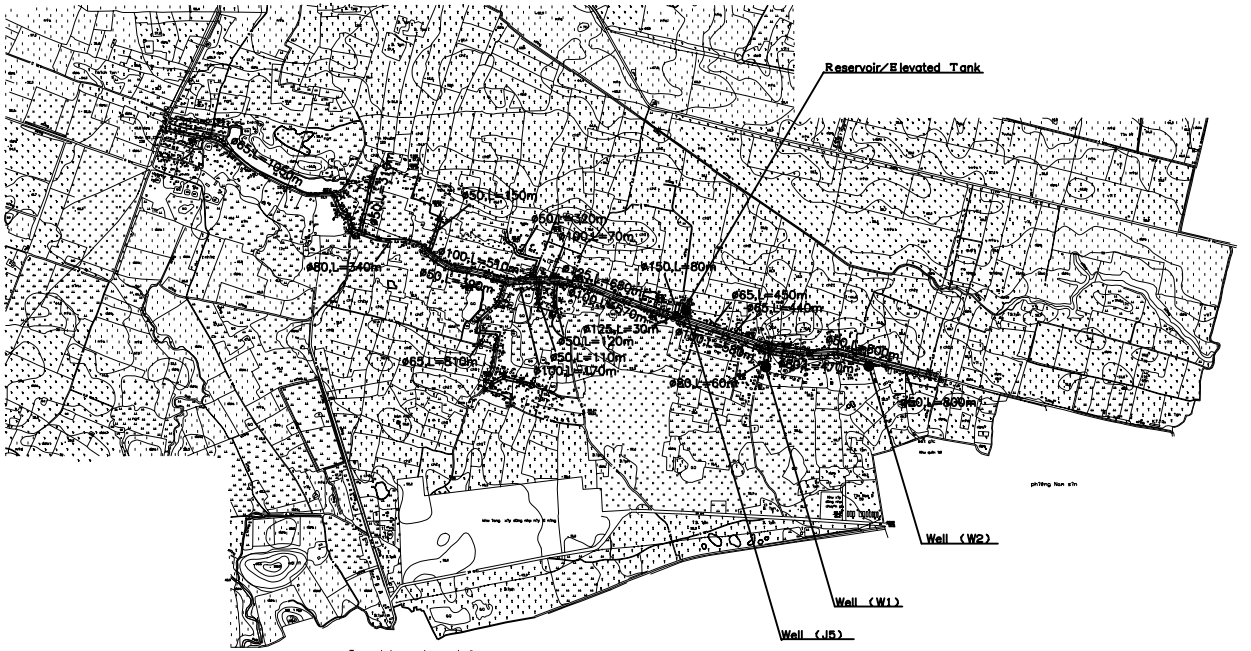
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES

General Plan of Water Supply Facilities Dong Phong (No. 5)

Date : Drawing No. 6

JAPAN INTERNATIONAL COOPERATION AGENCY

Dia(mm)	Length(m)
50	3,000
65	2,750
80	870
100	1,900
125	710
150	80
200	–
250	–
300	–
Total	9,310



LEGEND

: Distribution pipe

: Raw Water Transmission

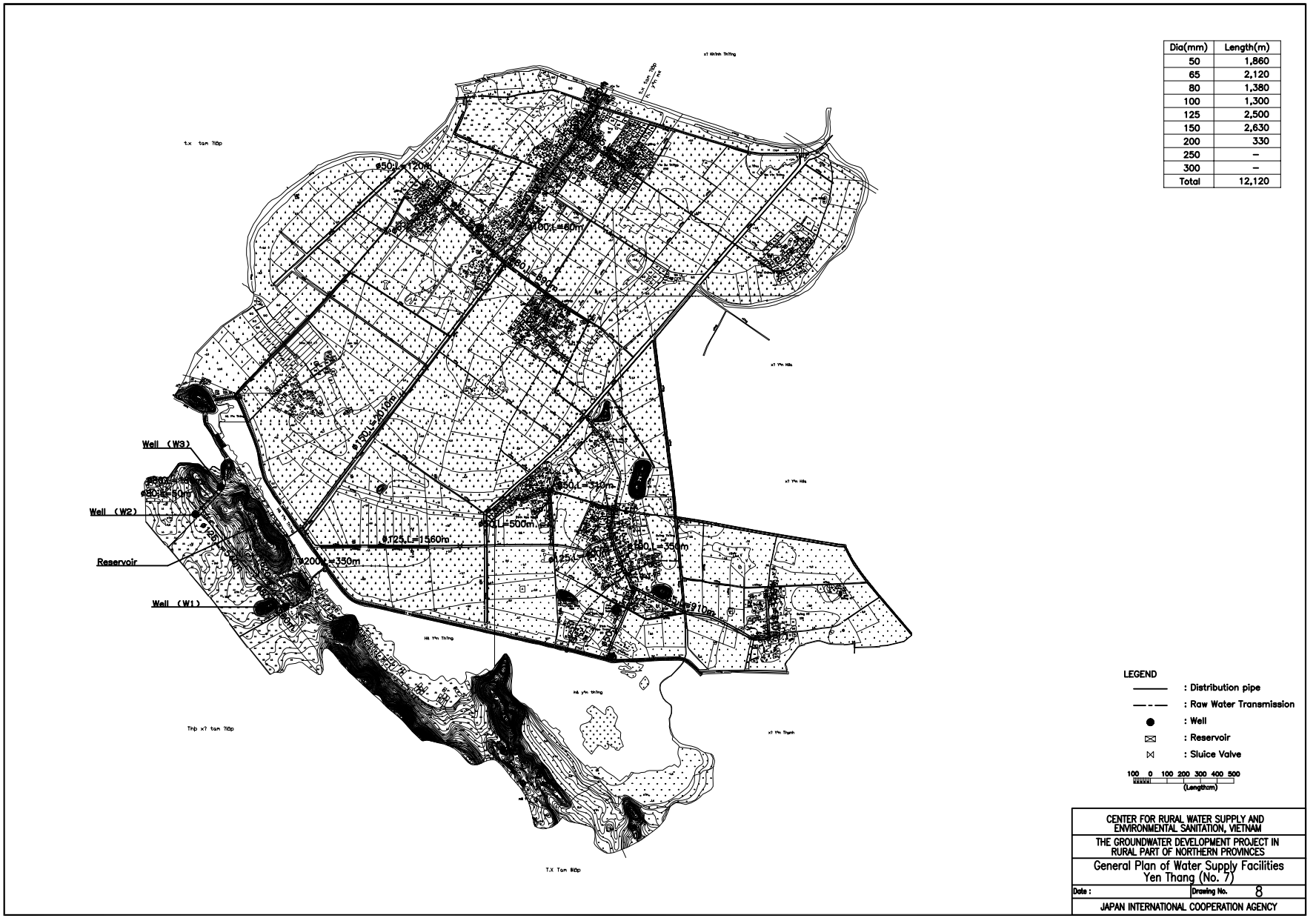
: Well

Reservoir/Elevated Tank

: Sluice Valve

100 0 100 200 300 400 500
(Length:m)

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
General Plan of Water Supply Facilities Quang Son (No. 6)	
Date :	Drawing No. 7
JAPAN INTERNATIONAL COOPERATION AGENCY	



Dia(mm)	Length(m)
50	1,860
65	2,120
80	1,380
100	1,300
125	2,500
150	2,630
200	330
250	–
300	–
Total	12,120

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM

THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES

General Plan of Water Supply Facilities
Yen Thang (No. 7)

Date : Drawing No. 8

JAPAN INTERNATIONAL COOPERATION AGENCY

Dia(mm)	Length(m)
50	3,830
65	–
80	3,670
100	1,880
125	1,770
150	1,760
200	140
250	440
300	30
Total	13,520

LEGEND

: Distribution pipe

: Raw Water Transmission

: Well

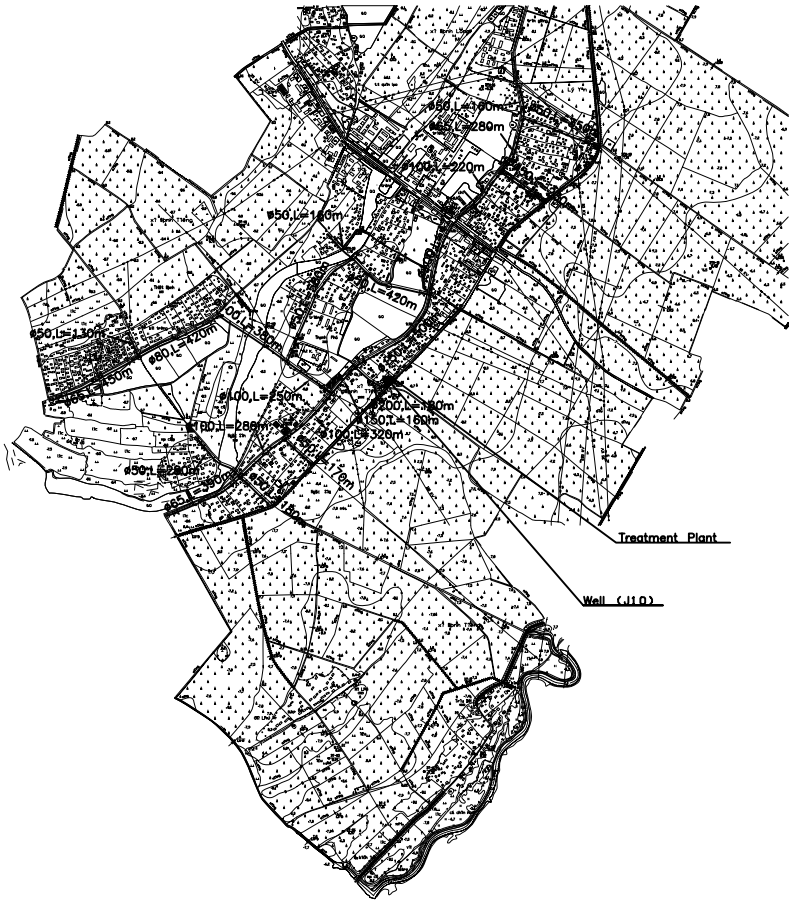
: Treatment Plant

: Sluice Valve

100 0 100 200 300 400 500
(Length:m)

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES
General Plan of Water Supply Facilities Vinh Thanh and Vinh Loc (No. 8 & 9)
Date : Drawing No. 9
JAPAN INTERNATIONAL COOPERATION AGENCY

Dia(mm)	Length(m)
50	2,660
65	1,120
80	420
100	1,920
125	–
150	660
200	180
250	–
300	–
Total	6,960



LEGEND

: Distribution pipe

: Raw Water Transmission

: Well

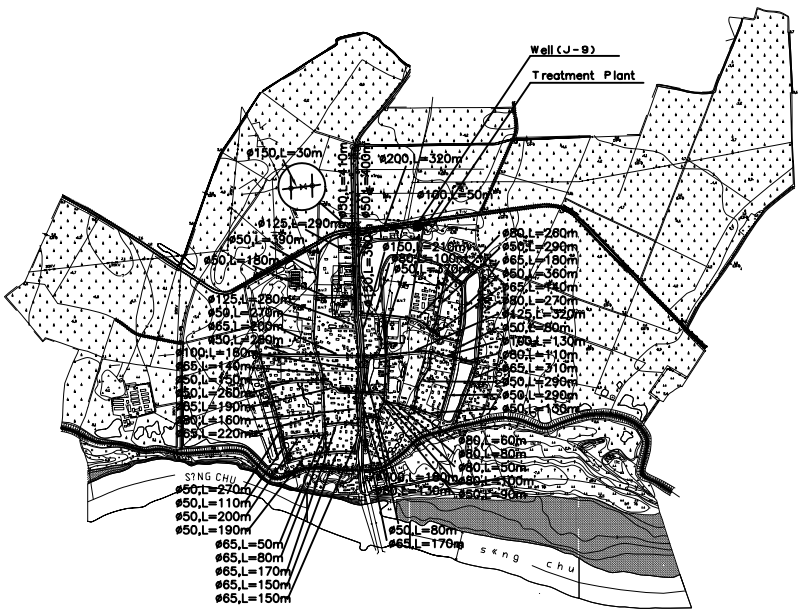
: Treatment Plant

: Sluice Valve

100 0 100 200 300 400 500
(Length:m)

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
General Plan of Water Supply Facilities Dinh Tuong (No. 10)	
Date :	Drawing No. 10
JAPAN INTERNATIONAL COOPERATION AGENCY	

Dia(mm)	Length(m)
50	5,090
65	2,150
80	1,320
100	540
125	890
150	600
200	320
250	–
300	–
Total	10,910



LEGEND

: Distribution pipe

: Raw Water Transmission

: Well

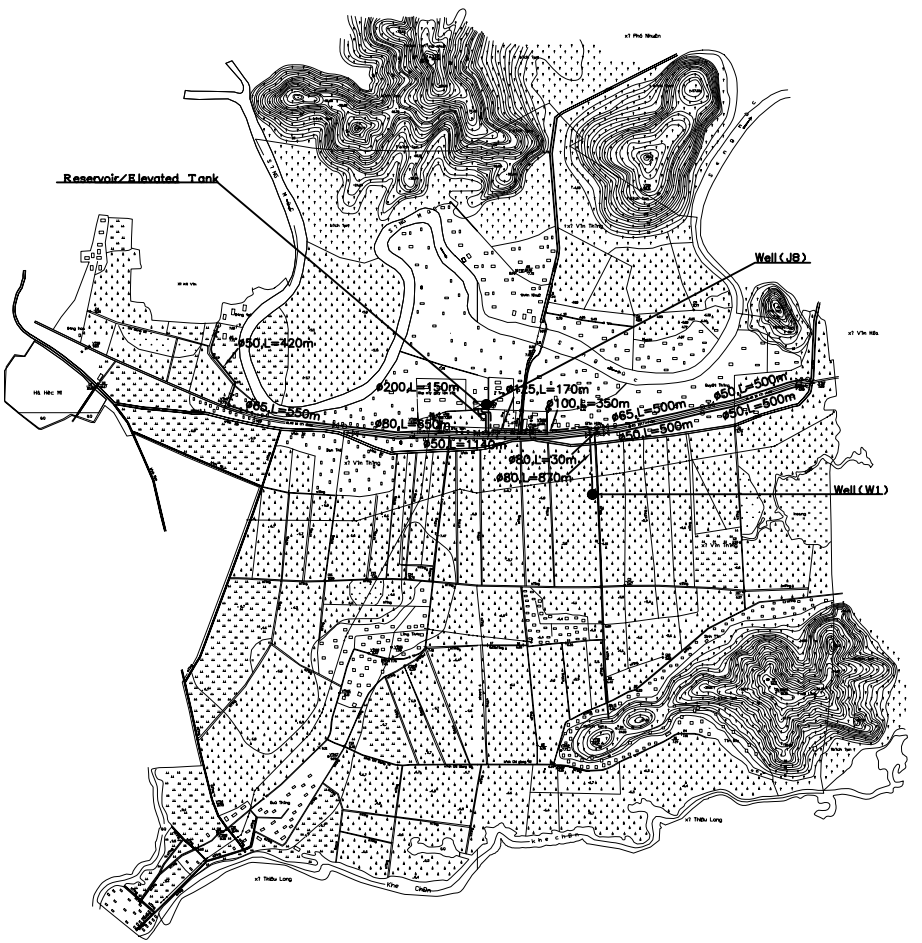
: Treatment Plant

: Sluice Valve

100 0 100 200 300 400 500
(Length:m)

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES
General Plan of Water Supply Facilities Van Ha (Thieu Hung) (No. 11)
Date : Drawing No. 11
JAPAN INTERNATIONAL COOPERATION AGENCY

Dia(mm)	Length(m)
50	3,060
65	1,050
80	1,550
100	350
125	170
150	–
200	150
250	–
300	–
Total	6,330



