4－4 Appendix 4 Minutes of Discussions & Technical Notes

MINUTES OF DISCUSSIONS
ON THE BASIC DESIGN STUDY ON THE PROJECT
FOR IMPROVEMENT
OF WATER SUPPLY FACILITIES IN URBAN AND SEMI-URBAN CENTRES
IN THE KINGDOM OF NEPAL

Based on the results of the Development Study, the Government of Japan decided to conduct a Basic Design Study on THE PROJECT FOR IMPROVEMENT OF WATER SUPPLY FACILITIES IN URBAN AND SEMI-URBAN CENTRES (hereinafter referred to as "the Project") and entrusted the study to the Japan International Cooperation Agency (hereinafter referred to as "JICA").

JICA sent to the Kingdom of Nepal (hereinafter referred to as " Nepal ") the Basic Design Study Team (hereinafter referred to as "the Team"), which is headed by Yoshio Fukuda, Team Director, Water Resources Development and Environmental Management Team, Project Management Group Ⅲ, Grant Aid Management Department, JICA , and is scheduled to stay in the country from June 12 to July 9, 2005.

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

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

Kathmandu, June 15, 2005

Mr. FUKUDA, Yoshio
Leader
Basic Design Study Team
Japan International Cooperation Agency
Japan

Mr. Poorna Das Shrestha
Joint Secretary
Ministry of Physical Planning & Works
Nepal

Mr. Hari Ram Koirala
Director General
Department of Water Supply and Sewerage
Ministry of Physical Planning & Works
Nepal

Mr. D. K. Bajimaya
General Manager
Nepal Water Supply Corporation
Ministry of Physical Planning & Works
Nepal

ATTACHMENT

1. Objective of the Project

The objective of the Project is to improve water supply situations in some Urban and Semi-urban Centres of Nepal in order to upgrade living standards of inhabitants, through the rehabilitation and expansion of water supply facilities

2. Project sites

The sites of the Project are Dhulabari, Gauradaha of Jhapa District and Mangadh of Morang District for Phase-1, Manthali of Ramechhap District, Besisahar of Lamjung District, Bhimeshwor of Dolkha District, Beljhundi of Dang District and Nepalgunj of Banke District for Phase-2 shown in Annex-I.

3. Responsible and Implementing Agencies

3-1.The Responsible Agency is the Ministry of Physical Planning & Works (MPPW) in Nepal.

3-2.The Implementing Agencies are the Department of Water Supply and Sewerage (DWSS) and Nepal Water Supply Corporation (NWSC).

4. Items requested by the Nepal side

After discussions with the Team, the items described in Annex-II were finally requested by the Nepal side. JICA will assess the appropriateness of the request and will recommend to the Government of Japan for approval.

5. Japan's Grant Aid Scheme

5-1. Nepal side understood the Japan's Grant Aid Scheme explained by the Team, as described in Annex-III.

5-2. Nepal side will take necessary measures, as described in the Table of Annex-III, for smooth implementation of the Project, as a condition for the Japanese Grant Aid to be implemented.

6. Schedule of the Study

6-1. The consultants will proceed to further studies in Nepal until July 9, 2005 for Phase-1 and from September to October 2005 for Phase-2.

6-2. JICA will prepare the draft report in English and dispatch a mission in order to explain its contents to Nepal side in September 2005 for Phase-1 and in February 2006 for Phase-2.

6-3. In case that the contents of the report are accepted in principle by the Government of Nepal, JICA will complete the final report and send it to the Government of Nepal by May 2006.

7. Other relevant issues

7-1 Both sides agreed that the Basic Design Study will be implemented in phases; Phase 1 and Phase 2.

7-2 Both sides agreed to implement the Basic Design Study taking into consideration that existing facilities will be fully utilized as long as they function.

7-3 Both sides agreed that Japanese side will include the extent of main distribution line as for distribution line to be constructed in the Project and Nepal side will construct other distribution line including house connection.

7-4 Japanese side explained security confirmation will be done before Phase-2 study and it is likely that some project site(s) might be dropped due to security reasons.
Nepal side strongly requested other site(s) covered in the Development Study will be studied as alternative(s) in phase-2.

7-5. Japanese side explained and Nepalese side understood that all project sites covered by the Basic Design Study might not be included in the scope of Japanese Grant Aid Project on the basis of Japanese side situation.

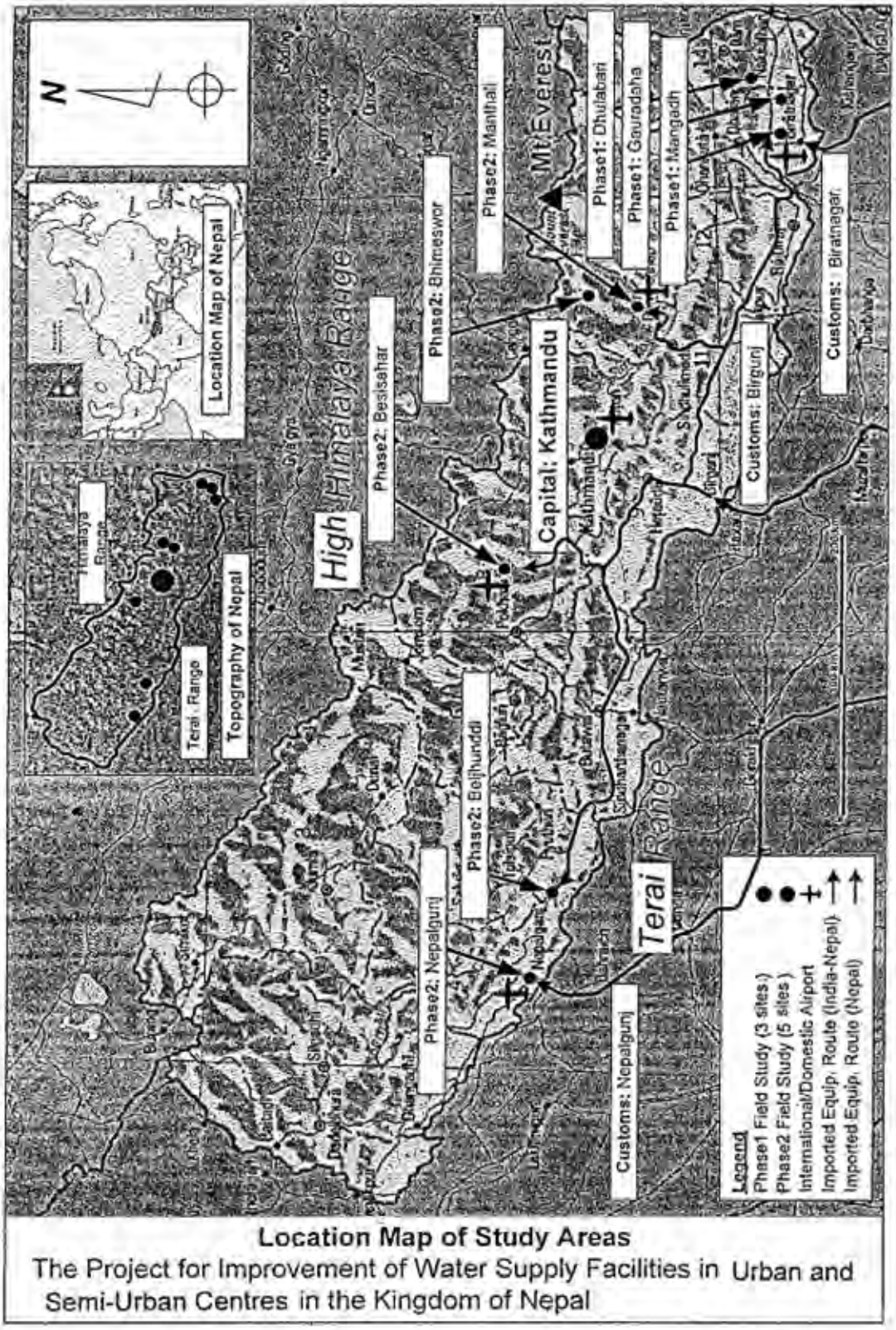
7-6. Both sides agreed that project implementation structure shown in Annex-IV will be set up for smooth implementation of the Project.

7-7. Nepalese side explained that Implementing Agencies will conduct IEE, wherever required, but EIA study is not required in the Project.

7-8. Both sides agreed to set year 2014 as target design year for the Project.

7-9. Nepalese side requested technical support including soft component and training in Japan for the purpose to attain the objective of the Project.

ANNEX- I Location of Project sites



Location Map of Study Areas
The Project for Improvement of Water Supply Facilities in Urban and Semi-Urban Centres in the Kingdom of Nepal

A-1

ANNEX- II ITEMS REQUESTED BY RECIPIENT SIDE

Contents of request on rehabilitation and construction of water supply systems by HMG/N are as follows:

Phase 1

Item	Dhulabari	Gauradaha	Mangadh
Intake Facility	Spring Intake Weir Type: 1 unit	-	-
Transmission Main Pipeline	HDPE: 10km	-	-
Water Treatment Plant	Conventional System	Iron Removal Plant	Iron Removal Plant
Clear Water Reservoir	500 m^3 x 1 basin	300 m^3 x 1 basin	300 m^3 x 1 basin
Chlorination Unit	1 unit	1 unit	1 unit
Service Reservoir	450 m^3 x 1 basin	-	-
Distribution Pipeline	DI, GI : 9 km	HDPE : 6km	-
Water Meter	4 units	2 units	2 units

Phase 2

Item		Manthali	Besisahar	Bhimeshwor	Beljhundi	Nepalgunj
Intake Facility	Spring	—	Weir: 1 unit	—	—	—
	Surface Water	Weir : 1 unit	Improvement of One Weir	Weir: 2 units	Weir: 5 units	—
	Well	—	—	—	—	Well: 2 units
Transmission Main Pipeline		HDPE: 5.35km	DI,GI: 2.3 km	HDPE,DI: 22 km	DI: 12.8km	DI: 7.4km
Water Treatment Plant		Conventional System	Conventional System	Conventional System	Conventional System	—
Chlorination Unit		1 unit	1 units	1unit	1unit	1unit
Service Reservoir		200m^3x 1 basin	—	4 basin 75, 18, 16, 8m^3	500m^3 x 1 basin	450m^3×2 basin 250m^3×1 basin
Distribution Pipeline		HDPE: 3.0km	DI: 9.0km	HDPE,GI: 18.0km	DI: 11.0km	DI,GI: 20.0km
Water Meter		3 units	—	4 units	5 units	5 units

ANNEX-Ⅲ JAPAN'S GRANT AID

1 JAPAN'S GRANT AID SCHEME

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

1.1 Grant Aid Procedures

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

- **Application** : Request made by a recipient country
- **Study** : Basic Design Study conducted by JICA
- **Appraisal and Approval** : Appraisal by the Government of Japan and Approval by Cabinet
- **Determination of Implementation** : The Notes exchanged between the Governments of Japan and the recipient country

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

Secondly, JICA conducts the study (hereinafter referred to as "Basic Design Study"), using (a) Japanese consulting firm(s).

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

Fourthly, the project, once approved by the Cabinet, becomes official with the Exchange of Notes (hereinafter referred to as "E/N") signed by GOJ and the recipient country.

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

1.2 Basic Design Study

(1) Contents of the Study

The aim of the Study, conducted by JICA on a requested Project (hereinafter referred to as "the Project") is to provide a basic document necessary for the appraisal of the Project by GOJ. The contents of the Study are as follows:

- Confirmation of the background, objectives, and benefits of the requested Project and also institutional capacity of agencies concerned of the recipient country necessary for the Project's implementation;
- Evaluation of the appropriateness of the Project to be implemented under the Grant Aid Scheme from a technical, social and economic point of view;
- Confirmation of items agreed upon by both parties concerning the basic concept of the Project;
- Preparation of a Basic Design of the Project; and
- Cost Estimating of the Project

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

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

(2) Selection of Consultants

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

The consulting firm(s) used for the Study is (are) recommended by JICA to

the recipient country to also work on the Project's implementation after E/N, in order to maintain technical consistency.

1.3 Japan's Grant Aid Scheme

(1) Exchange of Notes (E/N)

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

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

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

(3) Under the Grant Aid Scheme, in principle, Japanese products and services including transportation or those of the recipient country are to be purchased.

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

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

(4) Necessity of "Verification"

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

(5) Undertaking required to the Government of Recipient Country

In the implementation of the Grant Aid project, the recipient country is required to undertake various necessary measures as per the following:

① To secure land necessary for the sites of the Project and to clear, level and reclaim the land prior to commencement of the construction;
② To provide facilities for the distribution of electricity, water supply and drainage and other incidental facilities in and around the sites;
③ To secure buildings prior to the procurement in case the installation of the equipment;
④ To ensure all expenses and prompt execution for unloading, customs clearance at the port of disembarkation and internal transportation of the products purchased under the Grant Aid;
⑤ To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which will be imposed in the recipient country with respect to the supply of the products and services under the Verified Contracts; and
⑥ To accord what Japanese nationals, whose services may be required in connection with the supply of products and services under the Verified Contracts. Such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work.

(6) "Proper Use"

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

(7) "Re-export"

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

(8) Banking Arrangements (B/A)

① The Government of the recipient country or its designated authority should open an account in the name of the Government of the recipient country in a bank in Japan (hereinafter referred to as "the Bank"). GOJ will execute the Grant Aid by making payments in

Japanese yen to cover the obligations incurred by the Government of the recipient country or its designated authority under the Verified Contracts; and

② The payments will be made when payment requests are presented by the Bank to GOJ under an Authorization to Pay (A/P) issued by the Government of the recipient country or its designated authority.

(9) Authorization to Pay (A/P)

The Government of the recipient country should bear an advising commission of an Authorization to Pay (A/P) and payment commissions to the Bank.

2 GRANT AID PROCEDURES

Following Table shows "MAJOR UNDERTAKINGS TO BE TAKEN BY EACH GOVERNMENT" and Figure indicates "FLOW CHART OF JAPAN'S GRANT AID PROCEDURES", respectively.

TABLE MAJOR UNDERTAKINGS TO BE TAKEN BY EACH GOVERNMENT

No.	Items	To be covered by Grant Aid	To be covered by Recipient Side
1	To secure land		●
2	To clear, level and reclaim the site when needed		●
3	To construct gates and fences in and around the site		●
4	To construct the parking lot	●	
5	To construct roads		
	1) Within the site	●	
	2) Outside the site		●
6	To construct the building	●	
7	To provide facilities for the distribution of electricity, water supply, drainage and other incidental facilities		
	Electricity		
	1) a. The distributing line to the site		●
	1) b. The drop wiring and internal wiring within the site	●	
	1) c. The main circuit breaker and transformer	●	
	Water Supply		
	2) a. The city water distribution main to the site		●
	2) b. The supply system within the site (receiving and elevated tanks)	●	
	Drainage		
	3) a. The city drainage main (for storm sewer and others to the site)		●
	3) b. The drainage system (for toilet sewer, ordinary waste, storm drainage and others) within the site	●	
	Gas Supply		
	4) a. The city gas main to the site		●
	4) b. The gas supply system within the site	●	
	Telephone System		
	5) a. The telephone trunk line to the main distribution frame/panel (MDF) for the building		●
	5) b. The MDF and the extension after the frame/panel	●	
	Furniture and Equipment		
	6) a. General furniture		●
	6) b. Project equipment	●	
8	To bear the following commissions to the Japanese bank for banking service based upon the B/A		
	1) Advising commission of A/P		●
	2) Payment commission		●
9	To ensure unloading and customs clearance at port of disembarkation in recipient country		
	1) Marine (Air) transportation of the products from Japan to the recipient	●	
	2) Tax exemption and custom clearance of the products at the port of disembarkation		●
	3) Internal transportation from the port of disembarkation to the project site	(●)	(●)
10	To accord Japanese nationals, whose service may be required in connection with the supply of the products and the services under the verified contract, such facilities as may be necessary for their entry into the recipient country and stay therein for the performance of their work		●
11	To exempt Japanese nationals from customs duties, internal taxes and other fiscal levies which may be imposed in the recipient country with respect to the supply of the products and services under the verified contracts		●
12	To maintain and use properly and effectively the facilities contracted and equipment provided under the Grant		●
13	To bear all the expenses, other than those to be borne by the Grant, necessary for construction of the facilities as well as for the transportation and installation of the equipment		●

Remarks B/A: Banking Arrangement, A/P: Authorization to Pay

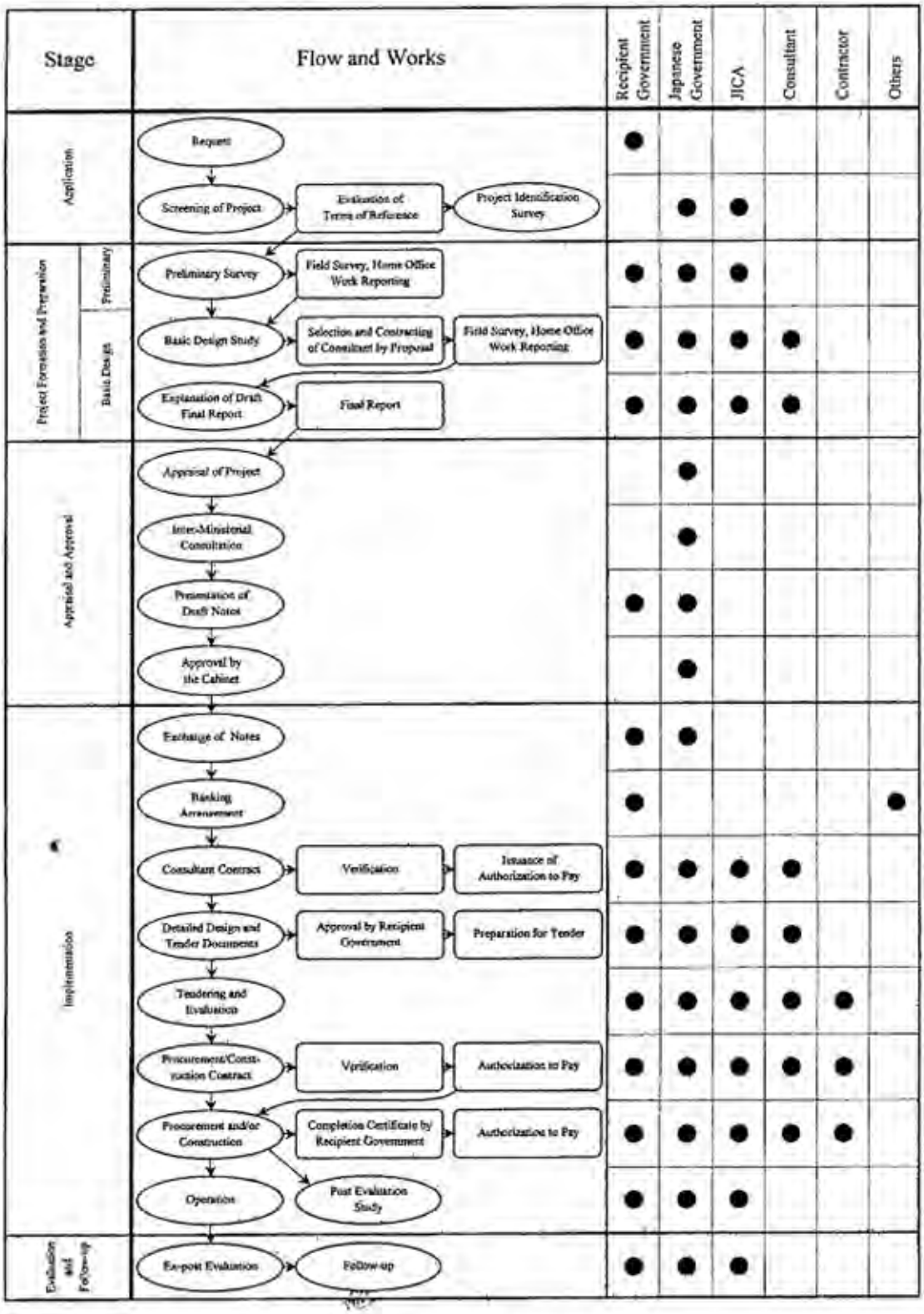


FIGURE FLOWCHART OF JAPAN'S GRANT AID PROCEDURES

ANNEX-IV

PROJECT IMPLEMENTATION STRUCTURE (TECHNICAL)

The following arrangement for the Project Implementation has been proposed:

a) Constitute a Steering Committee with broad representatives of the stakeholders.
b) Establish Project office at District level to look after each site in the area.
c) Constitute coordination committee at local level in each candidate site with broad representation of local government and bodies.

a) Steering Committee at Central Level

A Project Steering Committee (PSC) at the central level will be formed under MPPW. It will have the following representation.

- Ministry of Physical Planning and Works (MPPW), Secretary - Chair
- Joint Secretary, Water Supply and Sanitation Division, MPPW - Member
- Ministry of Health (MoH), Representative - Member
- Ministry of Finance (MOF), Representative - Member
- Ministry of Local Development (MLD), Representative - Member
- Department of Water Supply and Sewerage (DWSS), DG - Member Secretary
- Nepal Water Supply Corporation (NWSC), GM - Member Secretary
- JICA - Member

The roles and responsibilities of the Steering Committee will be to:

- Integrate and internalize the Japanese Grant Aid Project to national plan and policy.
- Coordinate among the ministries.
- Make decision regarding important issues submitted by the Project Office.
- Negotiation with donor agencies and obtain resources in time for the project.
- Overall monitoring and evaluation of the project implementation activities.
- Approve disbursement of funds and other resources for the project.
- Facilitate improvement activities relating to institutional, social and financial component of the project.
- Arrangement for land acquisition
- Meeting will be held once in two month and when required.

b) Project Office

Project Office will be established in the location at District/Municipality level for the execution of the project. The officers at least of gazetted class II and equivalent from DWSS or NWSC will be deployed in such offices as project managers. The roles and responsibility of these offices will be as follows:

- Prepare project related document and obtain its approval within the given time frame.
- Obtain approval from concerned agencies such as DOR, DDC and DOF for pipe laying, other construction works and water rights.
- Coordinate with the local level offices and Local Government.
- Capacity building of concerned stakeholders of candidate sites.
- Ensure for land acquisition
- Quality control and construction supervision of civil works
- Review and approve the work plan.
- Implement improvement activities relating to institutional, social and financial component of the project.
- Monthly Progress Meeting will be held.

c) Coordination Committee at Project level

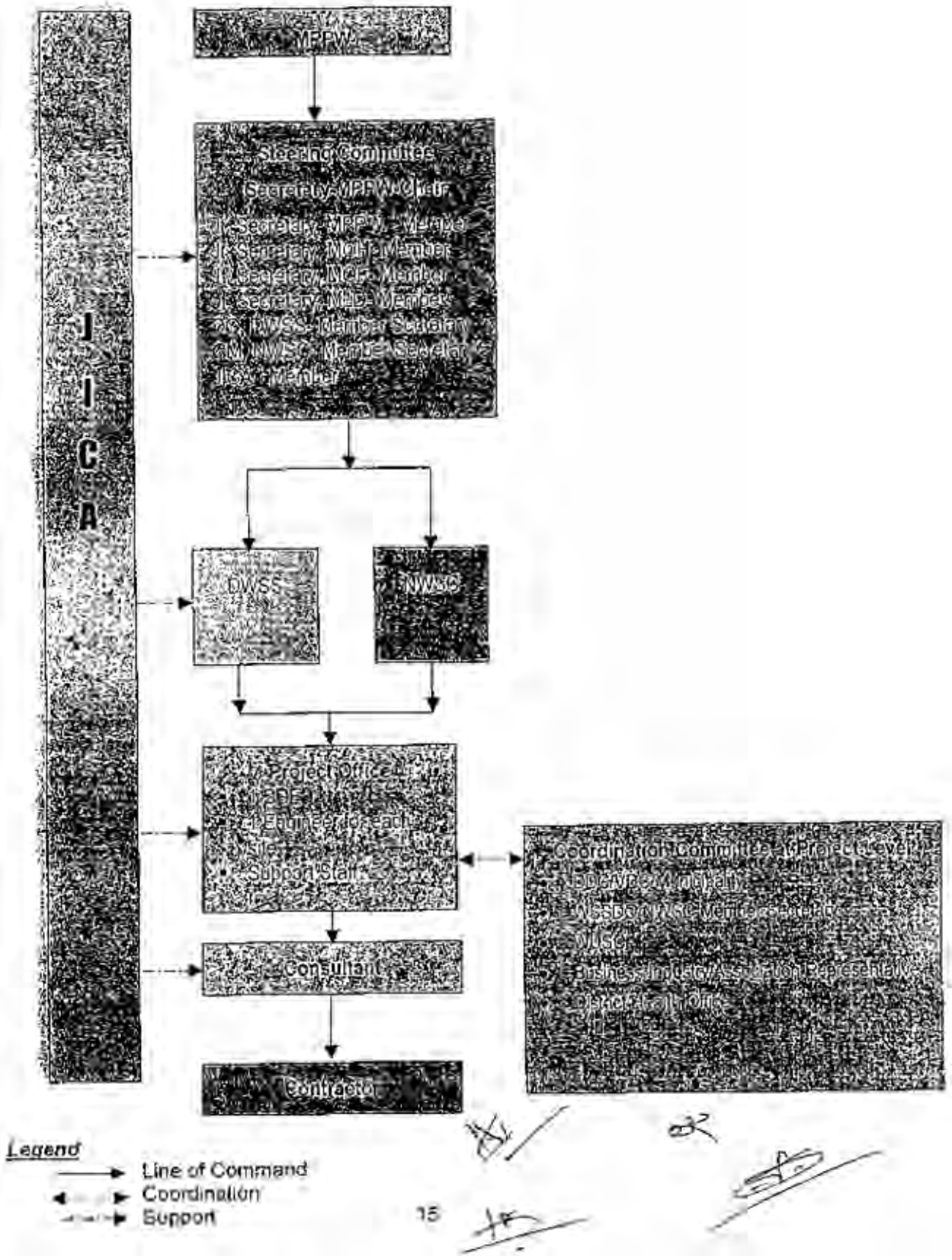
A Coordination Committee at project level will be constituted to facilitate the implementation of the project. The structure of the committee will be as presented below:

- DDC/Municipality / VDC
- WSSDO/NWSC (whichever applicable)- Member Secretary
- WUSC
- Representation from Business/Industry/Association
- District Health Office

The roles of such committees will be as follows:

- Advisory activities
- Facilitate project implementation works at the project level.
- Coordination/ networking
- Lobbying with the government when necessary

Proposed Project Implementation Structure (Technical)



MINUTES OF DISCUSSIONS
ON THE BASIC DESIGN STUDY
ON THE PROJECT FOR THE IMPROVEMENT
OF WATER SUPPLY FACILITIES IN URBAN AND SEMI-URBAN CENTRES
IN THE KINGDOM OF NEPAL
(EXPLANATION ON DRAFT REPORT FOR PHASE-1)

In June 2005, the Japan International Cooperation Agency (hereinafter referred to as "JICA") dispatched the Basic Design Study Team on THE PROJECT FOR THE IMPROVEMENT OF WATER SUPPLY FACILITIES IN URBAN AND SEMI-URBAN CENTRES (hereinafter referred to as "the Project") to the Kingdom of Nepal (hereinafter referred to as "Nepal", and through discussion, field survey, and technical examination of the results in Japan, JICA prepared a draft report of the study for Phase-1.