LEGEND

: Distribution pipe

: Raw Water Transmission

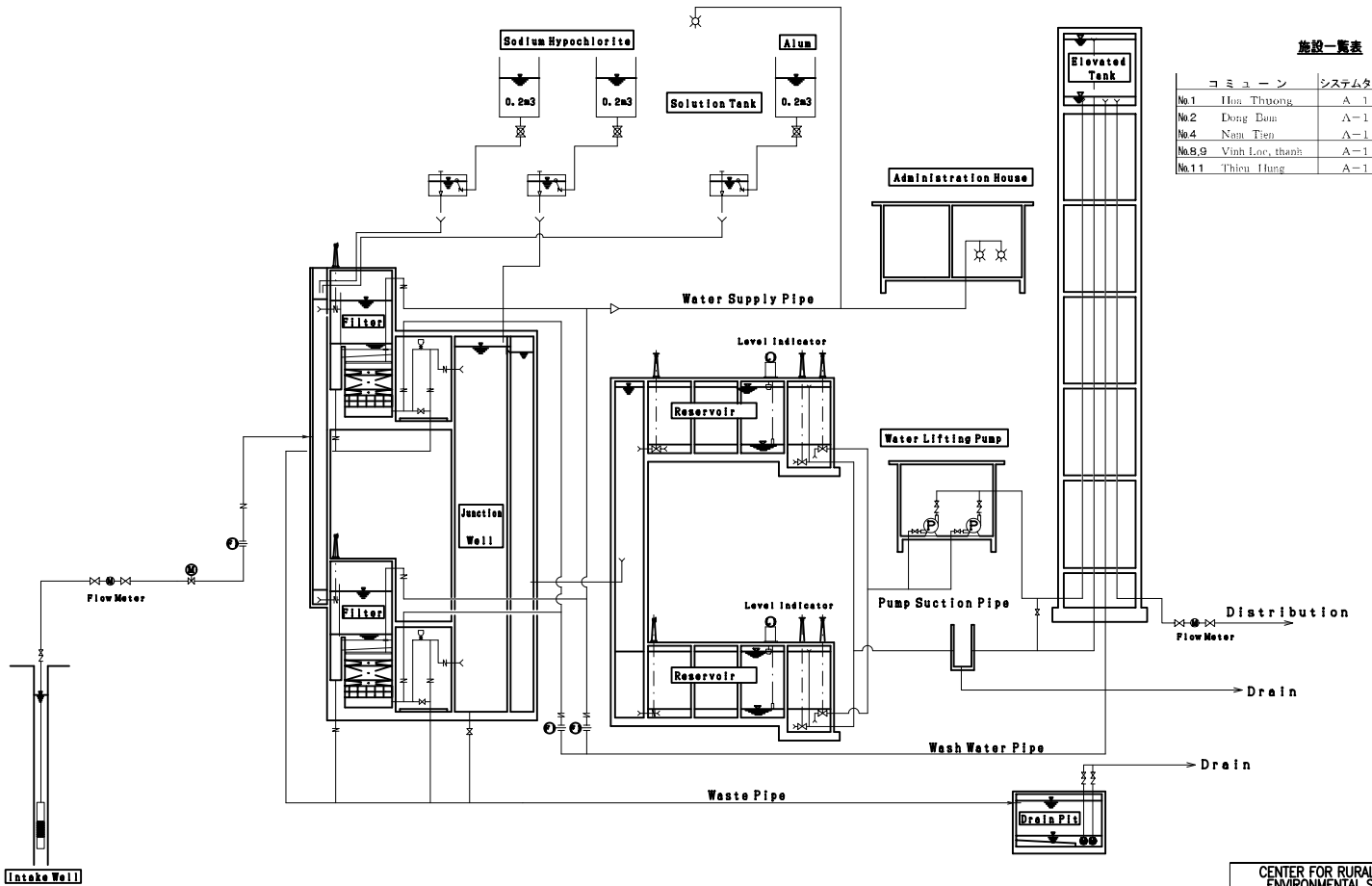
: Well

: Reservoir/Elevated Tank

: Sluice Valve

100 0 100 200 300 400 500
(Length:m)

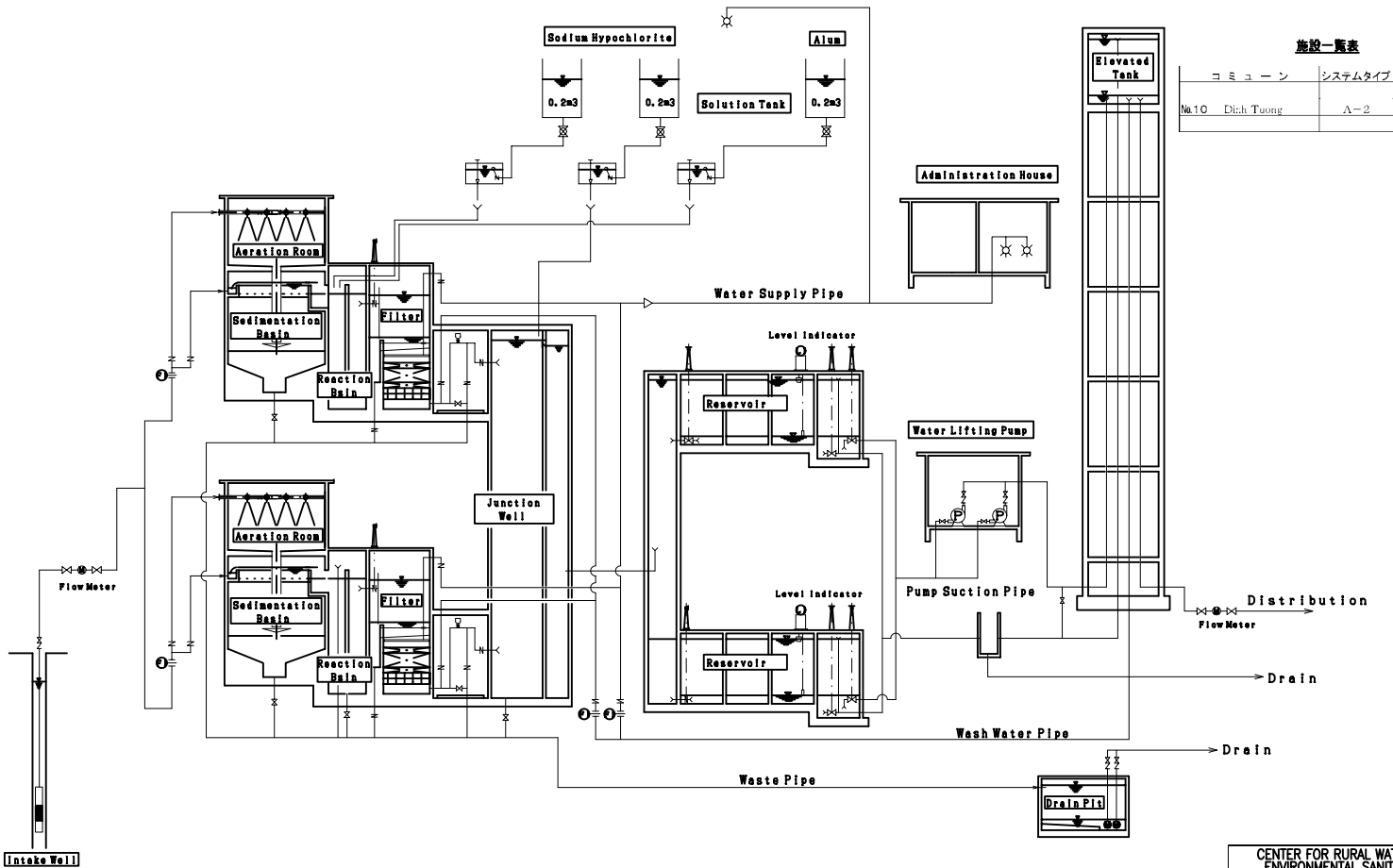
CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
General Plan of Water Supply Facilities Van Thang (No. 13)	
Date :	Drawing No. 12
JAPAN INTERNATIONAL COOPERATION AGENCY	



施設一覧表

	コミューン	システムタイプ	施設容量(m3/d)
No.1	Hua Thuong	A-1	810
No.2	Dong Bam	A-1	630
No.4	Nam Tien	A-1	475
No.8,9	Vinh Loc, thanh	A-1	1,350
No.11	Thieu Hung	A-1	760

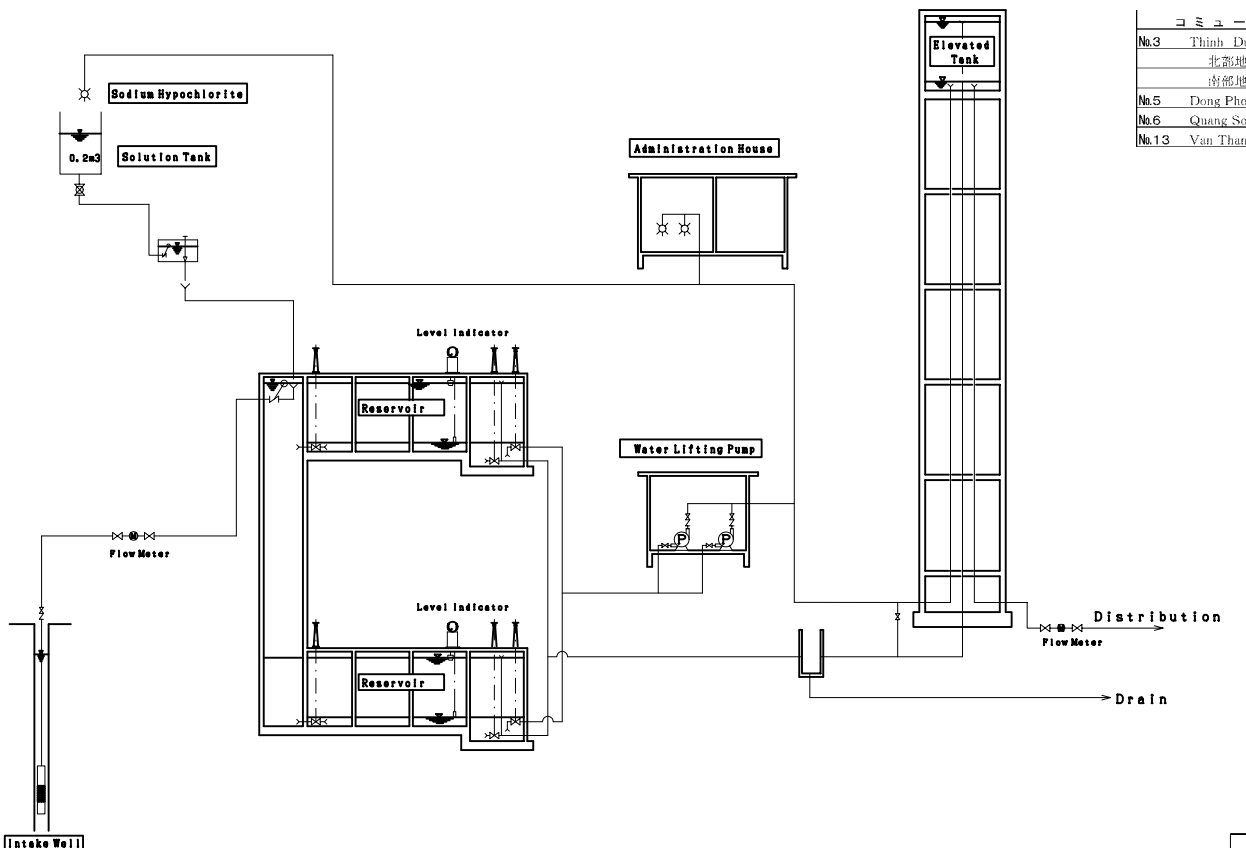
CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
Flow Sheet Type A – 1	
Date:	Drawing No.: 13
JAPAN INTERNATIONAL COOPERATION AGENCY	



施設一覧表

コミューン	システムタイプ	施設容量(m3/d)
No.10 Dich Tuong	A－2	660

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
Flow Sheet Type A－2	
Date:	Drawing No.: 14
JAPAN INTERNATIONAL COOPERATION AGENCY	



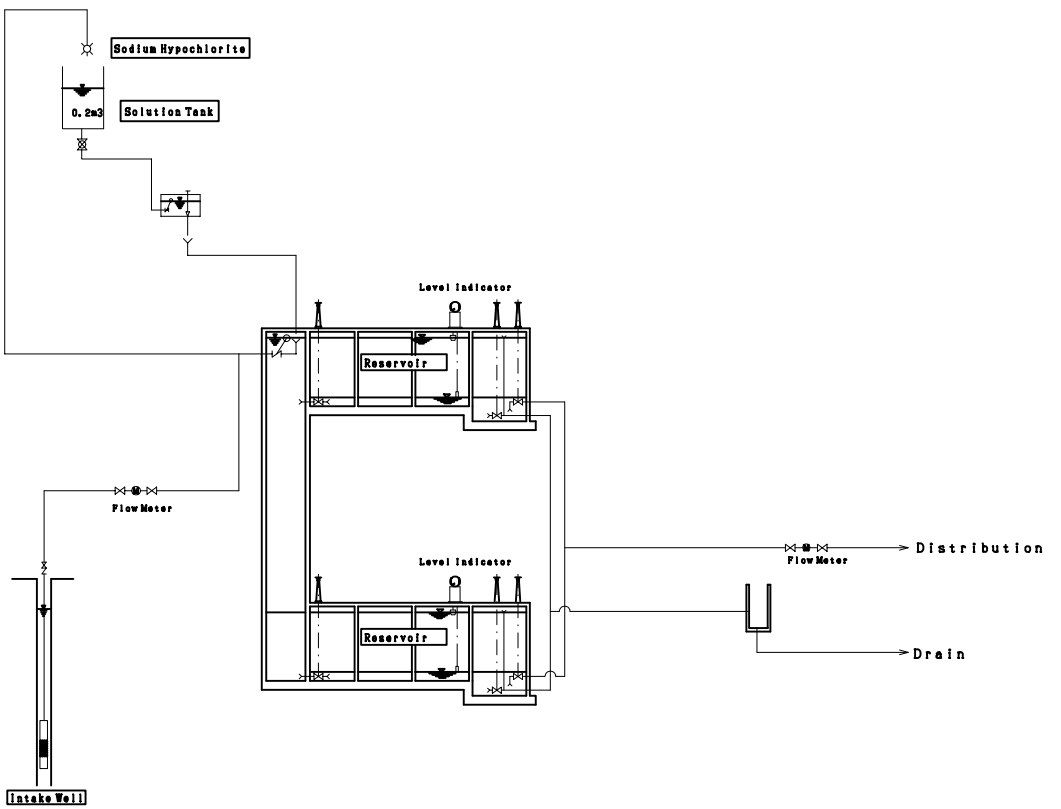
施設一覧表

コミューン		システムタイプ	施設容量(m3/d)
No.3	Thinh Duc		
	北部地区	B	150
	南部地区	B	200
No.5	Dong Phong	B	980
No.6	Quang Son	B	510
No.13	Van Thang	B	320

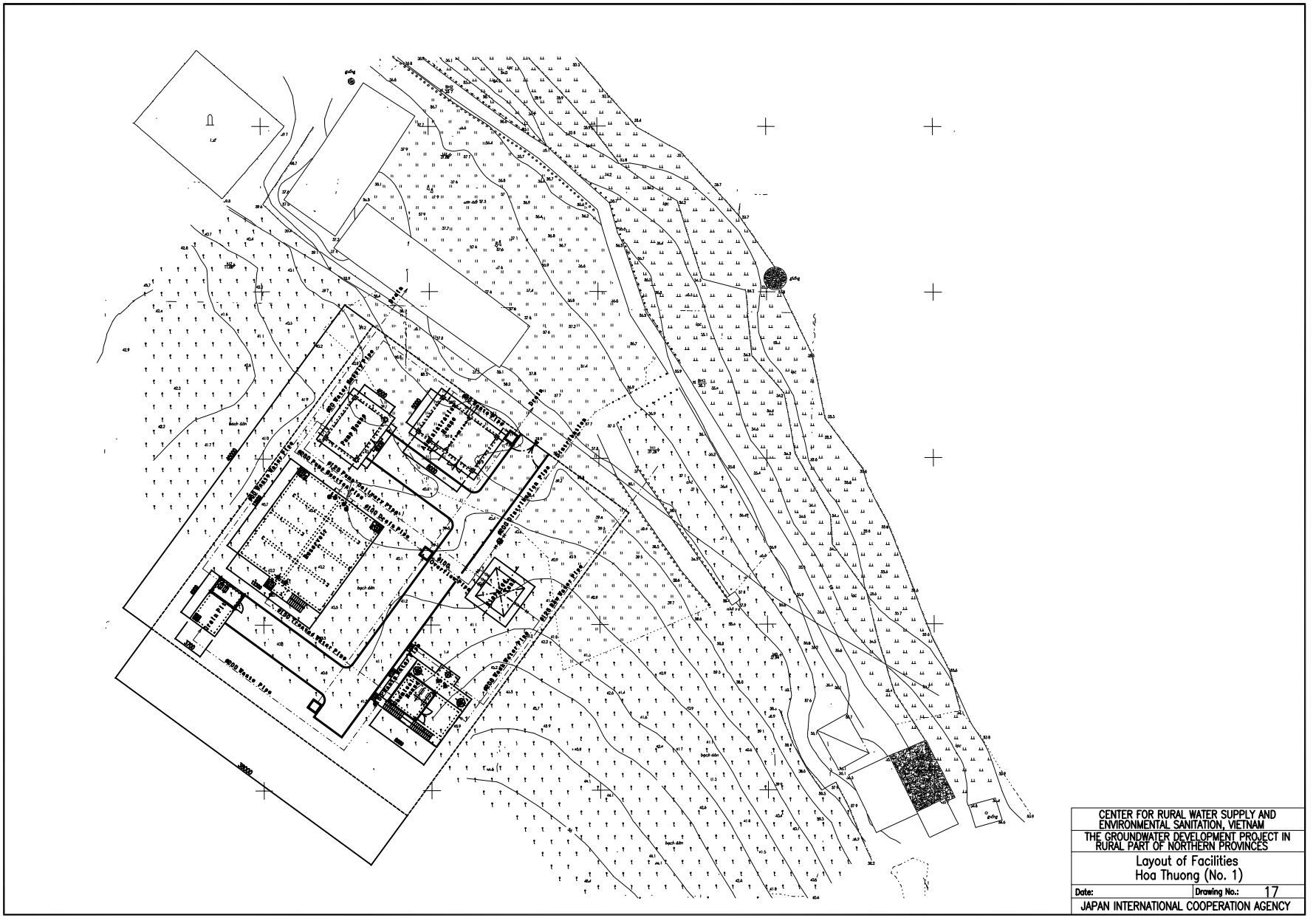
CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
Flow Sheet Type B	
Date:	Drawing No.: 15
JAPAN INTERNATIONAL COOPERATION AGENCY	