In order to explain and to consult with the Nepalese side on the contents of the draft report for Phase-1, the Draft Report Explanation Team (hereinafter referred to as " the Team "), which is headed by Mr. Shinji Yoshiura, Resident Representative of JICA Nepal Office, had a series of discussions from September 12th to September 15th, 2005.

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

Kathmandu, September 15, 2005

Shinji Yoshiura
Leader
Draft Report Explanation Team
Japan

Mr. Madan Gopal Maleku
Joint Secretary
Ministry of Physical Planning & Works and Works
Nepal

Mr. Hari Ram Koirala
Director General
Department of Water Supply and Sewerage
Nepal

Witnessed by:

Mr. Mani Kumar Uprety
Chairman
Dhulabari Water Users and Sanitation Committee
Jhapa District
Nepal

Mr. Padma Raj Dahal
Chairman
Gauradaha Water Users and Sanitation Committee
Jhapa District
Nepal

Mr. Ram Bahadur Ghimire
Chairman
Mangadh Water Users and Sanitation Committee
Morang District
Nepal

ATTACHMENT

1. Contents of the Draft Report

His Majesty's Government of Nepal (HMG/N) agreed and accepted the draft report explained by the Team. The component of the Project Phase-1 is summarized in the Annex.

2. Japanese Grant Aid Scheme

The Nepalese side understood the Japanese Grant Aid Scheme and the necessary measures to be taken by HMG/N as explained by the Team and described in the Minutes of Discussions signed by both sides on June 15, 2005.

3. Schedule of the Basic Design Study

JICA will complete the final report in accordance with the items agreed by both sides and send it to HMG/N by May 2006.

4. Other Relevant Issues

4-1. Obligation and Budgetary Arrangement of the Nepalese Side

The Nepalese side agreed to be responsible for the following items and to make necessary budgetary arrangement such as;

(1) To secure the land for the proposed water treatment plant sites and the raw water / transmission / distribution pipelines before commencement of the construction works.

(2) To construct gates and fences in and around the proposed project sites for the intake facility and the water treatment plant.

(3) To provide the electricity distribution lines to the proposed water treatment plant sites.

(4) To assign the personnel required for the operation and maintenance of the proposed water supply facilities before the completion of the Project.

(5) To clear the taxes, custom duties and other levies imposed by HMG/N.

4-2. Soft Component (Technical Assistance)

The Team explained the plan of technical assistance for the following objectives;

(1) To ensure the sustainable operation and maintenance of the proposed water supply facilities.

(2) To support for institutional development of Water User's and Sanitation Committee (WUSC).

The Nepalese side agreed to allocate necessary budget and to assign the proper personnel in WUSC and DWSS, in order to secure this assistance.

4-3. Revision of Water Tariff

The Nepalese side agreed to revise the water tariff to operate and maintain the proposed water supply systems appropriately.

4-4. Security Control and Risk Management

The Nepalese side agreed to take the responsibility for the security of the concerned parties including the risk management of any issues related to the Project during the implementation of the Project and to do their best to solve any problems encountered for ensuring smooth implementation of the Project.

4-5. Modification of the Project Title

By addition of "THE" in front of IMPROVEMENT", the Project Title is modified as shown below,

"THE PROJECT FOR THE IMPROVEMENT OF WATER SUPPLY FACILITIES IN URBAN AND SEMI-URBAN CENTRES IN THE KINGDOM OF NEPAL"

4-6. Environmental Impact Assessment (EIA)

The Team confirmed to DWSS that EIA is not necessary, but IEE for this Project will be conducted by the Nepalese side, if necessary.

4-7. Water right at the water intake site in Shantinagar VDC (Dhulabari)

The Team confirmed that WUSC has the permission to use the water to meet the design flow rate from the Shantinagar VDC at the designated site.

Annex The Proposed Components of Project

Site	Items	Q'ty
Dhulabari	**1. Construction**	
	a. Intake Facility	1
	b. Water Treatment Plant (4,326 m^3/day)	
	Treatment Plant (Slow Sand Filter System)	1
	Clear Water Reservoir (600m^3)	1
	Chlorination Unit	1
	c. Service Reservoir (450m^3)	1
	d. Generator Facility (for Well Facility)	1
	e. Chlorination Unit (for Well Facility)	1
	f. Raw Water and Transmission Pipeline	Approx. 11.8 km
	g. Distribution Pipes	Approx. 6.7 km
	h. Water Meter	4
	2.Soft Component	
	a. Technical Support for water supply facility operation and maintenance	
	b. Support for institutional development of WUSC	
Gauradaha	**1. Construction**	
	a. Water Treatment Plant (1,100m^3/day)	
	Iron Removal Plant	1
	Clear Water Reservoir (300m^3)	1
	Lift Pump	2
	Generator Facility	1
	Chlorination Unit	1
	b. Distribution Pipeline	Approx. 6.1km
	c. Water Meter	2
	2.Soft Component Program for WUSC	
	a. Technical Support for water supply facility operation and maintenance	
	b. Support for institutional development of WUSC	
Mangadh	**1. Construction**	
	a. Water Treatment Plant (2,200m^3/day)	
	Iron Removal Plant	1
	Clear Water Reservoir (300m^3)	1
	Lift Pump	2
	Generator Facility	1
	Chlorination Unit	1
	b. Water Meter	2
	2.Soft Component Program for WUSC	
	a. Technical Support for water supply facility operation and maintenance	
	b. Support for institutional development of WUSC	

TECHNICAL NOTE

ON THE BASIC DESIGN STUDY ON THE PROJECT
FOR INPROVEMENT
OF WATER SUPPLY FACILITIES IN URBAN AND SEMI-URBAN CENTERS
IN THE KINGDOM OF NEPAL
(DHULABARI, GAURADAHA)

AGREED UPON BETWEEN
DEPARTMENT OF WATER SUPPLY AND SEWERAGE
AND
JICA STUDY TEAM

BHADRAPUR,JUNE 28,2005

藤原廣輝

Mr. FUJIWARA,Hiroki
Chief Consultant
Basic Design Study Team
Japan International Cooperation Agency
Japan

Mr. Janak K. Adhikari
Division Chief, Jhapa
Water Supply and Sanitation Division Office
Department of Water Supply and Sewerage
Ministry of Physical Planning & Works
Nepal

After a series of discussions during the field survey in Dhulabari and Gaudaraha from June 16 through June 28, 2005, the following points were agreed between the Water Supply and Sanitation Division Office (WSSDO, Jhapa), Water Users and Sanitation Committee (WUSC, Dhulabari and Gaudaraha), Nepal and the JICA Study Team (Team). Based on the agreement, the Team will further analyze the results of field survey in consultation with JICA and concerned parties in Japan and will prepare a draft final report which includes the layout and design of facilities and/or equipment for the project.

I . DHULABARI

1.Basic Concept of the Water Supply Planning

(1) Target year:	2014
(2) Service area:	Dhulabari Word No.1,2,3,4,5,6
(3) Population:	Approx. 37,900 people in Service area in 2014
(4) % of population served:	85%
(5) Water demand criteria:	Based on DWSS Guidelines
(6) Water demand:	Approx. 4,700 m3/day (daily maximum) in 2014

2. Facilities Planning

(1) Intake Facility

Existing intake facility can not collect the spring water effectively. Therefore, the Team propose that the existing facility will be reconstructed in order to increase the intake water quantity. Furthermore, the new well under construction by DWSS will be used in dry season which lacks the intake water quantity. However, even in this case, it is supposed to lack some water quantity.

Result of flow measurement for intake water by the Team at June 24, 2005 was approx. 1,000 m3/day.

(2) Transmission Pipeline

Route: The new additional transmission pipeline will be installed in parallel with the existing pipeline in principle.

River crossing: The Team recommend under river-bed crossing of proposed transmission pipeline instead of the requested overhead bridge. The under river-bed crossing is to be made at right angles with the river. The crossing pipe will be protected by concrete and gabion.

(3) Water Treatment Plant

The requested treatment facility is conventional system. However, in order to reduce operation and maintenance cost, the Team recommend the Slow Sand Filter System (ANNEX- I -5) that does not require coagulant chemical and minimized electrical power.

(4) Service Reservoir (Elevated Tank)

The new elevated tank will be constructed in the inside of WUSC Office area that is near by the center area of the town. The tank material will be FRP (or GRP) or Steel Panel.

(5) Distribution Pipelines

Japanese side will extend main distribution lines for distribution network improvement in this Project and Nepal side will construct other distribution lines including house connections.

(ANNEX- I -6)

(6) Water Meter

Water meters will be equipped on the inlet and outlet of the treatment plant, and outlet lines of the elevated tanks.

3. Scope of Work of the Japanese Grant Aid (Tentative)

The component is summarized in ANNEX- I -2.

If iron contents of discharged water form the new well is high, the addition of iron removal plant is conceivable necessity.

4.Land Acquisition

The site for water treatment plant is the private land at present. WSSDO/WUSC assured that the necessary land will be acquired by them when Japanese side decides to implement this Project.

5. Equipment

Equipment for pipe maintenance work and water quality analysis is requested by WSSDO/WUSC. The items are as follows;

a. Pipe cutter, Torque wrench, etc.
b. Turbidimeter, pH meter, Residual chlorine analyzer

6. House Connection

House connection with water meter has been made by WUSC and approx.1,300 households have been connected by WUSC at present. WUSC has enough ability to conduct house connection and other piping works.

7. Obligations of Nepal Side

DWSS/WSSDO/WUSC will undertake the land acquisition, fencing, power supply, etc. according to the Minute of Discussions signed on June 15, 2005.

8. Standards

Industrial Standards applied to the Project are Nepal Industrial Standards for local products and Japanese Standards including JIS, JWWA and other internationally accepted standards such as ISO, IEC, ASTEM, BS, DIN for imported goods.

9. EIA

The Team confirmed to DWSS/WSSDO that IEE for this project will be conducted by Nepal Side, if necessary. EIA is not necessary.

10. Soft Component

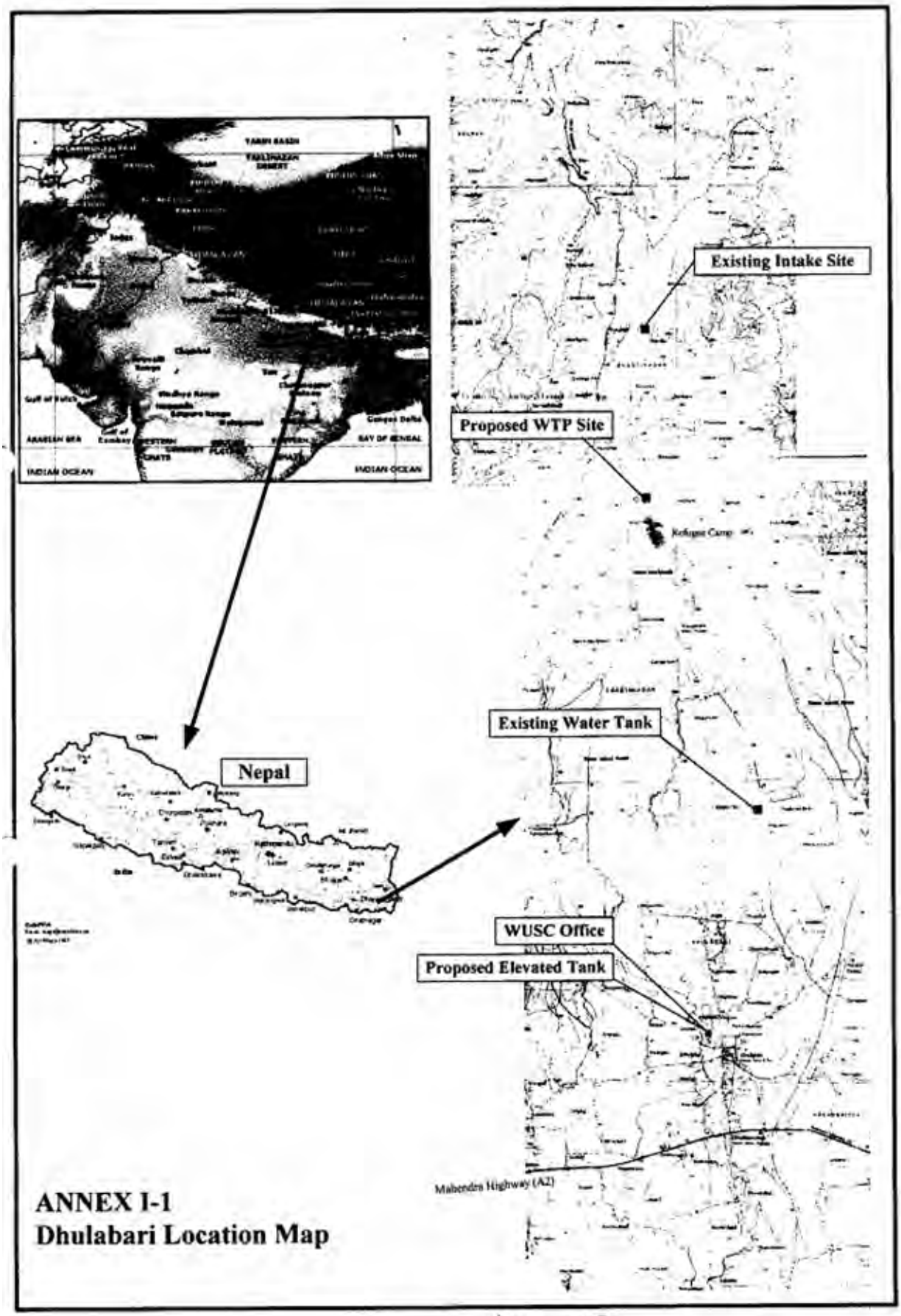
The necessity of following fields of soft component was recognized.

a. Operation and maintenance of Water Supply Facilities related with the Technical Assistance Program for the new water treatment plant.
b. Organization development.

11. Water right to intake water

The Team confirmed that WUSC has the permission to intake water from the Santinagar VDC at designated site.

ANNEX- I -1 Location Map for Dhulabari
ANNEX- I -2 Scope of work of the Japanese Grant Aid in Dhulabari
ANNEX- I -3 Service Area in Dhulabari
ANNEX- I -4 Dhulabari Water Supply System Schematic Diagram
ANNEX- I -5 Dhulabari Water Treatment Process Flow Diagram
ANNEX- I -6 Proposed Transmission and Distribution Pipeline Plan in Dhulabari



ANNEX I-1
Dhulabari Location Map

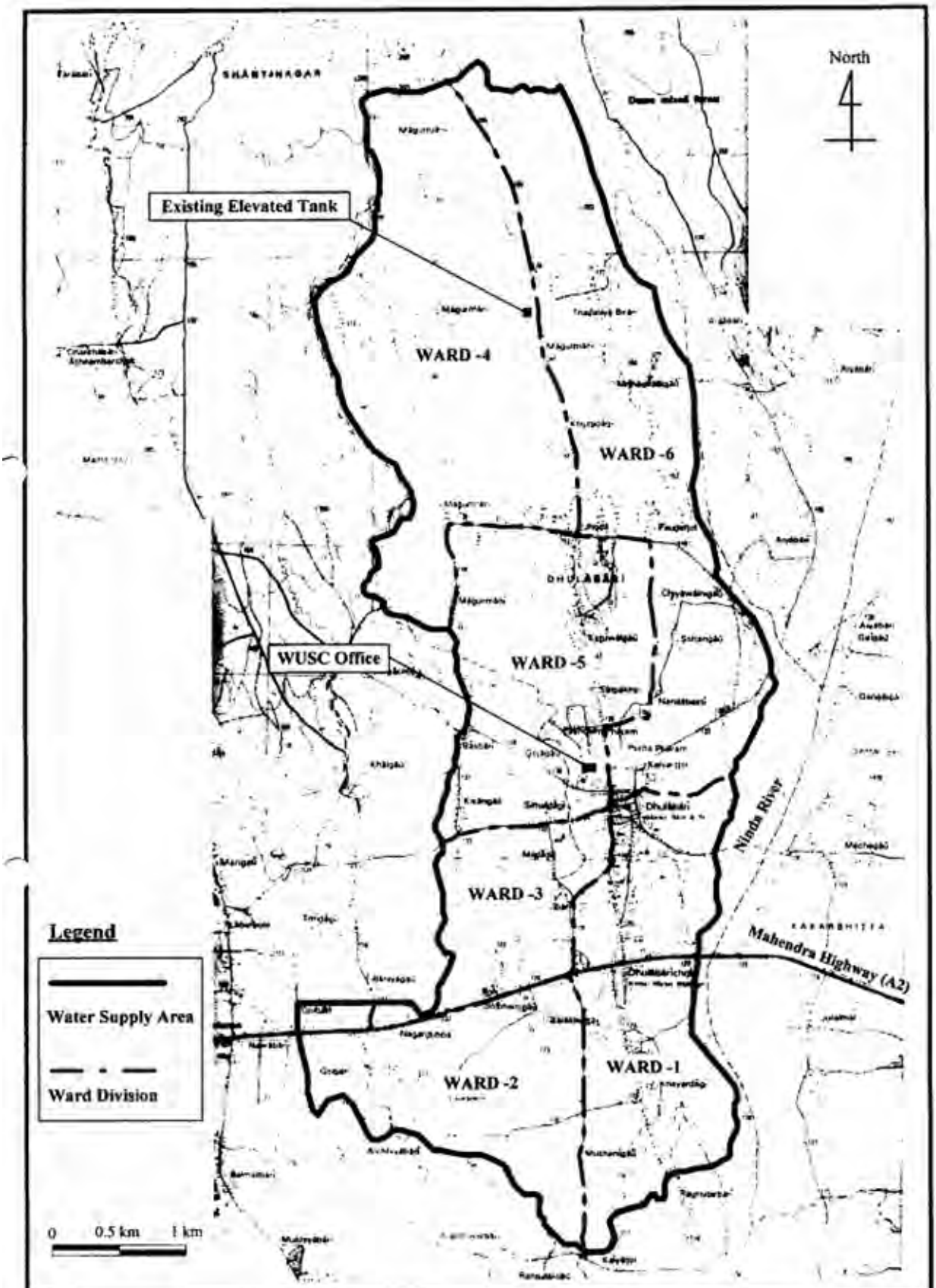
ANNEX- I -2 Scope of Work of the Japanese Grant Aid in Dhulabari

DHULABARI

No.	Item	Request	Study Result	Remarks
1	Intake Facility	Spring Intake Weir Type x 1	Spring Intake Weir Type x 1	Reconstruction
2	Transmission Main Pipeline	HDPE: 10 km River Crossing: Overhead	Approx. 11.5 km River Crossing: River-bed Protect by Concrete and gabion	
3	Water Treatment Plant			
3-1	Treatment System	Conventional System x 1 (Coagulant+Sedimentation +Rapid sand filter)	Slow Sand Filter System x 1 (Sedimentation+Rough Filter +Slow Sand Filter)	
3-2	Clear Water Reservoir	500 m3 x 1	Approx. 600 m3 x1	
3-3	Chlorination Unit	1 unit	1 unit	For spring water
4	Service Reservoir			
4-1	Elevated Tank	450 m3 x 1 (RC)	Approx. 450 m3 x 1 (FRP or Steel Panel)	Inside of the WUSC office area
4-2	Chlorination Unit	–	1 unit	For New Well water
5	Distribution Pipeline	DI, GI : 9 km	Approx. 7.5 km	
6	Water Meter	4 units	4 units	Inlet/outlet of WTP Outlets of E.Tanks
7	Equipment	–	For water quality analysis For pipe maintenance	

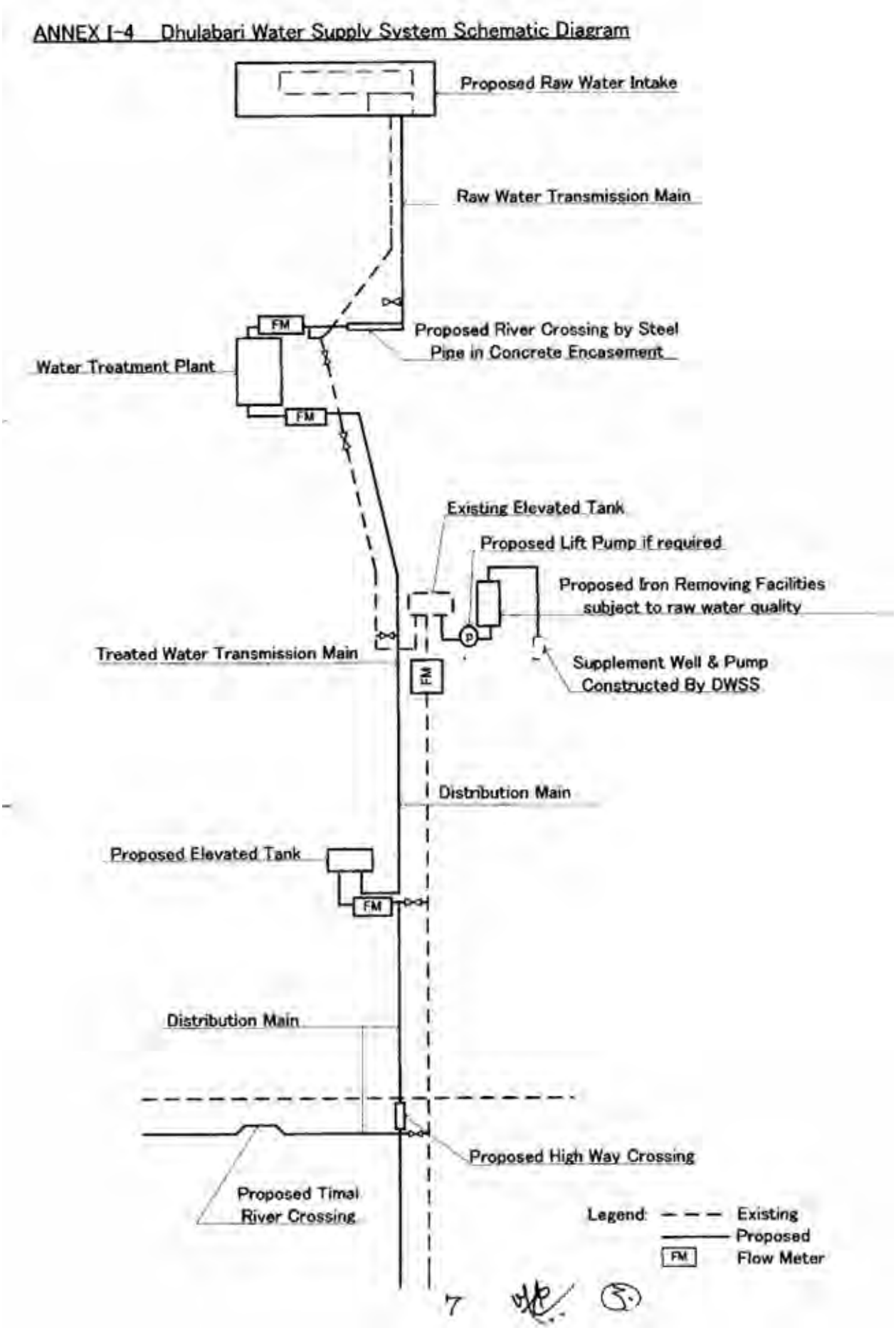
Note: Components of Study Result are tentative. Further study is required.

8 Generator 1 unit

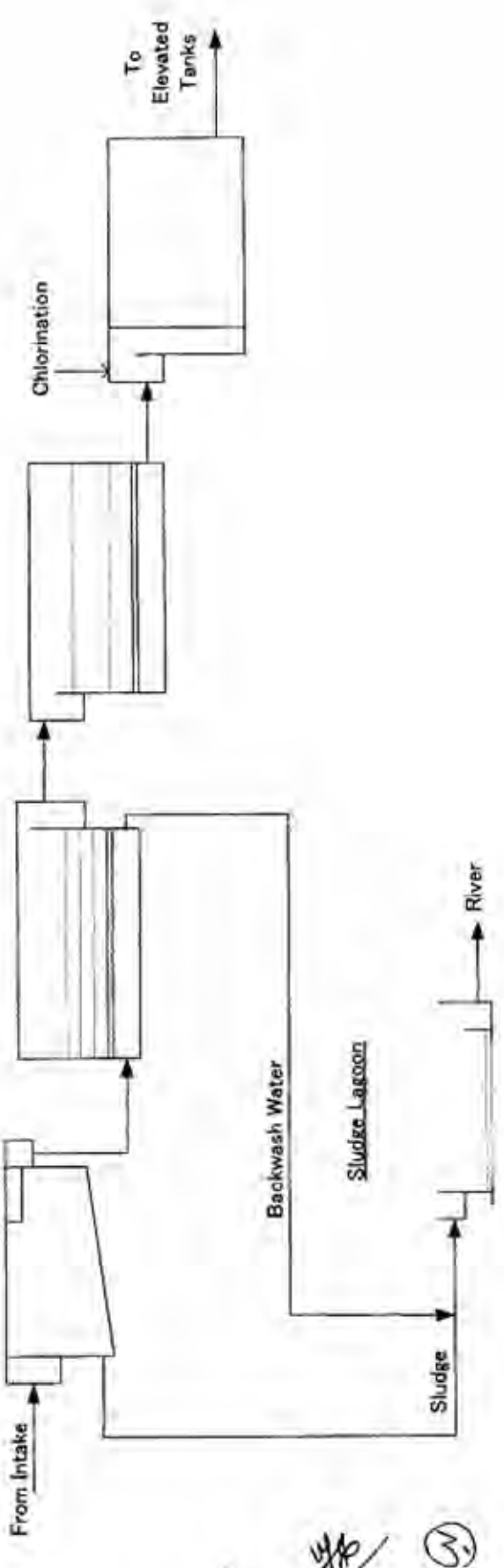


ANNEX I-3 Service Area in Dhulabari

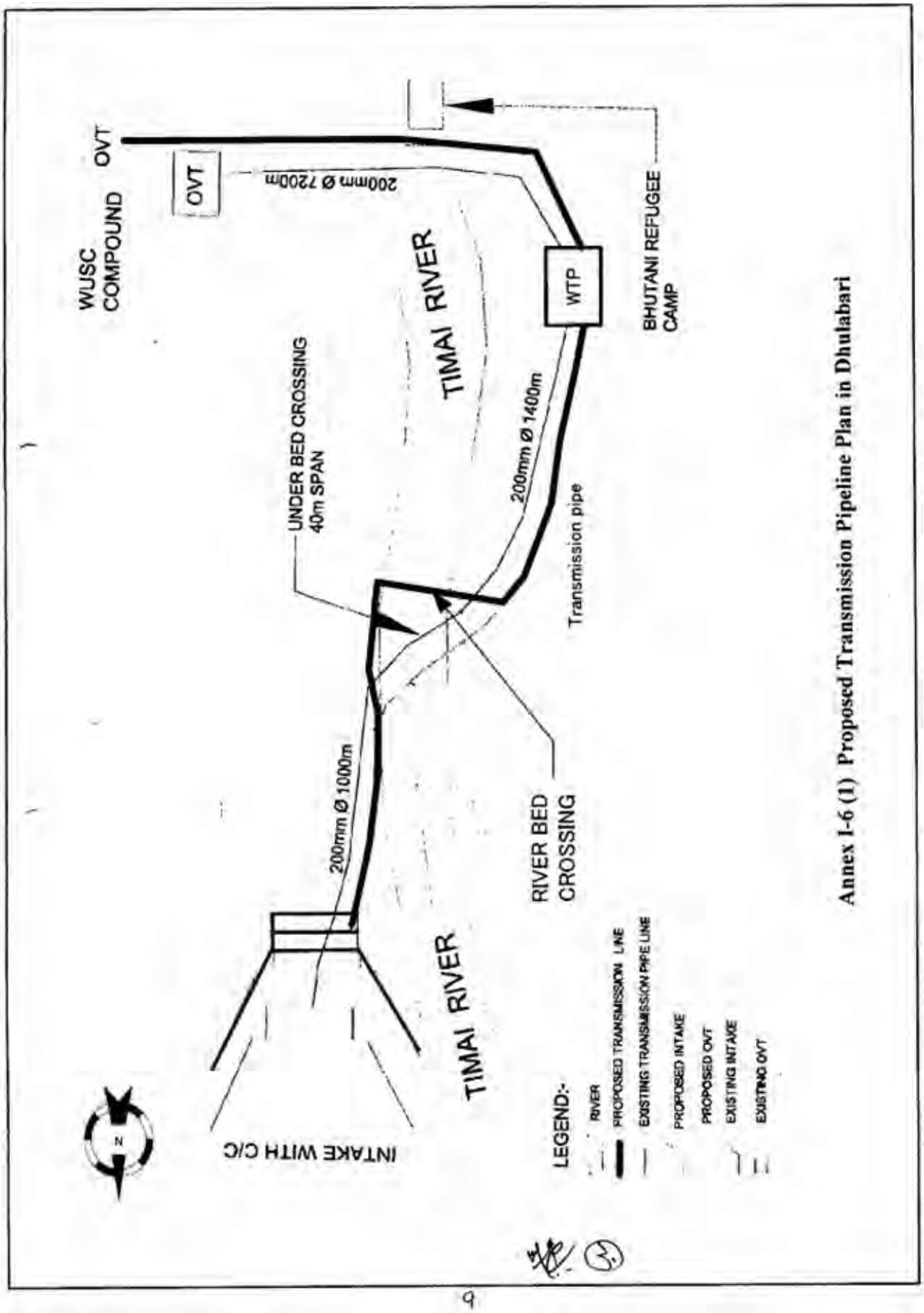
ANNEX I-4 Dhulabari Water Supply System Schematic Diagram



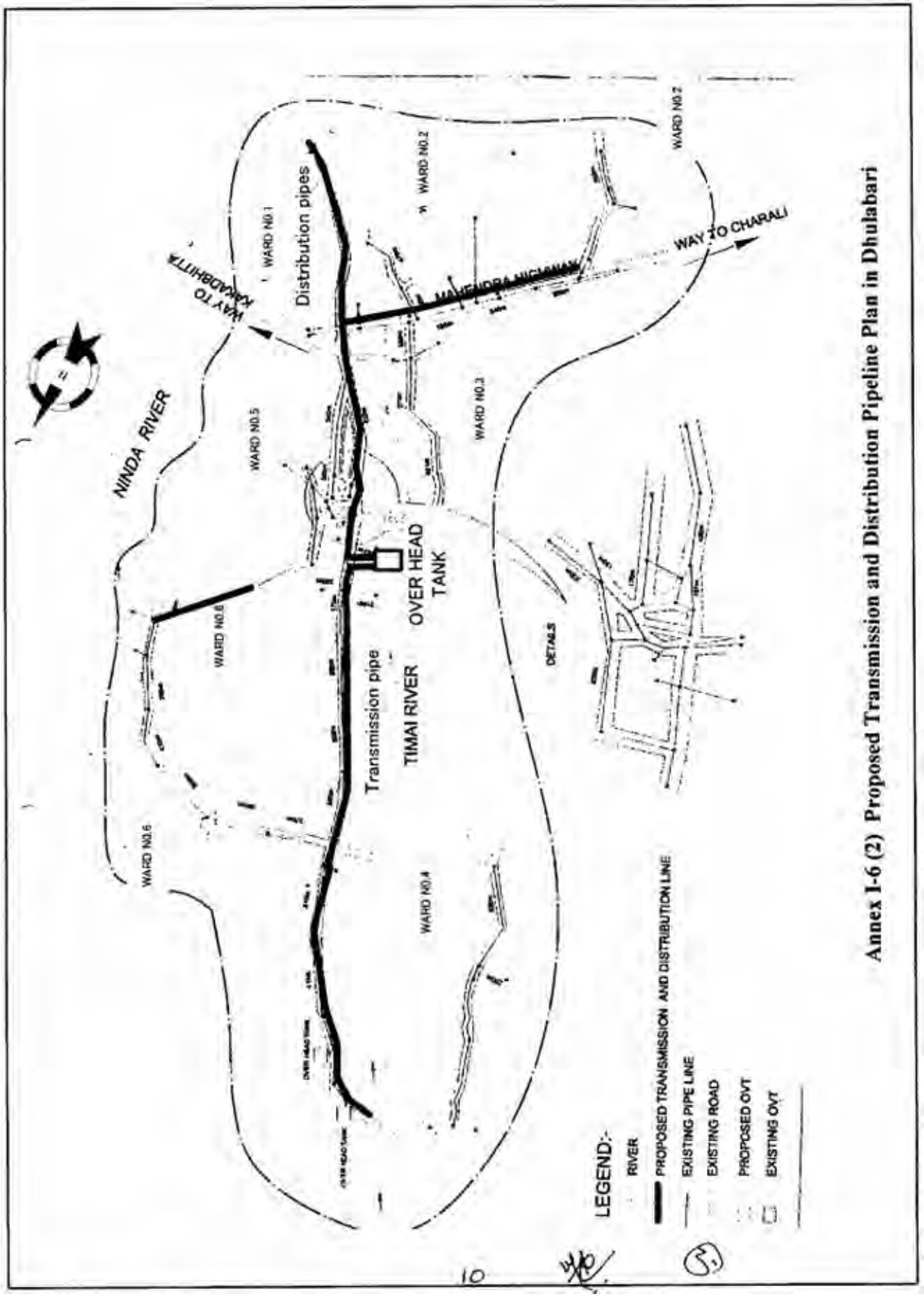
ANNEX I-5 Dhulabari Water Treatment Process Flow Diagram



Note: Components of the treatment facilities are tentative. Further study is required.



Annex I-6 (1) Proposed Transmission Pipeline Plan in Dhulabari



Annex 1-6 (2) Proposed Transmission and Distribution Pipeline Plan in Dhulabari

Ⅱ. GAUDARAHA

1.Basic Concept of the Water Supply Planning

(1) Target year:	2014
(2) Service area:	Gauradaha, Word No. 3,4,7,8,9
(3) Population:	Approx. 13,100 people in Service area in 2014
(4) % of population served:	Bazar area; 70%, out of Bazar; 65%
(5) Water demand criteria:	Based on DWSS Guidelines
(6) Water demand:	Approx. 1,100 m3/day (daily maximum) in 2014

2. Facilities Planning

(1) Iron Removal Plant

The Iron Removal Plant will be constructed in the inside of WUSC Office area.

(2) Clear Water Reservoir

Retention time of existing elevated tank is not enough, therefore, clear water reservoir is necessary when power failure and other situation is taken into consideration.

The clear water reservoir will be also constructed in the inside of WUSC Office area.

Lift pump from Reservoir to the existing elevated tank is required when the clear water reservoir is constructed. Generator only for lift pump and chlorination unit will be installed.

(3) Distribution Pipelines

Japanese side will extend main distribution lines as for distribution network improvement in this Project and Nepal side will construct other distribution lines including house connections.

(ANNEX- Ⅱ -4)

(4) Water Meter

Water meters will be equipped on the inlet line of the iron removal plant, and outlet line of the existing elevated tank.

3. Scope of Work of the Japanese Grant Aid (Tentative)

The component is summarized in ANNEX- Ⅱ -1.

4.Land Acquisition

The site for Iron Removal Plant and Clear Water Reservoir is the inside of existing WUSC Office area.

5. Equipment

Equipment for maintenance work and water quality analysis is requested by WSSDO/WUSC. The items are as follows;

a. Pipe cutter, Torque wrench, etc.

b. Turbidimeter, pH meter, Residual chlorine analyzer

6. House Connection

House connection with water meter has been made by WUSC and approx.230 households have been

connected by WUSC at present. WUSC has enough ability to conduct house connection and other piping works.

7. Obligations of Nepal Side

DWSS/WSSDO/WUSC will undertake the land acquisition, fencing, power supply, etc. according to the Minute of Discussions signed on June 15, 2005.

8. Standards

Industrial Standards applied to the Project are Nepal Industrial Standards for local products and Japanese Standards including JIS, JWWA and other internationally accepted standards such as ISO, IEC, ASTEM, BS, DIN for imported goods.

9. EIA

The Team confirmed to DWSS/WSSDO that IEE for this project will be conducted by Nepal Side, if necessary. EIA is not necessary.

10. Soft Component

The necessity of following fields of soft component was recognized.

a. Operation and maintenance of Water Supply Facilities.
b. Organization development.

ANNEX- II -1 Scope of work of the Japanese Grant Aid in Gaudaraha
ANNEX- II -2 Service Area in Gaudaraha
ANNEX- II -3 Gaudaraha Water Supply System Schematic Diagram
ANNEX- II -4 Gaudaraha Distribution Pipeline Plan

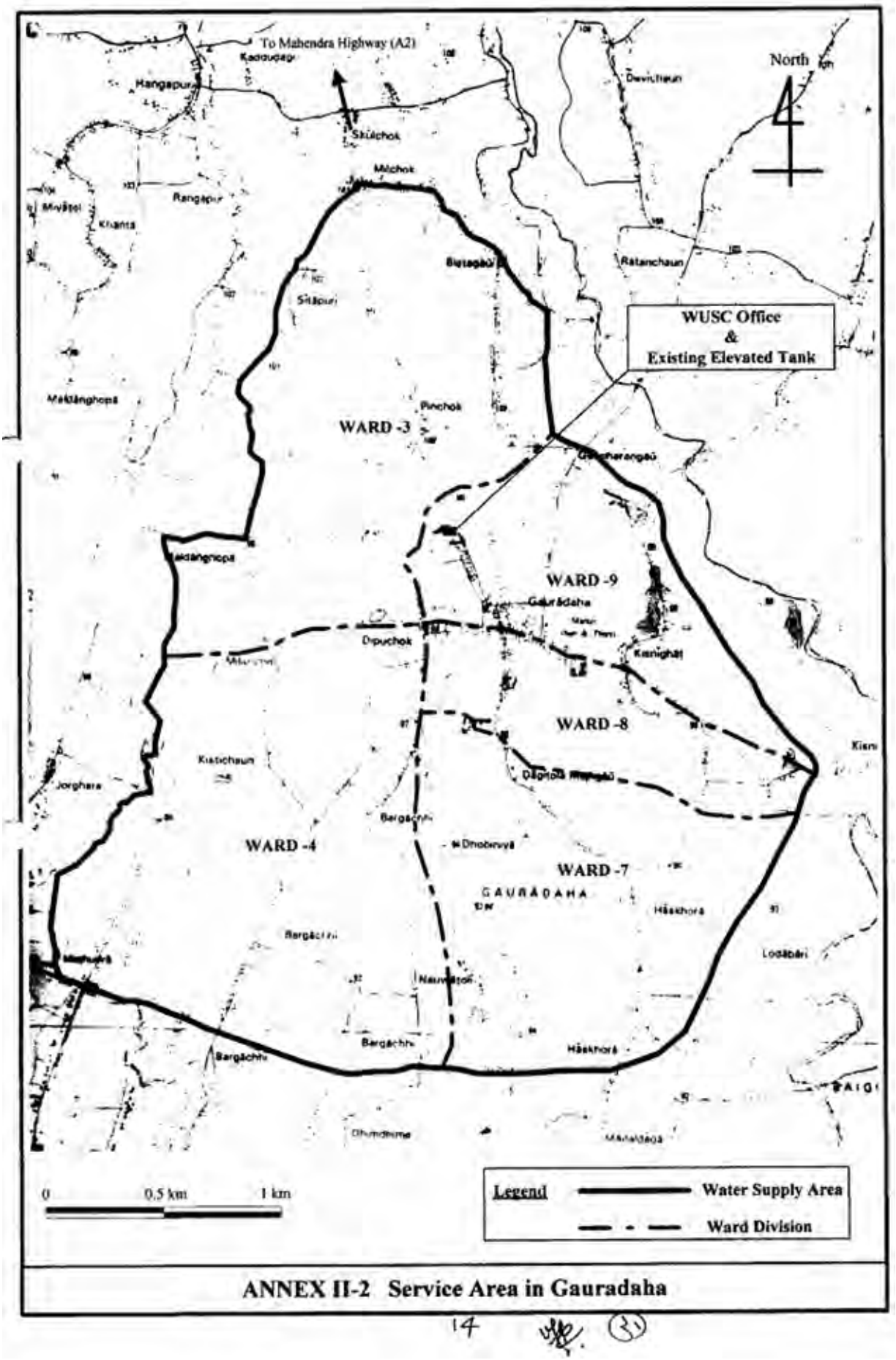
ANNEX- II -1 Scope of Work of the Japanese Grant Aid in Gaudaraha

GAURADAHA

No.	Item	Request	Study Result	Remarks
1	Iron Removal Plant	1 unit	1 unit	Inside of WUSC office
2	Clear Water Reservoir			Inside of WUSC office
2-1	Reservoir	300 m3 x 1	Approx. 300 m3 x1	
2-2	Lift Pump	—	2 units (1 unit as stand-by)	
2-3	Generator ~~Booster Pump~~	—	1 unit	
2-4	Chlorination Unit	1 unit	1 unit	
3	Distribution Pipeline	HDPE : 6 km	Approx. 6 km	
4	Water Meter	2 units	2 units	Inlet of IRP Outlet of Elevated Tank
5	Equipment	–	For water quality analysis For pipe maintenance	

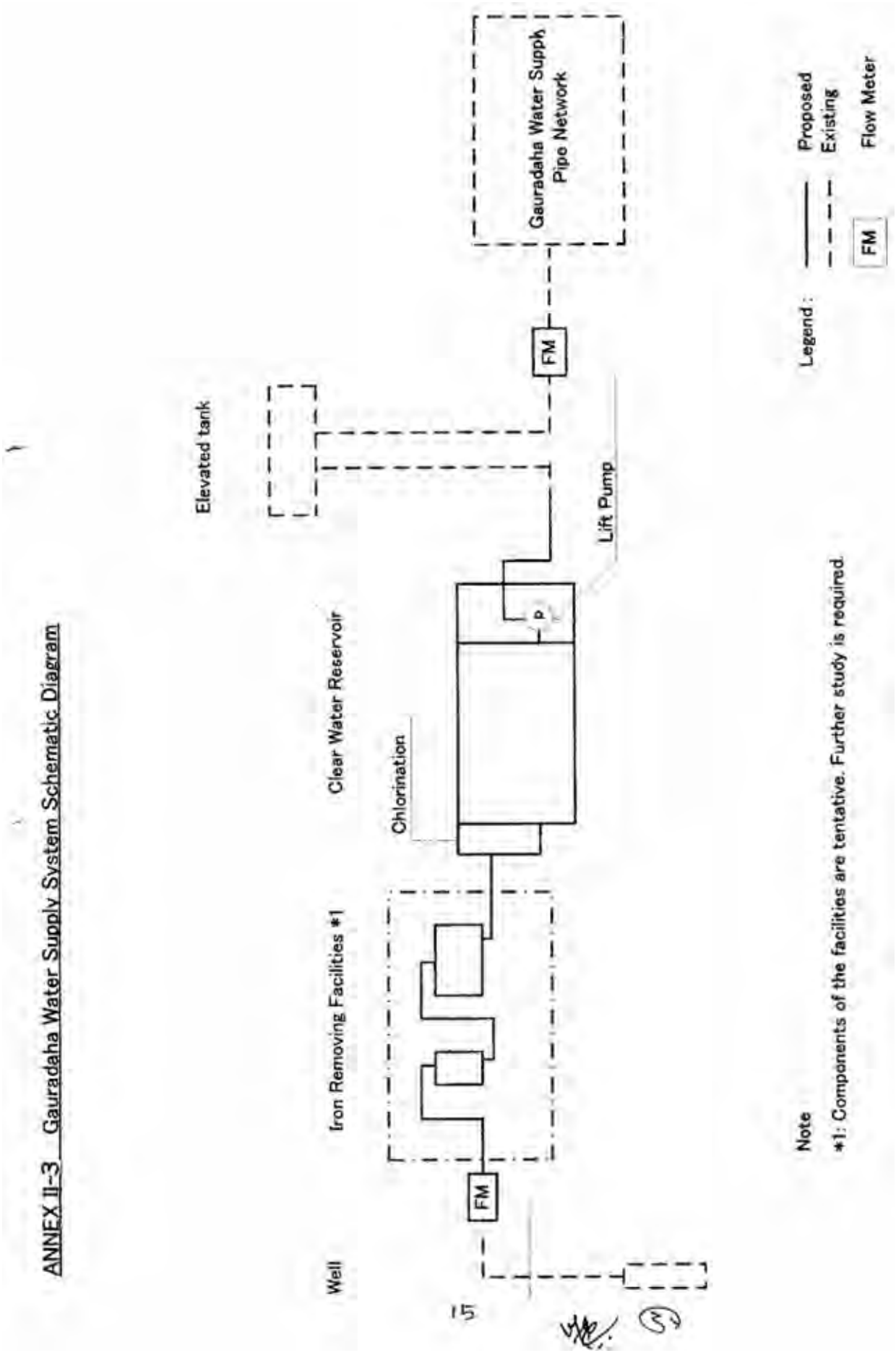
Note: Components of Study Result are tentative. Further study is required.

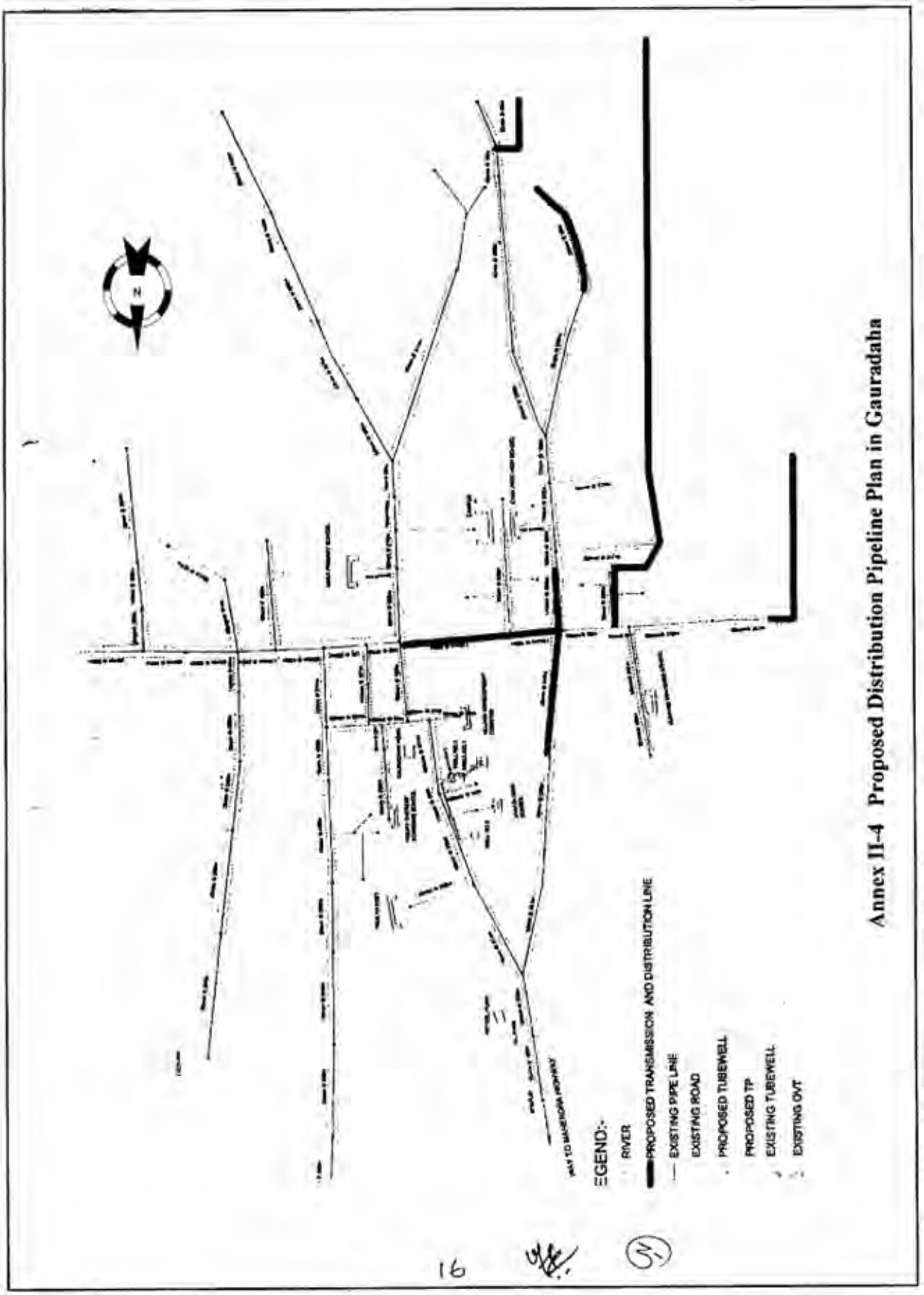
13



ANNEX II-2 Service Area in Gauradaha

14 (31)


ANNEX II-3 Gauradaha Water Supply System Schematic Diagram
Well
Iron Removing Facilities *1
Clear Water Reservoir
Chlorination
Lift Pump
Elevated tank
Gauradaha Water Supply Pipe Network
FM
P
Legend :
Proposed
Existing
Flow Meter
Note
*1: Components of the facilities are tentative. Further study is required.