施設一覧表

コミューン		システムタイプ	施設容量(m3/d)
No.7	Yen Thang	C	870

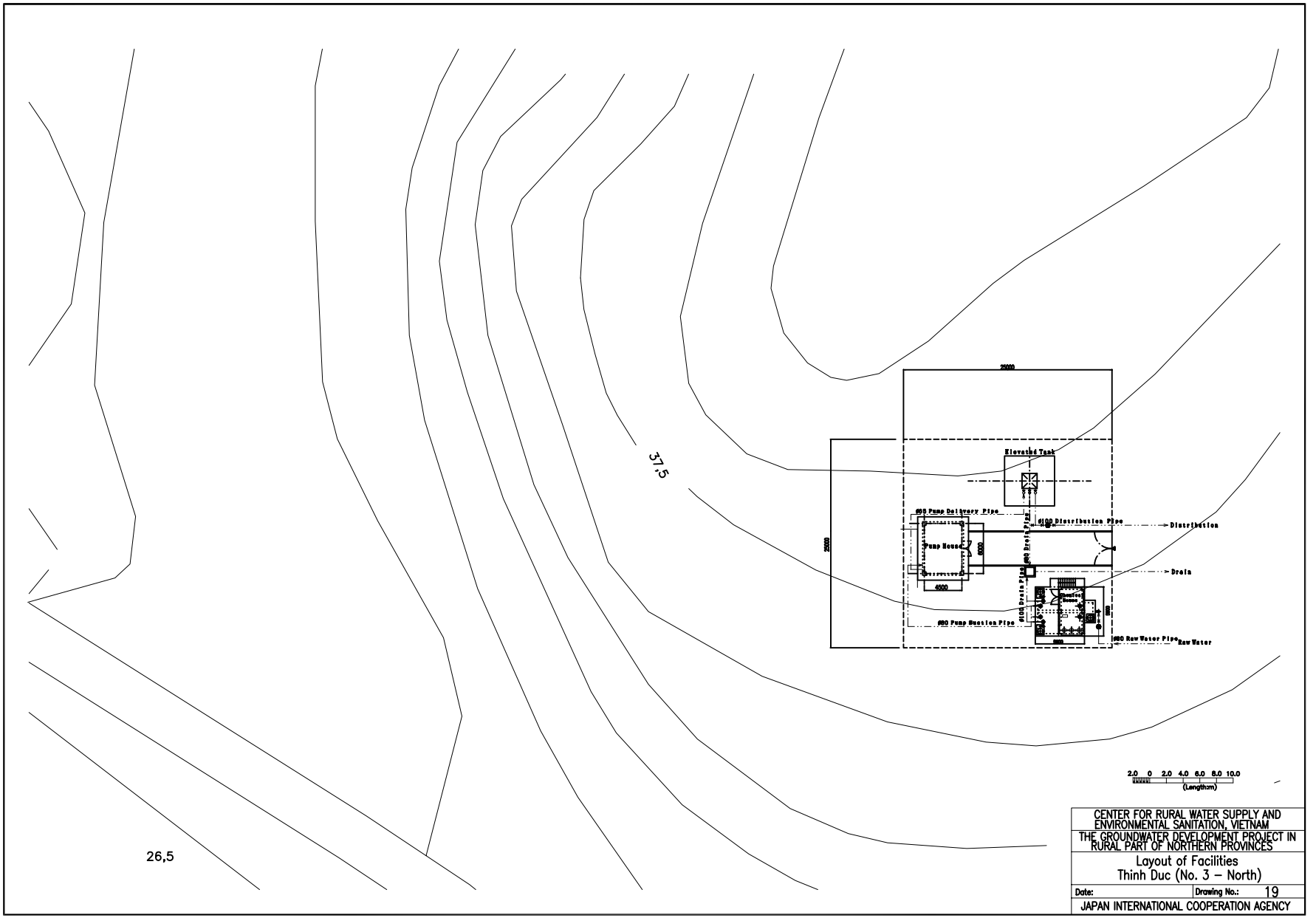


CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
Flow Sheet Type C	
Date:	Drawing No.: 16
JAPAN INTERNATIONAL COOPERATION AGENCY	

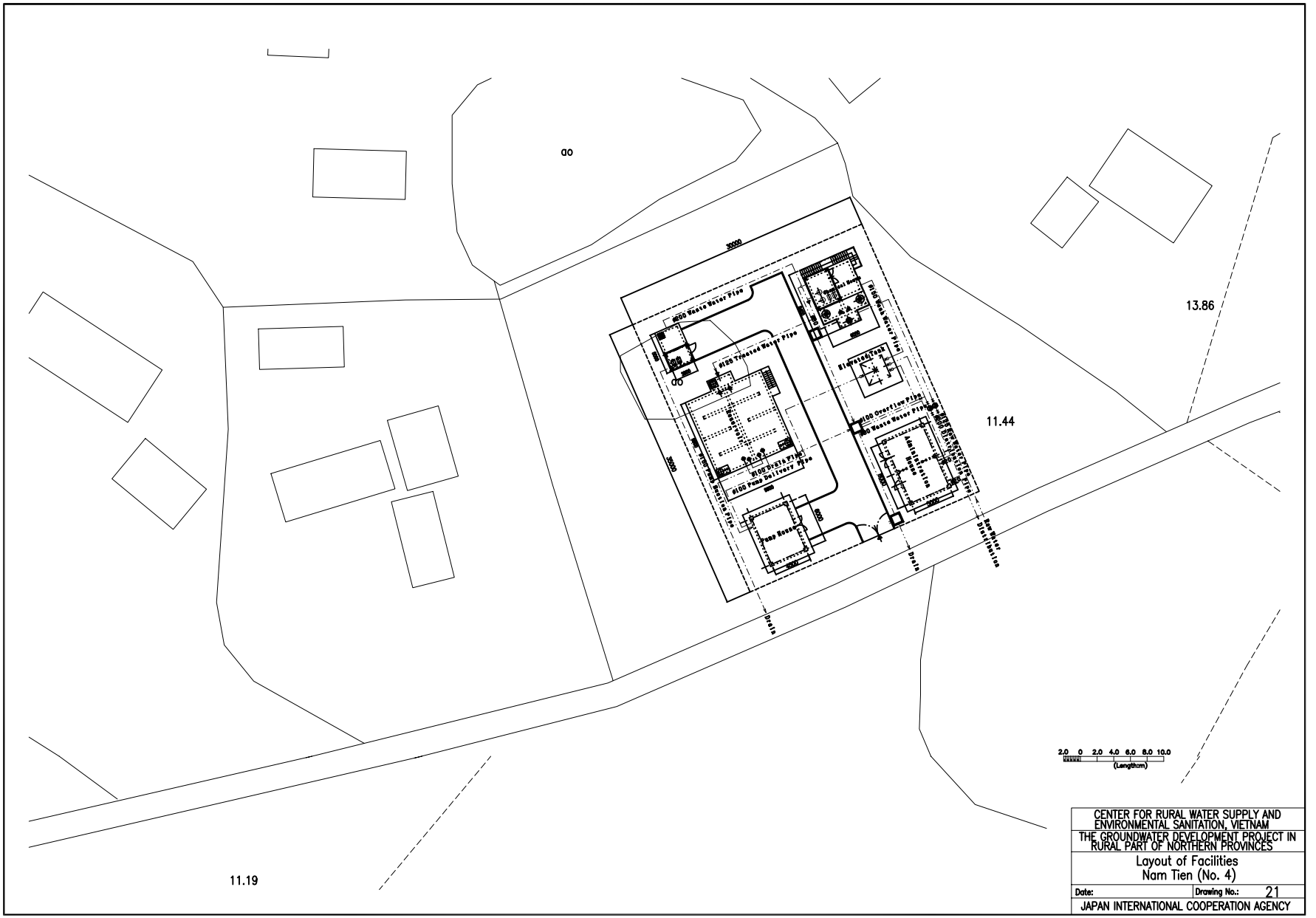


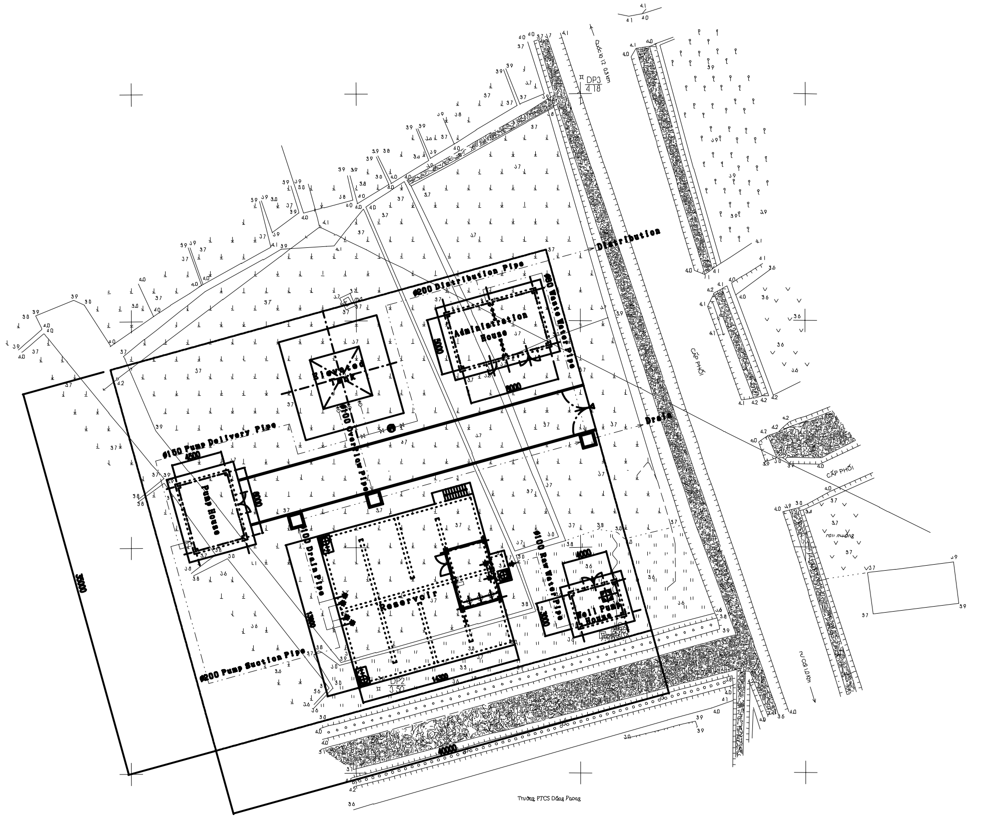
CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
Layout of Facilities Hoa Thuong (No. 1)	
Date:	Drawing No.: 17
JAPAN INTERNATIONAL COOPERATION AGENCY	


39,8
Pump Room
Administration Room
Raw Water
Drain
2.0 0 2.0 4.0 6.0 8.0 10.0
(Length:m)
CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES
Layout of Facilities
Dong Bam (No. 2)
Date:
Drawing No.: 18
JAPAN INTERNATIONAL COOPERATION AGENCY


37.5
26,5
Elevated Tank
Pump House
Plant for Chemical
Distribution
Drain
Raw Water
2.0 0 2.0 4.0 6.0 8.0 10.0
(Lengthm)
CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES
Layout of Facilities
Thinh Duc (No. 3 – North)
Date:
Drawing No.: 19
JAPAN INTERNATIONAL COOPERATION AGENCY

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES
Layout of Facilities
Thinh Duc (No. 3 – South)
Date:
Drawing No.: 20
JAPAN INTERNATIONAL COOPERATION AGENCY
2.0 0 2.0 4.0 6.0 8.0 10.0
(Length:m)
Pump House
Drain
Distribution
24.72
23,8


ao
ao
13.86
11.44
11.19
Drain
Drain
Raw Water Distribution
2.0 0 2.0 4.0 6.0 8.0 10.0
(Length:m)
CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES
Layout of Facilities
Nam Tien (No. 4)
Date:
Drawing No.: 21
JAPAN INTERNATIONAL COOPERATION AGENCY



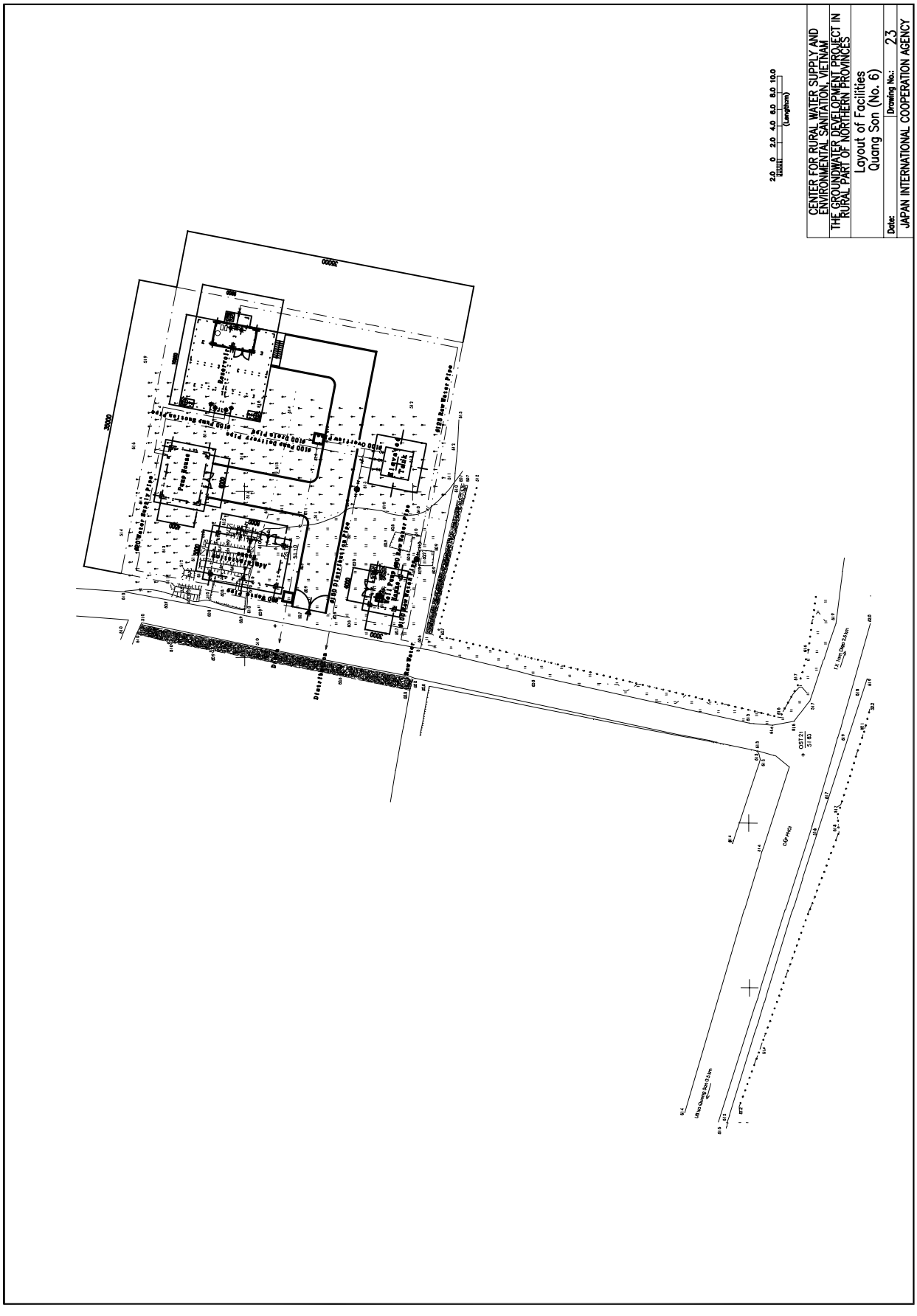
CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM

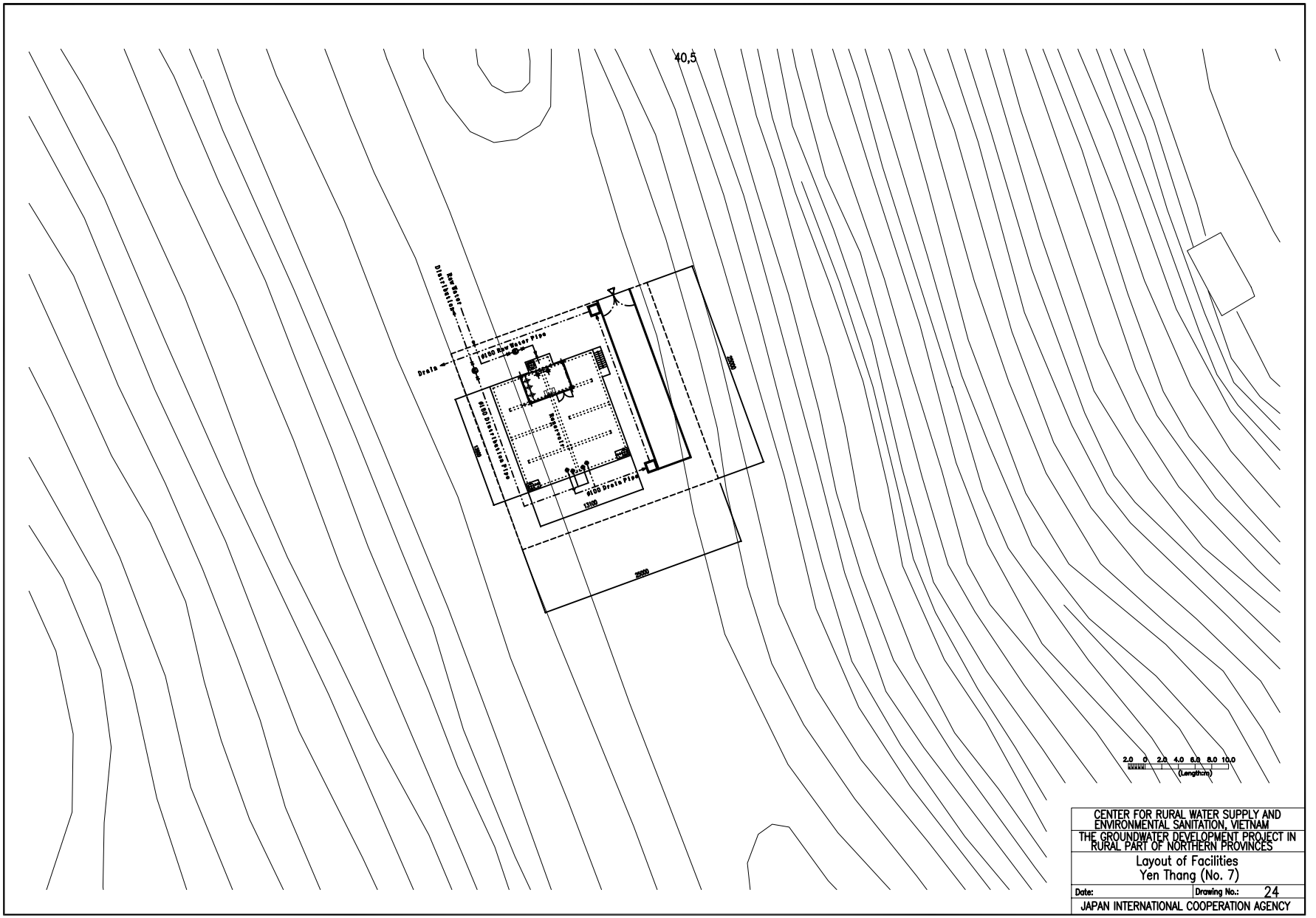
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES

Layout of Facilities
Dong Phong (No. 5)

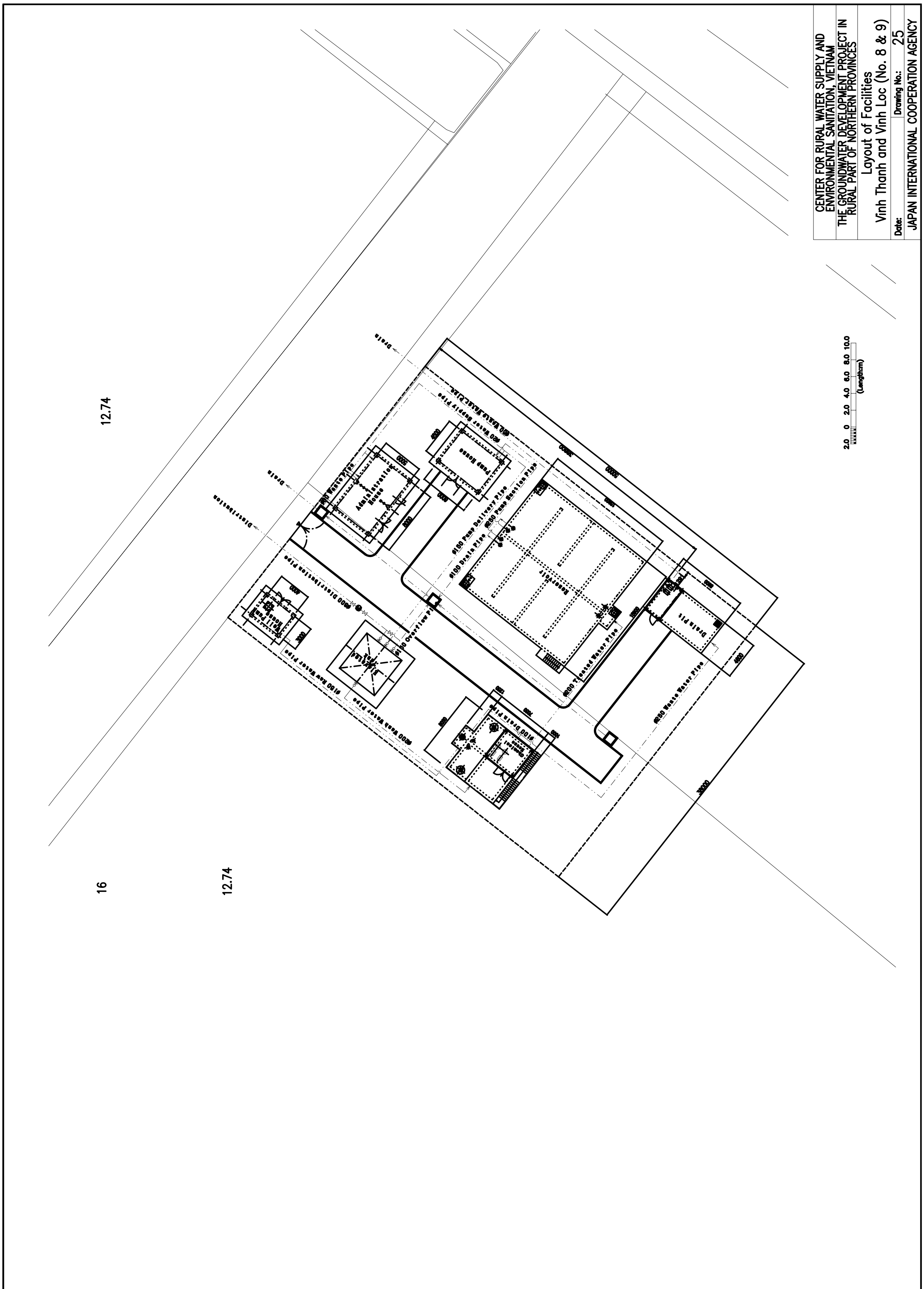
Date:		Drawing No.:	22

JAPAN INTERNATIONAL COOPERATION AGENCY

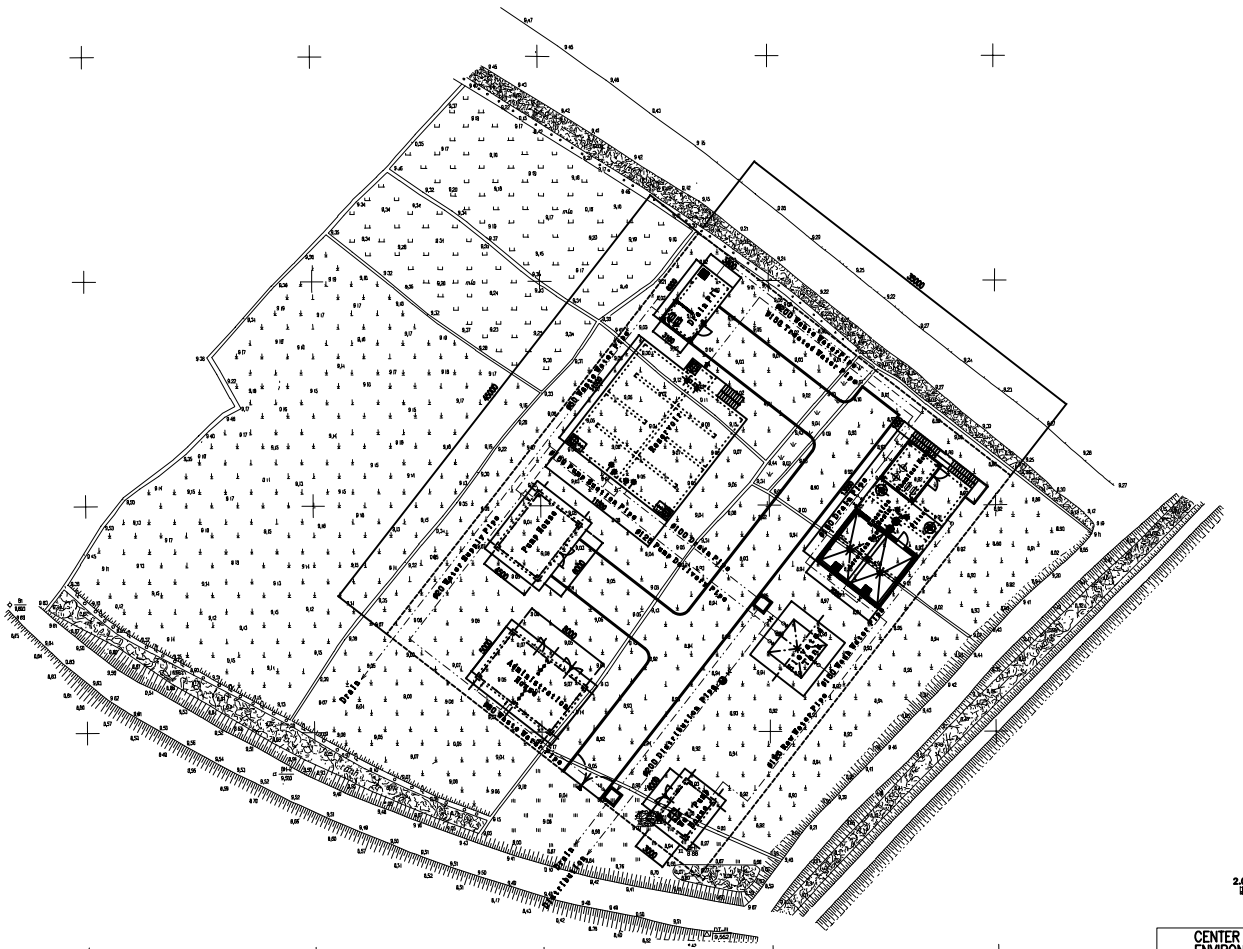

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES
Layout of Facilities
Quang Son (No. 6)
Date:
Drawing No.: 23
JAPAN INTERNATIONAL COOPERATION AGENCY
2.0 0 2.0 4.0 6.0 8.0 10.0
(Longitudinal)



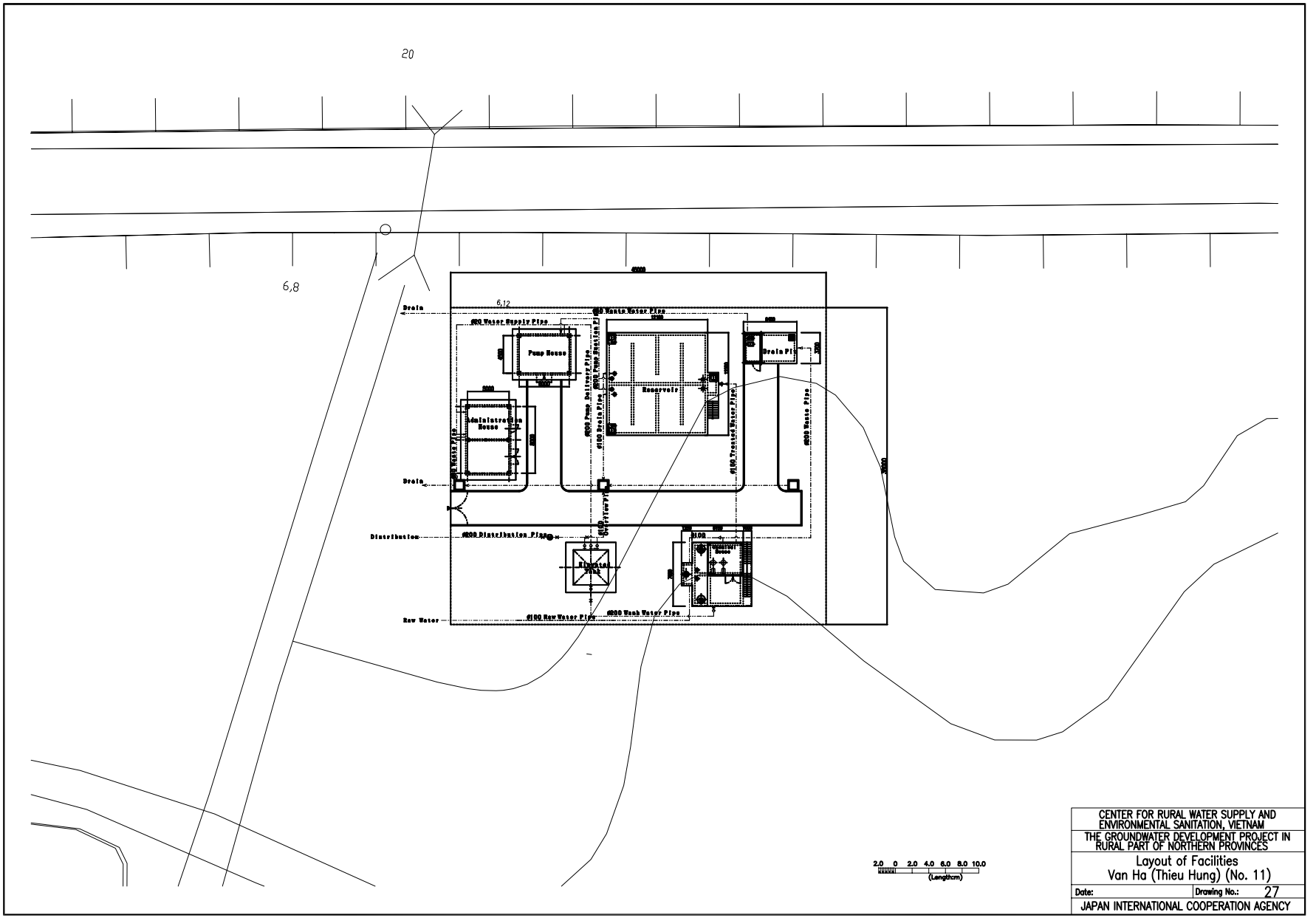
CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
Layout of Facilities Yen Thang (No. 7)	
Date:	Drawing No.: 24
JAPAN INTERNATIONAL COOPERATION AGENCY	