Annex II-4 Proposed Distribution Pipeline Plan in Gauradaha

TECHNICAL NOTE

ON THE BASIC DESIGN STUDY ON THE PROJECT
FOR IMPROVEMENT
OF WATER SUPPLY FACILITIES IN URBAN AND SEMI-URBAN CENTERS
IN THE KINGDOM OF NEPAL
(MANGADH)

AGREED UPON BETWEEN
DEPARTMENT OF WATER SUPPLY AND SEWERAGE
AND
JICA STUDY TEAM

JULY 4,2005

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Ministry of Physical Planning & Works
Nepal

05/7/20

Mr. Ram Bahadur Ghimire
Chairman
Mangadh Water Users and Sanitation Committee
Morang District
Nepal

After a series of discussions during the field survey in Mangadha from July 1 through July 4, 2005, the following points were agreed between the Water Supply and Sanitation Division Office (WSSDO, Morang), Mangadh Water Users and Sanitation Committee (WUSC), Nepal and the JICA Study Team (Team). Based on the agreement, the Team will further analyze the results of field survey in consultation with JICA and concerned parties in Japan and will prepare a draft final report which includes the layout and design of facilities and/or equipment for the project.

MANGADH

1.Basic Concept of the Water Supply Planning

(1) Target year:	2014
(2) Service area:	Biratnagar Word No. 1,4,5 and Tankisun Word No.3
(3) Population:	Approx.27,000 people in Service Area in 2014
(4) % of population served:	60 %
(5) Water demand criteria:	Based on DWSS design criteria
(6) Water demand:	Approx. 2,000 m3/day (daily maximum) in 2014

2. Facilities Planning

(1) Iron Removal Plant

The Iron Removal Plant will be constructed in the inside of WUSC Office area.

(2) Clear Water Reservoir

Retention time of existing elevated tank is not enough, therefore, clear water reservoir is necessary when power failure and other situation is taken into consideration.

The clear water reservoir will be also constructed in the inside of WUSC Office area.

Lift pump from Reservoir to the existing elevated tank is required when the clear water reservoir is constructed. Generator and chlorination unit will be installed.

(3) Water Meter

Water meters will be equipped on the inlet line of the Iron Removal Plant, and outlet line of the existing Elevated Tank.

3. Scope of Work of the Japanese Grant Aid (Tentative)

The component is summarized in ANNEX-2.

4.Land Acquisition

The site for Iron Removal Plant and Clear Water Reservoir is the inside of existing WUSC Office area.

5. Equipment

Equipment for maintenance work and water quality analysis is requested by WSSDO/WUSC. The items are as follows;

a. Pipe cutter, Torque wrench, etc.

b. Turbidimeter, pH meter, Residual chlorine analyzer

6. House Connection

House connection with water meter has been made by WUSC and approx.400 households have been connected by WUSC at present. WUSC has enough ability to conduct house connection and other piping works.

7. Obligations of Nepal Side

DWSS/WSSDO/WUSC will undertake the fencing, power supply, etc. according to the Minute of Discussions signed on June 15, 2005.

8. Standards

Industrial Standards applied to the Project are Nepal Industrial Standards for local products and Japanese Standards including JIS, JWWA and other internationally accepted standards such as ISO, IEC, ASTEM, BS, DIN for imported goods.

9. EIA

The Team confirmed to DWSS/WSSDO that IEE for this project will be conducted by Nepal Side, if necessary. EIA will be not necessary.

10. Soft Component

The necessity of following fields of soft component was recognized.

a. Operation and maintenance of Water Supply Facilities.
b. Institution development.

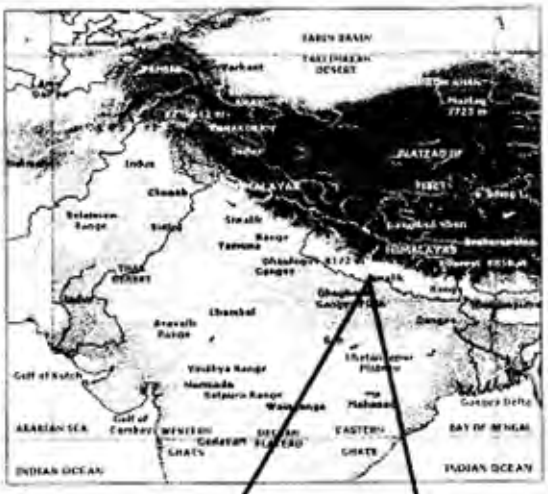
11. Additional request

Replacement of approx. 4km length of exiting main distribution pipeline is requested by WSSDO/WUSC. HDPE of existing pipeline will be replaced to DCIP in order to prevent leakage from joints in the future.

ANNEX-1 Location Map of Mangadh
ANNEX-2 Scope of work of the Japanese Grant Aid in Mangadh
ANNEX-3 Service Area in Mangadh
ANNEX-4 Mangadh Water Supply System Schematic Diagram

2

THE KINGDOM OF NEPAL
MANGADH AREA LOCATION MAP



NEPAL

Mangadh

Biratnagar Center Area

ANNEX -1 Location Map

3

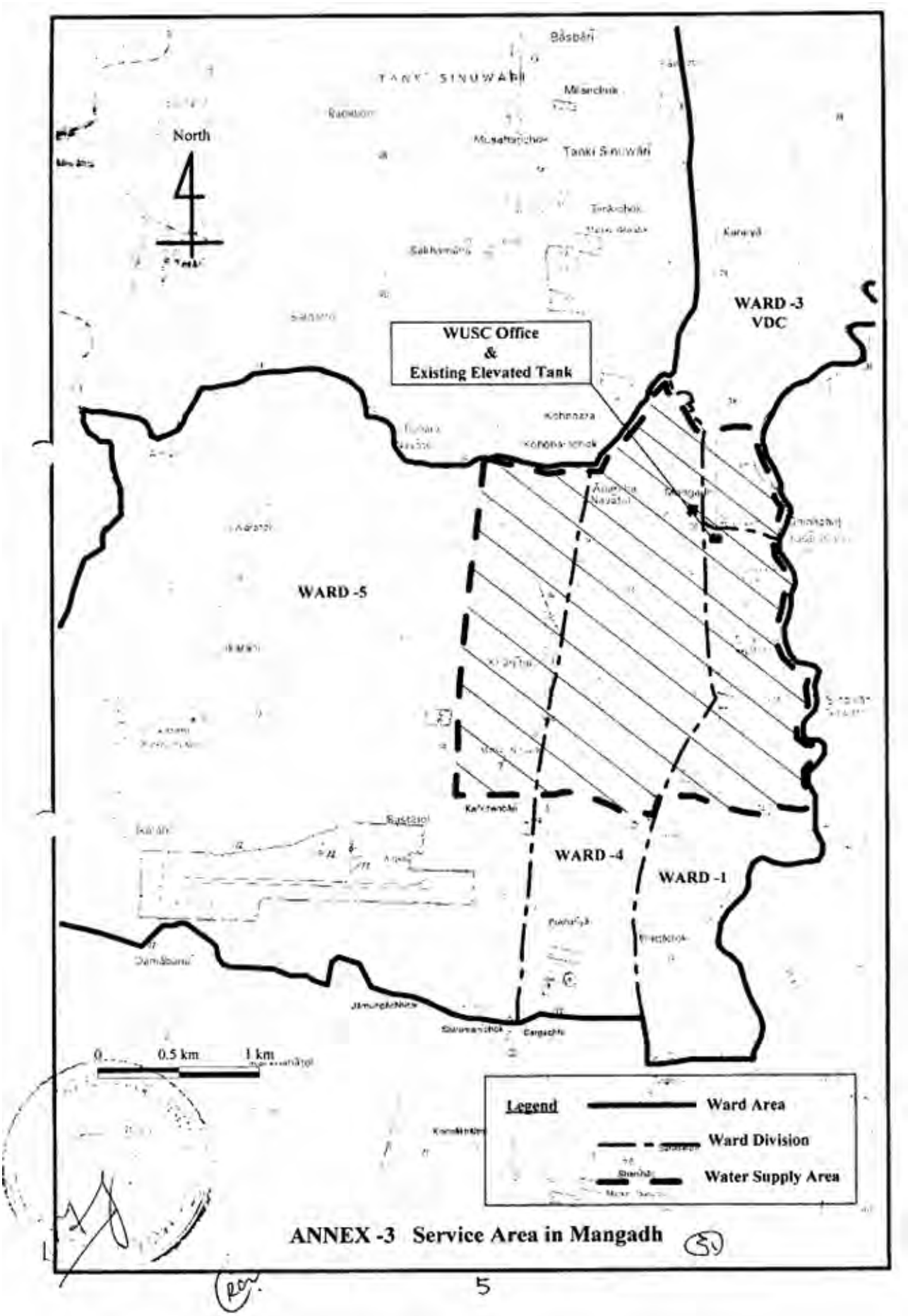
ANNEX-2 Scope of Work of the Japanese Grant Aid in Mangadh

MANGADH

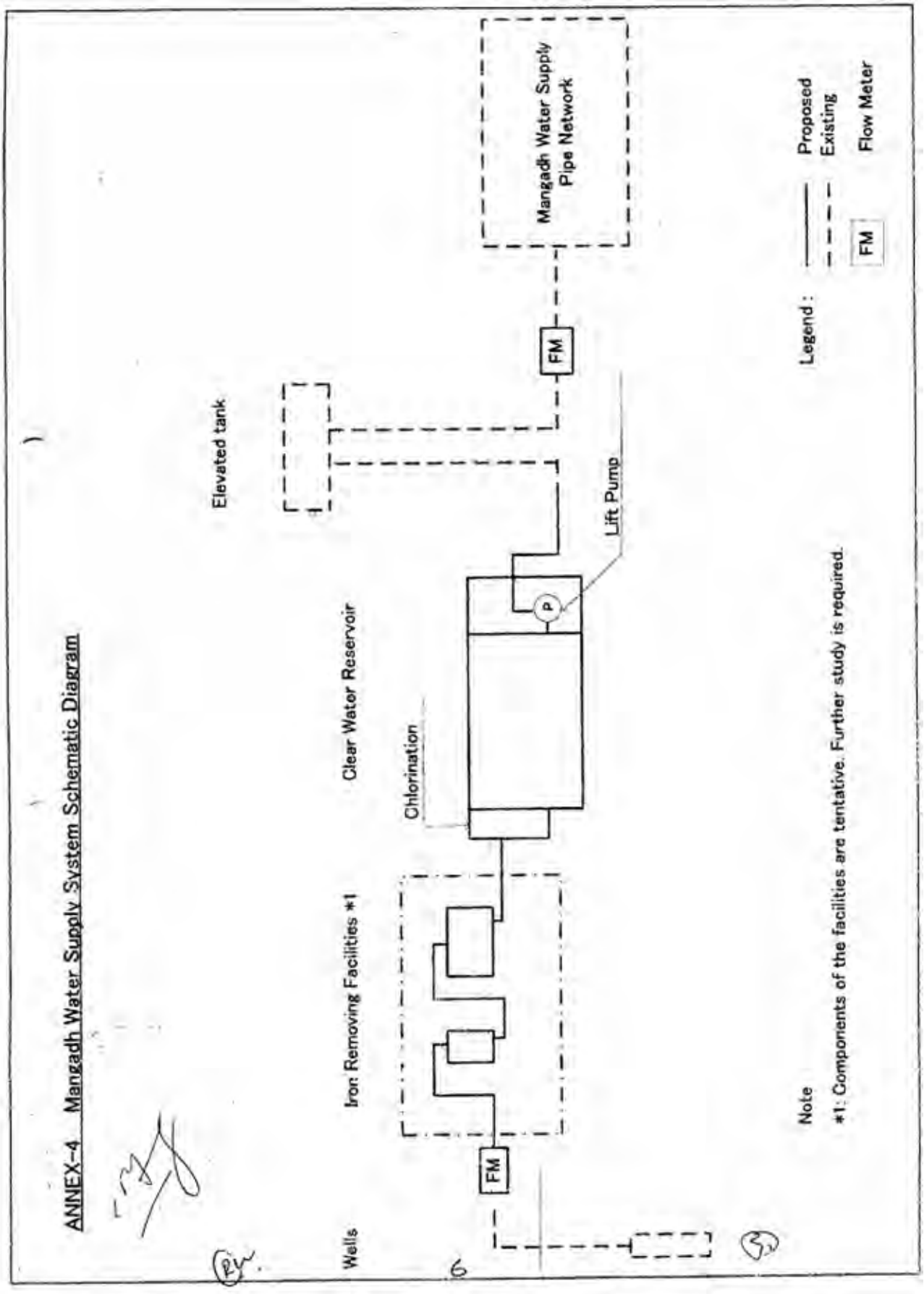
No.	Item	Request	Study Result	Remarks
1	Iron Removal Plant	1 unit	1 unit	Inside of WUSC office
2	Clear Water Reservoir			Inside of WUSC office
2-1	Reservoir	300 m3 x 1	Approx. 300 m3 x1	
2-2	Lift Pump	—	2 units (1 unit as stand-by)	
2-3	Generator	—	1 unit	
2-4	Chlorination Unit	1 unit	1 unit	
3	Water Meter	2 units	2 units	Inlet of IRP Outlet of Elevated Tank
4	Equipment	—	For water quality analysis For pipe maintenance	

Note: Components of Study Result are tentative. Further study is required.

4



ANNEX -3 Service Area in Mangadh


ANNEX-4 Mangadh Water Supply System Schematic Diagram
Wells
Iron Removing Facilities *1
Clear Water Reservoir
Chlorination
Lift Pump
Elevated tank
Mangadh Water Supply Pipe Network
FM
P
Legend :
Proposed
Existing
Flow Meter
Note
*1: Components of the facilities are tentative. Further study is required.

4－5 Appendix 6 Cost Estimation borne by the recipient

1) Land Acquisition (Dhulabari WTP)	3,100 thousand Nrs (Approx. 4.65 million Yen)
2) Fencing (Dhulabari WTP)	970 thousand Nrs (Approx 1.46 million Yen)
3) Fencing (Dhulabari Intake)	110 thousand Nrs (Approx 0.17 million Yen)
4) Installation of Power Transmission Lines (Dhulabari WTP)	800 thousand Nrs (Approx 1.20 million Yen)
Total	4,980 thousand Nrs (Approx 7.47 million Yen)

4－6 Appendix 7 Other relevant data

4-6-1 Appendix 7-1 Capacity Culculation for Facilities

Dhulabari Water Treatment Plant

1 Flow Rate		Q =		4,326 m^3／day (50 lit/s)
				water loss in treatment process and water supply to the plant inc
2 Receiving well				
Number of Compartment		N =		1
Retention Time		T =		4.5 min
Capacity		V =	4326/24/60*4.5=	13.5 m3
Dimensions	Width	B =	1.50	
	Length	L =	3.20	
	Effective Height	H =	3.00	
	Effective Capacity	V' =		14.4 m3
Incidental Facilities		Effluent Weir		1 unit
		Overflow Pipe (Φ150mm)		1 unit
		Drain Pipe (ϕ 100mm)		1 unit
3 Sedimentation Basin				
Type		Rectangular Horizontal Flow		
Number of Compartment		N =		2
Retention Time		T =		2 hours
Capacity		V =	4326/2/24*2	180 m3
Dimensions	Width	B =	5.00	
	Length	L =	13.40	
	Effective Height	H =	3.00	
	Effective Capacity	V' =		201.0 m3 / compartment
	Total Capacity			402.0 m3
Incidental Facilities		Perforated Baffle wall		1 set
		Effluent Trough		1 set
		Desludging Valve (ϕ 150mm)		1 set/a compartment
		Drain Pipe (ϕ 150mm)		1 set
		Flushing Pipes		1 set
4 Rough Filters				
Type		Downward Flow		
Number of filters		N =		4 filters
Filtration Rate		V =		36 m／day (1.5 m／hour)
Area		A =	4326/36/4=	30.04 m^2/filter
Dimensions	Width	B =	4.20	m
	Length	L =	7.00	m
	Effective Filtration Area	A' =	4.2x7	29.4 m^2/池
	Effective Depth	H =	1.30	m
	Effective Capacity	V' =		38.22 m^3/池
	Total Capacity			152.88
Gravel		3 layers		ϕ 24 ~ 50mm x 50 cm
				ϕ 12 ~ 18mm x 30 cm
				ϕ 8 ~ 12mm x 20 cm
Under Drain		Strainer + Precast Concrete Panels		
Backwash		Backwash Rate		60 cm／min
Piping		Inlet	Main	ϕ 250 mm
			Branch	ϕ 150 mm
		Outlet	Main	ϕ 250 mm
			Branch	ϕ 150 mm
		Backwash	Main	ϕ 500 mm
			Branch	ϕ 400 mm
Incidental Facilities		Effluent Weir		2 places
		Backwash Tank		150 m3

5 Slow Sand Filters

Type		Natural Equilibrium Type		(Stop Log)
Number of Filters	N =		4 filters	(one stand by)
Filtration Rate	V =		5 m／day	(0.2 m／hour)
Filtration Area	A =	4326/4/5=	216.3 m2	
Dimensions				
Width	B =	14.00	m	
Length	L =	16.50	m	
Effective Filtration Area	A' =	14.0 x 16.5	231.0 m2	
Effective Depth	H =	2.20	m	
Effective Capacity	V' =		m3/filter	
Total Capacity			924.00 m3	

Sand	Effective Size	φ0.4 mm
	Uniformity	2.0 以下
	Thickness	90 cm
Gravel	4 layers	φ 60 mm x 15 cm
		φ 20 ～ 30mm x 10 cm
		φ 10 ～ 20mm x 10 cm
		φ 3 ～ 4mm x 10 cm
Under Drain	Colleting Pipe (Main)	Φ300mm(PVC)
	Colleting Pipe (Branch)	φ100mm有孔管 (PVC)
Piping	Inlet Pipe	φ200 mm
	Outlet Pipe	φ200 mm
	Interconnecting Pipe	φ100 mm
	Drain Pipe (Effluent Chamber)	φ100 mm
Incidental Facilities	Inflow Weir	1 set
	Outflow Weir	1 set
	Wash Sand	1 set

6 Clear Water Reservoir

Number of Compartment	N =		2 compartments	
Retention Time	T =		3 hours	
Capacity	V =	4326/24*3=	540.8 m3	
Dimensions				
Width	B =	5 m		
Length	L =	20 m		
Effective Depth	H =	3 m		
Effective Capacity	V' =	300.0 m3/compartment		
Total Capacity		600.0 m3		

Piping	Inlet Pipe	φ250 mm
	Outlet Pipe	φ250 mm
	Overflow Pipe	φ150 mm
	Drain Pipe	φ100 mm

7 Chlorination

Chemical	Bleaching Powder	Effective Chlorination	30 %	
Feeding Ratio	Max.		2 ppm	
	Average		1 ppm	
Required Chlorination	Max	4326*2/1000/0.3=	28.84 kg/day	
	Average	4326*1/1000/0.3=	14.42 kg/day	
Chlorine Liquid Solution	Concentration		10 %	
	Max.		288.4 liter	
	Average		144.2 liter	
Feeding Method	Dropping by gravity			
Feeding Point	at Inflow weir in Clear Water Reservoir			
Solution Tank	Number		2 units (one stand by)	
	Capacity		1 m3	
Feeding Equipment			2 units (one stand by)	

4-6-2 Appendix 7-2 Hydraulic Analysis of Facilities

Hydraulic Analysis of Water Treatment Plant

Item		Unit		Remark
1.Criteria				
Design Flow Rate	Qd	m^3/d	4,200	
	Qh	m^3/hr	175.00	Qd/24
	Qm	m^3/min	2.92	Qd/1440
	Qs	m^3/s	0.05	Qd/86400
Intake	Q'd	m^3/d	4,326	Qd*1.03
	Q'h	m^3/hr	180.25	Q'd/24
	Q'm	m^3/min	3.00	Q'd/1440
	Q's	m^3/s	0.050	Q'd/86400
2.Analysis				
(1)Receiving Well				
(a)Basic Configuration				
Water Level			286.00	
Flow Rate	Q's	m^3/s	0.050	Intake
(b) Outlet Water Level at Receiving				
Weir Width	B	m	1.20	
Flow Coefficient	C		1.84	
Overflow height	h	m	0.08	$(Qs/(Cb))^{(2/3)}$
Elevation at Weir Top		m	285.92	
to Free Overflow Type Weir	h	m	0.25	add 0.25m for height to make free
Outlet water level at Receiving Wel			285.75	
©Pipe Friction Loss (Receiving Well to Sedimentation Basin)				
Pipe Diameter	φ	m	0.3	
Section Area	A	m^2	0.071	$\varphi^2 \cdot PI/4$
Flow Velocity	V	m/s	0.71	Q's/A
(c-1)Loss at Inflow to Pipe	h1			
Loss Coefficient	f1		0.5	Edge Shape
G-Force	9	m/s2	9.8	
Loss at Inflow	h1	m	0.01	$f1 \cdot V^2/(2g)$
(c-2)Straight Pipe	h2			
Loss Coefficient	f2		0.033	(0.02+0.0005/φ)*1.5
G-Force	9	m/s^2	9.8	
Length	L	m	20	
Loss Through Straight Pipe	h2	m	0.055	$f2 \cdot V^2/(2g)*L/\varphi$
(c-3)90 deg Bend	h3			
Loss Coefficient	f3		0.17	r/D=1.5
G-Force	9	m/s^2	9.8	
Number	n	units	4	
Loss by 90 deg Bend	h3	m	0.017	$f3 \cdot V^2/(2g)*n$
(c-4) Tee	h4			
Loss Coefficient	f4		1	
G-Force	9		9.8	
Number	n		1	
Loss by Tee	h4		0.026	$f4 \cdot V^2/(2g)*n$
(c-5)At Inlet	h5			
Loss Coefficient	f5		1	
G-Force	9	m/s^2	9.8	
Loss at Inlet	h5	m	0.026	$f5 \cdot V^2/(2g)$

Hydraulic Analysis of Water Treatment Plant

Item		Unit		Remarks
Total Friction Loss of Pipe	h	m	0.137	
Water Level at Inlet of sedimentation Basin			285.613	285.75-0.137=285.613
Water Level at Inlet of sedimentation Basin			285.61	
(2) Sedimentation Basin				
(a) Basic Configuration				
Water Level			285.61	Water Level at Inlet to Sedimentation Basin
Flow Rate	Q's	m^3/s	0.025	Intake Volume/2 basins
Number of Basins		units	2	
(b-1) Inlet Gate				
Dimensions	Os	m	0.50	0.4mW x 0.5mH
Section Area	A	m^2	0.20	
Flow Velocity	V	m/s	0.13	
Flow Coefficient	G		0.6	
Total of Loss			0.002	$H=(V/G)^2/29$
Water Level at Sedimentation Basi			285.608	285.61-0.002=285.608
Water Level at Sedimentation Basi			285.60	
(c-1) Height of Overflow	h			
Length of Trough	L	m	2	
Number of trough	n	本/池	3	2weirs/trough
Overflow Rate	q'	m^3/s	0.004	Q's/3units/2sides
Weir Load		$m^3/d \cdot m$	360.50	Q'd/2basins/3numbers/2sides
Weir Width	B	m	2	
Flow Coefficient	C		1.840	Whole Width Weir
Overflow Height	h	m	0.011	$(q'/CB)^{(2/3)}$
(c-2) Limit Flow Height at End of Overflow Weir			hc1	
Width of Trough	W	m	0.3	
Flow Rate of a Trough	q'	m^3/s	0.008	Q's/3
G-Force	g	m/s^2	9.8	
Limit Flow Height at End of Overflow Weir	hc1	m	0.009	$(q'^2/(gW^2))^{(1/2)}$

Hydraulic Analysis of Water Treatment Plant

Item		Unit		Remarks
(c-3)Limit Flow Height at Upper Sid	ho	m	0.015	$(3*hcl^2)^{(1/2)}$
(c-4)Elevation of Trough				Bottom Elevation
Depth of Weir	D	m	0.3	
Overflow Height	h	m	0.011	
Free Weir		m	0.05	
Elevation for trough			285.239	additional coverage
To make free overflow		m	0.229	Add 0.229m to make Free Overflow Weir
(c-5) Outlet Water Level			285.01	Elevation of Trough + Limit Flow Height at downstream of trough
(d-1)Loss at Inlet	h1			
Loss Coefficient	f1		0.5	
G-Force	9	m/s^2	9.8	
Interconnecting Pipe: Diameter	φ	m	0.3	
nterconnecting Pipe: Flow Velocit	V	m/s	0.708	
Loss at Inlet	h1	m	0.013	$f1 \cdot V^2/(2g)$
(d-2) Loss through straight pipes	h2			
Loss Coefficient	f2		0.033	$(0.02+0.0005/\varphi)*1.5$
G-Force	9	m/s^2	9.8	
Pipe Length	L	L	40	
Loss through Straight Pipes	h2	m	0.111	$f2 \cdot V^2/(2g)*L/\varphi$
(d-3).90 deg Bend	h3			
Loss Coefficient	f3		0.17	r/D=1.5
G-Force	9	m/s^2	9.8	
Number	n	units	4	
90 deg. Bend	h3	m	0.017	$f3 \cdot V^2/(2g)*n$
(d-4) Loss by Tee	h4			
Loss Coefficient	f4		1	
G-Force	9		9.8	
Number	n	units	2	
Loss	h4		0.051	
(d-5) Inflow Loss to Rough Filters				
Loss Coefficient	f5		1	
G-Force	9	m/s2	9.8	
Loss at Inlet	h5	m	0.026	$f5 \cdot V^2/(2g)$
Total Loss of Pipes	h5	m	0.218	
r Level at Inlet to Rough Filters			284.792	285.01-0.218=284.792
(3)Rough Filters				
(a)Basic Configuration				
Water Level			284.750	
Flow Rate(in Normal Operation)	Q's	m3/s	0.013	Intake Flow/4Filters
Flow Rate(1 Filter in washing))	Q"s	m3/s	0.017	Intake Flow/3Filters
Total Filtration Area in Normal Operation	A	m^2	117.60	7.0m x 4.2m x 4池
Total Filtration Area (1 Filter in washing)	A	m^2	88.20	7.0m x 4.2m x 3池
Filtration Rate(In Normal Operation	V's	m/s	0.00011	
Filtration Rate(1 Filter in Washing)	V"s	m/s	0.00019	
(b-1) Loss Through Inlet Canal				Loss is ignored.

Hydraulic Analysis of Water Treatment Plant

Item		Unit		Remarks
(b-2) Loss at Inlet of Rough Filt				
Loss Coefficient	f2		0.5	
G-Force	g	m/s^2	9.8	
Pipe Diameter	D2	m	0.15	
Flow Velocity	V'	m/s	0.944	
Loss at Inlet	h2	m	0.023	$f2 \cdot V^2/(2g)$
(b-3) Loss by Butterfly Valves				
Diameter	D3	m	0.15	
Flow Velocity	V'	m/s	0.944	Flow Rate in 1 filter in washing
Loss Coefficient	f3		0.52	
Loss By Butterfly	h3	m	0.024	
(b-4)Loss at Inlet Weir		m		
Width of Weir	B	m	0.85	
Flow Coefficient	C		1.84	
Overflow Height	h4	m	0.048	$(Q's/(Cb))^{(2/3)}$
Elevation of top of inlet weir			284.655	284.75-0.023-0.024-0.048
Water Level at Rough Filter			284.35	to make Free Weir
(b-5) Loss through Coarse Sand La	h8			
Thickness of Layer	H8	m	1	
Shape Factor	CD		28.8	24/Re+3/Re^0.5+0.34
Porosity	λ		0.45	
Shape Factor	α/β		5.5	
Grain Size in diameter	Dp	m	0.005	
Reynolds Number	Re		0.946	$v"s \cdot Dp \cdot \gamma/\mu$
Gravity of water	γ		1000	
Kinematic Viscosity	μ		0.001	
Loss at Sand Layer	h8	m	0.000003	$0.178 \cdot H \cdot CD/g \cdot V^s{}^2/\lambda^4 \cdot \alpha/\beta$

Hydraulic Analysis of Water Treatment Plant

Item		Unit		Remarks
(b-9) Loss by Under Drain	h9			
Flow Coefficient	α		0.6	
Open Area Ratio of Under Drain	β	%	0.6	Nozzle Type
Loss of Under Drain	h9	m	##########	1/(2g)・(V's/(α・β))^2
(b-10) Loss at outlet from under	h10			
Flow Rate per 1 Filter	qb	m	0.017	3filters in operation
Opening Area	A	m^2	0.8	
Flow Coefficient	C		0.6	
Loss at outlet	h10	m	0.00001	
(b-11)Loss by Butterfly Valve				
Diameter of Pipe	D11	m	0.15	
Flow Velocity	V	m/s	0.944	1池逆洗時の流速とする
Loss Coefficient	f11		0.52	
Loss by Butterfly Valve	h11	m	0.024	
(b-12) Loss by Tee	h12			
Diameter of Pipe	D12	m	0.3	
Flow Velocity	V12	m/s	0.236	
Loss Coefficient	f12		3	
G-Force	9	m/s2	9.8	
Number of Tee	n	units	5	
Loss	h12		0.043	f12・V^2/(2g)*n
(b-13)Loss by Confluent				
Flow Rate		m^3/s	0.050	
Diameter	D	m	0.3	
velocity	V13	m/s	0.708	
Places of confluent	n	units	4	
Loss	h13	m	0.026	
(b-14)Loss through Straight Pipe	h14			
Diameter of Pipe	D	m	0.3	
Flow Velocity	V	m/s	0.708	
Loss Coefficient	f14		0.033	(0.02+0.0005/ϕ)*1.5
G-Force	9	m/S2	9.8	
Pipe Length	L	L	20	
Loss Through Straight Pipe	h14	m	0.055	f14・V^2/(2g)*L/ϕ
(b-15) Loss at Outlet	h15			
Loss Coefficient	f15		1	
G-Force	9	m/s2	9.8	
Loss at Outlet	h15	m	0.026	f15・V^2/(29)
Total of Loss	h	m	0.173	

Hydraulic Analysis of Water Treatment Plant

Item		Unit		Remarks
Total Loss in Rough Filters		m	0.173	
Additional Coverage			0.657	For initial filtration
t Pumpe Well Water Level in Rough Filter			283.52	284.35-0.173-0.657
Overflow Weir At Pumping Well in Rough Filters				
Width of Weir	B	m	1.2	
Flow Coefficient	C		0.6	
Overflow Height	h	m	0.169	$(Q's/(CB))^{(2/3)}$
Top Elevation of Outlet Weir in Rough Filters Pumping Well			283.52	
(c-1) Loss by Back Wash				
Number of Trough per Filter	n		5	
Length of Trough	B	m	4.2	
Flow Coefficient	C		1.84	
Backwash Rate	Vw	m/s	0.01	
Filtration Area	A	m^2	29.4	7m x 4.2m
Volume of Backwash Water	Qw	m^3/s	0.294	
(c-2) Limit water Level at end of trough		hcl		
Correction Coefficient	α		1.1	
Width of Trough	W	m	0.46	
Flow Rate per a Trough	q'	m^3/s	0.0588	Qw/5
G-Force	g	m/s^2	9.8	
mit Water Level at end of trough	hcl	m	0.043	$(\alpha q'^2/(g \cdot W^2))^{(1/2)}$
(c-3) Limit Water Level at upper side of trough	hO	m	0.074	$(3*hcl^2)^{(1/2)}$
				Assuming 0.4m for height of trough
Overflow Height	ht	m	0.024	$(q'/CB)^{(2/3)}$
(c-2)Loss through Filter Sand Lay	hs			
Thickness of Layer	Ls	m	1	
Porosity	εS		0.45	
Gravity of Sand	ρs	kg/m3	2600	
Gravity of Water	ρf	kg/m3	1000	
Loss through Filter Sand Layer	hs	m	0.88	$Ls / \rho f \times (1-\varepsilon s) \times (\rho s-\rho f)$
(c-3)Loss Through Under Drain				
Backwash Rate	V	m^3/s	0.294	
Flow Coefficient	α		0.6	
Opening Ratio of Under Drain	β		0.6	Nozzle Type
Loss through Under Drain			0.034	$1/(2g) \cdot (V's/(\alpha \cdot \beta))^2$
(c-4) Loss at Outlet of Under Dra	hf			
Flow Rate per a Filter	qb	m3/s	0.294	
Opening Area	A	m2	0.8	
Flow Coefficient	C		0.6	
Loss	hf	m	0.004	$(qb/A)^2*C/(2g)$

Hydraulic Analysis of Water Treatment Plant

Item		Unit		Remarks
(c-5)Loss by Check Valve				
Backwash Rate	qb	m3/s	0.294	
Diameter	D6	m	0.5	
Flow Velocity	V'	m/s	1.497	
Loss Coefficient	f5		0.52	
Loss by Check Valve	h5	m	0.059	
(C-6)Loss by Tee	h6			
Pipe Diameter	D6	m	0.5	
Flow Velocity	V6	m/s	1.497	
Loss Coefficient	f6		1	
G-Force	9	m/s^2	9.8	
Number	n	Unit	1	
Loss	h6		0.114	
(c-7)Loss by Confluence				
Pipe Diameter	D	m	0.5	
Flow Velocity	V	m/s	1.497	
Number	n	units	2.00	
Loss	h8	m	0.229	
(c-8)Loss through Straight Pipes	h9			
Pipe Diameter	D9	m	0.5	
Flow Velocity	V9	m/s	1.497	
Loss Coefficient	f9		0.0315	(0.02+0.0005/φm)*1.5
G-Force	9	m/s^2	9.8	
Pipe Length	L	L	40	
oss Through Straight Pipe直管部損	h9	m	0.288	$f9 \cdot V^2/(2g)*L/\phi$
(c-9)90 deg Bend	h1t			
Loss Coefficient	f10		0.17	r/D=1.5
G-Force	g	m/s^2	9.8	
Number of Bend	n	units	6	
Loss by 90 deg Bend	h10	n	0.117	$f10 \cdot V^2/(2g)*n$
(c-10)Loss at Outlet	h11			
Loss Coefficient	f11		1	
G-Force	g	m/s2	9.8	
Loss at Outlet	h11	m	0.114	$f11 \cdot V^2/(2g)$
(c-11)Required Water Head				
Loss by Backwash		m	0.918	
Loss through Backwash Pipes	R12	m	0.922	
Overflow Height	ht	m	0.024	
Required Space above Wash Water Drain		m	1.864	
Bottom Elevation of Rough Filter			281.75	
Trough Setting Elevation			284.32	
Wash Water Tank Bottom Elevation			291.00	
Rough Filter H.W.L				
Rough Filter L.W.L				
Level of Pump Well			283.52	
Water Level of Outlet			283.52	

Item		Unit		Remarks
ugh Filters to Slow Sand Filters)				
(d-1) Loss at Outlet of Rough Fil	h1			
Flow Rate	V's	m3/s	0.050	
Diameter	D2	m	0.3	
Flow velocity	V	m/s	0.708	
Loss Coefficient	f1		0.5	
G-Force	g	m/s2	9.8	
Loss at Outlet	h1	m	0.013	$f1 \cdot V^2/(2g)$
(d-2)Loss through Straight Pipes	h2			
Diameter	D2	m	0.3	
Flow velocity	V	m/s	0.708	
Loss Coefficient	f2		0.0325	$(0.02+0.0005/\phi)*1.5$
G-Force	9	m/S2	9.8	
Pipe Length	L	m	15	
Loss through Straight Pipes	h2	m	0.042	$f2 \cdot V^2/(2g)*L/\phi$
(d-3)90 deg. Bend	h3			
Loss Coefficient	f3		0.17	r/D=1.5
G-Force	9	m/S2	9.8	
Number of Bends	n	units	3	
Loss by 90 deg Bend	h3	m	0.013	$f3 \cdot V^2/(2g)*n$
(d-4)Loss at Outlet	h4			
Loss Coefficient	f4		1	
G-Force	9	m/s2	9.8	
Loss at Outlet	h4	m	0.026	$f4 \cdot V^2/(2g)$
Total of Loss			0.093	
Water Level at Inlet of Slow Sand Filters			283.41	283.52-0.093-additional
(4)Loss in Slow Sand Filters				
(a)Basic Configuration				
Water Level			283.41	
Flow Rate (in Normal Operation)	Q's	m3/s	0.013	Intake Volume/4Filters
low Rate (in Scraping Surface Sand	Q"s	m3/s	0.017	Intake Volume/3Filters
Filtration Rate (in Normal Operation)	V'd	m/d	4.68	
Filtration Rate (in Scraping Surface Sand)	V"d	m/d	6.24	
Filtration Rate (in Normal Operation)	V's	m/s	5.41877E-05	
Filtration Rate (in Scraping Surface Sand)	V"s	m/s	7.22503E-05	
(b-1)Loss by Inlet Valve				
Diameter	D1	m	0.15	
Flow Velocity	V"	m/s	0.944	
Loss Coefficient	f1		0.52	
Loss by Butterfly Valve	h1	m	0.024	
(b-2)Loss by Fine Sand Layer	h2			
Thickness	H2	m	1.00	
Shape Factor	GD		343.68	24/Re+3/Re^0.5+0.34
Porosity of Sand	λ		0.45	
Shape Factor	α/β		5.5	
Grain Size in Diameter	Dp	m	0.001	
Reynolds Number	Re		0.072	$V"s \cdot Dp \cdot \gamma/\mu$

Gravity of water	γ		1000	
Kinematic Viscosity	μ		0.001	
Loss through Fine Sand Layer	h2	m	0.000002	0.178・H・CD/g・V"s^2/λ^4・α/β

Hydraulic Analysis of Water Treatment Plant

Item		Unit		Remarks
(b-3)Loss through Gravel Layer	h3			
Thickness of Layer	H3	m	0.4	
Shape Factor	CD		71.767	24/Re+3/Re^0.5+0.34
Porosity of Gravel	λ		0.4	
Shape Factor	α/β		5.5	
Grain Size in diameter	Dp	m	0.005	
Reynolds Number	Re		0.361	V"s・Dp・γ/μ
Gravity of Water	γ		1000	
Kinematic Viscosity	μ		0.001	
Loss through Gravel Layer	h3	m	3.2893E-07	0.178・H・CD/g・V"s^2/λ^4・α/β
(b-4)Loss through Under Drain	h4			
Loss Coefficient	α		0.6	
Opening Ratio of Under Drain	β	%	0.3	
Loss through Under Drain	h4	m	8.22012E-09	1/(2g)・(V"s/(α・β))^2
(b-5)Loss through Water Collecting Pipe				
Loss through Straight Pipes	h5			
Diameter	D	m	0.3	
Flow Velocity	V	m/s	0.236	
Loss Coefficient	f5		0.0325	(0.02+0.0005/ϕ)*1.5
G-Force	9	m/s2	9.8	
Pipe Length	L	L	17	
Loss through Straight Pipes	h5	m	0.005	f5・V^2/(2g)*L/ϕ
(b-6)Loss at Outlet	h6			
Loss Coefficient	f6		1	
G-Force	9	m/s2	9.8	
Loss at Outlet	h6	m	0.0028	f6・V^2/(2g)
Total of Loss		m	0.032	
Additional Coverage		m	0.70	
ater Level at Treated Water channe			282.68	283.41-0.032
			282.07	in consideration of sand surface level
(b-7)Loss at Stop Log		m		
Width of Stop Log	B7	m	0.50	
Loss Coefficient	C		1.84	
Overflow Height	h7	m	0.057	(Q's/(Cb))^(2/3)
To make Free Overflow Weir	h	m	0.43	Assuming 0.43 m for free overflow weir
Level at Outlet of Treated Water C			281.58	
(b-8)Loss by Confluence of Treated Water				
Loss Coefficient	f8		0.5	
Diameter	D	m	0.3	
Flow Velocity	V	m/s	0.354	Q"s/2
Loss by Confluence of Treated Wat	h8	m	0.0019	

Hydraulic Analysis of Water Treatment Plant

Item		Unit		Remarks
(b-9)Loss through Straight Pipes	h9			
Diameter	D9	m	0.3	
Flow Velocity	V	m/s	0.354	Q"s/2
Loss Coefficient	f9		0.0325	(0.02+0.0005/ϕ)*1.5
G-Force	9	m/s^2	9.8	
Pipe Length	L	L	50	
Loss through Straight Pipes	h9	m	0.035	$f9 \cdot V^2/(2g)*L/\phi$
(b-10) Loss at Tee Branch	h10			
Loss Coefficient	f10		1	
G-Force	9	m/s^2	9.8	
Number	n		4	
Loss at Tee Branch	h10	m	0.026	$f10 \cdot V^2/(2g)xn$
(b-11)90 deg. Bend	h11			
Loss Coefficient	f11		0.18	r/D=1.5
G-Force	9	m/s^2	9.8	
Number	n	units	4	
Loss by 90 deg. Bend	h11		0.005	$f11 \cdot V^2/(2g)*n$
(b-12) Loss by Inlet Valve to Cle				
Diameter	D12	m	0.3	
Flow Velocity	V'	m/s	0.708	
Loss Coefficient	f12		0.52	
Loss by Butterfly Valve	h12	m	0.013	
(b—13)Loss at Inlet in Clear Water Reservoir	h13			
Loss Coefficient	f13		1	
G-Force	9	m/s^2	9.8	
Loss at Inlet to Clear Water Reservoir	h13		0.026	$f13 \cdot V^2/(2g)$
Total Loss			0.106	
Water Level in Clear Water Reservoir			281.5	
(5)Clear Water Reservoir				
(a)Basic Configuration				
Water Level			281.5	
(b-1)Loss by Overflow Weir				
Width of weir	B	m	1.2	to each compartment (2locations)
Flow Coefficient	C		1.84	
Overflow Height	h	m	0.050	$(Q's/(CB))^{(2/3)}$
To Free Overflow Weir	h	m	0.15	Add 0.15m to make free overflow weir
ater Level of Clear Water Reservo			281.330	

4-6-3 Appendix 7-3 Hydraulic Analysis of Networks

Annex Hydraulic Analysis

1. Dhulabari Water supply System Hydraulic Analysis Result – Raw Water & Treated Water Transmission pipes

1.1. Analysis Criteria

1.1.1 Flow Rate

Flow rate for calculation is adopted from the result of demand projection (the daily maximum, 4,200 m^3/day in year 2014). However, water for operational use and loss in the treatment plant such as washing filters, solving chemical, contents of water in sludge extracted from sedimentation basin, etc is estimated as 3% of treated water volume and added to the nominal capacity of treatment plant. Therefore the water treatment design flow is 4,320 m^3/day.

The Flow is divided into followings based on the request by Nepal side:

For the existing raw water transmission pipeline: 17 liter per second (1,469 m^3/day)

For the new raw water transmission pipeline: 33 liter per second (2,851 m^3/day)

For hydraulic calculation the two pipelines are assumed as a combined single pipeline because the both pipelines alignment is in parallel and inflow and outflow points are common facilities for the both.

1.1.2 Pipe Materials, Diameter, and Roughness Factor

Existing raw water transmission pipeline: HDPE ND200mm (C=120)

New raw water transmission pipeline: HDPE ND200mm and ND150mm (C=120)

However, actual inside diameter of HDPE is used for calculation, for example 170mm for ND200mm and 120 mm for ND150mm.

1.1.3 Calculation Cases

The existing pipeline is renamed as a raw water transmission in the upstream segment between the intake and the treatment plant and a treated water transmission in the downstream segment between the treatment plant and the existing elevated tank respectively because the new treatment plant is to be constructed between the intake and the existing elevated tank. The new elevated tank is to be constructed in the center of the city, thus a new treated water transmission pipeline from the new treatment plant or the existing elevated tank to the new tank is required. The pipelines are hydraulically examined in the following cases:

Case-1： Use the existing pipeline for whole flow rate, however the new pipeline is used between the existing and the new elevated tanks.

Case-2： Use both the existing and new pipelines assuming the both as a combined pipeline.

Case-3： Use the new pipeline for whole flow rate.

1.2 Calculation Result

Case-1： The existing pipeline will be able to stream at the whole flow rate, 50 liter per second, from the

intake to the new treatment plant, however residual water head at the receiving well in the treatment plant is small i.e. 2.8 m and flow velocity of the pipeline is high i.e. 2.2 m/sec. Downstream of the existing pipeline is not able to stream at the whole flow rate.

Case-2： If flow rate set at 36 liter per second (3,110 m^3/day) in the existing pipeline and 14 liter per second (1,210 m^3/day) in the new pipeline assumed as ND150mm, the whole rate flows through the combined pipeline. If a new pipeline with ND200mm is installed in downstream from treatment plant, the same flow rates as the above are applied to the existing and the new pipelines respectively.

Case-3： If a new raw water transmission pipeline with ND200mm and a new treated water transmission pipeline with ND250mm are applied, water at whole rate flows through new pipelines. HDPE having larger than 200mm in diameter is not available in the local market, thus DIP or SP is to be used.

1.3 Conclusion

The calculation results shows that the existing pipeline has capacity for streaming the whole water rate from the intake to the new water treatment plant, however it has also weakness of protection of the pipeline as well as not enough earth cover at Timai river crossing. Nepal side requested to add a new pipeline for water increased in demand. Therefore, the existing and new pipelines are to be used for the transmission pipeline except Timai river crossing pipeline which is to have enough capacity for the whole flow rate against flushing the existing pipeline out by the river.

New Raw Water Transmission Pipeline：

HDPE ND150mm x 2,675m
SP ND150mm x 20m (crossing a branch of Timai river)
SP ND200mm x 135m (Timai river crossing)

New Treated Water Transmission Pipeline：

HDPE ND200mm x 8,950m
SP ND200mm x 25m(crossing a stream)

Dhulabari Water Supply System (Case-1)

	New Pipes		Existing Pipes	
	Raw Water Transmission	Treated Water Transmission	Raw Water Transmission	Treated Water Transmission
Elevation at inflow (m)	108.91		380	280
Coefficient	120		120	120
Pipe Diameter (m)	0.170		0.170	0.170
Flow Rate (m3/s)	0.032		0.050	0.049
Pipe Length (m)	3640		2830	5335
Loss Height (m)	53.07		94.21	171.09
Velocity (m/s)	1.41		2.2	2.16
Water Head at inlet to the existing elevated tank (m)				108.91
Elevation at outflow (m)	160		283	195
Residual Water Head (m)	-104.16		2.79	-86.09
Hazen - Williams Formula				

Dhulabari Water Supply System (Case-2)

	New Pipes			Existing Pipes	
	Raw Water Transmission	Treated Water Transmission (WTP to Ex.Tank)	Treated Water Transmission (Ex.Tank to New Tank)	Raw Water Transmission	Treated Water Transmission (WTP to Ex.Tank)
Elevation at inflow (m)	380	280	230.73	380	280
Coefficient	120	120	120	120	120
Pipe Diameter (m)	0.12	0.17	0.17	0.17	0.17
Flow Rate (m3/s)	0.014	0.025	0.032	0.036	0.025
Pipe Length (m)	2830	5335	3640	2830	5335
Loss Height (m)	48.76	49.27	53.07	51.31	49.27
Velocity (m/s)	1.24	1.1	1.41	1.59	0.51
Elevation at outflow (m)	283	195	160	283	195
Residual Water Head (m)	48.24	35.73	17.66	45.69	35.73

Hazen - Williams Formula

Dhulabari Water Supply System (Case-3)

	New Pipes			Existing Pipes	
	Raw Water Transmission	Treated Water Transmission	Treated Water Transmission	Raw Water Transmission	Treated Water Transmission
Elevation at inflow (m)	380	280	202.47		
Coefficient	120	120	120		
Pipe Diameter (m)	0.17	0.200	0.200		
Flow Rate (m3/s)	0.050	0.049	0.032		
Pipe Length (m)	2830	5335	3640		
Loss Height (m)	94.21	77.53	24.05		
Velocity (m/s)	2.2	1.56	1.02		
Water Head at inlet to the existing elevated tank (m)		202.47			
Elevation at outflow (m)	283	195	160		
Residual Water Head (m)	2.79	7.47	18.42		
Hazen - Williams Formula					

2. Dhulabari Water Supply System Hydraulic Calculation of Distribution Pipe Networks

2.1 Calculation Criteria

2.1.1 Flow Rate

The result of demand projection i.e. the daily maximum 4,200 m^3/day in year 2014 is applied for calculation.