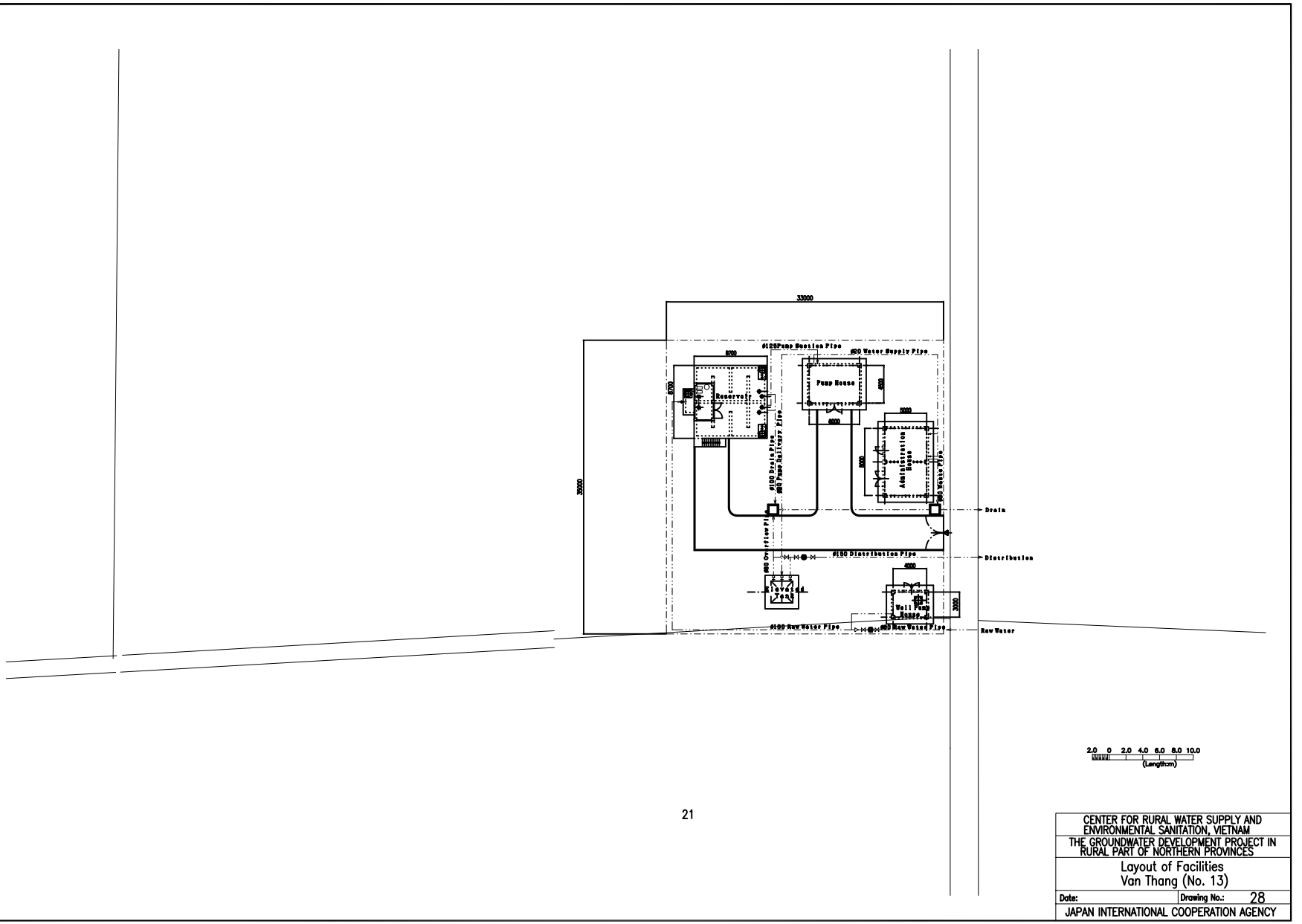


CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES
Layout of Facilities
Vinh Thanh and Vinh Loc (No. 8 & 9)
Date:
Drawing No.: 25
JAPAN INTERNATIONAL COOPERATION AGENCY
12.74
16
12.74



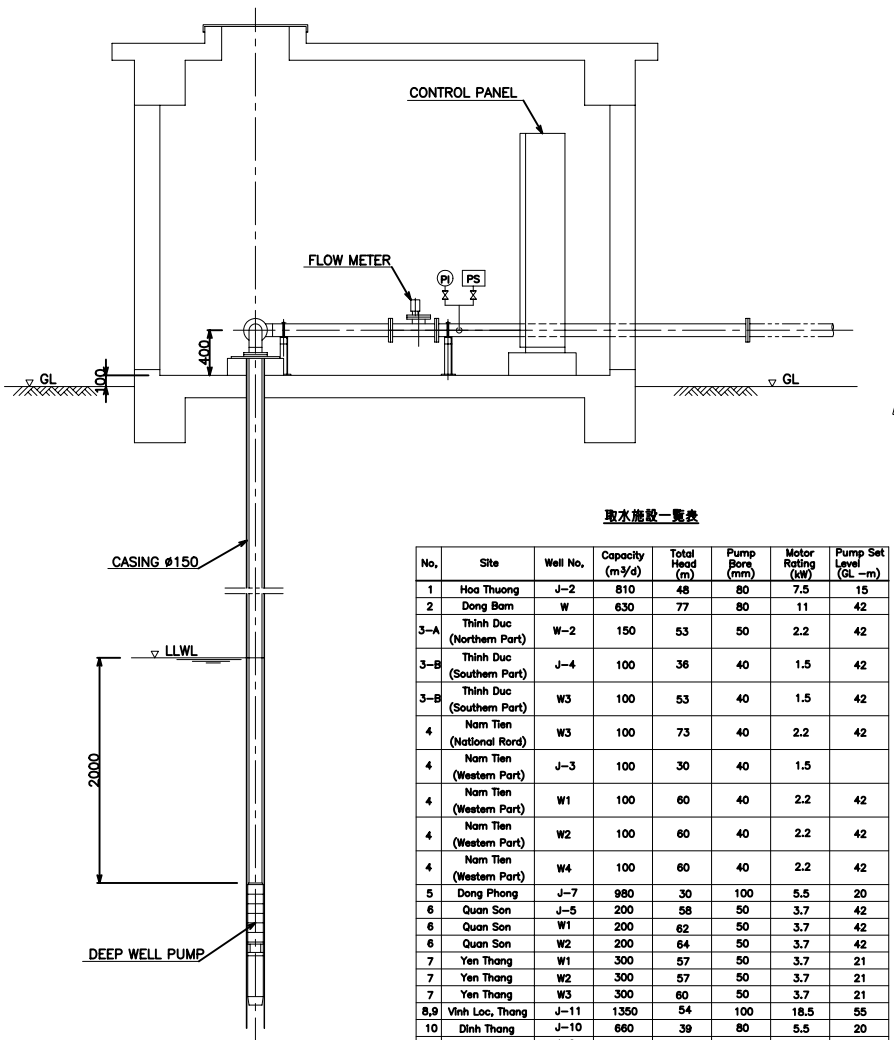
CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
Layout of Facilities Dinh Tuong (No. 10)	
Date:	Drawing No.: 26
JAPAN INTERNATIONAL COOPERATION AGENCY	

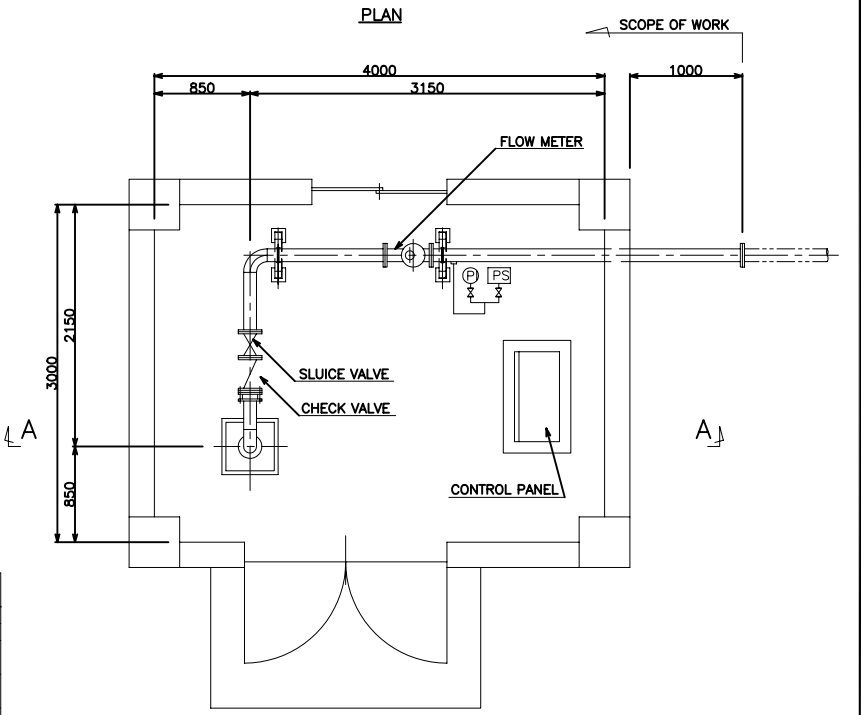

20
6,8
6,12
Drain
Pump House
Reservoir
Drain Pit
Administration House
Drain
Distribution
Raw Water
Chemical House
Guard House
2.0 0 2.0 4.0 6.0 8.0 10.0
(Length:m)
CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES
Layout of Facilities
Van Ha (Thieu Hung) (No. 11)
Date:
Drawing No.: 27
JAPAN INTERNATIONAL COOPERATION AGENCY



21

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
Layout of Facilities Van Thang (No. 13)	
Date:	Drawing No.: 28
JAPAN INTERNATIONAL COOPERATION AGENCY	





取水施設一覧表

No,	Site	Well No,	Capacity (m^3/d)	Total Head (m)	Pump Bore (mm)	Motor Rating (kW)	Pump Set Level (GL –m)
1	Hoa Thuong	J–2	810	48	80	7.5	15
2	Dong Bam	W	630	77	80	11	42
3–A	Thinh Duc (Northern Part)	W–2	150	53	50	2.2	42
3–B	Thinh Duc (Southern Part)	J–4	100	36	40	1.5	42
3–B	Thinh Duc (Southern Part)	W3	100	53	40	1.5	42
4	Nam Tien (National Rord)	W3	100	73	40	2.2	42
4	Nam Tien (Western Part)	J–3	100	30	40	1.5	
4	Nam Tien (Western Part)	W1	100	60	40	2.2	42
4	Nam Tien (Western Part)	W2	100	60	40	2.2	42
4	Nam Tien (Western Part)	W4	100	60	40	2.2	42
5	Dong Phong	J–7	980	30	100	5.5	20
6	Quan Son	J–5	200	58	50	3.7	42
6	Quan Son	W1	200	62	50	3.7	42
6	Quan Son	W2	200	64	50	3.7	42
7	Yen Thang	W1	300	57	50	3.7	21
7	Yen Thang	W2	300	57	50	3.7	21
7	Yen Thang	W3	300	60	50	3.7	21
8,9	Vinh Loc, Thang	J–11	1350	54	100	18.5	55
10	Dinh Thang	J–10	660	39	80	5.5	20
11	Thieu Hung	J–9	760	35	80	5.5	21
13	Van Thang	J–8	170	60	50	3.7	42
13	Van Thang	W	170	62	50	3.7	42

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM

THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES

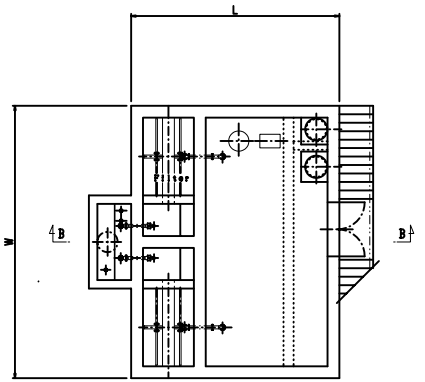
Intake Facilities

Date: Drawing No.: 29

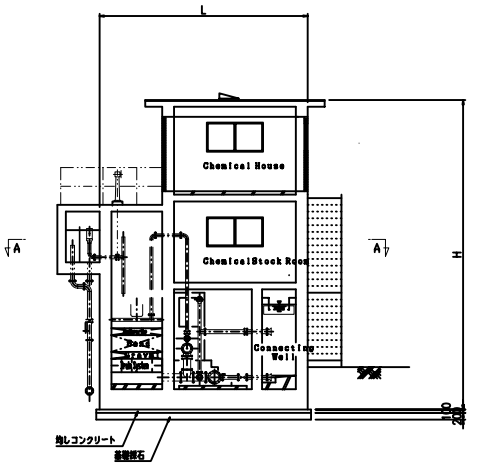
JAPAN INTERNATIONAL COOPERATION AGENCY

TYPE A-1

A－A

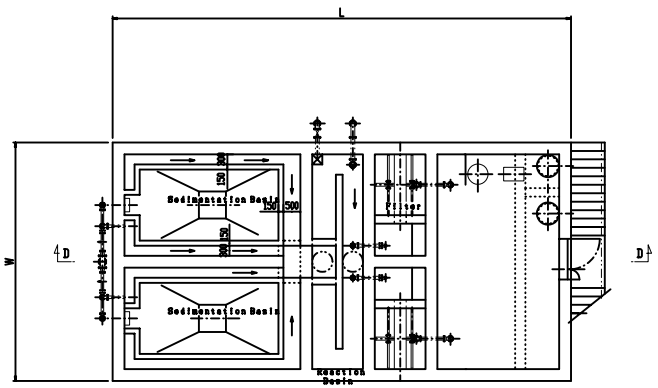


B－B

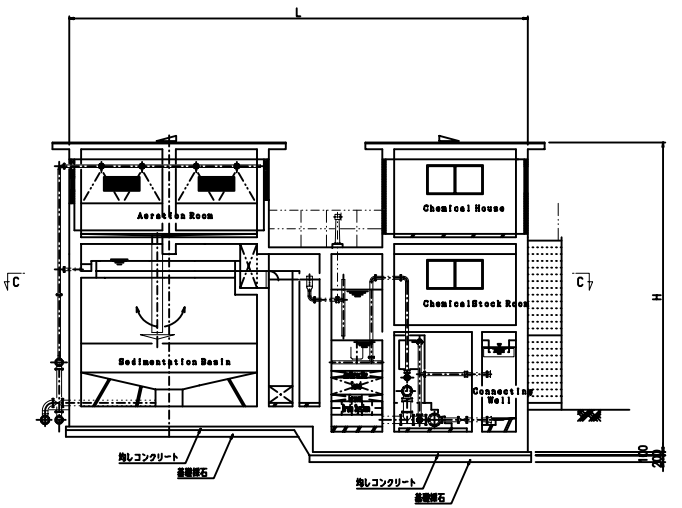


TYPE A-2

C－C



D－D



浄水施設一覧表

TYPE A－1

コミューン	容量 (m3)	概略寸法 W(m)	L(m)	H(m)
No.1 Hoa Thuong	810	8.05	6.15	9.15
No.2 Dong Bam	630	7.05	6.15	9.15
No.4 Nam Tien	475	6.05	6.15	9.15
No.8,9 Vinh Loc, thanh	1,350	8.05	7.05	9.15
No.11 Thieu Hung	760	7.65	6.15	9.15

TYPE A－2

コミューン	処理能力 (m3/d)	概略寸法 W(m)	L(m)	H(m)
No.10 Dinh Tuong	660	7.05	13.55	9.15

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM

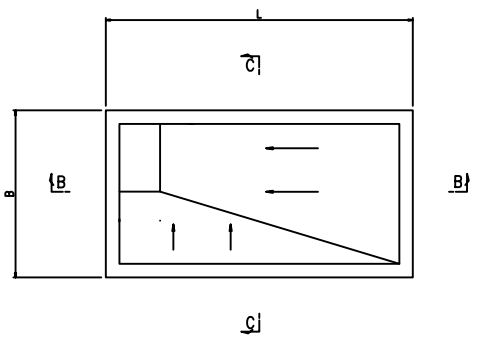
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES

Treatment Facilities

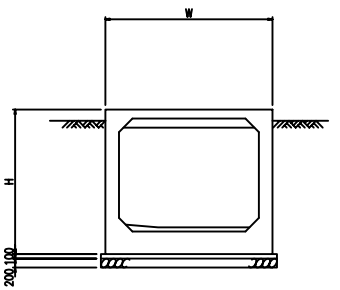
Date: | Drawing No.: 30

JAPAN INTERNATIONAL COOPERATION AGENCY

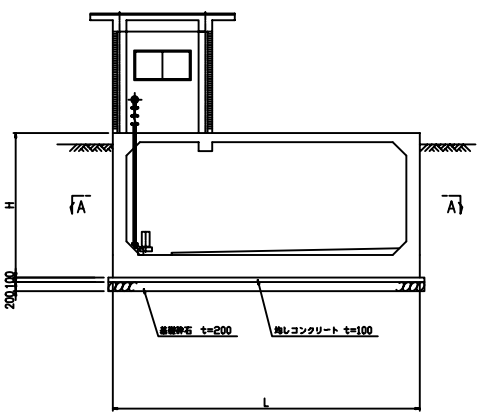
A－A



C－C



B－B



排泥ピット一覧表

コミューン		容量 (m3)	概略寸法 W(m)	L(m)	H(m)
No.1	Hoa Thuong	38.1	3.70	6.80	3.20
No.2	Dong Bam	30.0	3.40	6.20	3.20
No.4	Nam Tien	21.7	3.10	5.00	3.20
No.8,9	Vinh Loc, thanh	63.4	4.60	8.60	3.20
No.10	Dinh Tuong	30.0	3.40	6.20	3.20
No.11	Thieu Hung	35.0	3.70	6.40	3.20

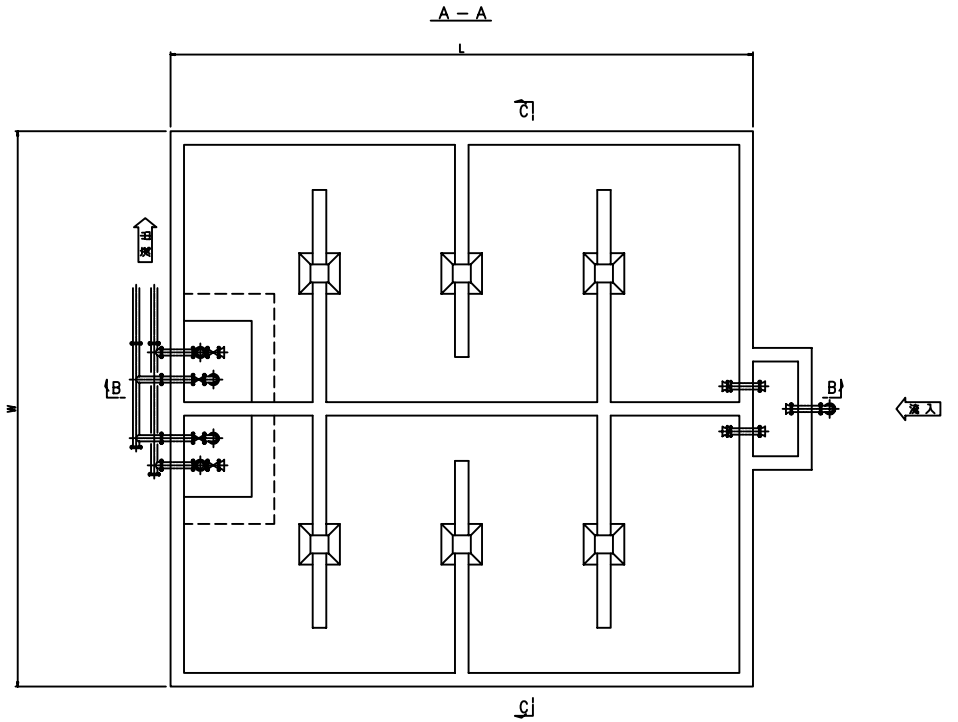
CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM

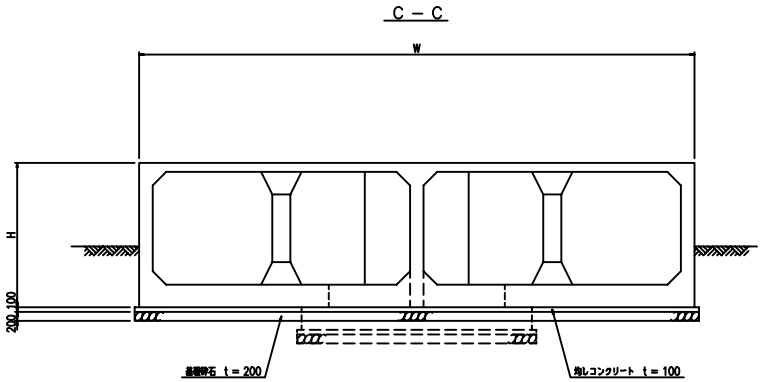
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES

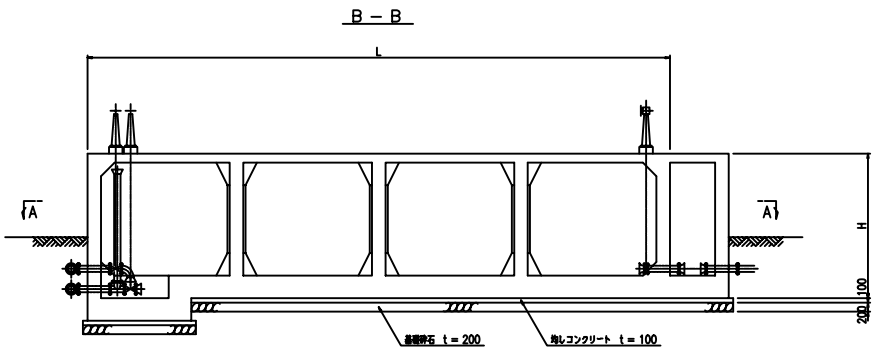
Drain Pit

Date: Drawing No.: 31

JAPAN INTERNATIONAL COOPERATION AGENCY





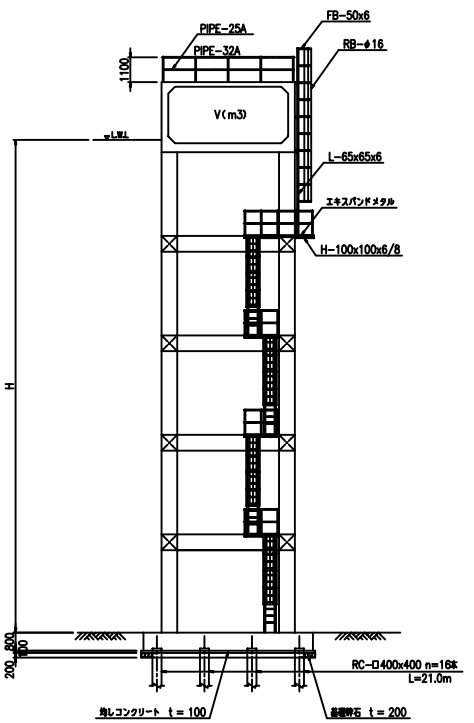


配水池一覧表

コミューン		容量 (m3)	概略寸法 W(m)	L(m)	H(m)
No.1	Hoa Thuong	260	12.30	12.90	3.20
No.2	Dong Bam	200	10.80	11.50	3.20
No.3	Thich Duc				
	北引水区	50	5.90	5.90	3.20
	南給水区	70	6.96	6.90	3.26
No.4	Nam Tien	150			3.28
No.5	Dong Phong	330	13.90	14.30	3.20
No.6	Quang Son	170	9.90	11.10	3.28
No.7	Yen Thanh	290	13.10	13.50	3.20
No.8,9	Vinh Loc, thanh	130	15.90	15.90	3.28
No.10	Dinh Tuong	210	11.30	11.50	3.20
No.11	Thieu Hoa	240	12.30	12.10	3.20
No.13	Van Thang	110	8.70	8.70	3.20

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
Reservoirs	
Date:	Drawing No.: 32
JAPAN INTERNATIONAL COOPERATION AGENCY	

断面図



高架水槽一覧表

コミューン		容量 V(m3)	設置高 H
№1	Hoa Thuong	35.0	GL.+16.0m
№2	Dong Bam	25.0	GL.+17.5m
№3	Thinh Duc		
	北部地区	6.3	GL.+28.1m
	南部地区	8.5	GL.+23.5m
№4	Nam Tien	20.0	GL.+17.0m
№5	Dong Phong	40.0	GL.+21.1m
№6	Quang Son	22.0	GL.+19.2m
№7	Yen Thang	-	-
№8,9	Vinh Loc, thanh	55.0	GL.+21.8m
№10	Dinh Tuong	26.0	GL.+19.0m
№11	Thieu Hung	30.0	GL.+18.5m
№13	Van Thang	13.0	GL.+17.9m

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM

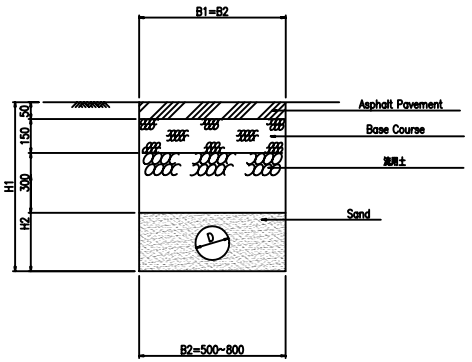
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES

Elevated Tanks

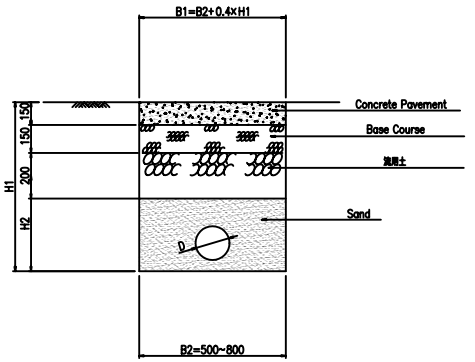
Date: Drawing No.: 33

JAPAN INTERNATIONAL COOPERATION AGENCY

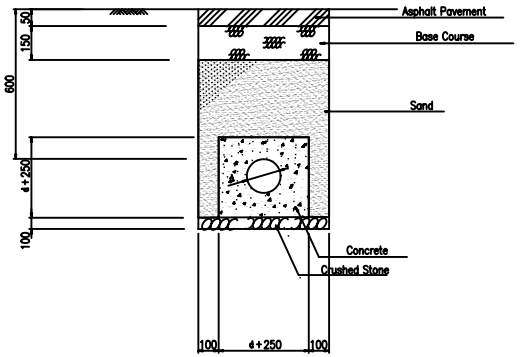
Asphalt Road (National Road)



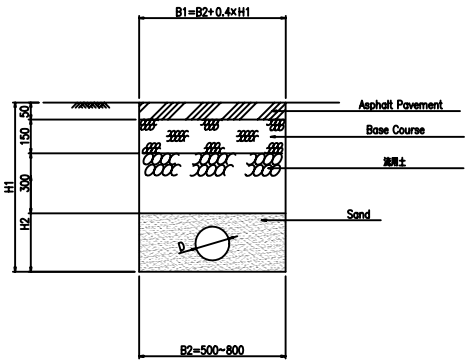
Concrete Road



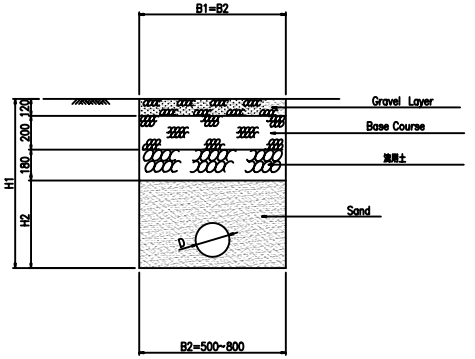
Crossing National Road



Asphalt Road (Sub-Road)

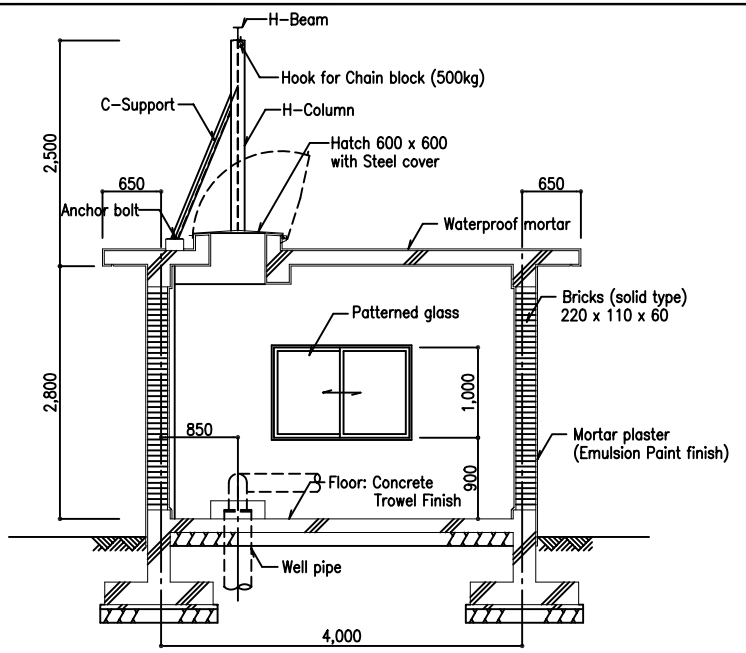


Gravel Road

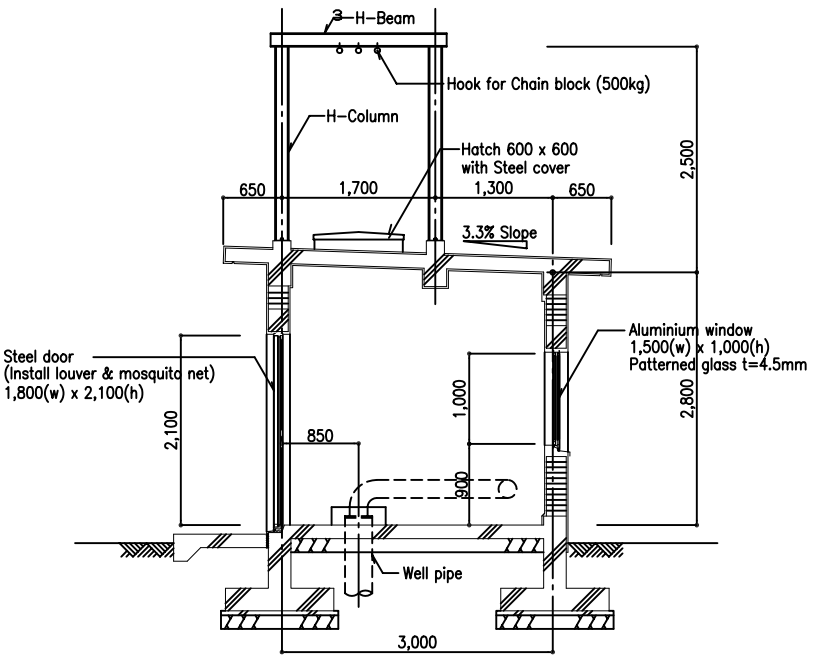


Note
D : Outside Diameter
d : Inside Diameter

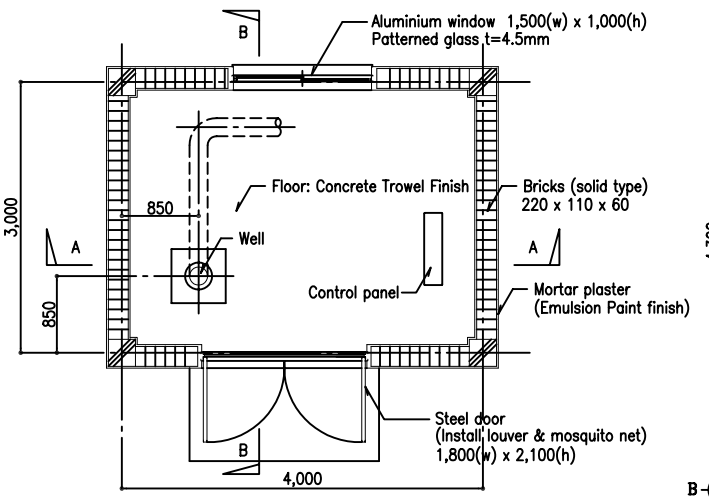
CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
Trench for Pipe Works	
Date:	Drawing No.: 34
JAPAN INTERNATIONAL COOPERATION AGENCY	