Calculation criteria are as follows:

1) Data of pipes and flow rate from/into nodes (component of pipe network connected with pipes) which constitute pipe network are based on the original calculation described in the design report.
2) Flow rates from nodes i.e. outflow and inflow is estimated separately in the existing supply area and in supply expansion area. Increase of population served and water consumption per capita are estimated to meet the projected daily maximum water demand in the existing supply area. Water demand is estimated by multiplying projected or surveyed population served by projected water consumption per capita in the expansion area.
3) Hourly maximum water demand is estimated by multiplying daily maximum water demand by the peak factor. The peak factor is 3.0 as a standard in Nepal, however the peak factor indicates the ratio of hourly maximum to hourly average in the day of the maximum demand and generally used to grasp hydraulic characteristic of principal pipes in pipe network such as distribution main pipes. In fact, the peak factor means that a ratio of water users open faucets at the same time to average use, but not increase of water flow of service pipes such as house connection pipes and tertiary pipes. Therefore the result of hydraulic calculation of service pipes will be neglected.
4) Minimum Water Head at a node
   Minimum Water Head at a node is set at 10m. To meet this hydraulic criterion, augmentation of the pipe network is planned. However, the service pipes mentioned above will not be taken consideration for augmentation of the pipe network.

2.1.2 Roughness factor of Pipes

Hazen-Williams Formula is applied to hydraulic calculation. Roughness factor of inner surface of pipes as 120 is applied.

2.1.3 Calculation Cases

Case-1：Calculation based on the present pipe networks with the designed flow.

Case-2：After augmentation of pipe network based on the result of Case-1, recalculation is made.

2.2 Results

Case-1： Almost all of water head of nodes show minus.

The minimum water head is －182.8m in the southwest area of the city.

Case-2： The minimum water head is +8.5 m in the center of the city.

The maximum water head is + 30.1m in the south area of the city where ground elevation is lower than others.

2.3 Conclusion

Augmentation of principle pipes in the network such as main pipes in the both directions i.e. north to south direction and east to west improves hydraulic condition in the southwest area of the city where water pressure is not enough. In addition, installation of new pipeline forming a loop improves in the southeast area of the city where water pressure is not enough. And improvement of pipe network in the northwest and the northeast will be necessary as shown in Fig.-1.

In conclusion of discussion between study team and Nepal side, improvement works for principle pipelines and pipes to high water demand area due to not enough distribution capacity are prioritized in the project.

Result

New Distribution Pipes：DIP ND 300mm x 80m

DIP ND 250mm x 1,520m

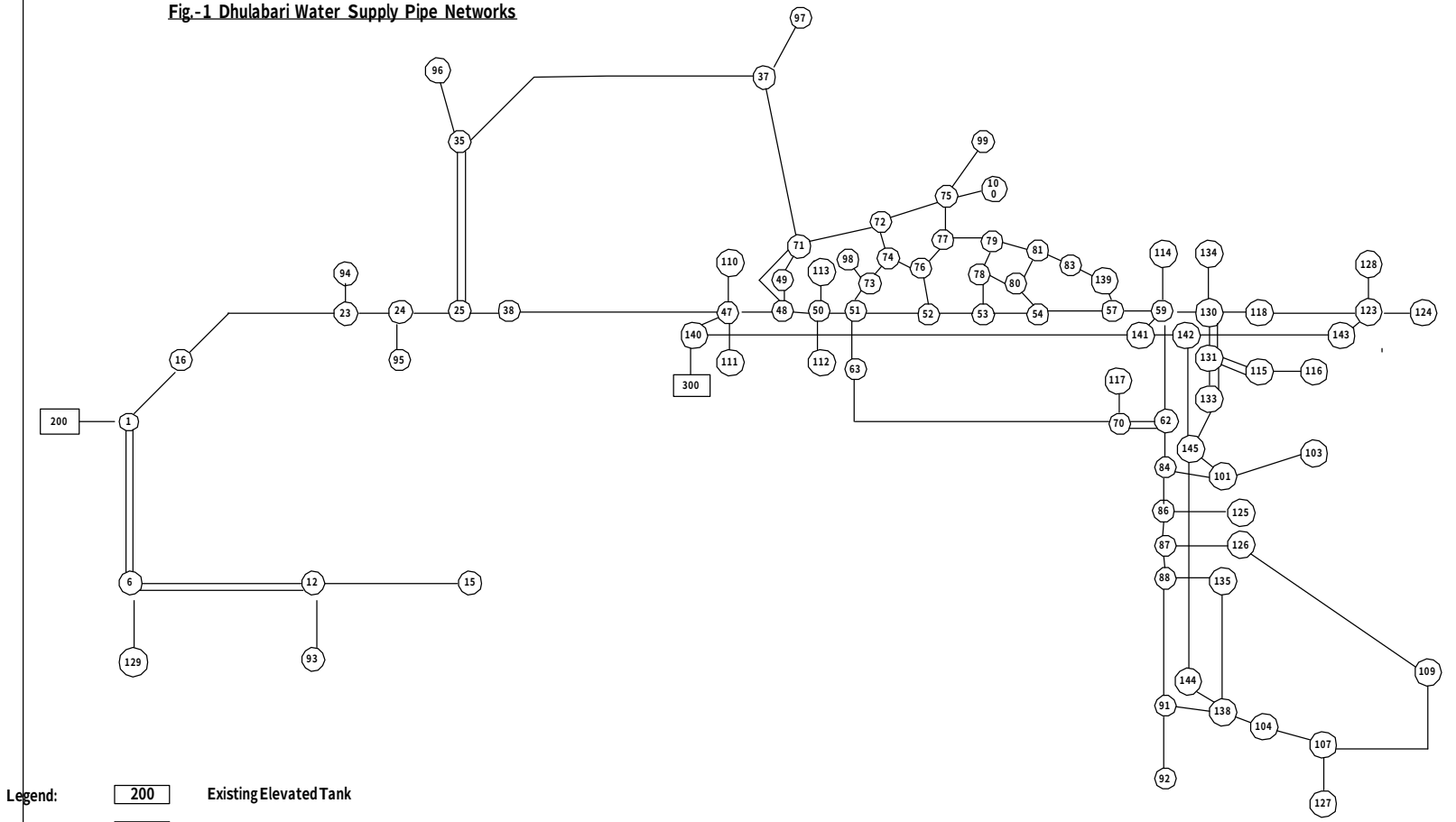
DIP ND 150mm x 3,085m

DIP ND 100mm x 880m

HDPE ND 75mm x 1,000m

SP ND150mm x 130m (Timai river crossing)

Fig.-1 Dhulabari Water Supply Pipe Networks



Hydraulic Calculation Result

Nos of nodes	147
Nos of pipes	170

NODE NO	Type	Q l/sec	WL m	GL m	EH m
200	1	-81.346	192.70	170.00	22.70
1	0	0.511	192.06	169.70	22.36
2	0	1.022	190.28	170.10	20.18
3	0	0.681	189.39	170.20	19.19
4	0	0.681	188.64	171.30	17.34
5	0	1.022	185.84	171.70	14.14
6	0	0.681	184.14	171.80	12.34
7	0	0.681	181.05	170.10	10.95
8	0	1.022	177.65	168.50	9.15
9	0	1.022	175.61	166.50	9.11
10	0	1.022	174.97	164.50	10.47
11	0	1.022	174.93	162.90	12.03
12	0	1.022	175.00	160.50	14.50
13	0	1.022	172.14	157.50	14.64
14	0	1.022	162.37	155.50	6.87
15	0	0.511	160.10	153.80	6.30
16	0	0.681	191.36	168.90	22.46
17	0	1.022	188.63	166.50	22.13
18	0	1.022	185.40	163.70	21.70
19	0	1.022	182.83	161.40	21.43
20	0	1.022	180.33	159.20	21.13
21	0	0.681	178.60	158.90	19.70
22	0	1.022	176.28	156.80	19.48
23	0	0.681	173.98	155.40	18.58
24	0	0.681	172.84	154.00	18.84
25	0	0.681	171.41	153.00	18.41
26	0	0.681	169.01	154.20	14.81
27	0	1.022	166.77	149.80	16.97
28	0	1.022	165.22	149.30	15.92
29	0	0.681	162.97	149.80	13.17
30	0	0.681	161.23	147.60	13.63
31	0	1.022	159.87	145.30	14.57
32	0	0.681	159.65	144.50	15.15
33	0	0.681	159.64	142.80	16.84
34	0	1.022	159.77	142.30	17.47

	35	0	0.681	160.60	140.60	20.00	
	36	0	1.022	160.00	139.50	20.50	
	37	0	0.681	159.97	139.20	20.77	
	38	0	0.681	170.03	150.20	19.83	
	39	0	0.681	168.68	148.70	19.98	
	40	0	0.681	168.03	147.90	20.13	
	41	0	0.681	166.79	146.00	20.79	
	42	0	0.681	165.61	144.00	21.61	
	43	0	0.681	165.04	143.80	21.24	
	44	0	1.022	163.94	141.60	22.34	
	45	0	0.681	163.23	139.60	23.63	
	46	0	0.681	162.47	139.40	23.07	
	47	0	0.681	161.60	137.40	24.20	
	48	0	1.022	160.56	136.60	23.96	
	49	0	1.022	160.30	134.70	25.60	
	50	0	1.022	159.14	136.20	22.94	
	51	0	1.022	158.03	135.00	23.03	
	52	0	1.022	157.85	135.30	22.55	
	53	0	1.022	157.65	133.90	23.75	
	54	0	1.363	157.41	133.00	24.41	
	55	0	1.363	157.22	131.10	26.12	
	56	0	1.363	156.84	128.70	28.14	
	57	0	2.044	155.42	128.80	26.62	
	58	0	0.178	154.69	128.40	26.29	
	59	0	1.022	154.17	127.50	26.67	
	60	0	1.022	152.45	127.90	24.55	
	61	0	1.363	150.22	128.20	22.02	
	62	0	2.044	148.48	127.30	21.18	
	63	0	1.532	153.96	132.30	21.66	
	64	0	1.532	150.80	131.70	19.10	
	65	0	1.532	148.74	134.30	14.44	
	66	0	1.363	147.74	132.10	15.64	
	67	0	1.363	147.34	130.30	17.04	
	68	0	0.681	147.26	130.40	16.86	
	69	0	2.044	147.27	129.20	18.07	
	70	0	2.044	147.87	128.60	19.27	
	71	0	1.022	160.35	133.60	26.75	
	72	0	2.044	141.63	134.90	6.73	
	73	0	1.022	154.60	135.60	19.00	
	74	0	1.022	146.33	134.80	11.53	
	75	0	2.044	135.80	133.80	2.00	
	76	0	2.044	143.58	134.30	9.28	
	77	0	1.703	142.34	133.80	8.54	
	78	0	2.044	149.93	134.30	15.63	
	79	0	2.044	143.72	133.80	9.92	

		80	0	0.681	157.36	133.10	24.26			
		81	0	1.022	156.15	132.20	23.95			
		82	0	1.022	152.55	131.30	21.25			
		83	0	1.022	151.37	130.00	21.37			
		84	0	0.681	148.28	125.60	22.68			
		85	0	1.363	147.26	123.80	23.46			
		86	0	1.363	146.89	124.40	22.49			
		87	0	1.363	146.45	125.10	21.35			
		88	0	1.532	146.18	126.90	19.28			
		89	0	1.022	146.17	125.00	21.17			
		90	0	1.022	146.25	125.20	21.05			
		91	0	1.022	146.74	126.70	20.04			
		92	0	1.022	136.59	125.80	10.79			
		93	0	1.022	161.85	161.30	0.55			
		94	0	1.022	168.69	155.40	13.29			
		95	0	1.022	169.07	154.30	14.77			
		96	0	1.022	156.92	140.90	16.02			
		97	0	1.022	152.08	138.10	13.98			
		98	0	1.022	151.07	136.30	14.77			
		99	0	1.022	123.69	132.30	-8.61			
		100	0	1.022	128.95	133.00	-4.05			
		101	0	1.022	150.73	125.80	24.93			
		102	0	1.022	136.23	124.40	11.83			
		103	0	1.022	110.06	123.00	-12.94			
		104	0	1.022	144.93	125.00	19.93			
		105	0	0.100	143.87	124.80	19.07			
		106	0	1.022	141.24	123.20	18.04			
		107	0	0.681	138.51	122.90	15.61			
		108	0	0.681	135.49	123.80	11.69			
		109	0	1.022	129.28	123.20	6.08			
		110	0	1.022	154.76	137.30	17.46			
		111	0	1.022	150.55	138.10	12.45			
		112	0	0.511	153.70	135.80	17.90			
		113	0	0.511	157.33	135.60	21.73			
		114	0	1.022	145.34	127.00	18.34			
		115	0	1.022	152.04	125.10	26.94			
		116	0	1.022	132.41	124.70	7.71			
		117	0	1.022	142.61	128.80	13.81			
		118	0	1.022	153.03	127.00	26.03			
		119	0	1.532	151.75	126.00	25.75			
		120	0	1.532	151.21	124.60	26.61			
		121	0	1.532	151.13	124.30	26.83			
		122	0	2.044	151.19	123.50	27.69			
		123	0	0.225	153.37	123.30	30.07			
		124	0	1.022	142.84	123.00	19.84			

125	0	1.022	120.01	124.70	-4.69
126	0	1.022	129.63	124.80	4.83
127	0	1.022	130.28	124.00	6.28
128	0	1.022	146.77	123.40	23.37
129	0	1.022	177.52	172.20	5.32
130	0	0.000	153.90	127.50	26.40
131	0	1.363	152.28	127.90	24.38
132	0	1.363	146.58	128.20	18.38
133	0	1.022	150.89	127.30	23.59
134	0	1.022	153.69	137.00	16.69
135	0	0.000	146.08	126.90	19.18
136	0	1.022	143.80	125.00	18.80
137	0	1.022	142.97	125.20	17.77
138	0	1.022	146.90	126.70	20.20
139	0	0.681	151.13	129.50	21.63
140	0	0.000	161.69	137.40	24.29
141	0	0.000	154.23	127.50	26.73
142	0	0.000	154.22	127.50	26.72
143	0	0.000	153.38	123.30	30.08
144	0	0.000	146.94	126.70	20.24
300	1	-61.712	162.00		162.00
145	0	0.000	150.89	127.30	23.59

PIPE

NO(u)	NO(d)	Dia mm	Length m	C	dH m	Q l/sec	V m/sec	I o/oo
200	1	300	88	100		81.35	1.15	7.22
1	2	125	226	100		8.52	0.69	7.89
2	3	125	143	100		7.50	0.61	6.23
3	4	125	143	100		6.81	0.56	5.22
4	5	100	220	100		6.13	0.78	12.74
5	6	100	187	100		5.11	0.65	9.09
6	7	80	165	100		4.19	0.83	18.70
7	8	80	253	100		3.51	0.70	13.47
8	9	80	286	100		2.49	0.50	7.13
9	10	80	237	100		1.47	0.29	2.68
10	11	81	204	120		0.45	0.09	0.20
11	12	81	231	120		-0.58	-0.11	-0.32
12	13	67	226	120		2.56	0.72	12.65
13	14	45	286	120		1.53	0.96	34.17
14	15	36	171	120		0.51	0.50	13.27

		1	16	300	143	100	66.36	0.94	4.95	
		16	17	250	231	100	65.68	1.34	11.81	
		17	18	250	281	100	64.65	1.32	11.47	
		18	19	250	231	100	63.63	1.30	11.14	
		19	20	250	231	100	62.61	1.28	10.81	
		20	21	250	165	100	61.59	1.25	10.49	
		21	22	250	226	100	60.91	1.24	10.27	
		22	23	250	231	100	59.89	1.22	9.96	
		23	24	250	121	100	58.18	1.19	9.44	
		24	25	250	160	100	56.48	1.15	8.93	
		25	26	100	198	100	5.97	0.76	12.13	
		26	27	100	231	100	5.29	0.67	9.70	
		27	28	100	237	100	4.27	0.54	6.52	
		28	29	80	193	100	3.25	0.65	11.66	
		29	30	80	231	100	2.57	0.51	7.54	
		30	31	80	319	100	1.89	0.38	4.26	
		31	32	80	220	100	0.86	0.17	1.01	
		32	33	81	231	120	0.18	0.04	0.04	
		33	34	67	220	120	-0.50	-0.14	-0.61	
		34	35	67	171	120	-1.52	-0.43	-4.84	
		35	36	67	220	120	1.12	0.32	2.75	
		36	37	45	117	120	0.10	0.06	0.21	
		25	38	250	231	100	45.48	0.93	5.98	
		38	39	250	231	100	44.80	0.91	5.82	
		39	40	250	116	100	44.12	0.90	5.66	
		40	41	250	226	100	43.44	0.88	5.50	
		41	42	250	220	100	42.76	0.87	5.34	
		42	43	250	110	100	42.08	0.86	5.18	
		43	44	250	220	100	41.40	0.84	5.03	
		44	45	250	146	100	40.37	0.82	4.80	
		45	46	250	165	100	39.69	0.81	4.65	
		46	47	250	193	100	39.01	0.79	4.51	
		47	48	250	124	100	54.42	1.11	8.34	
		48	50	250	209	100	48.75	0.99	6.80	
		50	51	250	176	100	46.71	0.95	6.29	
		51	52	250	66	100	29.76	0.61	2.73	
		52	53	250	94	100	26.13	0.53	2.15	
		53	54	250	152	100	22.21	0.45	1.59	
		54	55	250	264	100	14.39	0.29	0.71	
		55	56	200	220	100	13.03	0.41	1.76	
		56	57	150	244	100	11.67	0.66	5.81	
		57	58	150	196	100	9.16	0.52	3.71	
		58	59	150	145	100	8.98	0.51	3.58	
		59	60	150	123	100	18.73	1.06	13.96	
		60	61	150	178	100	17.71	1.00	12.58	

		61	62	150	160	100	16.35	0.93	10.85	
		51	63	100	201	100	7.89	1.00	20.28	
		63	64	100	232	100	6.35	0.81	13.60	
		64	65	100	253	100	4.82	0.61	8.16	
		65	66	100	248	100	3.29	0.42	4.02	
		66	67	100	268	100	1.93	0.25	1.50	
		67	68	80	165	100	0.56	0.11	0.46	
		68	69	80	245	100	-0.12	-0.02	-0.03	
		69	70	80	110	100	-2.16	-0.43	-5.49	
		70	62	100	275	100	-2.38	-0.30	-2.20	
		48	49	80	242	100	0.90	0.18	1.08	
		49	71	50	176	100	-0.12	-0.06	-0.28	
		71	72	32	165	100	1.00	1.24	113.46	
		51	73	80	55	100	8.04	1.60	62.38	
		73	74	65	83	100	6.00	1.81	99.68	
		74	72	65	99	100	4.02	1.21	47.47	
		72	75	65	215	100	2.97	0.89	27.14	
		74	76	40	77	100	0.96	0.76	35.74	
		76	77	50	44	100	1.52	0.77	28.19	
		77	75	40	138	100	1.12	0.89	47.41	
		52	76	50	187	100	2.60	1.33	76.34	
		53	78	50	83	100	2.90	1.48	93.08	
		78	79	50	132	100	2.00	1.02	47.02	
		79	77	40	22	100	1.30	1.04	62.81	
		54	80	125	11	100	6.45	0.53	4.72	
		80	78	40	149	100	1.15	0.91	49.88	
		81	79	40	187	100	1.34	1.07	66.48	
		80	81	100	160	100	4.62	0.59	7.55	
		81	82	65	220	100	2.26	0.68	16.36	
		82	83	65	220	100	1.24	0.37	5.37	
		83	139	40	110	100	0.21	0.17	2.23	
		139	57	32	154	100	-0.47	-0.58	-27.88	
		62	84	150	55	100	9.08	0.51	3.65	
		84	85	150	231	100	10.04	0.57	4.40	
		85	86	150	110	100	8.68	0.49	3.36	
		86	87	125	99	100	6.29	0.51	4.51	
		87	88	125	171	100	3.57	0.29	1.58	
		88	89	125	264	100	0.43	0.04	0.03	
		89	90	80	176	100	-0.59	-0.12	-0.49	
		90	91	80	154	100	-1.61	-0.32	-3.18	
		91	92	40	253	100	1.02	0.81	40.13	
		12	93	36	275	120	1.02	1.00	47.84	
		23	94	40	132	100	1.02	0.81	40.13	
		24	95	40	94	100	1.02	0.81	40.13	
		35	96	36	77	120	1.02	1.00	47.84	

		37	97	36	165	120	1.02	1.00	47.84
		73	98	40	88	100	1.02	0.81	40.13
		75	99	36	253	120	1.02	1.00	47.84
		75	100	36	143	120	1.02	1.00	47.84
		84	101	65	270	100	-1.64	-0.49	-9.07
		101	102	50	297	100	2.04	1.04	48.80
		102	103	32	220	100	1.02	1.27	118.96
		138	104	100	209	100	5.21	0.66	9.42
		104	105	100	169	100	4.19	0.53	6.29
		105	106	81	220	120	4.09	0.79	11.98
		106	107	67	154	120	3.07	0.87	17.72
		107	108	45	110	120	1.36	0.86	27.46
		108	109	36	275	120	0.68	0.67	22.59
		47	110	36	143	120	1.02	1.00	47.84
		47	111	36	231	120	1.02	1.00	47.84
		50	112	32	165	100	0.51	0.64	33.00
		50	113	32	55	100	0.51	0.64	33.00
		59	114	40	220	100	1.02	0.81	40.13
		131	115	32	77	100	0.14	0.18	3.09
		115	116	32	165	100	1.02	1.27	118.96
		70	117	36	110	120	1.02	1.00	47.84
		130	118	100	94	100	5.18	0.66	9.32
		118	119	100	206	100	4.16	0.53	6.21
		119	120	100	204	100	2.63	0.33	2.65
		120	121	100	154	100	1.09	0.14	0.53
		121	122	80	220	100	-0.44	-0.09	-0.29
		122	123	67	182	120	-2.48	-0.70	-11.99
		123	124	36	220	120	1.02	1.00	47.84
		86	125	32	226	100	1.02	1.27	118.96
		87	126	32	83	100	1.36	1.69	202.60
		107	127	36	172	120	1.02	1.00	47.84
		123	128	36	138	120	1.02	1.00	47.84
		59	130	125	17	100	12.39	1.01	15.78
		130	131	65	123	100	2.01	0.61	13.22
		131	132	40	178	100	0.90	0.72	32.03
		132	133	32	160	100	-0.46	-0.57	-26.98
		130	134	100	470	100	1.02	0.13	0.46
		88	135	65	11	100	1.60	0.48	8.64
		135	136	65	264	100	1.60	0.48	8.64
		136	137	50	176	100	0.58	0.29	4.70
		137	138	32	154	100	-0.44	-0.55	-25.52
		91	138	80	11	100	-3.65	-0.73	-14.49
		6	129	40	165	100	1.02	0.81	40.13
		300	140	300	100	120	61.71	0.87	3.09
		140	141	250	1890	120	43.58	0.89	3.95

		141	142	250	17	120		19.40	0.40	0.88
		142	143	150	1060	120		4.75	0.27	0.79
		142	145	150	526	120		14.65	0.83	6.32
		141	59	200	15	120		24.19	0.77	3.94
		143	123	150	15	120		4.75	0.27	0.79
		144	138	150	10	120		10.33	0.58	3.31
		71	37	100	500	120		1.60	0.20	0.76
		140	47	150	10	120		18.13	1.03	9.37
		70	62	100	275	120		-2.85	-0.36	-2.20
		48	71	150	418	120		3.75	0.21	0.51
		145	133	100	10	120		-0.39	-0.05	-0.06
		145	101	80	10	120		4.71	0.94	16.53
		145	144	150	1195	120		10.33	0.58	3.31
		126	109	65	1000	120		0.34	0.10	0.35
		1	6	100	919	120		5.96	0.76	8.62
		6	12	100	1376	120		5.17	0.66	6.64
		131	133	80	461	120		1.87	0.37	3.00
		130	131	80	123	120		4.17	0.83	13.22
		131	115	80	77	120		1.90	0.38	3.09
		25	35	100	2251	120		4.34	0.55	4.80
		End								

3. Gauradaha Water Supply System Hydraulic Calculation of Distribution Pipe Networks

3.1 Calculation Criteria

3.1.1 Flow Rate

The result of demand projection i.e. the daily maximum 1,100 m^3/day in year 2014 is applied for calculation.
Calculation criteria are as follows:

5) Data of pipes and flow rate from/into nodes (component of pipe network connected with pipes) which constitute pipe network are based on the original calculation described in the design report.

6) Flow rates from nodes i.e. outflow and inflow is estimated separately in the existing supply area and in supply expansion area. Increase of population served and water consumption per capita are estimated to meet the projected daily maximum water demand in the existing supply area. Water demand is estimated by multiplying projected or surveyed population served by projected water consumption per capita in the expansion area.

7) Hourly maximum water demand is estimated by multiplying daily maximum water demand by the peak factor. The peak factor is 3.0 as a standard in Nepal, however the peak factor indicates the ratio of hourly maximum to hourly average in the day of the maximum demand and generally used to grasp hydraulic characteristic of principal pipes in pipe network such as distribution main pipes. In fact, the peak factor means that a ratio of water users open faucets at the same time to average use, but not increase of water flow of service pipes such as house connection pipes and tertiary pipes. Therefore the result of hydraulic calculation of service pipes will be neglected.