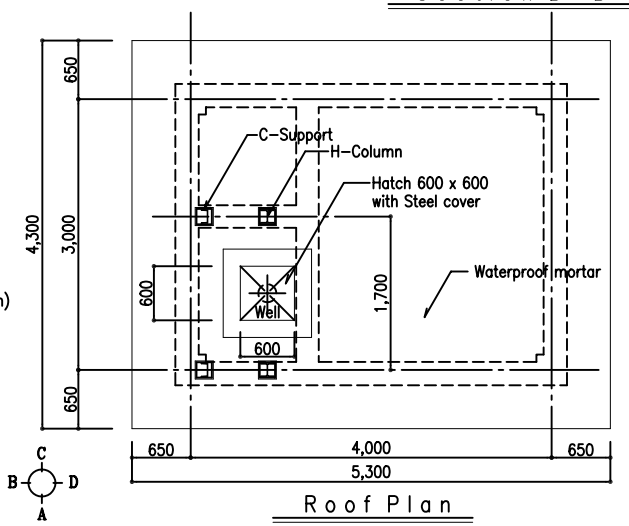
Section A－A



Section B－B

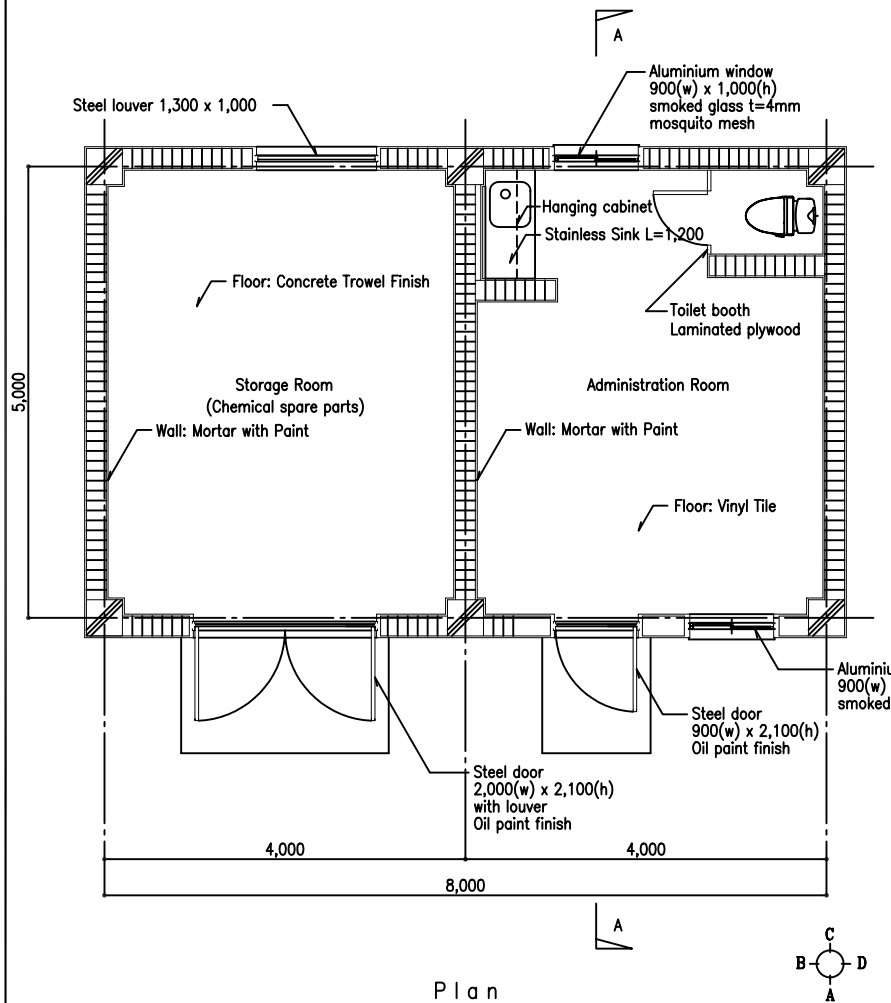


Plan

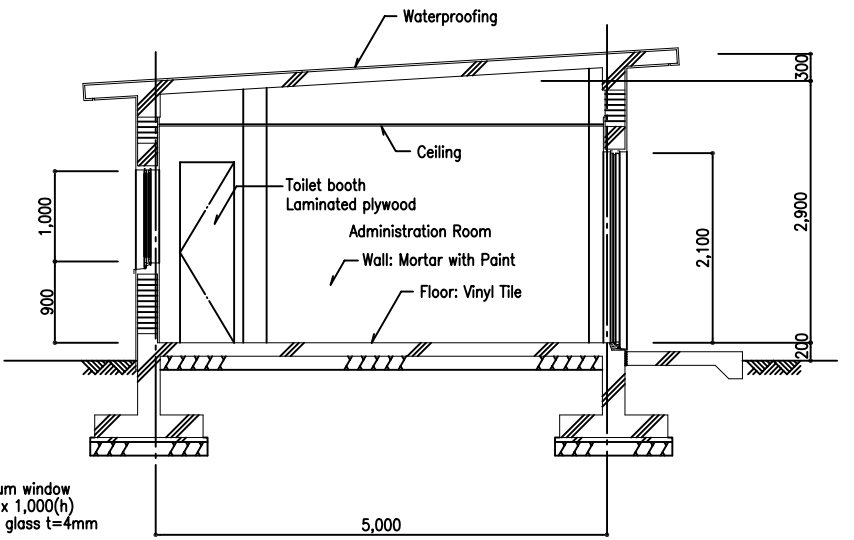


Roof Plan

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
Intake Pump Chamber	
Date:	Drawing No.: 35
JAPAN INTERNATIONAL COOPERATION AGENCY	



Plan



Section A－A

CENTER FOR RURAL WATER SUPPLY AND ENVIRONMENTAL SANITATION, VIETNAM	
THE GROUNDWATER DEVELOPMENT PROJECT IN RURAL PART OF NORTHERN PROVINCES	
Administration House	
Date:	Drawing No.: 36
JAPAN INTERNATIONAL COOPERATION AGENCY	

2.3.5 Supply of Well Drilling Equipment

(1) Equipment Requested

Content of the equipment requested is as follows:

1) Well drilling equipment
   - Well drilling machine: 2 units
   - Drilling and fishing tools, and work casings: 2 units
   - High-pressure air compressor: 2 units
   - Ancillary equipment: 2 units
   - Air lifting equipment: 2 units
   - Spare parts: 2 units

2) Supporting equipment
   - Cab-back crane cargo truck: 2 units
   - Water tank truck: 2 units
   - Double-cab pick-up truck: 2 units
   - Pumping test equipment: 1 unit
   - Well logging equipment: 1 unit
   - Spare parts: 1 unit

3) Mobile workshop truck: 1 unit

(2) Purpose of the Request and Justification of the Equipment Supply

The purpose of the Supply of Well Drilling Equipment is to contribute to the national policy of Vietnam in well construction through technology transfer by on-the-job training during well construction work of the project using the equipment supplied. In other word, Supply of Well Drilling Equipment will contribute to the plan with advanced technology of well construction after the Project completion.

MARD has an action program of "National Plan of Rural Water Supply for Northern provinces up to Year 2010", and decided construction of water supply systems with water treatment plant and pipe distribution system using water source of deep well. Construction of deep well using the equipment supplied and advanced technology of well construction in the action program can contribute to the national program.

The scope of the project is to include equipment supply with technical assistance and technical transfer regarding well drilling works; and to formulate effective cooperation with Vietnam.

(3) The Necessity of the Equipment Supply

Wherever groundwater potential is high, safe and serviceable public water supply systems can be constructed

using groundwater with treatment plant and distribution pipeline system. If the groundwater quality is good enough, it will be possible to construct a water supply system without the treatment plant. It is important that CERWASS will be able to carry out development of groundwater source for rural water supply systems in the future. The new equipment is necessary for the groundwater development technology improvement; and the equipment supply is to be involved in the Project.

Although CERWASS has drilling equipment as shown in table 2.18, they are usually used for geological survey. Drilling work using such existing machines seems to consume time and manpower. Time-consuming drilling work will cause difficulty to keep borehole wall intact from mud cake and clogging groundwater vein. The new well drilling equipment supply is necessary for CERWASS in order to carry out well construction efficiently.

Table 2.18 List of Existing Well Drilling Equipment of CERWASS

Organization	Drilling equipment	Drilling Depth	Drilling diameter	Quantity	Year procured
Central CERWASS	XG-100 (China)	100 m	100 - 169 mm	1	1993
Thai Nguyen Provincial CERWASS	XY-1 (China)	100 m	46 – 110 mm	1	1993
Ninh Binh Provincial CERWASS	XY-1 (China)	100 m	46 – 110 mm	1	1993
Thanh Hoa Provincial CERWASS	XY-1 (China) Longyear (Canada)	100 m 100 m	46 – 110 mm Small	1 1	1993 before 1985

(4) Other Donors

The counterpart organization of the Government of Vietnam, CERWASS, has no plan for well drilling equipment procurement as of December 2001; beside no international funding agency has made donations to support the equipment supply programs.

(5) Storage of the Equipment and its Maintenance in Vietnam

The equipment supplied is to be operated and maintained by the Center for Material Delivery and Technology Transfer of Central CERWASS. The Center is located southwest of Hanoi (Ta Thanh Oai Commune in Thanh Tri District) with 58 staffs. Organization chart of the Center is shown in a following figure. It has 5 Sections; among them the Technical Section has 23 staffs. The Technical Section is composed of the Operation and Maintenance sub-section. The Operation and Maintenance sub-section has 5 operators for well drilling works and maintenance works.

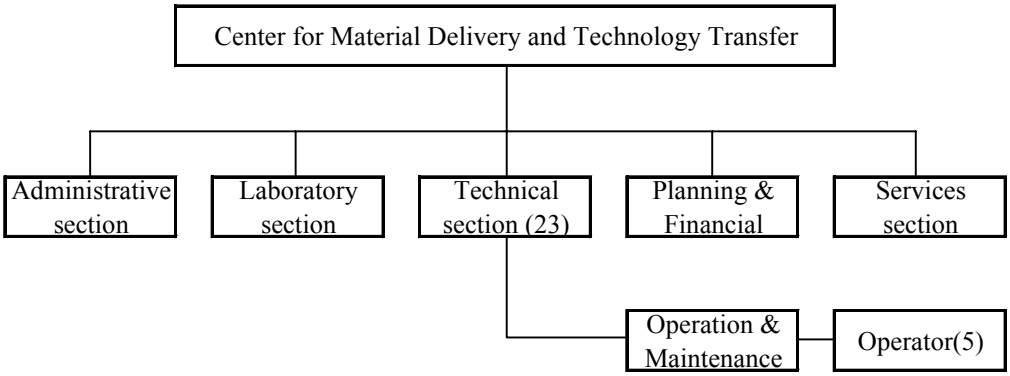


Fig.2.4 Organization Chart of Center for Material Delivery and Technology Transfer

The Center has the land area of 14,000 m2 in total. The yard for the daily routine works, located within the area, is protected with brick walls and watchmen and has an area of 3,500 m2, where the administration building is placed. The equipment supplied is to be stored in this yard. The area required for the equipment storage is about 35 m2 indoor and about 200 m2 outdoor. The yard has enough flat space paved with concrete for storage, thus, the condition for receiving equipment receipt is satisfactory.

Drilling equipment existing in the Central CERWASS is almost China made with capacity of drilling depth 100 m. On the other hand, equipment to be supplied is different from the existing type and contains new technology facilities, like hydraulic rotary drive system, down-the-hole (DTH) hammer drilling, etc. The present technology of well drilling and equipment maintenance in the Center are utilized as basic technology for technical transfer. The Center has enough staffs for operating, safekeeping and maintenance of the equipment, therefore, it is deemed satisfactory to supply the new equipment.

It is predicted the O/M cost would be more expensive than that of the existing equipment. CERWASS has carried out well construction on a project basis. Cost of well construction is borne by each project budget including maintenance cost of drilling equipment. CERWASS plans construction of 450 deep wells from 2002 to 2006 under the national program with the total budget of 67.5 billion VND. Average cost of one deep well construction and maintain drilling equipment supplied is 150 million VND. The following table shows the plan of deep well construction of CERWASS from 2002 to 2006.

Table 2.19 Plan of Deep Well Construction (CERWASS)

Year	Nos. of Deep Well Construction	Budget for Deep Well Construction (Billion VND)
2002	70	10.5
2003	100	15.0
2004	100	15.0
2005	90	13.5
2006	90	13.5
Total	450	67.5

Construction cost of a deep well (100 m depth) using equipment supplied is estimated at 5,976 US$. The cost is feasible to construct a deep well because the cost stand with in a deep well construction budget of 150 million VND (around 10,200 US$). The following table shows the cost estimation for construction of a deep well by equipment supplied.

Table 2.20 Cost Estimation for Construction of Deep well by Equipment Supplied (Unit：US$)

Items	Fuel & oil	Manpower	Materials (Procured in Vietnam)	Spare parts (Procured in Japan)	Total
Well Drilling Equipment	1,607	150	304 (Oxygen gas, acetylene gas etc.)	2,017 (Drilling bits, spare parts etc.)	4,078
Supporting Equipment	705	63	-	332 (Spare parts)	1,099
Potable Workshop Equipment	-	8	-	162 (Spare parts)	170
Others	-	11	619 (Mud, filter & seal etc.)	-	630
Total	2,312	230	923	2,511	5,976

Note：Estimate condition of deep well construction
- Drilling depth: 100 m, Borehole diameter: 150 mm - 200 mm
- Thickness of stratum: Alluvial deposits: 10 m, Soft rocks: 40 m, Medium rocks: 50 m
- Distance to site from Hanoi: 150 km
- Material cost of tube casing and screen is not included.

(6) Specification and Quantity of the Equipment

1) Countries Manufacturing Equipment

In accordance with suitable specification, the equipment manufacturers located in Japan, Europe, Russia and North America have been studied. Among them, Europe, Russia and North American countries were excluded from procurement, because the cost of transportation would be expensive due to long distance. Therefore manufacturer/s for procurement is selected in Japan.

2) The Principles for Specification of the Equipment

Following condition was considered to decide suitable specification of the equipment.

- Casing diameter is 150 mm to 200 mm in accordance with optimal well yield.
- Drilling method is both mud circulation drilling and air circulation drilling by down-the-hole (DTH) hammer.
- Maximum drilling depth is 150 m by mud circulation drilling and 180 m by air circulation drilling of DTH.
- Drilling diameter is 10-5/8” to 17-1/2” by mud circulation drilling and 10-5/8” by air circulation drilling by DTH.
- Drilling machine and air compressor are mounted on a 4x4 truck.
- Transportation truck for drilling tools is attached to cab-back crane.
- Workshop equipment is portable type which can be carried by a truck

3) Quantities and Specifications

Drilling equipment and supporting equipment are proposed to be supplied by one (1) set each, because the purpose is to construct wells and transfer technology through the well construction work (on-the-job training). However, water tank truck and double cab pick-up truck were excluded from the supply because they can be provided by Vietnamese side without difficulty. Quantities and specifications of the equipment are given in table 2.21.

Table 2.21 Quantity and Specifications of Equipment Supplied

Items		Quantities	Specifications (or equivalent)
I.	**Water Well Drilling Equipment**		
I-1	Water well drilling rig	1 unit	Type: Rotary drilling rig mounted on a truck Drilling method: Direct mud circulation and down-the-hole (DTH) drilling Max. drilling depth: 200 m Drilling diameter of borehole: 17-1/2 to 10-5/8 inches diameter by mud circulation drilling or 10-5/8 inches diameter by DTH drilling
I-2	Drilling tools & accessories	1 unit	Down-The-Hole (DTH) drilling tools: 10-5/8 inches borehole drilling diameter Direct mud circulation drilling tools: 10-5/8 to 17-1/2 inches borehole drilling diameter
I-3	High pressure air compressor	1 unit	Air compressor capacity: Free air delivery : 1,070 cfm (30.3 m3/min) Rated operating pressure : 350 psi (24.6 kgf/cm2)
I-4	Miscellaneous ancillary equipment	1 set	Engine generator: 17 kVA, AC380V Engine welder: 10 kVA, AC380V Submersible pump: 200 liter/min x 15m Oxygen-acetylene cutting and heating equipment: Hand tools kid:
I-5	Air lift equipment	1 set	Capacity: 200m depth
I-6	Spare parts	1 set	For rotary drilling rig: 1 set
II.	**Supporting Equipment**		
II-1	Cab-back crane cargo truck	1 unit	Crane: Hydraulic driven: 6,000 kgf Truck: Payload capacity: Approx. 12,000 kgf Cargo body: All steel plated floor type Cargo space length : More than 6.5 m
II-2	Pumping test equipment	1 set	Submersible pump: 1,000 liter/min x 80 m head Engine generator: 60kVA, AC380V Accessory for pumping test : 1 set
II-3	Well logging equipment	1 set	Normal resistivity, natural gamma and spontaneous module (SP)
II-4	Spare part	1 set	For supporting equipment: 1 set
III.	**Portable workshop equipment**		
III-1	Portable workshop equipment	1 set	Potable workshop equipment: 1 set

Note: Spare part will be prepared for 2 years normal operation.