8) Minimum Water Head at a node
Minimum Water Head at a node is set at 10m. To meet this hydraulic criterion, augmentation of the pipe network is planned. However, the service pipes mentioned above will not be taken consideration for augmentation of the pipe network.

3.1.2 Roughness factor of Pipes

Hazen-Williams Formula is applied to hydraulic calculation. Roughness factor of inner surface of pipes as 120 is applied.

3.1.3 Calculation Cases

Case-1：Calculation based on the present pipe networks with the designed flow.
Case-2：After augmentation of pipe network based on the result of Case-1, recalculation is made.
Case-3：Alternative augmentation plan to Case-2

3.2 Results

Case-1： Almost all of water head of nodes show minus.

The minimum water head is －41.1m in the south area of the city.

Case-2： Augmentation of the existing pipeline i.e. new pipelines installation in parallel to existing pipelines is necessary for almost all of principal distribution pipelines. The minimum water head is +8.9 m in the east area of the city.

The maximum water head is + 14.9 m in the south area of the city where ground elevation is lower than others.

Case-3： A new pipeline interconnecting the existing elevated tank with the existing pipeline along the main road which passes the area from the north to south is planned. This pipeline installation improves hydraulic condition in pressure of the south and southwest area of the city. The minimum water head is +6.8 m in the east area of the city. The maximum water head is + 14.7 m at vicinity to the existing elevated tank.

3.4 Conclusion

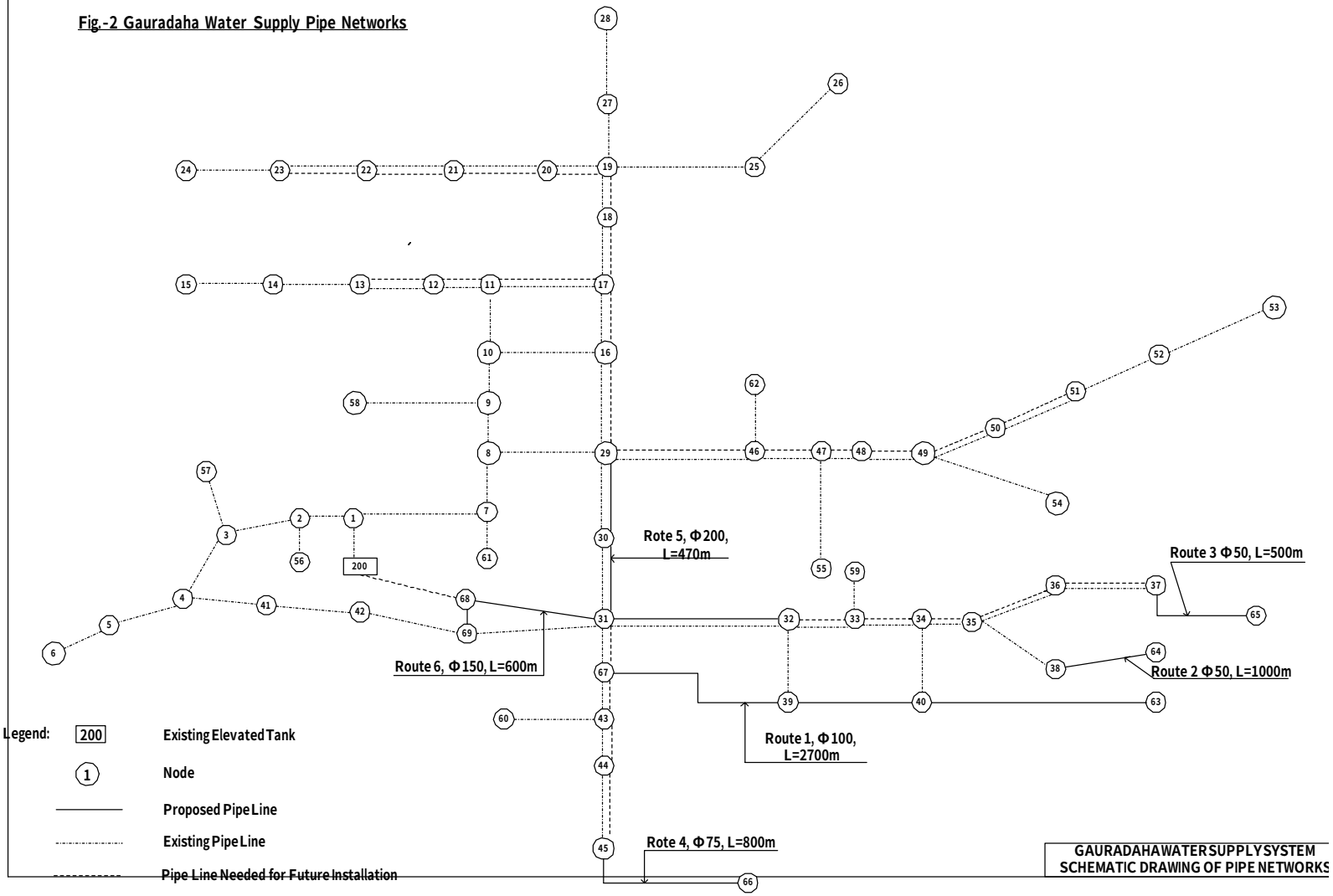
The result of calculation for Case-2 shows that augmentation for almost all of principal distribution pipelines is necessary. Pipeline looping in network improves hydraulic condition. However, augmentation of principle pipelines extended as arborescens in flange area is necessary as same as the Case-2 as shown in Fig.-2.

In conclusion of discussion between study team and Nepal side, improvement works for principle pipelines and pipes to high water demand area due to not enough distribution capacity are prioritized in the project.

Result

New distribution pipeline ： HDPE ND 150mm x 1,070m
HDPE ND 100mm x 2,700m
HDPE ND 75mm x 800m
HDPE ND 50mm x 1500m

Fig.-2 Gauradaha Water Supply Pipe Networks



Hydraulic Calculation Result

Case-2

Nos of nodes	70
Nos of pipes	107

NODE NO	Type	Q l/sec	WL m	GL m	EH m
1	0	0.220	115.95	100.91	15.04
2	0	0.220	115.78	101.14	14.64
3	0	0.440	113.99	101.98	12.01
4	0	0.440	111.20	102.79	8.41
5	0	0.440	106.76	103.24	3.52
6	0	0.440	98.10	103.84	-5.74
7	0	0.660	114.19	100.90	13.29
8	0	0.440	114.04	100.84	13.20
9	0	0.440	113.76	100.84	12.92
10	0	0.440	113.57	100.48	13.09
11	0	0.660	112.58	100.32	12.26
12	0	0.440	112.50	99.87	12.63
13	0	0.660	112.26	101.14	11.12
14	0	0.440	108.09	101.65	6.44
15	0	0.440	104.19	102.14	2.05
16	0	0.660	112.95	101.06	11.89
17	0	0.880	112.58	100.62	11.96
18	0	1.100	112.33	100.25	12.08
19	0	0.440	111.99	100.38	11.61
20	0	0.660	111.92	100.80	11.12
21	0	1.100	111.55	101.33	10.22
22	0	0.440	111.37	101.74	9.63
23	0	0.660	111.16	101.52	9.64
24	0	0.880	104.79	101.85	2.94
25	0	0.660	110.05	100.34	9.71
26	0	0.660	108.27	100.15	8.12
27	0	0.440	109.19	100.29	8.90
28	0	0.440	105.16	99.96	5.20
29	0	0.660	112.95	100.86	12.09
30	0	0.880	112.33	100.51	11.82
31	0	1.760	111.32	100.91	10.41
32	0	0.440	111.18	100.48	10.70

33	0	0.440	111.06	99.98	11.08			
34	0	0.440	110.94	99.76	11.18			
35	0	0.440	110.88	99.56	11.32			
36	0	0.440	109.86	98.90	10.96			
37	0	0.660	108.76	98.11	10.65			
38	0	0.660	105.27	98.85	6.42			
39	0	0.880	110.87	99.60	11.27			
40	0	0.660	110.78	100.06	10.72			
41	0	0.660	110.37	102.38	7.99			
42	0	0.220	110.62	102.10	8.52			
43	0	1.100	111.05	100.67	10.38			
44	0	0.660	110.77	99.06	11.71			
45	0	0.440	110.69	98.86	11.83			
46	0	1.100	112.59	99.89	12.70			
47	0	0.660	112.40	98.26	14.14			
48	0	0.440	112.24	97.44	14.80			
49	0	0.440	112.13	97.20	14.93			
50	0	0.440	110.87	96.23	14.64			
51	0	0.660	109.65	96.18	13.47			
52	0	0.440	101.11	95.34	5.77			
53	0	0.660	96.78	95.24	1.54			
54	0	0.440	109.05	96.88	12.17			
55	0	0.440	102.80	97.70	5.10			
56	0	0.440	97.01	101.27	-4.26			
57	0	0.440	106.55	101.82	4.73			
58	0	0.660	102.93	101.69	1.24			
59	0	0.440	78.72	99.85	-21.13			
60	0	0.440	108.30	100.63	7.67			
61	0	0.440	107.86	101.24	6.62			
62	0	0.440	100.16	99.95	0.21			
200	1	-38.060	116.00		116.00			
63	0	0.220	110.74	98.11	12.63			
64	0	0.220	103.95	98.11	5.84			
65	0	0.660	103.73	98.11	5.62			
66	0	0.660	108.75	98.86	9.89			
67	0	0.000	111.11	100.67	10.44			
68	0	0.000	111.31	102.10	9.21			
69	0	0.000	111.31	102.10	9.21			

PIPE NO(u)	NO(d)	Dia mm	Length m	C	dH m	Q l/sec	V m/sec	I o/oo
200	1	250	15	120		38.06	0.78	3.07
1	2	99	55	120		3.37	0.44	3.15

	2	3	81	321	120	2.71	0.52	5.58
	3	4	67	411	120	1.83	0.52	6.79
	4	5	42	259	120	0.88	0.64	17.12
	5	6	27	212	120	0.44	0.77	40.85
	1	7	143	441	120	10.09	0.63	4.00
	7	8	143	41	120	9.76	0.61	3.77
	8	9	126	30	120	11.33	0.91	9.18
	9	10	126	25	120	10.23	0.82	7.60
	10	11	81	278	120	2.13	0.41	3.58
	11	12	67	113	120	0.52	0.15	0.67
	12	13	53	440	120	0.25	0.11	0.53
	13	14	42	244	120	0.88	0.64	17.12
	14	15	34	293	120	0.44	0.48	13.29
	10	16	126	140	120	7.66	0.61	4.45
	16	17	112	255	120	3.06	0.31	1.44
	17	18	112	235	120	2.58	0.26	1.05
	18	19	99	359	120	1.76	0.23	0.94
	19	20	99	70	120	1.87	0.24	1.06
	20	21	81	321	120	1.14	0.22	1.13
	21	22	67	273	120	0.52	0.15	0.67
	22	23	53	393	120	0.25	0.11	0.53
	23	24	42	372	120	0.88	0.64	17.12
	19	25	53	166	120	1.32	0.60	11.68
	25	26	42	177	120	0.66	0.48	10.06
	27	28	34	303	120	0.44	0.48	13.29
	19	27	53	508	120	0.88	0.40	5.52
	8	29	112	145	120	7.44	0.76	7.49
	29	30	99	179	120	3.56	0.46	3.48
	30	31	99	330	120	3.31	0.43	3.06
	31	32	99	220	120	1.41	0.18	0.63
	32	33	81	197	120	0.83	0.16	0.62
	33	34	67	250	120	0.44	0.12	0.48
	34	35	67	152	120	0.37	0.10	0.35
	35	36	42	260	120	0.40	0.29	3.95
	36	37	42	473	120	0.30	0.22	2.32
	35	38	42	328	120	0.88	0.64	17.12
	32	39	42	382	120	0.17	0.12	0.80
	34	40	42	373	120	0.12	0.09	0.42
	4	41	53	419	120	0.51	0.23	1.98
	41	42	42	369	120	-0.15	-0.11	-0.69
	42	69	42	196	120	-0.37	-0.27	-3.53
	69	31	42	400	120	-0.01	-0.01	-0.01
	31	67	81	300	120	0.87	0.17	0.69
	43	44	53	409	120	0.28	0.13	0.68

	44	45	34	206	120	0.06	0.07	0.36
	29	46	81	322	120	1.13	0.22	1.11
	46	47	81	306	120	0.85	0.16	0.65
	47	48	81	403	120	0.64	0.12	0.39
	48	49	67	296	120	0.37	0.10	0.35
	49	50	53	293	120	0.77	0.35	4.32
	50	51	53	426	120	0.62	0.28	2.86
	51	52	42	330	120	1.10	0.79	25.87
	52	53	34	154	120	0.66	0.73	28.14
	49	54	34	232	120	0.44	0.48	13.29
	47	55	27	235	120	0.44	0.77	40.85
	2	56	19	83	120	0.44	1.55	226.14
	3	57	27	182	120	0.44	0.77	40.85
	9	58	34	385	120	0.66	0.73	28.14
	33	59	19	143	120	0.44	1.55	226.14
	43	60	34	207	120	0.44	0.48	13.29
	7	61	19	28	120	0.44	1.55	226.14
	46	62	19	55	120	0.44	1.55	226.14
	16	29	67	19	120	-0.22	-0.06	-0.14
	11	17	34	235	120	-0.01	-0.01	-0.02
	67	39	99	350	120	1.47	0.19	0.68
	39	40	99	447	120	0.76	0.10	0.20
	40	63	99	2003	120	0.22	0.03	0.02
	38	64	42	1000	120	0.22	0.16	1.32
	37	65	42	500	120	0.66	0.48	10.06
	67	43	81	50	120	1.22	0.24	1.29
	29	30	143	179	120	9.36	0.58	3.48
	30	31	143	330	120	8.72	0.54	3.06
	67	43	99	50	120	2.08	0.27	1.29
	31	32	143	220	120	3.72	0.23	0.63
	45	66	53	600	120	0.66	0.30	3.24
	32	33	143	197	120	3.69	0.23	0.62
	33	34	143	250	120	3.20	0.20	0.48
	34	35	143	152	120	2.71	0.17	0.35
	31	67	143	300	120	3.90	0.24	0.69
	35	36	67	260	120	1.36	0.39	3.95
	36	37	67	473	120	1.02	0.29	2.32
	43	44	99	409	120	1.48	0.19	0.68
	44	45	99	206	120	1.04	0.13	0.36
	29	46	143	322	120	5.03	0.31	1.11
	46	47	143	306	120	3.77	0.24	0.65
	47	48	143	403	120	2.88	0.18	0.39
	48	49	143	296	120	2.71	0.17	0.35
	49	50	67	293	120	1.43	0.41	4.32

	50	51	67	426	120	1.14	0.32	2.86
	29	16	143	19	120	1.65	0.10	0.14
	16	17	143	255	120	5.82	0.36	1.44
	17	18	143	235	120	4.90	0.31	1.05
	18	19	143	359	120	4.62	0.29	0.94
	17	11	143	235	120	0.50	0.03	0.02
	19	20	99	70	120	1.87	0.24	1.06
	20	21	99	321	120	1.94	0.25	1.13
	21	22	99	273	120	1.46	0.19	0.67
	22	23	99	393	120	1.29	0.17	0.53
	11	12	99	113	120	1.46	0.19	0.67
	12	13	99	440	120	1.29	0.17	0.53
	68	31	143	400	120	-0.36	-0.02	-0.01
	68	69	143	10	120	0.36	0.02	0.01
	1	7	200	441	120	24.39	0.78	4.00
	7	8	200	41	120	23.61	0.75	3.77
	8	29	143	145	120	14.16	0.88	7.49
	End							

Case-3

Nos of nodes	70
Nos of pipes	105

NODE NO	Type	Q l/sec	WL m	GL m	EH m
1	0	0.220	115.99	100.91	15.08
2	0	0.220	115.84	101.14	14.70
3	0	0.440	114.37	101.98	12.39
4	0	0.440	112.30	102.79	9.51
5	0	0.440	107.86	103.24	4.62
6	0	0.440	99.20	103.84	-4.64
7	0	0.660	111.83	100.90	10.93
8	0	0.440	111.49	100.84	10.65
9	0	0.440	111.31	100.84	10.47
10	0	0.440	111.19	100.48	10.71
11	0	0.660	110.44	100.32	10.12
12	0	0.440	110.37	99.87	10.50
13	0	0.660	110.13	101.14	8.99
14	0	0.440	105.95	101.65	4.30
15	0	0.440	102.06	102.14	-0.08
16	0	0.660	110.84	101.06	9.78

	17	0	0.880	110.45	100.62	9.83			
	18	0	1.100	110.20	100.25	9.95			
	19	0	0.440	109.87	100.38	9.49			
	20	0	0.660	109.79	100.80	8.99			
	21	0	1.100	109.43	101.33	8.10			
	22	0	0.440	109.24	101.74	7.50			
	23	0	0.660	109.03	101.52	7.51			
	24	0	0.880	102.66	101.85	0.81			
	25	0	0.660	107.93	100.34	7.59			
	26	0	0.660	106.15	100.15	6.00			
	27	0	0.440	107.06	100.29	6.77			
	28	0	0.440	103.04	99.96	3.08			
	29	0	0.660	110.86	100.86	10.00			
	30	0	0.880	110.99	100.51	10.48			
	31	0	1.760	111.30	100.91	10.39			
	32	0	0.440	111.16	100.48	10.68			
	33	0	0.440	111.04	99.98	11.06			
	34	0	0.440	110.92	99.76	11.16			
	35	0	0.440	110.86	99.56	11.30			
	36	0	0.440	109.84	98.90	10.94			
	37	0	0.660	108.74	98.11	10.63			
	38	0	0.660	105.25	98.85	6.40			
	39	0	0.880	110.85	99.60	11.25			
	40	0	0.660	110.76	100.06	10.70			
	41	0	0.660	112.10	102.38	9.72			
	42	0	0.220	113.77	102.10	11.67			
	43	0	1.100	111.03	100.67	10.36			
	44	0	0.660	110.75	99.06	11.69			
	45	0	0.440	110.67	98.86	11.81			
	46	0	1.100	110.50	99.89	10.61			
	47	0	0.660	110.30	98.26	12.04			
	48	0	0.440	110.14	97.44	12.70			
	49	0	0.440	110.04	97.20	12.84			
	50	0	0.440	108.77	96.23	12.54			
	51	0	0.660	107.56	96.18	11.38			
	52	0	0.440	99.02	95.34	3.68			
	53	0	0.660	94.68	95.24	-0.56			
	54	0	0.440	106.96	96.88	10.08			
	55	0	0.440	100.70	97.70	3.00			
	56	0	0.440	97.07	101.27	-4.20			
	57	0	0.440	106.93	101.82	5.11			
	58	0	0.660	100.47	101.69	-1.22			
	59	0	0.440	78.70	99.85	-21.15			
	60	0	0.440	108.28	100.63	7.65			

61	0	0.440	105.49	101.24	4.25			
62	0	0.440	98.06	99.95	-1.89			
200	1	-38.060	116.00		116.00			
63	0	0.220	110.72	98.11	12.61			
64	0	0.220	103.93	98.11	5.82			
65	0	0.660	103.71	98.11	5.60			
66	0	0.660	108.73	98.86	9.87			
67	0	0.000	111.09	100.67	10.42			
68	0	0.000	115.67	102.10	13.57			
69	0	0.000	115.67	102.10	13.57			

PIPE

NO(u)	NO(d)	Dia mm	Length m	C	dH m	Q l/sec	V m/sec	I o/oo
200	1	250	15	120		19.35	0.39	0.88
1	2	99	55	120		3.09	0.40	2.69
2	3	81	321	120		2.43	0.47	4.58
3	4	67	411	120		1.55	0.44	5.03
4	5	42	259	120		0.88	0.64	17.12
5	6	27	212	120		0.44	0.77	40.85
1	7	143	441	120		16.04	1.00	9.44
7	8	143	41	120		14.94	0.93	8.27
8	9	126	30	120		8.95	0.72	5.94
9	10	126	25	120		7.85	0.63	4.66
10	11	81	278	120		1.82	0.35	2.69
11	12	67	113	120		0.52	0.15	0.67
12	13	53	440	120		0.25	0.11	0.53
13	14	42	244	120		0.88	0.64	17.12
14	15	34	293	120		0.44	0.48	13.29
10	16	126	140	120		5.59	0.45	2.49
16	17	112	255	120		3.16	0.32	1.54
17	18	112	235	120		2.58	0.26	1.05
18	19	99	359	120		1.76	0.23	0.94
19	20	99	70	120		1.87	0.24	1.06
20	21	81	321	120		1.14	0.22	1.13
21	22	67	273	120		0.52	0.15	0.67
22	23	53	393	120		0.25	0.11	0.53
23	24	42	372	120		0.88	0.64	17.12
19	25	53	166	120		1.32	0.60	11.68
25	26	42	177	120		0.66	0.48	10.06
27	28	34	303	120		0.44	0.48	13.29
19	27	53	508	120		0.88	0.40	5.52
8	29	112	145	120		5.55	0.56	4.35
29	30	99	179	120		-1.52	-0.20	-0.72

	30	31	99	330	120	-1.76	-0.23	-0.95
	31	32	99	220	120	1.41	0.18	0.63
	32	33	81	197	120	0.83	0.16	0.62
	33	34	67	250	120	0.44	0.12	0.48
	34	35	67	152	120	0.37	0.10	0.35
	35	36	42	260	120	0.40	0.29	3.95
	36	37	42	473	120	0.30	0.22	2.32
	35	38	42	328	120	0.88	0.64	17.12
	32	39	42	382	120	0.17	0.12	0.80
	34	40	42	373	120	0.12	0.09	0.42
	4	41	53	419	120	0.23	0.11	0.47
	41	42	42	369	120	-0.43	-0.31	-4.51
	42	69	42	196	120	-0.65	-0.47	-9.71
	69	31	42	400	120	0.69	0.50	10.93
	31	67	81	300	120	0.87	0.17	0.69
	43	44	53	409	120	0.28	0.13	0.68
	44	45	34	206	120	0.06	0.07	0.36
	29	46	81	322	120	1.13	0.22	1.11
	46	47	81	306	120	0.85	0.16	0.65
	47	48	81	403	120	0.64	0.12	0.39
	48	49	67	296	120	0.37	0.10	0.35
	49	50	53	293	120	0.77	0.35	4.32
	50	51	53	426	120	0.62	0.28	2.86
	51	52	42	330	120	1.10	0.79	25.87
	52	53	34	154	120	0.66	0.73	28.14
	49	54	34	232	120	0.44	0.48	13.29
	47	55	27	235	120	0.44	0.77	40.85
	2	56	19	83	120	0.44	1.55	226.14
	3	57	27	182	120	0.44	0.77	40.85
	9	58	34	385	120	0.66	0.73	28.14
	33	59	19	143	120	0.44	1.55	226.14
	43	60	34	207	120	0.44	0.48	13.29
	7	61	19	28	120	0.44	1.55	226.14
	46	62	19	55	120	0.44	1.55	226.14
	16	29	67	19	120	-0.51	-0.14	-0.64
	11	17	34	235	120	-0.02	-0.02	-0.04
	67	39	99	350	120	1.47	0.19	0.68
	39	40	99	447	120	0.76	0.10	0.20
	40	63	99	2003	120	0.22	0.03	0.02
	38	64	42	1000	120	0.22	0.16	1.32
	37	65	42	500	120	0.66	0.48	10.06
	67	43	81	50	120	1.22	0.24	1.29
	29	30	143	179	120	-4.00	-0.25	-0.72
	30	31	143	330	120	-4.64	-0.29	-0.95

	67	43	99	50	120	2.08	0.27	1.29
	31	32	143	220	120	3.72	0.23	0.63
	45	66	53	600	120	0.66	0.30	3.24
	32	33	143	197	120	3.69	0.23	0.62
	33	34	143	250	120	3.20	0.20	0.48
	34	35	143	152	120	2.71	0.17	0.35
	31	67	143	300	120	3.90	0.24	0.69
	35	36	67	260	120	1.36	0.39	3.95
	36	37	67	473	120	1.02	0.29	2.32
	43	44	99	409	120	1.48	0.19	0.68
	44	45	99	206	120	1.04	0.13	0.36
	29	46	143	322	120	5.03	0.31	1.11
	46	47	143	306	120	3.77	0.24	0.65
	47	48	143	403	120	2.88	0.18	0.39
	48	49	143	296	120	2.71	0.17	0.35
	49	50	67	293	120	1.43	0.41	4.32
	50	51	67	426	120	1.14	0.32	2.86
	29	16	143	19	120	3.74	0.23	0.64
	16	17	143	255	120	6.01	0.37	1.54
	17	18	143	235	120	4.90	0.31	1.05
	18	19	143	359	120	4.62	0.29	0.94
	17	11	143	235	120	0.80	0.05	0.04
	19	20	99	70	120	1.87	0.24	1.06
	20	21	99	321	120	1.94	0.25	1.13
	21	22	99	273	120	1.46	0.19	0.67
	22	23	99	393	120	1.29	0.17	0.53
	11	12	99	113	120	1.46	0.19	0.67
	12	13	99	440	120	1.29	0.17	0.53
	68	31	143	400	120	17.37	1.08	10.93
	68	69	143	10	120	1.34	0.08	0.10
	200	68	250	400	120	18.71	0.38	0.83
	End							

4-6-4 Appendix 7-3 Water Quality Examination

SECTION 3
WATER QUALITY EXAMINATION

2.1 INTRODUCTION

Water Quality Examination is the part of the Basic Design Study on the Project for Improvement of Water Supply Facilities in Urban and Semi-urban Centers in the Kingdom of Nepal. This Study has been carried out upon the request of His Majesty's Government of Nepal (HMG/N) to the Government of Japan (GOJ). The Study is implemented by the Japan International Cooperation Agency (JICA).

Accordingly, the Japan International Cooperation Agency (hereinafter referred to as 'JICA'), the official agency responsible for implementation of the technical cooperation programs of the GOJ, through NJS Consultants Co. Ltd. as Engineers is undertaking the Basic Design Study under the supervision of JICA Study Team.

There are various types of surveys to be conducted within the Kingdom of Nepal to prepare the Basic Design for Improvement of Water Supply Facilities in eight selected urban and semi-urban centres of Nepal. These surveys, among others, are listed below:

- Topographic and Route Survey
- Questionnaire Survey
- Water Quality Examination

The Study is being carried out in two phases. The Phase 1 study includes three towns in the Eastern Nepal Namely Dhulabari, Gauradaha in Jhhapa District and Maangadh in Morang District.

Objectives Of The Water Quality Examination

The Objective of the Water Quality Examination is to collect water quality data on water sources and to evaluate suitability if the water treatment processes based on the water quality report.

Scope Of Works

The Water Quality Examination shall include the following parameters:

Ground Water Samples

- Physical:

Turbidity, Color, Conductivity

- Chemical:

Total Dissolved Solids(TDS), pH, Alkalinity, Ammonia (NH4), Phosphorous (P), Iron (Fe), Manganese (Mn), Calcium (Ca), Magnesium (Mg)

- Heavy Metal: Arsenic (As)
- Biological

Coliforms, E- Coli

Surface Water Samples:

- Physical:

Turbidity, Color, Suspended Solids

- Chemical:

Total Dissolved Solids(TDS), pH, Alkalinity, Chloride (Cl), Chemical Oxyzen Demand (COD), Sulphate (SO4), Dissolved Oxygen (DO), Manganese (Mn), Ammonia (NH4), Nitrogen (N), Phosphorous (P), Calcium (Ca), Iron (Fe).

- Biological

Coliforms, E- Coli

Location And Date Of Water Sampling

The location of water sampling and the date of sampling for Water Quality Examination are given below in **Table 3.1.**

Table 3.1: Location & Date of Water Sampling

Name of the Town	Sample Location	Sample Date
Dhulabari	Upstream of existing Intake	June 18, 2005
Gauradaha	Operating well within the compound of Water Tank	June 28, 2005
Maangadh	Operating well within the compound of Water Tank	June 29, 2005

2.2 METHODOLOGY

Samples were collected at the field in different bottles already prepared in Kathmandu to collect relevant samples. For Physical and Chemical examination one liter sample was collected. For examining heavy metals like Fe, Mn, and As; a different sample was collected and HNO3 as preservative was added. For the examination of COD, sample was collected in different bottle and H2SO4 as preservative was added. For the sample collection of DO, MnSO4 and Alkali Azide were added as preservatives. A different sterilized bottle had been used to collect sample for Biological Examination.

Water samples from Dhulabari were immediately transported to Kathmandu for the laboratory testing within 12 hours. Sample from Gauradaha and Maangadh were preserved in a special box made for the preservation and were brought to Kathamndu for laboratory testing within 48 and 24 hours respectively.

The pH was directly measured at site using electronic pH meter and the temperature of water was also measured directly at field in Gauradaha and Maangadh.

2.3 RESULTS

The results of the measurement of pH and temperature at the field are given below in **Table 3.2.**

Table 3.2: Temperature and pH measurements at field

Name of the town	Date	Time	pH	Temperature	Weather
Dhulabari	June 18, 2005	4:00 PM	8.0	-	Cloudy
Gauradaha	June 28, 2005	3:30 PM	6.8	26	Windy and Sunny
Maangadh	June 29, 2005	11:00 AM	7.3	27	Partly Cloudy

The results of all the examined parameters at the laboratory are given in the below Table 3.2

Table 3.2: Results of Water Quality Testing

Parameters	Observed Values			WHO Limits for Drinking Water
	Dhulabari	Gauradaha	Maangadh	
Physical Parameters				
Turbidity (NTU)	2	66	44	5
Color (Chromacity Unit)	0.11	0.07	0.08	15
Conductivity (µmhos/cm)	NA	122	660	
Suspended Solids (mg/l)	<1	NA	NA	
Chemical Parameters				
TDS (mg/l)	70	105	330	1000
pH	7.5	6.3	7	6.5-8.5
Alkalinity (as CaCo3 mg/l)	27.6	62.81	301.5	
NH4 (mg/l)	0.12	ND <0.05)	0.33	1.5
P (mg/l)	0.11	0.06	ND (<0.05)	
Fe (mg/l)	0.15	8.64	2.20	0.3
Mn (mg/l)	ND (<0.05)	0.31	0.56	0.5
Ca (mg/l)	10.82	10.82	80.16	
Mg (mg/l)	NA	0.97	18.5	
Cl (mg/l)	4.11	NA	NA	250
COD (mg/l)	1.5	NA	NA	
SO4 (mg/l)	4.11	NA	NA	250
DO (mg/l)	7.05	NA	NA	
N (mg/l)	1.45	NA	NA	
As (mg/l)	NA	ND (<0.005)	ND (<0.005)	0.01
Biological				
Coliforms (MPN Index/100ml)	1100	Nil	1100	Nil
E-Coli (MPN Index/100ml)	4	Nil	48	Nil

The laboratory test report of each water sample is given in the following pages.

Nepal Environmental & Scientific Services (P.) Ltd.
G.P.O. Box No. 7301, Thapathali, Kathmandu, Nepal
Phone: 00977-1-4244989, 4241001, Fax No.: 977-1-4226028, E-mail: ness@mos.com.np

QS TEST REPORT / CERTIFICATE

NS Accreditation No. Pra. 01/053-54

Entry No. : NCL - 142 (W) (1) - 06 - 2005
Sample : Surface Water
Client : Silt Consultant
Location : Dhulabari, Jhapa

Date Received : 19 - 06 - 2005
Date Completed : 24 - 06- 2005
Sampled By : Client
Sampling Date :

S. N.	Parameters	Observed Values	WHO Limits for Drinking Water
a. Physical Parameters			
1.	pH	7.5	6.5 - 8.5
2.	Turbidity, (NTU)	2	5
3.	Color, (Chromacity Unit)	0.11	15
4	Total Suspended Solids, (mg/l)	<1	-
b. Chemical Parameters			
1.	Total Dissolved Solids, (mg/l)	70	1000
2.	Total Alkalinity as $CaCO_3$, (mg/l)	27.6	-
3.	Chloride, (mg/l)	1	250
4	Sulfate, (mg/l)	4.11	250
5.	Ammonia, (mg/l)	0.12	1.5
6.	Dissolved Phosphate, , (mg/l)	0.11	-
7.	Calcium, (mg/l)	10.82	-
8.	Iron, (mg/l)	0.15	0.3
9.	Manganese, (mg/l)	N. D. (<0.05)	0.5
10.	Dissolved Oxygen, (mg/l)	7.05	-
11.	Chemical Oxygen Demand, , (mg/l)	1.5	-
12.	Total Kzeldahl Nitrogen, (mg/l)	1.46	-
c. Microbiological Parameters			
1.	Total Coliform Count, (MPN Index / 100ml)	1100	Nil
2.	E. Coli, (MPN Index / 100ml)	4	Nil

N. D. / Not Detected

Remarks: The microbial counts exceed the prescribed limits of WHO guidelines for drinking water.

(Analyzed By) (Checked BY)

Authorised Signature

NOTE:
1. The result listed refer only to the tested samples and applicable parameters. Endorsement of products is neither inferred nor implied.
2. Liability of our institute is limited to the invoiced amount.
3. Samples will be destroyed after one month from the date of issue of test certificate unless otherwise specified.
4. This report in not to be reproduced wholly or in part and cannot be used as an evidence in the Court of Law and should not be used in any advertising media without our special permission in writing.
5. This report/certificate is in reference to Laboratory Quality Control Manual, QS (002), Section OPT.
6. The clients are requested to take back their hazardous samples along with the report/certificate.

Nepal Environmental & Scientific Services (P.) Ltd.
G.P.O. Box No. 7301, Thapathali, Kathmandu, Nepal
Phone: 00977-1-4244989, 4241004, Fax No.: 977-1-4226028, E-mail: ness@mos.com.np

QS TEST REPORT / CERTIFICATE

Entry No.	NCL - 159 (W) (7) - 05 - 2005	Date Received	30 - 06 - 2005
Sample	Groundwater	Date Completed	05 - 07 - 2005
Client	Silt Consultant	Sampled By	Client
Location	Mangadh & Gauradaha	Sampling Date	-

S. N.	Parameters	Observed Values		WHO Limits for Drinking Water
		Mangadh	Gauradaha	
a. Physical Parameters				
1.	pH	7	6.3	6.5 - 8.5
2.	Turbidity, (NTU)	44	66	5
3.	Conductivity, (µmhos/cm)	600	122	-
4.	Color, (Chromacity Unit)	0.08	0.07	15
b. Chemical Parameters				
1.	Total Dissolved Solids, (mg/l)	330	105	1000
2.	Total Alkalinity as $CaCO_3$, (mg/l)	301.5	62.01	-
3.	Ammonia, (mg/l)	0.33	N. D. (<0.05)	1.5
4.	Dissolved Phosphate, (mg/l)	N.D. (<0.05)	0.06	-
5.	Calcium, (mg/l)	80.15	10.82	-
6.	Magnesium, (mg/l)	18.5	0.97	-
7.	Iron, (mg/l)	2.20	8.04	0.3
8.	Manganese, (mg/l)	0.56	0.31	0.5
9.	Arsenic, (mg/l)	<0.005	N. D. (<0.005)	0.01
c. Microbiological Parameters				
1.	Total Coliform Count, (MPN Index / 100ml)	>1100	Nil	Nil
2.	E. Coli, (MPN Index / 100ml)	46	Nil	Nil

N. D. : Not Detected

Remarks: The observed values for turbidity, iron in all samples and both microbial counts in Mangadh samples exceed the prescribed limits of WHO guidelines for drinking water.

(Analyzed By) (Checked By) Authorised Signature

NOTE:
1. The result listed refer only to the tested samples and applicable parameters. Endorsement of products is neither inferred nor implied.
2. Liability of our institute is limited to the invoiced amount.
3. Samples will be destroyed after one month from the date of issue of test certificate unless otherwise specified.
4. This report in not to be reproduced wholly or in part and cannot be used as an evidence in the Court of Law and should not be used in any advertising media without our special permission in writing.
5. This report/certificate is in reference to Laboratory Quality Control Manual, QS (002), Section OPT.
6. The clients are requested to take back their hazardous samples along with the report/certificate.

CEMAT
WATER LAB P. LTD.
(Water Analysis, Treatment Consultancy & Environment Research)

P. O. Box : 3953
E-mail : cemat@ccsl.com.np
Bijuli Bazar, New Baneshwor
Kathmandu, Nepal

WATER ANALYSIS REPORT

Sender:- Gauradaha Khanepani Yojana Source of Sample:- Boring water Collector:- Mr. Suresh Pokharel Date of Receipt:- 21-03-061	Sample No:- 1 Location:- Jhapa Date of Collection:- Date of Analysis:- 21-03-061	Lab. No:- 268/061 District:- Jhapa

Parameters	Results	Units	WHO GV	Method
CHEMICAL				
Iron (Fe)	4.13	mg/L	0.3 (Max)	Spectrophotometric (Bipyridine)
Arsenic (As)	< 0.01	mg/L	0.01 (Max)	Atomic absorption spectrophotometric, Hydride generation

WHO GV = World Health Organization Guideline Value (1991).

Analysed by:
Date:

Checked by:
Date: 25-3-061

Authorised Signature:
Date:

Remarks: -The observed value of Iron is found to be out of the limit of WHO guideline value.

CEMAT WATER LAB (P.) LTD.

Nepal Laboratory Accreditation Scheme
Accredited Laboratory
No. 04057-58

NS Accredited Parameters - pH, EC, Temp, DO, TDS, TSS, Turbidity, Colour, Alkalinity, Hardness, Ca, Mg, Cl, NI, Cu, Cd, Fe, Mn, P, K, Na, NH_4^+, NO_3^-, & NO_2^-

SEAM-N-MMA Environmental Laboratory

(Morang Merchants Association Complex)
G[illegible] Road, Biratnagar-9
Phone 536887
Fax: 524732

Date: 24·12·04

Name of client: - **Mangadh water supply project ,Biratnagar.**

Sampled by: - SEAM-N-MMA Environmental Laboratory

Type of Sample: - Drinking water

Date of Received: - 17 Dec 2004

Date of analysis: - [illegible]

Sample code No: - **S.N. 117(W) 004**

SN.	Parameter	Sample Serial No.	Unit	WHO G.V.	Results	Remarks
1.	pH	Sample No. 1	-	6.5-8.5	6.78	
2.	Turbidity		NTU	5.0	5.63	
3.	Total Hardness		mg/l	[illegible]	[illegible]	
4.	[illegible]		[illegible]	[illegible]	[illegible]	
5.	[illegible]		mg/l	[illegible]	[illegible]	
[illegible]	[illegible]		mg/l	[illegible]	[illegible]	
[illegible]	[illegible]		mg/l	[illegible]	[illegible]	
8.	Manganese		mg/l	0.1	1.68	
9.	Total Coliform		MPN/100	50	0	
10.	E - Coli		Cells/100	50	0	

* NIL = Not detected

Comments: Except Turbidity, Ammonia, Iron & Manganese, all obtained results are within the range of WHO guideline values.

Rajendra
Analyst

Ghanshyam Jha
Authorized Signature
(Laboratory In-charge)

P.O Box 104, E-mail seamnmma_envlab@yahoo.com

[illegible]

S.R.A.M.-H-MMA [illegible] Environmental Laboratory

[illegible] Complex
[illegible] Biratnagar-9

Phone [illegible]
Fax [illegible]

266

Date: 27 June 005

Name of client: Dhulabari Water Supply Project.

Location: Dhulabari (Jhapa)

Sampled by: Client.

Type of Sample: Drinking water (Deep boring).

Date of Received: 24 June 005

Date of analysis: 24 June 005

Sample code No.: S.M.- 266 (W) 0.5

SN.	Parameter	Unit	WHO G.V.	Results	Remarks
1.	Iron (Fe)	mg/l	0.3	16.95	----
2.	Manganese (Mn)	mg/l	0.1	0.001	----

Comments: The value of iron is exceeding the range of WHO guideline values.

Analyst

Ghanshyam Jha
Authorized Signature
(Lab in charge)

P.O.Box 161 E-mail: [illegible]_envlab@yahoo.com

Regd No 5180 052/053

"Training For Success"

Tel : 977-1-418156
Fax: 977-1-411642

SAVE WATER

Water

Engineering & Training Centre (P) Ltd.

Laboratory, R & D on Total Water Management, Treatment & Consultancy

LABORATORY ANALYSIS REPORT

Name of Sender: Gauradaha Water Supply Project — **Source :Boring Water (Office)**

Sample No. : 0216/058-059 — **Analyzed date : 30/06/02**

PHYSICAL

Parameters	*Units*	*WHO GV*	*Result*
• Colour	Hazen	(15)	...
• Turbidity	NTU	(5)	...
• Conductivity	µS/cm		208.0
Suspended Solids	mg/l		...
Dissolved Solids	"	(1000)	...
Total Solids	"		...
Carbon Dioxide	"		...
Temperature	°C		...

CHEMICAL

• pH		(6.5-8.5)	6.9
• Total Hardness	mg/l as CaCO3	(500)	...
• Magnesium Hardness	" "		...
• Calcium hardness	" "		...
• Total Alkalinity	" "	(500)	...
• phenolphthalein Alkalinity	" "		...
• Methyl Orange Alkalinity	" "		...
• Chloride	"	(250)	...
• Silica	"		...
• Ammonia	"	(1.5)	...
Orthophosphate	"		...
• Iron	"	(0.3)	3.12
• Manganese	"	(0.5)	0.37
• Calcium	"		...
• Magnesium	"		...
Sulphate	"	(250)	...
Nitrite	" as NO2	(3)	...
Nitrate	" as NO3	(50)	...

TRACE ELEMENTS & HEAVY METALS

Parameters	*Units*	*WHO GV*	*Result*
Sodium	mg/l	(200)	...
Potassium	"		...
Nickel	"	(0.02)	...
Copper	"	(2)	...
Zinc	"	(3)	...
Chromium	"	(0.05)	...
Arsenic	"	(0.01)	...
Mercury	"	(0.001	...
Cadmium	"	(0.003)	...
Lead	"	(0.01)	...

BIOCHEMICAL

Dissolved Oxygen	mg/l		...
Permanganate Value	"		...
BOD	"		...
COD	"		...

BIOLOGICAL

• Coliforms	MPN/100 ml	Nil	...
• E.coli	"	"	...
Fecal Streptococci	"	"	...
Salmonella sp.	"	"	...

WHO GV – World Health Organization Guideline Value, • Routine Chemical, • Routine Biological

Comment:

Analyst

Lab-Incharge

Ga 1/262, Dillibazar, Post Box # 8975 EPC 5205, Kathmandu, Nepal. e-mail: bhola@ktmwetc.wlink.com.np

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SAVE WATER **Water** Engineering & Training Centre (P) Ltd.

Laboratory, R & D on Total Water Management, Treatment & Consultancy

LABORATORY ANALYSIS REPORT

Name of Sender: Gauradaha Water Supply Project
Sample No. : 0215/058-059

Source :Boring Water (School)
Analyzed date : 30/06/02

PHYSICAL

Parameters	Units	WHO GV	Result
• Colour	Hazen	(15)	...
• Turbidity	NTU	(5)	...
• Conductivity	µS/cm		272.0
Suspended Solids	mg/l		...
Dissolved Solids	"	(1000)	...
Total Solids	"		...
Carbon Dioxide	"		...
Temperature	°C		...

CHEMICAL

• pH		(6.5-8.5)	7.3
• Total Hardness	mg/l as CaCO3	(500)	...
• Magnesium Hardness	" "		...
• Calcium hardness	" "		...
• Total Alkalinity	" "	(300)	...
• phenolphthalein Alkalinity	" "		...
• Methyl Orange Alkalinity	" "		...
• Chloride	"	(250)	...
• Silica	"		...
• Ammonia	"	(1.5)	...
• Orthophosphate	"		...
• Iron	"	(0.3)	2.6
• Manganese	"	(0.5)	0.23
• Calcium	"		...
• Magnesium	"		...
Sulphate	"	(250)	...
Nitrite	" as NO2	(3)	...
Nitrate	" as NO3	(50)	...

TRACE ELEMENTS & HEAVY METALS

Parameters	Units	WHO GV	Result
Sodium	mg/l	(200)	...
Potassium	"		...
Nickel	"	(0.02)	...
Copper	"	(2)	...
Zinc	"	(3)	...
Chromium	"	(0.05)	...
Arsenic	"	(0.01)	...
Mercury	"	(0.001	...
Cadmium	"	(0.003)	...
Lead	"	(0.01)	...

BIOCHEMICAL

Dissolved Oxygen	mg/l	...
Permanganate Value	"	...
BOD	"	...
COD	"	...

BIOLOGICAL

• Coliforms	MPN/100 ml	Nil	...
• E.coli	"	"	...
Fecal Streptococci	"	"	...
Salmonella sp.	"	"	...

WHO GV : World Health Organization Guideline Value • Primary Chemical: • Primary Biological

Comment:

Analyst

Lab-Incharge

Ga-1/262, Dilibazar, Post Box # 8975 EPC 5205 Kathmandu Nepal e-mail: bhola@ktmwatc.wlink.com.np

Nepal Environmental & Scientific Services (P.) Ltd.
G.P.O. Box No. 7301, Thapathali, Kathmandu, Nepal
Phone: 00977-1-4244989, 4241801, Fax No.: 97751-4226028, E-mail: ness@mos.com.np

QS TEST REPORT / CERTIFICATE

NS Accreditation No. Pra. 01/053-54

Entry No. : NCL - 228(W) (2) - 09- 2005
Sample : Spring Water
Client : Dhulabari Water Supply Project
Mechi Nagar Nagarpalika, Jhapa

Date Received : 16 - 09 - 2005
Date Completed : 18 - 09 - 2005
Sampled By : Client
Sampling Date : 15 - 09 - 005

S. N.	Parameter	Observed Value	WHO Guideline Value
1.	Turbidity (NTU)	220	5

Note : Sample was collected during heavy rain

Remarks: The observed level of turbidity was found extremely high than the recommended WHO guideline value.

(Analyzed By)

(Checked By)

Authorised Signature

NOTE:
1. The result listed refer only to the tested samples and applicable parameters. Endorsement of products is neither inferred nor implied
2. Liability of our institute is limited to the invoiced amount.
3. Samples will be destroyed after one month from the date of issue of test certificate unless otherwise specified.
4. This report in not to be reproduced wholly or in part and cannot be used as an evidence in the Court of Law and should not be used in any advertising media without our special p 4-101 in writing.
5. This report/certificate is in reference to Laboratory Quality Control Manual, QS (002), Section OPT.

Nepal Environmental & Scientific Services (P.) Ltd.
G.P.O. Box No. 7301, Thapathali, Kathmandu, Nepal
Phone: 00977-1-4244989, 4241001, Fax No.: 977-1-4226028, E-mail: ness@mos.com.np

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Sample : Spring Water
Client : Dhulabari Water Supply Project
Mechi Nagar Nagarpalika, Jhapa

Date Received : 16 - 09 - 2005
Date Completed : 18 - 09 - 2005
Sampled By : Client
Sampling Date : 15 - 09 - 005

S. N.	Parameter	Observed Value	WHO Guideline Value
1.	Turbidity (NTU)	38	5

Note : Sample was collected after two hours of heavy rain.

Remarks: The observed value for turbidity exceeds the prescribed limit of WHO guideline value for drinking water.

(Analyzed By)

(Checked By)

Authorised Signature

NOTE:
1. The result listed refer only to the tested samples and applicable parameters. Endorsement of products is neither inferred nor implied
2. Liability of our institute is limited to the invoiced amount.
3. Samples will be destroyed after one month from the date of issue of test certificate unless otherwise specified.
4. This report in not to be reproduced wholly or in part and cannot be used as an evidence in the Court of Law and should not be used in any advertising media without our special permission in writing.
5. This report/certificate is in reference to Laboratory Qu 4-102 Iroi Manual, QS (002), Section OPT.
6. The clients are requested to take back their hazardous samples along with the report/certificate.

4-6-5 Appendix 7-4 Water Resource Examination

FAX. NO.	0081-3-3432-8907	TIME. DATE	
ATTN.	MR. FUJIWARA	FIRM	NJS CONSULTANTS CO., LTD.
FROM	MR. JANAK, WSSDO, Bhadrapur & MR. HARI WUSC, Dhulabari, Jhapa, NEPAL		
TEL. NO.	977-23-520196	FAX. NO.	977-23-520279

Subject: **RESULTS OF SPRING HYDROMETRY**

1. Records for Water Source ②

No.	Month	Date	h (cm)	h (m)	C	Q (m^3/sec)	Q (liters/sec)
1	July 2005	15	5.0	0.050	1.84	0.012334	12.34
2	July 2005	31	5.5	0.055	1.8275	0.01490	14.90
3	August 2005	16	13.75	0.1375	1.8178	0.05551	55.51
4	August 2005	31	15.0	0.15	1.822	0.06350	63.50
5	September 2005	16	15.0	0.15	1.822	0.06350	63.50
6	September 2005	30	16.0	0.16	1.82596	0.07011	70.11
7	October						
8	October						
9	November						
10	November						
11	December						
12	December						
13	January						
14	January						
15	February						
16	February						
17	March						
18	March						
19	April						
20	April						
21	May						
22	May						

2. Records for By-pass ④

No.	Month	Date	h (cm)	h (m)	C	Q (m^3/sec)	Q (liters/sec)
1	July 2005	15	10.0	0.10	1.81	0.0143	14.30
2	July 2005	31	11.0	0.11	1.8189	0.01658	16.58
3	August 2005	16	15.625	0.1562	1.8565	0.02863	28.63
4	August 2005	31	15.625	0.1562	1.8565	0.02863	28.63
5	September 2005	16	15.625	0.1562	1.8565	0.02863	28.63
6	September 2005	30	15.625	0.1562	1.8565	0.02863	28.63
7	October						
8	October						
9	November						
10	November						
11	December						
12	December						
13	January						
14	January						
15	February						
16	February						