(7) The Technology Transfer

Technology transfer regarding well drilling work is to be carried out through actual construction work of deep wells in the project. The schedule of the technology transfer will be decided with coordination of time for the supply of the equipment and for construction of facilities.

The technology transfer will be carried out to experts of CERWASS as on-the-job training (OJT). Contents of the technology transfer will include well drilling work (mud circulation method and air method by DTH), well finishing, well logging and pre-pumping test. At the same time, technology of the equipment maintenance will also be transferred. Personel cost for the technology transfer will be provided by the Vietnamese side.

2.4 Implementation Plan

2.4.1 Implementation Concept

The project sites are spread over 3 provinces in areawise, and it will take more than 5 hours by vehicles between the sites located at the ends of the extreme south and north in the project area. The proposed facilities will be consisted of deep wells as water source treatment facilities such as aeration, sedimentation, filtration, sterilization and so on, and distribution facilities such as reservoirs, elevated tanks and distribution pipelines; and they seem comparatively complicated in system.

Since such facilities will be completed within an appropriate period at every site without any hindrances, it is most important to formulate the proper implementation plan.

(1) Project Implementation System.

The project will be implemented by the Japan's Grant Aid Scheme and be definitely executed by the Japanese consulting firm/s and construction contractor/s on the side of Japan.

On the other hand, CERWASS under the MARD is an executing agency on the side of Vietnam and Project Management Unit (PMU) will be organized in CERWASS at the stage of the implementation for the project.

The major items such as administrative approvals and others to be executed by the Vietnamese Government will have to be explained directly to the PMU by the consultant and the contractor in order to implement securely and promptly.

(2) Project Execution System.

It is important and necessary to utilize a local construction companies who have construction experience of the above-mentioned facilities for the project execution; however, it is also indispensable to employ certain engineers or technicians who are familiar with the water supply systems, the operation and maintenance and so on for constructing facilities appropriately.

Therefore, the project implementation plan will be worked out in consideration of the employment of deep well construction engineers, equipment engineers, electric engineers and so on who will be properly dispatched from Japan depending on the progress of the facilities construction.

2.4.2 Implementation Conditions

The items to be particularly considered for the project implementation are described below:

(1) Items to be Considered for Implementation

Though the project area is rural and also most of the beneficiaries are farmers, water wll be supplied mainly to the houses along the National roads or major farm roads in the village urbanized or being urbanized.

In the case of the farm roads, it is expected not so difficult to obtain the approval of utilizing roads for pipe installation, as they are officially and practically maintained by the district or the local maintenance office under the appropriate administrative organization. However, in the case within the right of way for national roads, it is important to obtain the permission/approval of Ministry of Transportation and Communication smoothly and promptly in cooperation with CERWASS and PMU for pipe installation work, since the organization (MOTC) for maintaining national roads is different from MARD.

Executing the above procedure of obtaining the approval from the related organizations concerned for the project is very important. The area where houses and stores stand close together densely along the national roads, there will not be enough space for pipe installation. Therefore it is necessary to discuss fully with organizations concerned and stakeholders beforehand, and based on that, the most suitable countermeasures will have to be taken in order to install pipes without hindrance.

(2) Items to be Considered for Procurement

The project is to be implemented by the Japan's Grant Aid Scheme. The period of implementation, construction period, is limited. In this context, the pipe installation work will be executed in parallel with construction work

of treatment facilities and others.

For this, a procurement period of pumps and system equipment in series from Japan will be very sensitive matter in the treatment facilities construction; then those materials should be timely procured depending on the progress of civil construction works. Therefore, the consultant and the contractor will have to consider not only the procurement of materials in Vietnam but also the period of manufacturing materials for the treatment facilities and importing them from Japan.

Furthermore, as for pipe installation, major materials of PVC pipes and fittings will be procured in Vietnam. However, there is a limitation of pipe production capacity in Vietnam, and the procurement plan will have to made in consideration of the manufacturing capability.

(3) Items to be Considered for Safety Construction

Where pipes are installed on national roads and major farm roads, it is very important to take a proper safety countermeasures against accidents as well as for vehicles and pedestrians.

It was reported in No.2 Dong Bam Commune that, when the pumping test was executed at the test well, water level of a dug well nearby the test well dropped rapidly and also the thin concrete slab at the farmer's house had crackings. From the above, the construction of the proposed deep well will have to be constructed carefully with confirming the land transformation at / around the well. Especially pumping test after construction of the well shall be carefully executed.

2.4.3 Scope of Work

For the implementation of the project under the Grant Aid Scheme of the Government of Japan, the scope of works to be taken by the Governments of Japan and of Vietnam is given in a list.

The Grant Aid Scheme will cover up to the extent of distribution pipelines, but will not include the work of installation of block service pipes to be connected to distribution pipelines, house connection pipes and water meters.

Certain quantity of the block service pipes, the house connection pipes and the water meters will be provided through the Grant Aid, and the following countermeasures will be considered to make the effectiveness of the project.

- The project will be properly implemented with confirming the progress in cooperation with the works to be

taken by the Government of Vietnam. They are installation of block service pipes, house connection pipes and water meters.

- The consistency with the works to be taken by the Government of Vietnam will have to be considered from the beginning of the project.

Table 2.22 List of Scope of Work

Items	By Japan Government	By Vietnam Government
Land acquisition （for wells, treatment facilities, distribution facilities） and its development		√
Access road construction to each facility for construction work		√
Preparation of temporary storage places for construction materials		√
Installation of fence, gate and so on (around wells, treatment facilities, reservoirs and elevated tanks)		√
Electricity wiring up to wells, treatment facilities and distribution facilities with transformers and panels		√
Drainage work for treatment facilities		√
Intake facilities construction, and procurement and installation of intake pumps and related equipment	√	
Treatment facilities construction, and procurement and installation of related apparatus	√	
Distribution facilities construction, and procurement and installation of related equipment	√	
Distribution pipelines construction, and installation of related structures	√	
Acquisition of permission and approval for the above distribution pipelines		√
Procurement and supply of well drilling machinery (Rig)	√	
Material supply of water meters, block service pipes and house connection pipes	√	
Planning, designing, installation and construction for the above pipes		√

2.4.4 Consultant Services

For the project implementation, the consultant will take the following works.

(1) Detailed Design (D/D)

The site investigation for the D/D study will be carried out in consideration of the plan of the B/D study by the

consultant, then the contents of the facilities and its scale and work quantity will be finally decided on the basis of the results of the D/D. Consequently a series of the work, the D/D of the facilities, the review of the budget, implementation plan, and the tender documents preparation for the project will be executed in Japan. Furthermore, the tender documents will be prepared in accordance with the guideline of Japan's Grant Aid Scheme.

(2) Assistance for Tendering and Contract for Construction Work

The consultant will execute the tender notice, pre-qualification, delivering the tender documents, explanation of the tender, endering and its evaluation in series and in accordance with the above guideline on behalf of CERWASS, and then assist CERWASS to make the contract for construction work for the project with the Japanese contractor.

(3) Construction Supervision

a) Supervision Work

The consultant will be engaged in approving the drawings and documents to be submitted by the construction contractor and instructing the contractor based on the judgment as well as confirming and inspecting the major materials, inspecting the work quantity and quality, the progress of construction and operation of pumps and system equipment etc. Then the consultant will report the progress of the project to CERWASS of Vietnam and the consultant will be in charge of inspecting the project completion and turning the facilities of the project over to the Government of Vietnam.

Besides, the consultant will assist CERWASS to take care of the request of payment from the contractor for the work completion. As for the works to the Government of Japan, the consultant will inform the progress of the project, the situation of payment and be in charge to assist the evaluation of the necessary procedures for turning the facilities over to the Government of Vietnam.

b) Supervision System

Construction supervision will be continuously undertaken from the commencement of the construction work to turning over the facilities. For this purpose, the resident supervision work will be required, and one in-charge will be fully assigned through whole construction period. Since the project consists of rather complicated facilities, the following engineers and experts will be properly assigned to retain the implementation schedule.

Engineers/Experts and Their Assignment:

- Project Manager: Arrangement of the project commencement, inspection at the middle stage and works for the project completion
- Resident civil engineer: Supervision throughout the project and management of the project including reporting to the organizations concerned
- Facilities Engineer: Supervision of facilities （civil structure construction）
- Facilities Engineer: Supervision of facilities equipment （equipment system/ electricity）
- Mechanical Engineer: Procurement of equipment and supervision of installation of facilities
- Well Engineer: Supervision of well construction

2.4.5 Procurement Plan

(1) Procurement of Materials Equipment

Materials and equipment necessary for the project will be procured in either Vietnam or Japan. The Japanese contractor will procure such materials and equipment under the supervision of the consultant. Materials of cement, steel bars, aggregate, PVC pipes and so on being obtainable within Vietnam will be procured in Vietnam; and well drilling machinery (Rig) and pumps and equipment in series operation system for the intake facilities, treatment facilities and distribution facilities will be procured from Japan.

(2) Construction Equipment

Basically, machines and equipment for construction works will be procured locally in Vietnam.

(3) Material/Equipment Procurement Plan

The procurement plan of materials and equipment with the specification and place of the procurement is shown in table 2.23.

2.4.6 Implementation Schedule

The project sites are spread over 3 provinces and the sites lie scattered in areawise. In order to execute the project in accordance with the implementation plan as scheduled, suitable employment of work force and effectiveness of equipment will have to be undertaken.

Rather tight implementation time schedule is anticipated to construct the intake facilities, treatment facilities and distribution facilities without delay, the installation work of distribution pipelines will have to be proceeded simultaneously with the above facilities' construction. Then finally those works have to be connected each other to make the function of complete water supply system.

Table 2.23 Procurement Plan of Material and Equipment

Item	Specification	Place of Procurement		
		Vietnam	Japan	Third Country
Material				
• Cement		√		
• Aggregate（Stone・Sand）		√		
• Steel Bar		√		
• Form		√		
• Brick		√		
• Asphalt		√		
Fuel				
• Diesel		√		
• Petroleum		√		
Steel Material.				
• H-shape/ Channel			√	
• L-shape		√		
Pipes & Fittings				
• PVC Pipe		√		
• PE Pipe		√		
• Steel Pipe	Aqueduct crossing	√		√
• FRP Pipe	Screen for wells and casing		√	
• Branch-tee	Block service pipes	√		
• Concrete Pipe		√		
• Valve		√		
• Water Meter		√		
Treatment Facilities				
• Treatment Equipment	Aeration apparatus etc.		√	
• Electric equipment	Switch board, Control Panel etc.			√
• Filter	Manganese sand, Anthracite		√	
• Filter	Sand, Gravel	√		
Pumps				
• Submersible pump	For deep well		√	
• Pumps for Facilities	At drain pit		√	
• Distribution pump	To elevated tank/ reservoir		√	
Well Drilling Machinery (Rig) and Supporting Equipment			√	

Intake facilities, treatment facilities, elevated tanks and reservoirs, will be constructed. For that, the work of piling foundation will be required depending on the geological condition at the sites, and it will be also rather troublesome that a number of pipelines will be installed along the national roads.

The equipment and apparatus and its fittings will be mainly manufactured in Japan and consecutively transported to Vietnam. Therefore, it is necessary to consider the period of transportation from Japan to Vietnam; and then

domestic transportation in Vietnam after the custom clearance.

Implementation plan and time schedule for the project is shown in the following page. The project is to be implemented in three stages. The First Stage is composed of the supply of well drilling machinery and construction of water supply systems in No.5 Dong Phong, No.6 Quang Son, No.7 Yen Thang and No.11 Van Ha (Thieu Hung); and the Second Stage of construction in No.1 Hoa Thuong, No.2 Dong Bam, No.3 Thinh Duc and No.4 Nam Tien, and the Third Stage of construction in Nos.8&9 Vinh Thanh & Vinh Loc, No.10 Dinh Tuong and No.13 Van Thang.

The each stage will require 12 months for the project implementation including the detail design period; thus the whole project of the three stages will take 36 months in total for completion.

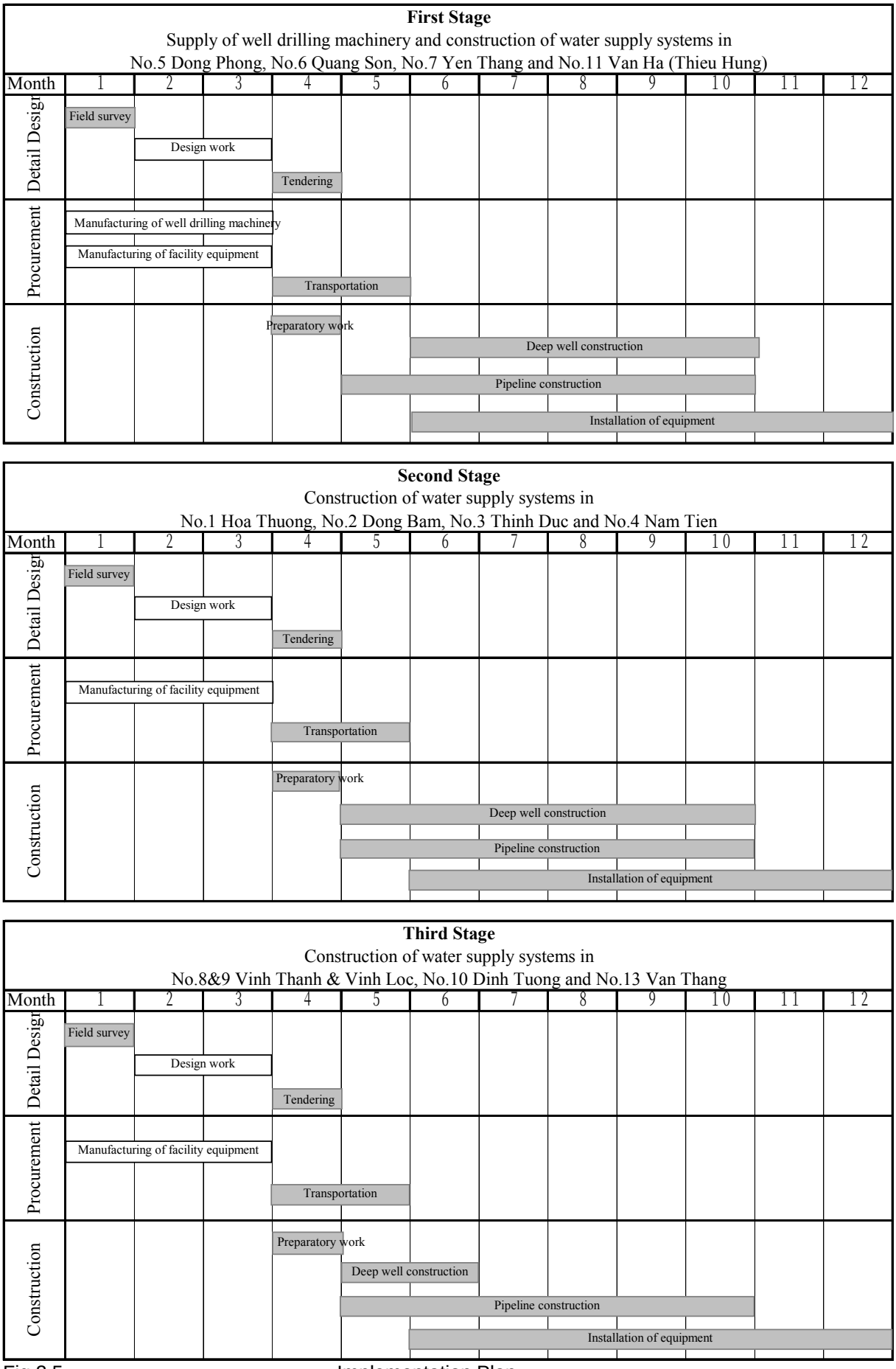


Fig.2.5 Implementation Plan